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Puerto Rico

Castillo San Cristóbal

Historic Structures Report



Cultural Resources, Partnerships and Science Division

Interior Region 2: South Atlantic-Gulf

Castillo San Cristóbal

San Juan National Historic Site

Historic Structures Report

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About the front cover: San Carlos Ravelin with the main fortifications of Castillo San Cristóbal and El Caballero de San Miguel in the background, view from east. Photograph by Wiss, Janney, Elstner Associates, Inc., February 2023.

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Castillo San Cristóbal

San Juan National Historic Site

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Foreword

In September 1625, a fleet of 17 ships, commanded by Boudewijn Hendricksz began what would become the greatest military assault that the city of San Juan has ever witnessed. At the time, the ability of Spain to retain control of Puerto Rico rested on whether the garrison of professional soldiers and the inhabitants of the city were able to endure the relentless bombardment of Castillo San Felipe del Morro by the Dutch artillery. This attack devastated the city of San Juan. The Dutch ransacked San Juan and whatever they could not take, they burned. This traumatic experience would have significant consequences in the development of the fortification system and the city it was meant to protect. The Spanish, deciding that they could not risk losing San Juan and Puerto Rico, decided to build a land defense to protect the city. In 1634 the construction of Castillo San Cristóbal began.

The fort has undergone many improvements, ensuring its continued use as a military installation until 1961. These developments contributed to the transformation of San Cristóbal into the biggest fortification built by the Spanish in America. The fortification is also a prime example of the application of the military concepts of "defense in depth" which consisted of a series of lines of interconnected defenses meant to protect the land approach to the city of San Juan. Castillo San Cristóbal and its Outworks were, once major construction was completed at the end of the 18th century, almost inexpugnable.

Preserving this masterpiece of military engineering requires resources, technical "knowhow," skilled labor, and a sensitivity to the craftmanship that built them. It also requires extensive knowledge on how they were built, with what materials, and a knowledge of the interactions of geography, military engineering, and weapons technology. This current Historic Structure Report is the latest effort to ensure that all of these factors are comprehensively documented. As we prepare to commemorate the events that happened four centuries ago, it is our goal that this document guides future preservation and treatment efforts of Castillo San Cristóbal.

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; from Wiss, Janney, Elstner Associates, Inc.: Deborah Slaton, Conservator; Tim Penich, Historical Architect; Mike Ford, Historical Architect; Ken Itle, Historical Architect; Nicole Declet, Architectural Associate and Conservator; Heba Elsayed, Historical Engineer; Erin Frye, Engineering Associate; and Mike Horst, Structural Engineer; from Historical Research Associates, Inc.: Matthew Sneddon, Architectural Historian and Amalia Baldwin, Historian; from WFT Architects, P.A.: Wes Harp, Architect; and from Maptech, Inc.: Chris Pesnell, Professional Surveyor; Bryan Abrams, Surveyor; and Ryan Moore, Surveyor. The Park would also like to thank Interior Region 2 Historical Architect Megan Jenkins for her work as the NPS regional liaison on this project.

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Superintendent
San Juan National Historic Site
National Park Service

Management Summary

Management Summary

At the request of the National Park Service (NPS), Liz Sargent Historical Landscape Architect (LSHLA), with its subconsultants, Wiss, Janney, Elstner Associates, Inc. (WJE), Historical Research Associates, Inc. (HRA), WFT Architects, P.A. (WFT), and Maptech, Inc. (Maptech) have developed this Historic Structures Report (HSR) for Castillo San Cristóbal, part of the San Juan National Historic Site in San Juan, Puerto Rico. Figure 1 is a map of San Juan National Historic Site showing the location of Castillo San Cristóbal. Figure 2 is an annotated site plan of Castillo San Cristóbal showing the buildings and structures that comprise the site.

In 1949, Secretary of the Interior Julius A. Krug designated the San Juan National Historic Site under authority granted to him by the 1935 Historic Sites Act. The purpose of the designation was to allow for the preservation of the fortifications of El Morro and Castillo San Cristóbal as well as the historic city wall.[1]

The historic district that comprises San Juan National Historic Site is composed of two main fortifications: Castillo San Felipe del Morro (El Morro) at the northwest corner of the city and Castillo San Cristóbal. A smaller fortification known as Fort San Juan de la Cruz (El Cañuelo) is situated across San Juan Bay to the west. The historic San Juan city wall surrounds much of Old San Juan.

Castillo San Cristóbal sits at the northeast corner of Old San Juan bordered by the Atlantic Ocean to the north and east, Calle Norzagaray to the west, and Avenida Luis Muñoz Rivera to the south. The study area consists of the main fortifications at the west end of the site as well as the outer defenses to the east.

Public access to Castillo San Cristóbal occurs largely through an entry plaza and ramp along Calle Norzagaray at the northwest corner of the site that leads to the fortifications. Additional access is provided through three gates on the south side of the fortification along Avenida Luis Muñoz Rivera: one directly east of the main fortification adjacent to La Trinidad Counterguard, one east of La Trinidad, and the third at the east end of the site near the outer defenses. On-site parking is located in the historic dry moat between the main fortification and the outer defenses.

The focus of this HSR is Castillo San Cristóbal, the largest historic fortification managed by the NPS. Construction of the fortification began in 1634, following a Dutch attack on San Juan in 1625 that destroyed much of the city. The fortification was rebuilt in the later eighteenth century, at which time the outer defenses were constructed. Additional modifications were made by the Spanish in the 1890s, and later by the United States Army in the first half of the twentieth century. The main fortification at Castillo San Cristóbal, El Caballero de San Miguel, the moat, tunnels, La Trinidad Counterguard, San Carlos Ravelin, Santa Teresa Battery, El Abanico, and La Princesa are all addressed as part of this study. The World War II

1. Edwin C. Bearss, *Historic Structure Report, Historical Data Section, San Juan Fortifications, 1898–1958*. (Denver, Colorado: U.S. Department of the Interior, National Park Service, Denver Service Center, Historic Preservation Division, 1984), 381.

Joint Command Center (Visitor Center), which is located east of the main fortification in the moat, is included as part of Volume II of this study (currently in progress).

Castillo San Cristóbal is listed in the National Register of Historic Places. It is also a contributing feature to the Old San Juan National Historic Landmark District. (See Cultural Resources Data, below.)

The San Juan National Historic Site, including Castillo San Cristóbal, is a UNESCO World Heritage Site.

Historical Data

Within the walls of Old San Juan, an area of less than one half square mile, a four-century-long lesson in fortification design and Puerto Rican history is inscribed in stone and mortar. From La Fortaleza, completed in 1540, to the observation tower constructed during World War II on the walls of Castillo San Cristóbal, the military landscape of San Juan provides one of the best representations of the martial character of Spanish colonialism and later, U.S. expansionism, in the Caribbean and the Americas.

San Juan's fortifications took shape within the context of European exploration and colonization in the late fifteenth and sixteenth centuries. In this age of sail, favorable harbors at key points such as San Juan along the so-called trade winds became essential nodes in the establishment of Spanish colonies in the New World. The Spanish brought Catholicism, a particular approach to government, the practice of slavery, and European rivalries with them to their construction projects in Puerto Rico and the Americas. Whether triggered by conquest, religion, alliances, trade, exploitation of natural resources or other sources, war became a frequent backdrop for the development of Spain's colonies. In the Caribbean, war came from the sea in battles fought with smoothbore cannon of various types and muskets. Military engineers sent from Spain adapted European designs for coastal fortifications, relying on coerced labor, whether "royal slaves" or esclavos del rey, native peoples enslaved through the encomienda system, or prisoners, for unskilled work.

San Juan's initial fortifications began as piecemeal efforts to conquer the island and defend the harbor. Recognizing the limitations of La Fortaleza at a site inside the bay, the Spanish started work in 1539 on a battery and defensive position on Castillo San Felipe del Morro, a promontory at the western end of the islet, to control entrance to the harbor. As the port's importance in protecting Spanish treasure fleets and commerce grew, Spain invested in more substantial defenses with the latest European designs that drew on formalized mathematical approaches. Although El Morro was improved in the late sixteenth century, San Juan's residents and governors urged the crown to protect the city with walls. San Juan competed with Santo Domingo, Cartagena, Havana, Manila, Vera Cruz, and other colonial outposts for funding to construct fortifications, which led to periods of neglect. After attacks by the English in 1598 and the Dutch in 1625 exposed the vulnerability of San Juan to landward incursions from the east, approval was finally gained to extend city walls across the islet to a point anchored by a new fort planned for a high point on San Cristóbal Hill.

Work on Castillo San Cristóbal started in 1634. Intended as a triangular, bastioned citadel, the original Castillo San Cristóbal's walls were never fully enclosed but were integrated into the larger city wall project, forming a continuous front at the eastern end of the city. A dry ditch, or moat, and counterscarp extended the defenses eastward. The fortifications finally protected the town itself and were designed to resist a siege. However, after its construction, Castillo San Cristóbal was not adequately maintained or improved for over 100 years. The loss of Manila and Havana to a British attack in 1762 jolted Spain into undertaking a massive new program of fortification in its colonies. Applying the latest lessons in European design, military engineers incorporated remnants of the original fort at Castillo San Cristóbal into a modern defensive works with new bastions, counterguards, moats, covered ways, advanced works, covered lines of retreat, and an extensive network of countermine tunnels. The multiple

levels of gun platforms from the southern bastion El Príncipe to the highest positions on the Plataforma ó Caballero, dramatically increased the number of guns brought to bear on a landward attack from the east. The resulting much larger C*astillo* also included officers' quarters, barracks, cisterns, and a kitchen to support a garrison. Largely completed by 1790, the improvements and new construction at Castillo San Cristóbal showcased the role of foreign military engineers such as Irishmen Alexander O'Reilly and Thomas O'Daly in the service of the Spanish crown. By the end of the eighteenth century, the walled city—buttressed by the citadels of Castillo San Felipe del Morro to the west and Castillo San Cristóbal and its outworks to the east—provided a formidable example of defense in depth against attacks by land or sea.

San Juan's run as "Gibraltar of the Americas" was short lived. Within 100 years the city walls and citadels were obsolete. Utilizing steam and combustion engines developed in the first half of the nineteenth century, naval engineers designed armored vessels able to support heavy guns and move against the wind. Pursuit of better rate of fire, range, accuracy, and destructive power in the second half of the nineteenth century resulted in breach loaded, rifled guns firing explosive shells that doomed the stone and brick forts of the past. Adjusting to a new era of naval and coastal artillery, the Spanish replaced outdated cannon in the 1890s with more contemporary Ordóñez breach-loading, rifled guns at some existing batteries, and installed new concrete gun emplacements and buried vaults to protect men and ammunition at the Santa Teresa and La Princesa advance works. No longer concerned with land assaults from the east, the Spanish reduced Castillo San Cristóbal to focus on repelling potential naval threats. After the United States declared war on Spain in 1898, the fort faced such an attack by the U.S. fleet. San Juan's defenses were at a disadvantage due to their shorter range and lower hitting power as compared to the opposing naval forces, but the fortifications generally withstood the day-long bombardment by the U.S. Navy.

Contemporaneous with the rising tensions that led to war between Spain and the United States, Castillo San Cristóbal faced a different threat, growing pressure to expand the city. In the 1880s a gap was cut at the southeast corner of the city walls to build a railroad line into the city's docks. To better connect and expand San Juan eastward, the military agreed to the removal of the southern bastions and walls in 1897. In future years, a number of government and other buildings were constructed on land southeast of the fort.

During the initial years of U.S. occupation of Puerto Rico, the Army considered re-arming the San Juan fortifications, but nothing came of the plans until U.S. entry into World War I. At that time, three 4.7-inch Armstrong guns were temporarily emplaced at three locations, including one at the La Princesa battery. Between the world wars, the Army undertook preservation projects at San Juan, including work on crumbling walls and *garitas,* but also constructed new buildings and structures within the historic fabric of the military complex, such as an officers' quarters complex built on the former glacis near the La Princesa battery. When San Juan again girded for war in 1941, defenses had to account for a new threat—aircraft—in addition to long-range naval guns. The Army built a bomb-proof concrete bunker (Joint Operations Center) partially underground in Castillo San Cristóbal's dry moat, added a concrete observation tower to the north wall of Castillo San Cristóbal's cavalier (El Caballero de San Miguel), and installed anti-aircraft guns and 155-millimeter mobile guns at four locations in the vicinity of the Santa Teresa and La Princesa batteries. The guns were removed after the war.

As the age of coastal fortifications faded during the Cold War, Castillo San Cristóbal underwent a final transition from military grounds under the U.S. Army to heritage site under the stewardship of the NPS. Since gaining full custody of the bulk of the San Juan fortification in 1961, the NPS has faced several challenges at San Cristóbal. The scale and age of the fort necessitated careful consideration of approaches to maintenance and repair, and the long history of the site presented questions about what to preserve or restore and what to remove.

The NPS presence on the site came with alterations to historic structures, whether for offices, air conditioning, or spaces for interpretation. As visitation to the San Juan National Historic Site exceeded one million persons in 2022, Castillo San Cristóbal and its associated fortifications have exchanged a military function for a historical role, one that embodies many formative aspects of the history of Puerto Rico.

Treatment and Use

Castillo San Cristóbal is listed in the National Register of Historic Places and 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.

Ongoing monitoring, repair, and maintenance are required to ensure continued preservation and use of Castillo San Cristobal.

Administrative Data

Locational Data

Building names:

- Castillo San Cristóbal Main Fortification
  - Guardhouse
  - North casemates
  - Troops' quarters
  - Officers' quarters
  - Chapel (La Capilla de Santa Bárbara)
  - Main gate
  - South gate
  - North bastion, curtain wall, and south bastion
- El Caballero de San Miguel
- Moat
- Tunnels
- La Trinidad Counterguard
- San Carlos Ravelin
- Santa Teresa Battery
- El Abanico
  - South gate
  - Guardhouse
  - Northeast gate
- La Princesa

Location: San Juan National Historic Site, San Juan, Puerto Rico

Real Property Information

Dates of construction:

- Castillo San Cristóbal Main Fortification
  - Guardhouse (circa 1784–1839)
  - North casemates (1768–1771)
  - Troops' quarters (1765–1771)
  - Officers' quarters (1773–1775)
  - Chapel (circa 1839–1861)
  - Main gate (1783)
  - South gate (1773–1783)
  - North bastion, curtain wall, and south bastion (1634–1644)
- El Caballero de San Miguel (1634–1644)
- Moat (1634–1644)
- Tunnels (1634-1644; 1766; 1773)
- La Trinidad Counterguard (1765–1783)
- San Carlos Ravelin (1766–1770)
- Santa Teresa Battery (1783–1792)
- El Abanico (1779–1783)

- South gate (1896–1898)
- Guardhouse (1896)
- Northeast gate (1896–1898)

- La Princesa (1779–1783)[2]

Numbering Information

- Castillo San Cristóbal Main Fortification
  - Guardhouse: CRIS-HS 091719
  - North casemate: CRIS-HS 091718
  - Troops' quarters: CRIS-HS 091724
  - Officers' quarters: CRIS- N/A
  - Chapel (La Capilla de Santa Bárbara): CRIS-HS 091721
  - Main gate: CRIS-HS 001271
  - South gate: CRIS-HS 091723
  - North bastion, curtain wall, and south bastion: CRIS-HS 091725
- El Caballero de San Miguel: CRIS-HS 091720
- Moat: CRIS-HS 091712, CRIS-HS 091733
- Tunnels: CRIS-HS 091742
- La Trinidad Counterguard: CRIS-HS 091711
- San Carlos Ravelin: CRIS-HS 006066
- Santa Teresa Battery: CRIS-HS 006067
- El Abanico: CRIS-HS 001270
  - South gate: CRIS-HS 091716
  - Guardhouse: CRIS-HS 091714
  - Northeast gate: CRIS-HS 091715
- La Princesa: CRIS-HS 091713

Size Information

- Castillo San Cristóbal Main Fortification
  - Guardhouse: 30 feet by 27 feet
  - North casemate: 208 feet by 79 feet
  - Troops' quarters: 135 feet by 60 feet
  - Officers' quarters: 198 feet by 46 feet
  - Chapel (La Capilla de Santa Bárbara): 30 feet by 19 feet
  - Main gate: 50 feet by 14 feet (ramp)
  - South gate: 10 feet (width)
  - North bastion, curtain wall, and south bastion: 570 feet by 300 feet
- El Caballero de San Miguel: 342 feet by 60 feet
- Moat: 90 to 100 feet wide
- Tunnels: variable width
- La Trinidad Counterguard: 160 feet by 72 feet by 219 feet by 105 feet by 121 feet
- San Carlos Ravelin: 248 feet by 197 feet by 218 feet
- Santa Teresa Battery: 416 feet by 121 feet
- El Abanico: 195 feet by 203 feet by 203 feet
  - South gate: 21 feet by 5 feet
  - Guardhouse: 54 feet by 20 feet
  - Northeast gate: 20 feet by 5 feet
- La Princesa: 225 feet by 225 feet

Related Studies

Edwin C. Bearss, *Historic Structure Report, Historical Data Section, San Juan Fortifications, 1898–1958*. (Denver, Colorado: U.S. Department of the Interior, National Park Service, Denver Service Center, Historic Preservation Division, 1984), NPS Document No. 393-D2185.

Mark A. Berhow, ed., *American Seacoast Defenses: A Reference Guide* (Bel Air, Maryland: Coast

2. Teresa Dujnic Bulger and Paola Schiappacasse, Richard Grubb & Associates, Inc., *San Juan National Historic Site National Register of Historic Places Nomination* (Washington, D.C.: U.S. Department of the Interior, National Park Service June 22, 2021, entered in the National Register, January 13, 2022).

Defense Study Group Press, third edition, 2015).

Joan Berkowitz, E. Blaine Cliver, Richard Crisson, Robert Holzheimer, Judy Jacob, Frank Matero, Marjorie Smith, and Barbara Yocum, *The Fortifications of San Juan National Historic Site: Historic Structures Report*. (Atlanta, Georgia: U.S. Department of the Interior, National Park Service, Southeast Regional Office, 1991).

National Park Service, *Foundation Document: San Juan National Historic Site* (Atlanta, Georgia: U.S. Department of the Interior, National Park Service, Southeast Regional Office, 2013).

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Eliot Foulds and Alexandra von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks*. (Boston, Massachusetts: Olmsted Center for Landscape Preservation, National Park Service, 2015).

United Nations Educational, Scientific, and Cultural Organization (UNESCO). World Heritage List, "La Fortaleza and San Juan National Historic Site in Puerto Rico," accessed June 1, 2023, https://whc.unesco.org/en/list/266.

Cultural Resource Data

The San Juan National Historic Site, including Castillo San Cristóbal, was administratively listed in the National Register of Historic Places on October 15, 1966. Castillo San Cristóbal is addressed in several National Register documentation efforts undertaken since that time. Most recently, National Register of Historic Places additional documentation for San Juan National Historic Site was accepted by the National Register in 2022.[3] The buildings that comprise the main fortification of Castillo San Cristóbal, as well as El Caballero, Castillo San Cristóbal Moat, La Trinidad Counterguard, San Carlos Ravelin, Santa Teresa Battery, El Abanico, and La Princesa are listed as contributing resources in the 2022 additional documentation.[4] The site is also a contributing resource to the Old San Juan National Historic Landmark Historic District.[5]

San Juan National Historic Site, including Castillo San Cristóbal, Castillo San Felipe del Morro, San Juan de la Cruz (El Cañuelo), and the earlier fortifications of La Fortaleza were inscribed in the World Heritage List in 1983 as resources of outstanding universal value.[6]

Period of Significance: 1634–1971[7]

Proposed Treatment: Preservation

3. Bulger and Paola Schiappacasse, *San Juan National Historic Site National Register Nomination,* 2022.
4. Bulger and Paola Schiappacasse, *San Juan National Historic Site National Register Nomination,* 2022.
5. Arleen Pabón-Charneco, Puerto Rico SHPO Consultant, "Old San Juan Historic District," National Historic Landmark documentation (Washington, D.C.: U.S. Department of the Interior, September 24, 2012) (NRIS 13000284).
6. UNESCO World Heritage List, "La Fortaleza and San Juan National Historic Site in Puerto Rico," accessed March 2024, https://whc.unesco.org/en/list/266.
7. The 2022 National Register additional documentation encompasses the period of significance relevant to Castillo San Cristóbal as part of the larger fortifications begun in 1539, with construction of the first Spanish defensive fortifications on the El Morro headlands, through 1971, fifty years before the date of the nomination. The additional documentation notes that the periods associated with areas of significance of ethnic heritage and social history extend through 1971 as events associated with these areas continued throughout the twentieth century. A period of 1634–1971 is appropriate when considering Castillo San Cristóbal as an individual resource, beginning with initial

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 that comprise Castillo San Cristóbal. 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.[8]

The HSR addresses key issues specific to Castillo San Cristóbal, which includes the main fortification and its outer defenses. This report documents the general historical context and the history and development and use of the fortification and associated structures. The report also provides the existing physical condition of the structures and their character-defining features and includes specific treatment recommendations to ensure the preservation of Castillo San Cristóbal.

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. Four appendices are included: measured drawings, previous documentation from the Historic American Buildings Survey (HABS), structural analysis, and materials and finishes analysis. A glossary of military fortification terms is also included.

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 Castillo San Cristóbal and past modifications and repairs. This information was referenced in assessing existing conditions and developing treatment recommendations. Documents reviewed included maps, drawings, specifications, historic photographs, and other written and illustrative documentation about the history of construction and repairs to Castillo San Cristóbal. The research for this study built upon prior historical and archival research completed by the NPS. Primary reference material for this study was obtained from the San Juan National Historic Site archives and records held at the visitor center in San Juan. Additional research material was obtained from the Archivo General de Puerto Rico (Puerto Rico General Archives), Center for Historic Research of the University of Puerto Rico (Rio Piedras Campus), and Puerto Rico State Historic Preservation Office (PR SHPO). Research and photographic logs were created for work conducted at the park archives. Additional research material was obtained from the National Park Service Technical Information Center (TIC) in Denver, Colorado, and the National Archives and Records Administration in College Park, Maryland.

Condition Assessment and Documentation. Concurrent with the archival research, a condition survey of Castillo San Cristóbal was performed, and observations were documented by the project team architects, engineers, and conservators with digital photographs, field notes, measurements, field sketches, and annotation on baseline drawings.

In addition to the visual condition assessment, the engineering team reviewed structural concerns identified by the park and gathered information

construction of this fortification and concluding fifty years before the date of the nomination.

8. Deborah Slaton, *Preservation Brief 43: The Preparation and Use of Historic Structure Reports* (Washington, D.C.: National Park Service, Technical Preservation Services, 2005).

necessary to perform a structural analysis of identified features. The structural analysis considered the effects of wind loads on the building facades and included an investigation of special conditions affecting the facades and outer walls including parapets, openings, and sentry boxes. Additionally, an inspection opening was made at the Officers' Quarters building for review by the project engineers.

The project team also documented and removed finish and materials samples for limited laboratory study including petrographic examination of brick masonry, mortar, stone, concrete, and render (stucco) to characterize materials and observed deterioration. All sample locations were coordinated with park staff and documented with notes and photographs.

The condition assessment addressed all visible and accessible portions of Castillo San Cristóbal including tunnels.

Laser scanning was performed to document the existing conditions of the fortification with a focus on Plaza de Armas and the adjacent buildings, for which measured drawings were completed.

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. The site history drew on the extensive historical contexts written for past HSRs completed in 1984 and 1991 and synthesized and summarized this information to focus on the developmental history of Castillo San Cristóbal. 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*.[9] The 2022 National Register additional documentation for San Juan National Historic Site was also reviewed in support of the significance assessment. This evaluation of history and significance provided the basis for the development of recommended treatment alternatives.

Guidelines for Treatment. Based on the evaluation of historical and architectural significance of the structure, guidelines were prepared to assist in the selection and implementation of treatments. Castillo San Cristóbal was administratively listed in the National Register of Historic Places on October 15, 1966. Castillo San Cristóbal is addressed in several National Register documentation efforts undertaken since that time. Most recently, National Register of Historic Places additional documentation for San Juan National Historic Site was accepted by the National Register in 2022.[10]. 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.

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 structures. Following the overall treatment approach of **Preservation** for Castillo San Cristóbal, specific recommendations were developed to address the observed distress conditions as well as long-term preservation objectives.[11] The recommendations developed as part of this HSR outline repair and maintenance protocol relating to the preservation of brick, stone, and stucco and plaster exterior finishes, as well as interior finishes at the structures that

9. *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 of Historic Places, 1997).
10. Bulger and Paola Schiappacasse, *San Juan National Historic Site National Register Nomination,* 2022.
11. 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).

comprise Castillo San Cristóbal. Recommendations regarding waterproofing and water management are also included.

Preparation of Historic Structure 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 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.[12]

12. NPS-28, Cultural Resource Management Guideline. Accessed July 2023. https://www.nps.gov/parkhistory/onlinebooks/nps28/28intro.htm; Slaton.

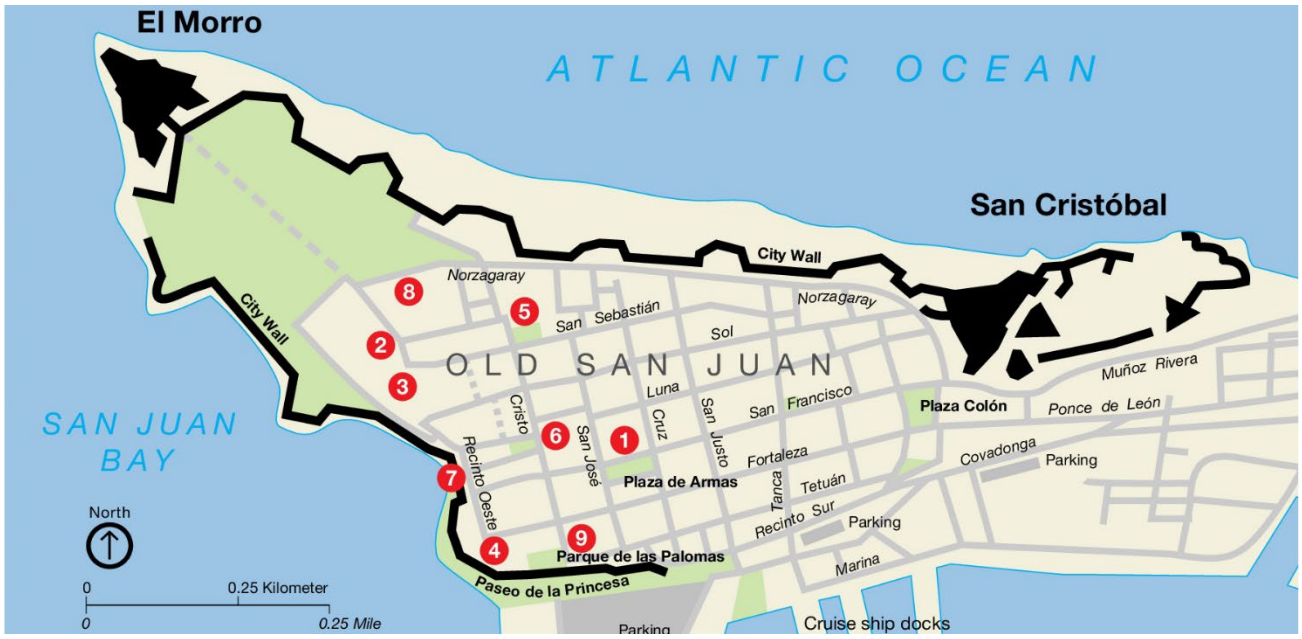


Figure 1. A map of the San Juan National Historic Site and Old San Juan showing the locations of El Morro, Castillo San Cristóbal, and the City Wall. (Source: National Park Service)



Figure 2. An aerial view of Castillo San Cristóbal showing the location of the buildings and structures that comprise this study. Note that the World War II Joint Command Center (visitor center) shown in orange is included as part of Volume II of this study (in development). (Source: *The National Map*, USGS, annotated by authors)

Developmental History

Introduction

The historic context that follows traces the development of the Castillo San Cristóbal fortifications within the framework of the history of Puerto Rico and the geography of San Juan Islet. The islet sits on the eastern side of the entry into San Juan Harbor, detached from the main island of Puerto Rico by a narrow causeway. The western end of the islet served as a key place of defense of the harbor in the days when European nations vied for control of safe harbors along lengthy trade routes between the so-called Old World and the New. A low-lying area on the south side of the islet provided protected access to the islet, while cliffs along the north side offered a measure of protection from direct landing by Atlantic Ocean vessels. The highpoint of the islet, once known as Saint Christopher (San Cristóbal) hill, stands 150 feet above the Atlantic Ocean along these northern cliffs. From the hill, the land generally sloped to the east and south, offering views of the swampy eastern end of the islet and its connection to the main island. In short, the islet's geography offered an ideal template on which to build impressive fortifications.

Initial Spanish Colonization of Puerto Rico and Development of Defenses, 1508–1759

Initial Colonization

Spanish colonization of the Caribbean began just after Christopher Columbus's expedition to the New World in 1492. In his report to the Spanish crown, Columbus described the Caribbean islands, noting that they were inhabited by agricultural societies that had not been hostile to his approach, and speculated that the islands had repositories of gold. Columbus's positive report inspired the Spanish crown to fund a second voyage to the Caribbean in 1493 with the intent of settling the island of Hispaniola. From Hispaniola, Columbus explored the nearby islands, including Puerto Rico, while Spanish settlers on Hispaniola tried to establish a sugar industry using the encomienda system of coerced labor and began shipping trade goods back to Europe. The influx of European diseases devastated the Native population on Hispaniola, causing the Spanish to look further afield, enslaving other indigenous peoples to produce agricultural commodities and extract mineral resources. In pursuit of labor (and gold), the Spanish expanded European settlement to the island of Puerto Rico in 1508, Jamaica in 1509, and Cuba in 1511. None of the islands proved rich in gold, the sugar industry did not flourish on any of them, and the Native populations on Puerto Rico, Jamaica, and Cuba were just as susceptible to European diseases as those on Hispaniola. From the Caribbean, Spanish explorers and colonizers moved further west in the mid- and late sixteenth century, finding in North and South America the lodes of precious metals they had hoped for. Fleets of galleons and other vessels were required to transport the bullion extracted from the mines of Potosí and elsewhere in the Viceroyalties of New Spain back to the mother country. Well-fortified Caribbean garrisons like Castillo San Cristóbal, Havana, and San Augustín provided waystations, cover, and protection from privateering for the fleet as it

transported precious metals across the Atlantic to Europe.[13]

On Puerto Rico, the arrival of the Spanish brought diseases that ravaged the indigenous Taíno population living on the island. The Taíno initially were cooperative with the Spanish, teaching them how to raise and harvest foods and construct canoes, homes, and hammocks. Taíno accommodation of the Spanish disintegrated when the Spanish instituted a system of forced labor that worked people to death. The Taíno fought back against the Spanish between 1511 and 1516, destroying several Puerto Rican Spanish settlements including Caparra, the previous Spanish capital on the island. Many Taíno moved into the mountains following the conflict and resisted Spanish efforts to subjugate them. The Taíno conducted occasional attacks on coastal Spanish settlements through the 1530s but became relatively passive in their resistance thereafter. Meanwhile, the Spanish moved their capital to San Juan Islet in part because of its more defensible location.[14]

The Spanish brought the practice of slavery—with roots in Spain as far back as the Roman invasion of the Iberian Peninsula—with them to the Caribbean. When the enslavement of local Indigenous peoples proved insufficient as a labor force, the Spanish transported enslaved Africans and prisoners to Puerto Rico. Despite their efforts, the initial Spanish attempts at running sugar plantations did not prove fruitful on Puerto Rico, and the Spanish crown focused on developing the military potential of San Juan Harbor to support maritime trade and the treasure fleets. Spanish development of San Juan thus focused on its military function to the exclusion of social programs and civilian needs.[15]

Fortification

The initial Spanish fortification in San Juan, La Fortaleza was on the southwestern end of the islet facing the Bay of San Juan. La Fortaleza was primarily designed for use by local citizens to defend against Taíno and Caribs.[16] Raids by French corsairs in the 1530s exposed the vulnerability of San Juan, and the crown approved construction of a battery and tower structure on a promontory on the islet's western end to contest entrance to the harbor. Begun in 1539, Castillo San Felipe del Morro provided some protection from naval attacks but left the town of San Juan inadequately protected by La Fortaleza. As Dutch and English corsairs added to the attacks on Spanish ports and commerce in the Caribbean, San Juan officials implored the crown to protect the eastern side of the islet from invasion with a wall or a ditch that would span from the ocean side to the harbor side of the islet, a distance of approximately 400 steps.[17] Some of these recommendations, repeated in the 1560s, 1570s, and 1580s, recognized the strategic importance of creating a wall at the high point of the islet. When Spain finally requested a report on land-facing fortification possibilities, San Juan Governor Diego Menéndez de Valdés sent back a proposal

13. John E. Kicza, "Patterns in Early Spanish Overseas Expansion," *The William and Mary Quarterly* 49, no. 2 (April 1992): 238–252.
14. Tony Castanha, *The Myth of Indigenous Caribbean Extinction: Continuity and Reclamation in Borikén (Puerto Rico)* (New York: Palgrave Macmillan, 2011), 63-64, 67; Félix Matos Rodríguez, *Women and Urban Change in San Juan, 1820–1868* (Gainesville: University Press of Florida, 1999), 11; Ricardo Torres-Reyes, "Historical Studies Management Plan," (1972), Folder 331, Box 52, SJNHSA, 7; Eliot Foulds and Alexandra von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site,* (National Park Service, 2015), 79; Burchardt, Hans-Jürgen, "Lessons Learned: The Legacies of Spanish Colonialism," in *(Post-)colonial Archipelagos: Comparing the Legacies of Spanish Colonialism in Cuba, Puerto Rico, and the Philippines*, Hans-Jürgen Burchardt and Johanna Leinus, eds. (Ann Arbor: University of Michigan Press, 2022), 334.
15. Burchardt, Hans-Jürgen, "Lessons Learned: The Legacies of Spanish Colonialism," 331-334.
16. Milagros Flores Román, Luis Lugo Amador, and José Cruz de Arrigoitia, San Juan City of Castles and Soldiers (National Park Service and Puerto Rican Academy of History, 2009), 123.
17. Ricardo Torres Reyes, *Construction History of San Cristóbal, 1634–1800,* (National Park Service, June 1965), 1–2.

for not only a wall, but a fortress within the wall on the highest point of the land.[18]

In 1586, after war had recently broken out with England, Spain sent military engineer Bautista Antonelli and army officer Juan de Tejeda to the Americas to survey the existing defenses and recommend improvements. As part of this massive project, Antonelli and Tejeda proposed new fortifications for San Juan and nine other ports in the Americas. Just a few months after the defeat of the Spanish Armada, Antonelli sailed for San Juan in 1589. After reviewing and approving Menendez's[19] recommendations, Antonelli designed a substantial modification to El Morro, one informed by the latest European approaches to fortification. Antonelli, and his brother Giovanni, were veterans of the seemingly endless wars of religion and empire involving Spain, France, England and their various allies.[20]

Since Charles VIII's invasion in 1494, Italy had served as a proving ground for new approaches to fortification. Raised in this era of warfare, the Antonelli brothers were well-versed in the latest developments in siege and defense to the extent that Giovanni had authored a treatise on the mathematical underpinnings of fortress design.[21] Bautista brought this knowledge to his work in San Juan. The low-profile, two bastion "hornworks" proposed for El Morro added landward defenses to the fort which would be later augmented with a ravelin protecting the front gate, moat, covered way, and glacis—all standard features of the sixteenth-century "trace italienne" fortress widely built in Europe in this period. The design was similar to one made for another "El Morro"; one that guarded the entrance to Havana. However, the work on El Morro did little to protect San Juan itself, which lay outside the walls of the citadel and vulnerable to attack by land from the east.[22]

Construction of the San Juan and other Spanish fortifications in the Americas during the sixteenth century relied heavily on enslaved labor. Slavery in the Spanish colonies differed in some respects from European and African practices and took several forms, as detailed in Evelyn Jennings' *Slavery and the Building of the Spanish Empire in Havana*. Spain developed a system of state-sponsored slavery, the "royal slaves" or esclavos del rey, that could be sent to various construction sites. This was codified in the Americas after the establishment of St. Augustine (Florida) in 1565, when the Law of the Indies stipulated that wherever there is [military] construction, slaves be brought to work.[23] According to Jennings, "there was considerable similarity in the types of work performed by *esclavos del rey* in Spain and its American possessions throughout the colonial period, as military and defense needs predominated. State slaves constructed and repaired fortifications and ships, worked in arsenals and mines, and built roads and canals. They also worked at ancillary tasks in ports, dockyards, and warehouses; in transport occupations; and in personal service."[24] Some enslaved peoples developed particular skills, such as stone working or carpentry, that were valued in fortification construction. Coercion of Native peoples through encomienda, the "granting" of local people and land to colonists in exchange for the right to be converted to Christianity, provided another system of enslavement.[25] The fortification

18. Torres Reyes, *Construction History of San Cristóbal, 1634–1800*, 3–4.
19. Menendez was himself a veteran of Spain's wars in Flanders and familiar with leading edge fortresses such as that at Antwerp.
20. Ray F. Broussard, "Bautista Antonelli: Architect of Caribbean Defense," *The Historian* 50 (August 1988): 508–510.
21. Sandro Parrinello and Silvia Bertacchi, "Geometric Proportioning in Sixteenth-Century Fortifications: The Design Proposals of Italian Military Engineer Giovanni Battista Antonelli," *Nexus Network Journal* 17 (2015): 401–402.
22. Torres Reyes, *Construction History of San Cristóbal, 1634-1800*, 3–6.
23. Javier Á. Cancio-Donlebún Ballvé, "The King of Spain's Slaves in St. Augustine, Florida (1580–1618)," *Estudios del Observatorio / Observatorio Studies* (2021): 9.
24. Evelyn Jennings, *Slavery and Building the Spanish Empire in Havana* (Baton Rouge: Louisiana State University Press, 2020), 47.
25. Robert Himmerich y Valencia, *The* Encomenderos *of New Spain, 1521-1555* (Austin: University of Texas Press, 1991), 1.

projects, which involved extensive excavation and transportation of heavy stones, were viewed as particularly difficult service, and consequently were "sites of punitive labor for centuries—punishing unruly enslaved people or runaways, smugglers, army deserters, and convicts from around the empire."[26]

Thus when work began on the improvement of El Morro in 1590, the construction site would have represented a combination of technical expertise, some skilled labor, esclavos del rey imported from Spain, and Tainos and others coerced under the *encomienda* laws. Typical of other fortification construction projects in the Americas, some prisoners, rented enslaved peoples, and hired free labor would likely have populated the work force as well.

Fortunately for the Spanish, El Morro was largely complete when explorer and privateer Sir Francis Drake attacked San Juan in 1595. During the early years of the Anglo-Spanish War (1586–1604) Drake had sacked Santo Domingo and Cartagena and raided widely in the Americas. Now, Drake set his sights on the Spanish treasure fleet temporarily at anchor in the Bahía de San Juan. Drake initially positioned his fleet to land on the east side of the islet, but a delay allowed the Spanish to bring up several artillery pieces that discouraged the landing. Subsequently Drake attempted to force the harbor at night but retreated after stubborn resistance by the Spanish defenses.

Three years later, another English attack led by Sir George Clifford, Earl of Cumberland, learned from Drake's failure by landing troops to surround El Morro from the east. Although Clifford's siege damaged El Morro and induced its surrender, the English force departed after incurring significant losses from dysentery and other local diseases. Although Drake's expedition was driven by bounty, Clifford's force was intent on occupation and expelling the Spanish from Puerto Rico.[27]

Following the English attacks, San Juan governors continued to request fortifications on the eastern side of the islet, but not until a Dutch invasion of San Juan in 1625 was Spain spurred into action. El Morro, rebuilt after the English assault in 1598, successfully resisted a siege but the Dutch burned the undefended city of San Juan including important government and religious structures before departing.

Although the attacks by the English and Dutch made it clear that San Juan was vulnerable without land-facing defenses, a project to build a substantial defensive line across the island at the narrow point recommended nearly 100 years earlier only began in the early 1630s. Although the design of the new works are typically attributed to another Antonelli, Bautista's nephew Juan Bautista Antonelli (sometimes referred to as "the Younger"), historian Juan Blanco documents this effort as one that involved a combination of several actors, including regional governmental leadership (governors, Capitanes Generales), trades masters, construction superintendents, and the royal military engineers, who debated various approaches to a more holistic defense of the city.[28] San Juan governors Jerónimo de Soto and Enriquez Sotomayor, for example, oversaw various projects on the city's perimeter walls, bastions, and batteries and Antonelli was accompanied by another engineer, Domingo Fernandez Cortina, who stayed on after Antonelli's departure to oversee future construction.[29] Governors, superintendents, and royal engineers like Juan Bautista Antonelli, as his

26. Jennings, *Slavery and Building the Spanish Empire in Havana*, 49.
27. Juan Blanco, "A History of the Formative Influences on the Development of the System of Fortifications of San Juan," (unpublished manuscript, 1988), NPS SAJU Archives, San Juan, Puerto Rico, 122–123.
28. Juan Blanco, "A Study of the Morphological Structure of the System of Fortifications of San Juan de Puerto Rico with a Special Emphasis on the Developments of the 'Frente de Tierra de San Cristóbal'" (hereafter referred to as "A Study of the Morphological Structure of the System of Fortifications of San Juan de Puerto Rico"), (unpublished manuscript, 1988), NPS SAJU Archives, San Juan, Puerto Rico, 290–293.
29. Blanco, "A Study of the Morphological Structure of the System of Fortifications of San Juan de Puerto Rico," 292.

father and uncle had to an earlier generation, served as a conduit between Europe and the Americas for developments in fortification.

Drawings and other accounts suggest that the plan was to build a small three-bastion, triangular citadel as a central bulwark of the eastern defenses. The construction of citadels—self-sufficient and sometimes separate, smaller-scale (compared to the walled cities they protected) polygonal fortresses of the trace italienne type capable of continuing defense after the fall of an associated city—gained favor after early versions were constructed in Antwerp (completed in 1572) and Turin (1577). In some cases, especially within the context of the Hapsburg wars to maintain control of Flanders and the Netherlands, citadels were built as much to defend troops from associated walled cities as they were to protect the city. In 1577 Dutch citizens tore down the Antwerp citadel's two bastions and curtain wall facing the city in response to a murderous riot by mutinous Spanish soldiers stationed there. The new fort project at San Juan, however, suffered from a lack of funds that prevented the completion of a fully "closed" citadel. To reduce costs, the San Juan authorities requested enslaved peoples for the workforce but had to use paid labor instead.[30] Plans also specified mampostería—rubble-type stone and mortar—construction; a cheaper and less durable building method compared to cut-and-dressed or ashlar stonework.[31] Another indication of the limited royal resources for the project was that the city walls integrating the Castillo San Cristóbal into the existing Santiago bastion and city gates were built with local funds.[32]

When completed in the late 1630s, the dedication of the new fort to San Cristóbal reified the way that religion, the military, and politics overlapped the sixteenth- and seventeenth-century Spanish world. The fort's immediate association came from San Cristóbal Hill, evidently earlier known as "gallows' hill," on which it was located. Such dedications might have multiple meanings or origins. Naming conventions potentially related to recent victories, such as that over the French and Dutch at San Cristóbal Island (now Saint Kitts), more tangible associations such as batteries with heavier artillery, or symbolic power, in this case with San Cristóbal who bore the Christ-child across a river, carrying Catholicism onward against dangerous currents.[33] Other dedications honored the crown, the church, religious orders, or local associations. Whatever their purpose, dedications and Catholic iconography served as a reminder of the profoundly religious context underlying the construction of a military complex at San Juan. Wars against the English and Dutch, after all, were fueled in some respects by the crusade against Protestantism. The naming of some features held obvious connections, such a battery dedicated to Santa Bárbara, patron saint of artillerists. Others honored the crown, such as San Felipe, San Carlos, San Fernando, and Príncipe, that sponsored the work. Whereas some features had more purely religious symbolism such as the Baluarte Trinidad or Bastion of the Holy Trinity, others juxtaposed religion, nationalism, and warfare such as the *Baluarte Santiago,* which referenced the Spanish battle cry "¡Santiago y cierra, España!" calling on St. James—the patron saint of Spain—for inspiration in combat. As much of the funding for the city walls was local, Blanco suggests that the names of some bastions along the city walls may have been associated with the influential Dominican presence in the area and religious brotherhoods (cofradias) that financed and maintained chapels and other structures in San Juan. Religious ceremonies held at the three city gates within the wall system further instantiated the connections between the church and defense

30. Blanco, "A Study of the Morphological Structure of the System of Fortifications of San Juan de Puerto Rico," 191.
31. Blanco, "A Study of the Morphological Structure of the System of Fortifications of San Juan de Puerto Rico," 178.
32. Blanco, "A Study of the Morphological Structure of the System of Fortifications of San Juan de Puerto Rico," 191, 198, 294.
33. Blanco, "A Study of the Morphological Structure of the System of Fortifications of San Juan de Puerto Rico," 297–298.

of the city.[34] Thus the names of the various components of the fortifications provided a sort of taxonomy of construction and funding while also reflecting how those manning the works would seek protection against harm in God and the saints as long as Catholicism served as the dominant religion in San Juan.

Deterioration

The years following the initial work on Castillo San Cristóbal and the city walls were difficult ones for Puerto Rico and Spain. European rivals sought footholds in the Caribbean, and naval setbacks between 1638 and 1640 greatly diminished the strength of the Spanish navy. Corsairs ran rampant in the Caribbean, harassing ports and commerce. England under Oliver Cromwell dispatched a massive fleet in 1654 to seize Spanish holdings in the Caribbean. Although the fortifications and garrison on Santo Domingo, Hispaniola repelled the English attack, the Island of Jamaica, which lacked substantial defensive works, fell to England.

With subsidies and commerce waylaid by corsairs and coffers drained by the constant effort of protecting its colonies and wars in Europe, Spain's support of the San Juan fortifications ebbed. Correspondence in the 1670s commented on the poor quality of the San Cristóbal fort and other components of the city's defensive works, just a few decades old.

With renewed war against France in the offing, Spain sent military engineer Luis Venegas Osorio, who had served in Spain, Portugal, and Italy and was a veteran of several sieges, to evaluate the San Juan fortifications in the 1670s.[35] A 1678 drawing from Osorio's survey showed the eastern defensive works spanning the full width of San Juan Islet. The eastern works consisted of two primary halves: the southern section, part of the city walls that sprung from the Santiago bastion on the southern corner to join the northern section, the incomplete Castillo San Cristóbal. The wall between the Santiago bastion and the fort contained the Santiago Gate, protected by a small ravelin. The drawing illuminates the triangular nature of the original fort design, which Osorio proposed to complete as a four-bastion, quadrilateral structure--a true citadel. At the center of the fort stood a semicircular cavalier called Santísima Trinidad ("Holy Trinity") with a converted bastion on its west side. A ditch, counterscarp, and covered way covered the eastern front of the main structure.[36] The drawing also hints at Osorio's plan for additional outworks to the east of the existing works.

Although embroiled in the Nine Years' War with France in the 1690s, the Spanish had still not funded the additional work despite the potential for French attack. At some point prior to 1702, likely in the mid-sixteenth century, the Spanish constructed a water battery and sentry post near the water below the northeast corner of Castillo San Cristóbal (later known as La Garita del Diablo or the Devil's Sentry Box) and added a powder magazine to the main fort but otherwise made no substantial changes to the eastern fortifications since initial construction. During the end of the seventeenth century, French military engineer Sébastien Le Prestre, Marquis of Vauban emerged as one of the leading experts in fortification design and siege, which he put to use in the Nine Years' War.

After Charles II died in 1700 without leaving a direct heir to the throne, the ensuing political upheaval and associated War of the Spanish Succession occupied Spain to the detriment of its Caribbean defenses. By 1731, the Spanish still had not improved the structures and reports from the island indicated that the Castillo San Cristóbal structures were deteriorating, including at least one landslide into the moat in 1740 and structural problems along the sea-facing north bastion,

34. Blanco, "A Study of the Morphological Structure of the System of Fortifications of San Juan de Puerto Rico," 298–300.
35. Real Academia de la Historia, "Luis de Venegas Osorio," https://dbe.rah.es/biografias/luis-de-venegas-osorio.
36. Torres Reyes, *Construction History of San Cristóbal, 1634–1800* 6–10; Joan Berkowitz et al., *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1 (National Park Service1991), 21, 23; Román, et al., San Juan City of Castles and Soldiers, 28.

which the Spanish shored up with buttresses, due to wave action.[37] After over a hundred years of calls to enhance and repair the San Juan fortifications, it took the crowning of a new king, Charles III, in 1759 for Spain to finally respond.

Fort Reconstruction and Successful Defense of the Island: 1760–1799

While the fortifications in San Juan were neglected, another war between the great powers in Europe erupted in 1756 on a nearly global scale. Known as the Seven Years' War, the conflict was rooted in a struggle between Britain and France for control of North American territory. As different European countries allied themselves with Britain or France, the conflict expanded to areas around the globe. Spain sided with France during the conflict with disastrous consequences for its colonies. Despite fortifications similar to San Juan, Havana and Manila were taken by the British during the war. The British took advantage of key weaknesses in the Havana defenses, undermined the Cuban El Morro and took the citadel which in turn served as a prime location to bombard the city into submission.[38]

Although settlements that ended the Seven Years' War restored Havana and Manila to Spain (at the expense of Florida), Charles III looked to strengthen Spain's sovereignty through "broad military, economic, administrative, and political reforms" including reinvestment in Spanish colonies and ports in the Caribbean, especially in the critical San Juan Harbor.[39] In historian José Ignacio Avellaneda's words, Spain's desire was to stop the advancement of Britain into the New World by, in part, making "San Juan an impregnable fortress."[40]

A Modernization Program

Within a year of his coronation, King Charles III carried his campaign of reforming and modernizing the military in Spain to the Spanish colonies. As part of this effort, Charles sent Field Marshal Alexander O'Reilly to Puerto Rico in 1765 to conduct a thorough assessment of San Juan's defenses and to direct the redesign and enlargement of the city's fortifications. After reviewing O'Reilly's report on San Juan, Charles declared San Juan a "city of the first order of support for the island, bulwark of the Antilles, safeguard of the Gulf of Mexico, depository, point of acclimatization, port of call and naval station of the navigation fleets, favorable to foster and secure the commerce that will improve industry, agriculture and art, the foundation of true wealth."[41] Given this importance, San Juan needed defenses of the first order. O'Reilly commissioned San Juan's Chief Military Engineer Thomas O'Daly to develop a plan showing existing fortifications and a plan for redevelopment of the fortifications. O'Reilly, O'Daly, and Juan Francisco Mestre completed the plans in two months and sent them to Spain, where Charles and a council of military engineers approved them (Figure 3).[42]

That the task of rebuilding one of Spain's most important fortifications in the Caribbean was given to two Irishmen may seem unusual, but it testified to the meaningful role foreign-born soldiers—particularly the Irish—played in Spain's army. Irish began joining the Spanish army in the sixteenth century during Tudor efforts to bring Ireland under tighter English control. The flow of Irish to Spain increased in the seventeenth

37. Torres Reyes, *Construction History of San Cristóbal, 1634-1800*, (National Park Service, June 1965), 11–17; Berkowitz et al. *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1, 23.
38 British Battles, "capture of Havana," https://www.britishbattles.com/frederick-the-great-wars/seven-years-war/capture-of-havana/.
39. José Ignacio Avellaneda, *Historic Furnishings Report: El Castillo de San Cristóbal*,5.
40. Avellaneda, *Historic Furnishings Report: El Castillo de San Cristóbal*, 55.
41 Maria M. Alonso and Milagros Flores, *The Eighteenth Century Caribbean and The British Attack on Puerto Rico in 1797* (National Park Service, 1997), 161.
42. Berkowitz et al. *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1, 23; Avellaneda, *Historic Furnishings Report: El Castillo de San Cristóbal*, 5, 55–56.

century, particularly during Cromwell's brutal campaigns between 1649 and 1653, culminating in the "Flight of the Wild Geese" or "Sarsfield's Exodus" in 1691 when some 14,000 Irish left Ireland for France and later Spain after the Jacobite' defeat in the Williamite War. During these years, repressive laws enacted in the wake of these campaigns against Catholics in Ireland led to further emigration to Catholic countries. Irish units, often fighting together in a tercio (somewhat similar in size to a battalion or roughly 1,000 men but this number often varied), saw service in Flanders, Italy, the Americas, and other theaters of war. Spain encouraged Irish immigration by granting them equal rights to military, administrative, and political positions, although foreigners still faced discriminatory practices in their pursuits.[43]

O'Reilly and O'Daly showed the different paths open to foreigners in the Spanish service. O'Reilly, of County Meath, was from noble birth. He joined the Spanish army as a cadet (officer in training) in his youth and served in the Hibernian Infantry Regiment in Italian campaigns of the mid-eighteenth century, rising through ranks through merit to attain the high office of field marshal. O'Reilly was held in high enough repute that Charles looked to him to restore the Caribbean defenses after the disasters of the 7 Years' War. In recognition of his loyalty, ability as an administrator, and expertise in colonial affairs, the crown later appointed O'Reilly governor of Spanish Louisiana in 1769.

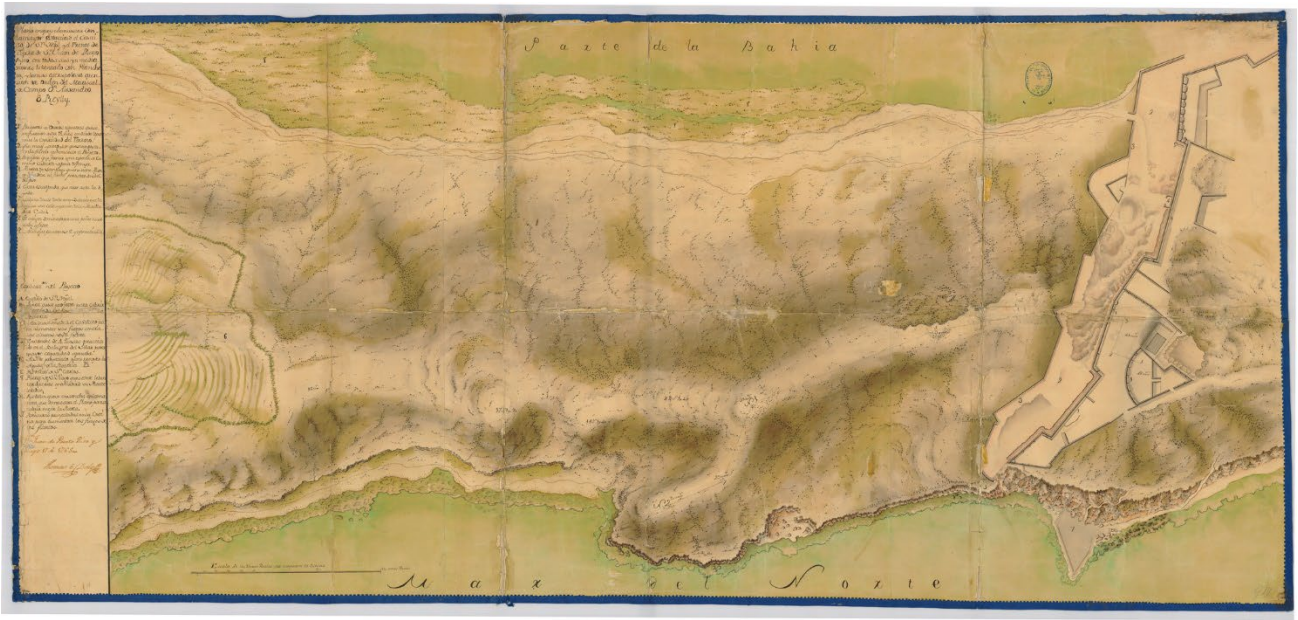


Figure 3. "Plan in which the Castle of [San Cristóbal] is demonstrated with the greatest accuracy and the land front of Sn. Juan de Puerto Rico with all its mediations," 1765. (Source: Archivo General Militar de Madrid, image PRI-19-12)

43. Jorge L. Chinea, "Spain is the merciful heavenly body whose influence favors the Irish': Jaime O'Daly y Blake, Enlightened Immigrant, Administrator and Planter in Late Bourbon-Era Puerto Rico, 1776-1806," *Tiempos Modernos: Revista Electronica de Historia Moderna* 25 (2012): 4.

Thomas O'Daly (Blake), born in Galway, also left as a youth to join the Spanish Army.[44] Because he began his career as a second lieutenant in the Irish Ultonia Regiment and later attended the Academia Militar de Barcelona, the recently established royal mathematical school of military engineering, O'Daly came from a background of some education. At the Academia, O'Daly likely would have been introduced to several foundational treatises from the French school of military engineering such as Vauban's *Le Directeur Général des Fortifications* (1685) and *De L'Attaque et de la Defense des Places* (1700); Guillaume Le Blond's *Élements de Fortification* (1739); and Spanish-born Bernard Forest de Bélidor's *La Science des Ingénieurs* (1729). O'Daly's attendance at the Academia marked an important development in the professionalization of military engineers which came at a time when European nations began to establish specialized schools for artillerists and engineers. After service in Spain, in 1760 O'Daly was appointed chief engineer of the project to revive the fortifications of San Juan, a position that came with a land grant. O'Daly developed a sugar plantation on his lands with enslaved labor while attending to his duties with the army.[45]

O'Daly's training at the Academia de Barcelona in the 1740s came during a period of transition in fortification design. Vauban and his adherents dominated the theory of fortress design and siege in the first half of the eighteenth century, but critics began to emerge mid-century, especially after 7 Years' War showed the limitations using some fortresses built on his designs. Marc René, marquis de Montalembert, for one, offered a different approach that in effect sought to concentrate more effective and greater artillery fire on besiegers, and better oppose contemporary siege tactics. Some of what Montalembert proposed came from what might be called an analysis of a soldier's psychology—that is, he believed that too often a fort fell because defenders considered further resistance futile after an important component such as a bastion was breeched. Although Montalembert's pursuit of impregnability might bolster a defender's fortitude, critics charged that the expense it incurred came at the cost of funds that might be put to better use elsewhere, such as building a larger navy.[46] Because Montalembert's work was not widely published until 1776, well after O'Daly's graduation from the Academia and his survey of San Juan's defenses in the early 1760s, the plans to bring Castillo San Cristóbal and the eastern outworks up to contemporary standards illustrate that the reassessment of Vauban was not limited to the French, and that others, perhaps independently, were headed in a similar direction as Montalembert.

The Constructed Works

Castillo San Cristóbal

The excellent drawings made for the project permit a detailed look at O'Reilly, O'Daly, and Mestre's plans to overhaul the San Juan defenses. The drawing representing conditions in 1765 shows the remnants of the original 1634 design with the project to "close" Castillo San Cristóbal as an independent citadel abandoned long ago. Instead, the fort had been integrated into the city wall system and a ditch, counterscarp, and small ravelin in front of the gate extended the defenses to the east, although the ditch appeared poorly maintained in the drawing. The surveyor noted several problematic high points in the topography to the east that could potentially be used during a siege to batter the walls. Only one true "bastion" is present, the demi-bastion in the northeast corner, as the shortness of the flanking walls and wide salient angles of the other elements of the defense

44. A document recording his death and burial indicates that O'Daly was born in Clonbrusk (likely Clonbrock), County Galway, to Demetrio (Dremont O'Daly) and Juana Blake (Jane Henrietta Blake), died January 20, 1780. FamilySearch, Puerto Rico, Catholic Church Records, 1645-1969 San Juan Nuestra Señora de los Remedios Defunciones 1780-1784, image 51 of 334; folio 42.
45. Chinea, "Spain is the merciful heavenly body whose influence favors the Irish," 15.
46. Janis Langins, *Conserving the Enlightenment: French Military Engineering from Vauban to the Revolution* (Cambridge: the MIT Press, 2004), 283–293.

functioned more as simple curtain walls. The eastern defenses were vulnerable even by seventeenth-century standards.

With the lessons of Havana and Manila in the recent past, the engineers transformed Castillo San Cristóbal into a modern fortress. In their assault on Havana, the British used the surrounding land (a forested high ground called La Cabaña) and city against the El Morro citadel, carrying siege lines up to the point where combat engineers undermined and blew up a key bastion. After the English forces stormed the breach, the Havana defenses capitulated.

At Manila, the British also approached the walled city from its landward side, concentrating fire on one bastion which they took after creating a breach. The city surrendered shortly thereafter with little resistance. Both sieges showed the British capable of sending large fleets and troops great distances over the sea. At its peak, the force marshalled for the assault on Havana totaled an estimated 28,400 men.[47] Both battles also revealed an old foe, disease, perhaps the greatest enemy of a siege. Between June and October 1762, the British lost 5,366 men in Havana—658 in battle and 4,708 to disease.[48]

The engineers' plan for Castillo San Cristóbal was designed to prevent the kind of attacks that captured Havana and Manila. First, the curtain walls of the old fortification (including the section of city wall south of Castillo San Cristóbal) were fronted by three "detached" structures: two revellín (ravelins) (San Carlos and Príncipe) with a central counterguard (Trinidad) placed between them. If one these ravelins was breached, undermined, or taken, the enemy still faced the formidable task of taking the other two and crossing a ditch to attack Castillo San Cristóbal itself. To make this more difficult, the engineers added a caponier that bridged the ditch between the San Carlos ravelin and Castillo San Cristóbal. The caponier (typically roofed) provided a protective structure from which to fire on enemy troops in the ditch and allow defenders to retreat in order from the ravelin. By this design, the fall of one important component would not precipitate the loss of the fortress or discourage the defenders.

Second, the shape of the detached bastion and ravelins and artillery embrasures followed what Montalembert observed in his treatise La Fortification Perpendiculaire (Perpendicular Fortification)—that the placement of artillery should make use of the tendency for troops to fire forward rather than at an angle at targets when in battle.[49] Although the geometry of San Carlos, Trinidad, and Santiago resulted in half the fire of the ravelins aimed at the Bay of San Juan (in the event an enemy fleet ran El Morro and attacked from the bay), nearly all of the guns on Castillo San Cristóbal faced east.

Third, the new design brought far more artillery to bear on invading troops. If the embrasures of the fort as it stood in 1765 are a measure of its guns, the old Castillo San Cristóbal had approximately 13 east-facing openings on the main level and 7 in the semi-circular caballero. Undoubtedly more guns could have been placed as needed behind the parapet but would have lacked protection for the gun crews. The new plans showed 78 east-facing artillery openings spaced closely together: 37 in the main level, 14 in the cavalier, 22 in ravelins, and 5 casemated openings—the last, a departure from the Vauban forts. In the past, casemates lacked broad acceptance because the smoke from discharge of the guns adversely affected operations, and taller structures presented an easier target. However, casemates like the ones employed at Castillo San Cristóbal (if few in number in this case) allowed a greater concentration of fire. Stacked levels of casemates

47. Elena A. Schneider, *The Occupation of Havana: War, Trade, and Slavery in the Atlantic World* (Chapel Hill: The University of North Carolina Press, 2018), 6..
48. British Battles, "Capture of Havana," accessed March 3, 2024, https://www.britishbattles.com/frederick-the-great-wars/seven-years-war/capture-of-havana/
49. Janis Langins, *Conserving the Enlightenment: French Military Engineering from Vauban to the Revolution* (Cambridge: The MIT Press, 2004), 284.

became a staple of fort design from the late eighteenth to mid-nineteenth century. The new Castillo San Cristóbal was capable of delivering a multi-level broadside against an attacking force.

Fourth, the new fort provided for a larger garrison of professional troops needed to counter the sizeable forces enemy nations might send. A rainwater collection system fed five cisterns[50] built under the troop quarters with a capacity to supply the garrison for five months during a siege. Bombproof officers' quarters, barracks, toilets, and a kitchen around the perimeter of Plaza de Armas were added later.

Finally, outworks, or "advanced" works to hinder siege lines, were sketched out. Topographical survey had shown some vulnerabilities in the land sloping away to the east, including areas that were difficult to see and reach with artillery, and high points that might be used by besiegers. The eastern defenses in 1765 also lacked a proper glacis, important for covering walls from direct artillery fire. The new plans would remedy both deficiencies and provide greater defense in depth, a direction that fortification practice headed as the seventeenth century wore on. In his correspondence Alexander O'Reilly approved of the advanced works strategy with the justification that "These will remove to greater distance the attacks of the enemy, are of little cost and, well defended, they can gain many days. In works so sustained, nearby and visible, the defenders are apt to comport themselves very well, and the attackers to move with caution."[51] O'Daly's successor, Juan Francisco Mestre added that "in a climate where the delays, in a short time, as proved by experience, consume with diseases most of the European troops."[52]

The engineers made extensive use of another sort of outworks, countermines, in the updated design. Countermines under the ravelins and outworks had a dual purpose. The first was to impair besiegers efforts to dig their own tunnels under the fortifications, as the British had done at Havana; the second was to establish specific locations where explosive charges could be detonated to destroy strategically important positions if taken or as a preemptive measure.

After approval in Spain by the war council and crown, construction was underway in 1766 with the threat of renewed war with Great Britain in the background. Like his predecessors, O'Daly and the other managers of the project relied heavily on coerced labor for construction, however, the composition of this workforce, in Puerto Rico at least, was changing. In the early eighteenth century, work on fortification projects in the Spanish Americas still drew on a mix of free, convict, and enslaved labor. An engineer writing in 1741 determined that the cost of labor was the most expensive part of fortification projects. Although free labor incurred a lower initial cost compared to purchasing and maintaining enslaved peoples, he warned such an approach often ended in cost overruns in the long term especially if the enslaved peoples could be sold after the project was completed.[53] The report showed that the military still depended on esclavos del rey, rather than privately owned, hired out enslaved labor. Historian Pedro Luengo found the esclavos del rey were often transported from site to site for fortification projects. Given this practice, Luengo noted that it was "plausible that these enslaved workers acquired techniques that were rare among forced laborers or local artisans," and that the data suggested that "enslaved Africans were utilized at more critical military infrastructure programs, thereby, their skills were more highly valued than

50. Ricardo Torres Reyes's translation of O'Daly's project reports describes the reservoir system as consisting of "two independent cisterns, one with two vaults and the other with three." Torres Reyes, "Construction History of San Cristóbal: 1634–1800," 89.
51. Alexander O'Reilly, "Land Front," (1765), 25, Legajo – 2510, Santo Domingo (Archive General de Indias Seville), copied at NPS SAJU Archives, San Juan, Puerto Rico.
52. Quoted in Torres Reyes, "Construction History of San Cristóbal: 1634–1800," 110.
53. Pedro Luengo, "Housing the King's Enslaved Workers in the Spanish Caribbean," *Arts* 12 (2023), 5.

those of prisoners and other forced laborers."[54] During this period in the mid-eighteenth century when trade in enslaved people sharply increased in Spanish America, enslavers strove to codify complete control over the lives of the people they had acquired.[55]

The substantial modernization of the Havana defenses that was undertaken relatively concurrently with that at San Juan provides one example of who composed the workforce. A 1772 report listed 424 "forced" workers (prisoners), 23 African freemen, 321 royal enslaved workers, and 7 privately hired out Africans working at the Cabaña fortification project adjacent to the Cuban El Morro.[56]

While the case of Havana showed a high percentage of enslaved people in the work force, San Juan reflected the growing popularity for use of convict labor or presidiarios on state projects in the late eighteenth century. Whether due to the low availability of enslaved people locally, competition from Havana, or the high capital outlay to acquire enslaved workers, planning for the San Juan defenses focused on using presidiarios from the start. The crown authorized use of 445 presidiarios on the San Juan fortifications in 1768, which was increased in later years. Most came from Spain (generally soldiers) and Mexico (generally civilians).[57] Data compiled by historian Ruth Pike shows the number of presidiarios used for construction ranged from a high of 528 at the end of 1772 to 142 in 1783 when the construction was nearing completion.[58] After serving their sentences, presidiarios generally were resettled in Puerto Rico under Spanish policy. Soldiers stationed at San Juan (troops of the Toledo and Victoria Regiments) also were used for unskilled tasks.[59] While Pike's study brings the question of who provided unskilled labor on the modernization of the San Juan defenses into sharper focus, further work in Puerto Rican and Spanish archives may detail the character of skilled work involving masons, blacksmiths, carpenters, and other trades.

Expanding the Defenses

The Spanish did not design Castillo San Cristóbal as a stand-alone feature. While it commanded views from the highest point in all directions, Castillo San Cristóbal was one component in a larger system of protection for San Juan. Integration of the city walls into the modernization of the city's defenses required raising and enlarging certain sections, adding batteries and powder houses, and extending new walls to cover gaps near the water on both the north and south sides.[60] Many of these features south of Castillo San Cristóbal were removed in the late nineteenth century to open San Juan to further urban development.

Initially O'Daly planned more temporary fortifications for two advanced eastern works that became known as Redoubt 1, near the north bastion that would allow for retreat from the covered way, and Redoubt 2, east of the San Carlos

54. Luengo, "Housing the King's Enslaved Workers in the Spanish Caribbean," 5.
55. Giuseppe Patisso and Fausto Ermete Carbone, "Slavery and Slave Codes in Overseas Empires," in Jane Reeves, ed., *Modern Slavery and Human Trafficking* (IntechOpen, 2021); on the rise of trade in enslaved people, see Alex Borucki, David Eltis, and David Wheat, "Atlantic History and the Slave Trade to Spanish America," *The American Historical Review* 120 (April 2015): 437.
56. Luengo, "Housing the King's Enslaved Workers in the Spanish Caribbean," 5. Luengo notes that the term "forced laborer" or "force labor" refers to one who has committed a serious crime and was sentenced to forced labor, which in this instance is assumed to apply to "forced worker" as well.
57. Ruth Pike, "Penal Servitude in the Spanish Empire: Presidio Labor in the Eighteenth Century," *The Hispanic American Historical Review* 58 (February 1978): 33.
58. Pike, "Penal Servitude in the Spanish Empire," 37. Pike notes that a certain percentage—up to 40 percent in some years—of the annual numbers listed was unavailable due to illness, injury, death, escape, and other reasons.
59. Torres Reyes, *Construction History of San Cristóbal, 1634–1800*, 77.
60. Torres Reyes, *Construction History of San Cristóbal, 1634–1800*, 66–91.

ravelin on a small rise that would allow for advance protection of the city wall. Construction of the redoubts proceeded between 1778 and 1779 alongside a massive relandscaping effort for the glacis and two lines of retreat to further delay an enemy's advance if the advanced redoubts fell.[61]

Between 1779 and 1783 the temporary redoubts were converted to the more substantial, masonry works—the Batería of Santa Teresa and fuerte El Abanico (Fan). A small battery with a covered way, the fuerte de la Princesa (Princess), was added to protect the northern flank of El Abanico.[62] The form of El Abanico was similar to a ravelin but largely lacked flanking fire (except for two embrasures covering the northeast), instead directing its battery of three cannon eastward through a "'common embrasure" on the salient angle. According to Reyes, "this unique method of firing three guns through a single embrasure, known as convergence of fire, was originated by a French engineer or writer by the name of Mr. Trincano."[63] The more permanent advanced works were likely a product of Spain's declaration of war against Great Britain in 1779 and possibly associated with O'Daly's death in 1780. His righthand man, Juan Francisco Mestre, took over as chief engineer on the project.

In addition to the fortifications around the city (Castillo San Cristóbal, El Morro, and the city walls), the Spanish relied on several other forts and strongpoints as part of the overall defense system. El Cañuelo, a square masonry fort mounting about six guns, was built on a small island across the channel from El Morro in the mid-seventeenth century to provide a crossfire at vessels attempting to enter San Juan harbor. Other small forts at San Antonio and San Gerónimo defended the eastern end of the islet and an important bridge across to the mainland. These points had been fortified for some two hundred years but were strengthened by masonry construction as part of O'Reilly's modernization project. Other more temporary batteries were constructed at various points along the coastline. It was this so-called "first line of defense" in the east that proved crucial in the final attempt by the British to take San Juan in 1797. The British landed their invasion force—some 3,000 strong--east of San Juan on the beaches of Cangrejos and sought to invest the city from the southeast. Meeting stubborn defense at the San Antonio and San Gerónimo forts supported by gunboats and floating batteries, the British abandoned the effort after just over two weeks.[64]

61. Torres Reyes, *Construction History of San Cristóbal, 1634-1800,* 67–73.
62. *Fuerte de al Princesa* was likely dedicated to María Amalia, a daughter born to King Charles IV in 1779.
63 Torres Reyes, *Construction History of San Cristóbal, 1634-1800,* 98. Full name of Didier-Grégoire Trincano.
64. Torres Reyes, *Construction History of San Cristóbal, 1634–1800*, 114; Berkowitz et al., *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1, 21–22.

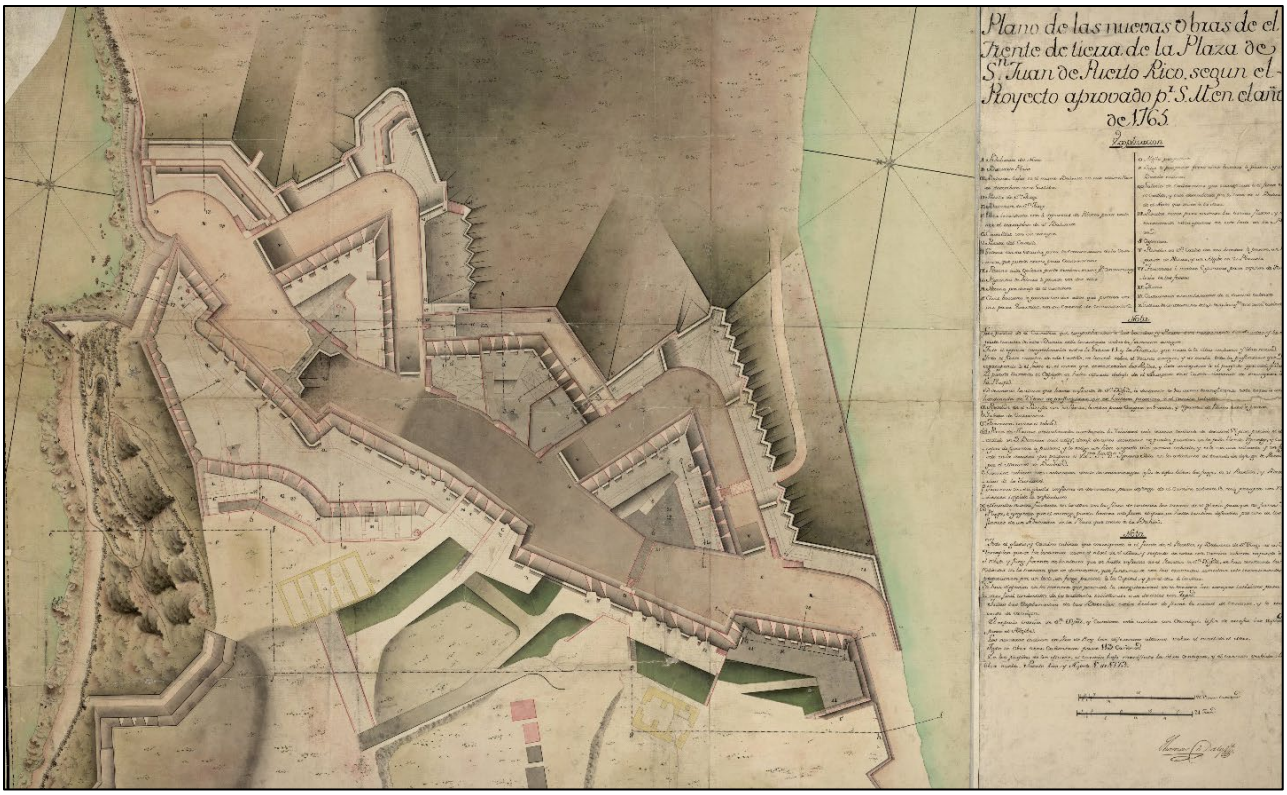


Figure 4. "Plan of the new works of the Land Front of the Plaza de Sn. Juan de Puerto Rico: according to the approved Project [per] His Majesty in the year 1765." The main fortification can be seen at the bottom. (Source: Archivo Cartográfico y de Estudios Geográficos del Ejército, image number AR_J_T_4_C_2_69)



Figure 5. A detailed view of Castillo San Cristóbal showing the outworks in 1792 from a map created by Juan Francisco Mestre. (Source: *Manuscrito por Juan Francisco Mestre,* Servicio Histórico Militar Núm. 5795, Madrid)

Shifting Global Politics and the Loss of Spanish Control, 1800–1898

The nineteenth century was a period of great unrest on the island of Puerto Rico and in Spanish America generally as a revolutionary spirit took hold in the region. The Spanish military gradually, and then fully, lost its hold on the island. The new century dawned in war as the French Empire, under Napoleon, recast the balance of power in Europe. Preoccupied with the Peninsular War, Spain's control of its American colonies faltered and one after another declared independence, beginning with Colombia, Chile, and Mexico in 1810. The loss of Mexico was a particular blow for Spain, as it had been the source of funds for much of its military in the Americas, including its Puerto Rican military. Britain and the United States took advantage of the rifts in the Spanish Empire and supported the independence movements, looking for new opportunities for trade. U.S. opposition to Spain's presence in the Caribbean grew more aggressive as the century wore on, particularly in Cuba, eventually resulting in war.[65]

As Spanish control of its colonies in the Americas diminished, so too did the Spanish military's hold on Puerto Rico. From the country's colonization of the island through the 1700s, the primary value of Puerto Rico to Spain was as a military base protecting the Spanish Empire's trade routes in the Atlantic to North and South America. As former Spanish colonies declared independence, these trade routes became less valuable, but that was not the only reason for the shift. The disruption of life on Hispaniola following the Haitian Revolution (1791–1804) offered new opportunities for sugar and tobacco plantation owners in Puerto Rico. The importance of Puerto Rican products increased the political power of landowners on the island, earning them a place in Puerto Rican governance for the first time.[66]

Shifting Global and Local Politics

Powerful European alliances in the wake of the Napoleonic Wars in Europe concerned the newly independent United States, which was eager to expand its trade partners in the Americas. By the early 1820s, U.S. Secretary of State John Quincy Adams worried that European powers might seek to restore a Spanish Empire in Spanish America. Adams encouraged President James Monroe to recognize the newly independent Spanish American countries diplomatically and to open trade with them. Monroe followed Adams's advice, and took the matter further in December 1823, when he articulated his goal of having the Americas become free of European colonization and control. Monroe's goal, which became the Monroe Doctrine, eventually morphed into the position that threats to the independence (or free markets) of countries in the Americas would be seen by the U.S. government as threats against the United States. Although most European and Spanish American countries initially ignored the Monroe Doctrine, by the end of the nineteenth century the United States had a stronger political position from which to enforce it.[67]

While the United States struggled to gain a foothold in global markets, Spain lost one colony after another to independence. Puerto Rico was not immune to the revolutionary spirit in the Americas, especially since many residents of Hispaniola and other Spanish American countries fled the violence in their own countries to settle on the island. The influx of immigrants (many of them war widows) filled San Juan, increasing tensions in the already crowded city. As landowners began to push for a louder political voice, civilians started defying military restrictions on building construction. The city's expansion of its civil infrastructure forced marginalized residents of San

65. Mark T. Gilderhus, "The Monroe Doctrine: Meanings and Implications," *Presidential Studies Quarterly* 36, no. 1, (March 2006), 6–8; Román, et al., *San Juan City of Castles and Soldiers*, 213-214.
66. Burchardt, Hans-Jürgen, "Lessons Learned: The Legacies of Spanish Colonialism," 331–333.
67. Gilderhus, "The Monroe Doctrine: Meanings and Implications," 6–9.

Juan, such as women, those of mixed race, and Black Puerto Ricans, out of their wood and palm homes (one area of which was near the entrance of Castillo San Cristóbal) to areas outside the city walls.[68] By the mid-1860s the Spanish military began to cooperate with the city to authorize the construction of housing and city buildings outside the city walls. Although this was a remarkable transition for the city, the military only relinquished the land for which it had no military use.[69]

San Juan's urban growth coincided with a period of significant changes for the island's labor force. In part caused by British introduction of an open slavery market during their period of occupation of Havana and Manila, the number of enslaved peoples brought to the Americas increased in the last half of the eighteenth century. In Puerto Rico, this was driven by sugar cane and coffee plantations; less is known about slavery in more urban areas, the numbers of enslaved people in Puerto Rico peaked in 1846 at just over 50,000 or 11.5 percent of the population.[70] At the same time, antislavery movements in Europe and elsewhere were gaining strength. Whether through fiat, legislation, or war (in the case of the United States), the pressure to end slavery manifested in different outcomes. Ultimately, the abolition of slavery in Spanish American countries unfolded to some degree on a colony-by-colony basis. On March 22, 1873, the Spanish National Assembly abolished slavery in Puerto Rico, however enslaved people were required to work another three years. As in other countries such as the United States, the legal end of slavery in Puerto Rico had little impact on the lasting effect of its legacy. Landowner-friendly laws compelled free laborers to make contracts with employers that resulted in arrangements not far removed from working conditions under slavery.[71] Such was the context for labor on the San Juan fortifications during the nineteenth century.

During the early 1800s, as unrest swirled around the island and Spanish America, the Spanish military did little in the way of construction at Castillo San Cristóbal and its outworks. The only changes during the first eight decades of the century appear to have been operational in nature and did not enhance the defensive capabilities of the fortress. These included construction of a guardhouse near the north casemates, a chapel adjacent to the plaza, an addition to the officers' quarters, a bathhouse, and a loggia along the north casemates.[72] By the 1880s, military officials recognized that there was no longer great military value in the city walls other than that they were integral to the construction of the fortresses that were still seen as valuable for defending the San Juan Harbor from naval attack. Under pressure from the city government, the military authorized the destruction of the eastern city wall from the southern spur of the wall to the city gate in 1883 to allow for expansion of the city, provided that the remaining fortifications could be stabilized. This provision stalled the demolition for years. Finally, in 1897, amidst a rebellious undercurrent in Puerto Rico and a growing threat of war with the United States, the Spanish military again authorized the deconstruction of the city wall, and this time provided for the stabilization of the fortress structures and the modernization of several features important for naval warfare.[73]

68. Rodríguez, *Women and Urban Change in San Juan, 1820–1868*, 2-4, 42; Luis E. González Vales et al., *San Juan: The City That Grew Beyond Its Walls* (National Park Service and Puerto Rican Academy of History, 2005), 70–75.
69. Foulds and von Bieberstein. *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 4–5; Luis E. González Vales et al., *San Juan: The City That Grew Beyond Its Walls*, 70–75.
70. James W. Wessman, "The Demographic Structure of Slavery in Puerto Rico: Some Aspects of Agrarian Capitalism in the Late Nineteenth Century," *Journal of Latin American Studies* 12 (November 1980): 273.
71. Luis A. Figueroa, *Sugar, Slavery, and Freedom in Nineteenth-Century Puerto Rico* (Chapel Hill: The University of North Carolina Press, 2005), 118–119.
72. Berkowitz et al., *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1, 25.
73. González et al., *San Juan: The City That Grew Beyond Its Walls*, 19–22, 49–51, 70–75; Román

A Civilian Victory and Preparation for War

By the 1890s, the construction of a canal across the isthmus of Central America had clear potential. With the trade possibilities the canal would open, the United States grew more aggressive in carving out political power in the Caribbean and Latin America. The United States convened the first Pan-American conference in 1889, where it proposed alliances across the Americas, and in 1895 it inserted itself into disputes between Latin American colonies and European powers. Spain also recognized the potential of an isthmus canal and saw the increased U.S. presence in the region. In the 1890s, Spain began arming its fortifications with modern weaponry in conjunction with its demolition of the eastern city wall.[74]

As it prepared for the possibility of war in the late 1890s, the Spanish surmised that any attack on San Juan would come from the sea. Castillo San Cristóbal and its outworks had been constructed with the aim of protecting San Juan from a land attack. In the 1890s, Spain focused its reconstruction and modernization of the eastern fortifications on creating ocean-facing defenses. Gun positions were installed on the terreplein of the north casemates, cavalier (El Caballero de San Miguel), and north bastion. They also added two gun positions and an earth-covered field magazine to the Santa Teresa Battery and constructed four gun emplacements, bomb-proof vaults, and traverses at La Princesa. El Abanico received a new cistern and a guardhouse to protect La Princesa. Gates were added to the wall surrounding the outworks, and a road graded from the city to the Santa Teresa battery.[75]

While rearming the fortifications at San Cristóbal, the military also deconstructed the eastern city wall, removing the Santiago bastion and gate and part of the La Trinidad Counterguard. While this was a victory for civilians seeking more autonomy, the city had already expanded beyond the wall by 1897, and a greater conflict loomed.[76]

Spanish-American War

Conflict between Spain and the United States was brewing in the late 1890s after three years of a Cuban civil war. The explosion of the battleship USS Maine in Havana Harbor in February 1898 offered the United States an opportunity to pursue its objective of gaining more control in the region. The United States had been actively gathering information on Spanish fortifications in the Caribbean in the last decade of the nineteenth century. A book of "Military Notes on Puerto Rico" (published just after the Spanish-American War) identified Castillo San Cristóbal as having two bombproof barracks, 22 cannon on the cavalier (El Caballero de San Miguel), three ravelins, a redan, defense lines, and batteries Santa Teresa and La Princesa on the ocean-side.[77] In April 1898, President William McKinley asked the United States to declare war on Spain, starting the Spanish-American War. The U.S. Navy's goal during the war was to destroy the Spanish Atlantic Fleet, thereby establishing itself as a powerful entity while greatly reducing Spain's ability to play a role in the Caribbean. In May 1898, the U.S. Navy arrived at Puerto Rico expecting to find the

et al., San Juan City of Castles and Soldiers, 205; Rodríguez, Women and Urban Change in San Juan, 1820–1868, 27, 34, 125; Castanha, The Myth of Indigenous Caribbean Extinction, 99-100.

74. Gilderhus, "The Monroe Doctrine: Meanings and Implications," 9–10; Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 4–5.
75. Berkowitz et al., *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1, 26; Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 16.
76. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 5; Berkowitz et al., *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1, 26; González et al., San Juan: The City That Grew Beyond Its Walls, 70–75, 81.
77. War Department, Adjutant-General's Office, "Military Notes on Puerto Rico," (Washington: Government Printing Office, 1898), 34-35.

Spanish fleet resupplying after its own journey across the Atlantic. Finding San Juan Harbor empty, the Navy fired on the San Juan defenses for several hours. The encounter was remarkably ineffective on both sides. Despite firing some 1,362 rounds from rifled, large-caliber guns with explosive shells including the 13-inch guns of the battleship USS *Indiana*, damage was light at the fort. Casualties from the Spanish return fire, 441 shells worth, were few and no ships were sunk or even heavily damaged.[78] Without a plan for an invasion, the Navy moved on to Havana, where it defeated the Spanish Atlantic Fleet while the Army took possession of Cuba. In late July 1898, the United States followed up the naval attack with a land invasion of Puerto Rico which met little resistance. The war ended a few months later.[79]

At the end of the war, U.S. Maj. Gen. John Brooke took possession of Puerto Rico for the United States and in September and October 1898, the Spanish military evacuated the island. Before the Spanish departed, U.S. military officials and Spanish officials inspected the fortifications together, and the U.S. officials noted some of the damage (relatively minor) caused by its naval bombardment. On October 18, 1898, the U.S. flag was raised over San Juan for the first time. In December 1898, at the Treaty of Paris, the U.S. War Department formally took control of all of Spain's former military reservations and additional Spanish landholdings in Puerto Rico.[80]

U.S. Military Use of Castillo San Cristóbal, 1898–1949

The transfer of Puerto Rico from possession by the Spanish to possession by the United States did not immediately end military control of the island. From 1898 to 1900, the U.S. military governed the island (Figure 6 and Figure 7). The United States had achieved global recognition as a naval power with its victory over the Spanish fleet in the Spanish-American War. The United States sought to enhance this image, and San Juan was an excellent base from which to do so. American plans to begin building a canal in Panama brought added incentive for the United States to strengthen its naval forces and expand its presence in the Caribbean.

The War Department assessed the possibilities the island held for naval and artillery bases and decided which of the fortifications it could use for future military purposes. After this initial assessment, Congress authorized some civilian control of the island through the 1900 Foraker Act, which created a popularly elected House of Delegates to serve as a legislative body for the island. By 1903, the War Department had determined which of the lands and buildings in Puerto Rico to keep for military purposes and gave use of the others to the civilian government (which it still intended to guide) through a 1903 Executive Order signed by President Theodore Roosevelt. In the city of San Juan, this brought two governing bodies into proximity, a relationship that was often tense.[81]

78. Mark R. Barnes and Julia C. Walker, "Naval and Land Actions in the Island of Puerto Rico, April–August 1898," National Register of Historic Places Multiple Property Documentation Form (1999), Section E, Page 28.
79. Gilderhus, "The Monroe Doctrine: Meanings and Implications," 9–10; Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 6, 15–16; Edwin C. Bearss, *San Juan Fortifications, 1898–1958, Historic Structure Report*, (Denver: National Park Service, February 1984), 5–15.
80. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 6; Bearss, *San Juan Fortifications, 1898–1958, Historic Structure Report*, 23, 35–38; Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 20.
81. Bearss, *San Juan Fortifications, 1898–1958, Historic Structure Report*, 59–61; Gilderhus, "The Monroe Doctrine: Meanings and Implications," 10; John Holladay Latané, "The Effects of the Panama Canal on Our Relations with Latin America," *The Annals of the*



Figure 6. View of Castillo San Cristóbal from the south, 1900. (Source: Library of Congress, LC-DIG-stereo-1s16109 (digital file from original) LC-USZ62-117183)



Figure 7. View of Castillo San Cristóbal from Plaza Colón, 1904. (Source: Library of Congress, LC-DIG-stereo-1s16145 (digital file from original) LC-USZ62-91742 (b&w film copy neg.))

Assessing and Staffing Castillo San Cristóbal in Years of Peace: 1900–1915

The War Department's assessment of Puerto Rico (and its other recent acquisitions, such as Manila Bay and Pearl Harbor) was an extension of its massive 1890s program to modernize all its coastal defenses. The Board of Officers that reviewed the structures and land in Puerto Rico assumed that the federal government would call for U.S. defense of the island in the event of conflict in the Caribbean (Figure 8). It therefore recommended that the military retain most of San Juan's fortification structures for military use and advised that the designated military reservation extend around the fortification wall that enveloped Castillo San Cristóbal and its outworks and stretch to the fortifications at the eastern end of the islet. Following this recommendation, the Board of Army Engineers sent Capt. Henry Hodges to provide an independent assessment of the fortifications and their use. Hodges reported to the Secretary of War that there was great value in San Juan's large and well protected harbor and advised that the city and harbor should be protected against amphibious attack through the emplacement of modern guns, submarine mines, and approximately 600 men. The Secretary of War approved Hodges's plan for the defense of Puerto Rico in 1902, but Congress did not appropriate funding for the armaments and their installation that year, or when the issue was again raised in 1905. Instead, the Army made the decision to transport moveable artillery to the island as a temporary measure.[82]

American Academy of Political and Social Science 54 (July 1914), 84–85; Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 20–22.

82. Bearss, *San Juan Fortifications, 1898–1958, Historic Structure Report*, 52–61, 65–69; Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 16–19.

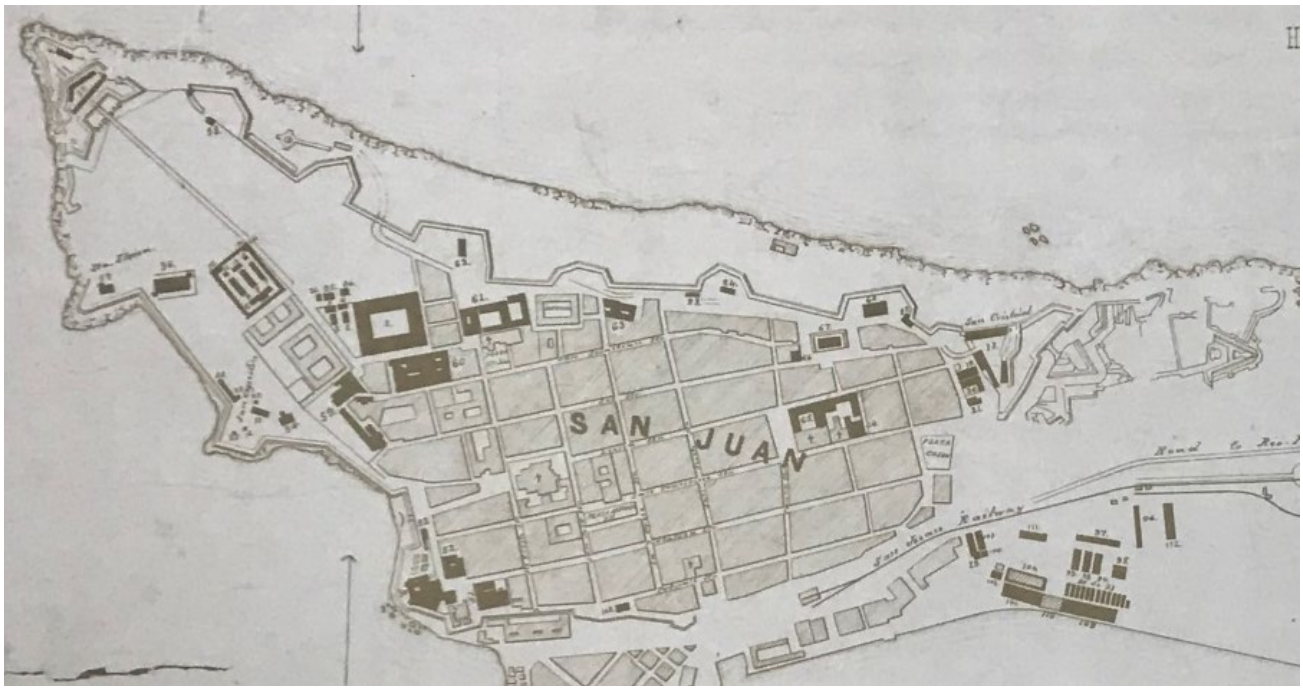


Figure 8. 1899 U.S. Quartermaster map showing the existing walls and the locations of fortifications and other buildings. Castillo San Cristóbal is on the right. (Source: USDOI, *Historic Base Map – San Cristobal & El Morro, US Army, 1899*, Washington, DC, 1960; SJNHS, Park Archives)

The first U.S. occupant of the Castillo San Cristóbal fortification was the Porto Rico Regiment (65th U.S. Infantry), which arrived from the United States in 1898.[83] The Army then placed several companies of artillerymen in the fort to operate the temporary coastal defenses placed there and to use, if necessary, the Spanish armaments still installed at the fortifications. The Spanish however reclaimed their guns, and when funding for emplacing permanent guns in San Juan failed to come through the Army removed the artillerymen from Puerto Rico as the United States shifted its attention to constructing the Panama Canal. For the next thirteen years, the Army housed a locally recruited Porto Rico Regiment in Castillo San Cristóbal and El Morro. In these first years of San Juan occupation, the Army focused on training the new regiment and conducted only the repairs and modernization projects necessary for use of the aging fort and outworks. The work included masonry repairs, installing electricity and other utilities, repairing woodwork, resurfacing the concrete entrance ramp, filling in the defensive lines for sanitary reasons, and installing fences. [84]

The repairs the Army authorized were necessary for the safe use of the forts, but some officials also recognized great value in maintaining the historic structures. Without current defensive need of the buildings, however, their non-mandatory maintenance was difficult for the Army to justify. By the 1910s, civilians recognized the deterioration and clamored for the transfer of the historic structures to civilian management. The Army saw the possibility of future use of the structures, however, and refused to transfer the buildings but offered to work with civilian officials to attempt to maintain them. Despite the Army's need for the buildings, in 1910 Congress authorized the military to turn any structures not needed for military purposes over to the Puerto Rican government. When bubonic plague erupted on the island in 1912, the civilian administrators pleaded with the

83. Note that the U.S. government used "Porto Rico" on all official documents until 1932.
84. Bearss, *San Juan Fortifications, 1898–1958, Historic Structure Report*, 2, 73–74, 81–86, 103–104, 109–117; Foulds, Eliot and Alexandra von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 19–24; Berkowitz et al., *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1, 26.

Army to transfer the rat-infested city walls to them. The Army yielded, transferring some of the walls—but not those of Castillo San Cristóbal.[85]

The Army's limited transfer of structures occurred at a time when the United States had gained military control of the Caribbean with the completion of the Panama Canal in 1914.[86] However, another global conflict was awakening in Europe that would cause the United States to reconsider the need for active use of the San Juan fortifications.

Use of the Fort during World War I and the 1920s

In 1917, the United States granted additional legislative rights to the civilian government of Puerto Rico (as well as U.S. citizenship) but also reasserted its control and use of military fortifications on the island as it entered World War I. After the United States declared war against Germany in 1917, the Porto Rico Infantry Regiment that had been housed on the island was sent to Panama to protect the canal. In its place, the United States installed a detachment of Coast Artillery forces from Florida along with three rapid-fire 4.7-inch Armstrong guns. In 1918, the Army installed one of these guns at La Princesa, a site the U.S. Army saw as advantageous because it was nearly invisible from the city and from steamers. The Florida detachment lived in Castillo San Cristóbal and was charged with protecting the coast from potential attack by German ships and submarines. To facilitate command at Castillo San Cristóbal, the Army constructed a garage for vehicles near Santa Teresa. Armistice occurred just five months after the Army finished emplacing the guns. Not long after, the Army scrapped the guns. The Coast Artillery detachment remained in Castillo San Cristóbal until the Porto Rico Regiment returned from Panama, after which the Coast Artillery departed.[87]

On its arrival, the newly swelled wartime Porto Rico regiment found the fort too small to meet housing needs, but paradoxically there was very little defensive need for the troop presence. During the late 1910s and early 1920s, the Porto Rico Regiment saw very little funding for site improvements, despite the housing shortage and the continued deterioration of city walls. With no need to re-arm the fortifications, it was difficult for the War Department to justify any additional expenditures. The failure of the U.S. military to fund the repair of the walls it had included in its military reservation revived the tension between civilian and military officials in San Juan during this post-war era. After the civilian government approved its own funding to repair the walls, the War Department secured funding to do so as well. In 1924, the Army began repair and restoration of its walls. Civilian dissatisfaction did not abate, however, as the civilians disagreed with the way in which the Army repaired the walls by using concrete—a durable but incompatible material from a historic preservation standpoint—instead of masonry work more sensitive to the original methods of construction. When the Army completed its repair work in 1927, including riprapping sea walls, tensions between the two controlling agencies in the city remained high. There was an increase in outmigration from San Juan to the United States during this period, further evidence of civilian dissatisfaction with a general lack of funding and self-determination. Meanwhile, the housing shortage remained, and it is possible that the Army erected a tent city on the Castillo San Cristóbal outworks to provide the needed beds. In 1929, the War Department finally approved funding for increased Army housing in

85. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 24, 27–29; Bearss, *San Juan Fortifications, 1898-1958, Historic Structure Report*, 157–174.
86. Latané, "The Effects of the Panama Canal on Our Relations with Latin America," 84–85.
87. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site,*30–31; Bearss, *San Juan Fortifications, 1898–1958, Historic Structure Report*, 143–144, 150–155.

San Juan as part of a worldwide effort to improve housing (not for defensive necessity).[88]

Continued Funding Shortages and A New Alternative: 1930–1939

Although the War Department approved funding for a worldwide improvement in military housing in 1929, funding shortages for upkeep of the massive Spanish fortifications in San Juan persisted and only intensified during the Great Depression. Political tensions remained high in Puerto Rico, where the American military retained control of many of San Juan's structures and American companies dominated land ownership and exporting businesses, leaving local residents underemployed. As protests advocating independence erupted around Puerto Rico, the federal government sought solutions in the Depression-era federal relief programs that would employ local residents while addressing the deteriorating conditions of the historic structures. Relief funding failed to materialize for most of the decade, but another solution for the buildings presented itself in a new tourism initiative.[89]

During the 1930s, the tension between the U.S. government and the Puerto Rican government continued to manifest itself in civilian protests over the deteriorating historic fortifications. In 1932, for example, the Chief Army Engineer called attention to the fact that the Spanish military had continually repaired and maintained the fortifications through daily small actions. In contrast, the United States had allowed major structural deterioration to occur and only funded necessary projects when safety was a concern. When Congress eliminated an appropriation for a new daily maintenance program at the San Juan fortifications, the Puerto Rican government protested it. Meanwhile, the Army unsuccessfully sought Civilian Conservation Corps (CCC) or Works Progress Administration (WPA) relief funding for repair work in San Juan throughout the early 1930s.[90]

While the Army failed to get funding for repair of the old structures in the early 1930s, the 1929 War Department housing initiative resulted in the 1930 and 1931 construction of ten new officers' bungalows on the outworks near La Princesa. (In fact, the bungalows required the dismantling of part of La Princesa, the destruction of the old defensive lines and some tunnels, and the relandscaping of the outworks field.) The War Department also spent over $100,000 on sidewalks, roads, and utilities between 1930 and 1931 (including roads, water, sewer, gas, and electricity); converted the El Abanico Guardhouse to a garage; and fenced the outworks along the ocean cliffs to complete the La Princesa housing development. In 1939, the Army approved the construction of a laundry wing on each of the La Princesa bungalows, and the demolition of the Army garage to be replaced by a concrete laundry building.[91]

During the construction of the La Princesa houses, the federal government under new President Franklin Roosevelt sought solutions to the worsening economic conditions in Puerto Rico as an extension of his relief programs on the mainland. Roosevelt's government saw potential opportunities in a tourism campaign to bring U.S. dollars to the island. American tourism to Puerto Rico had started on a small scale in the 1920s, but by the 1930s there were only two foreign-owned tourist hotels and a handful of restaurants and nightclubs geared to tourists in San Juan. U.S. officials determined to bring economic development to the island through tourism in the 1930s and directed the federally appointed

88. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 36–38; Bearss, *San Juan Fortifications, 1898–1958, Historic Structure Report*, 179, 181–194, 213–228; Burchardt, "Lessons Learned: The Legacies of Spanish Colonialism," 332.
89. Burchardt, "Lessons Learned: The Legacies of Spanish Colonialism," 332.
90. Bearss, *San Juan Fortifications, 1898-1958, Historic Structure Report*, 249–253.
91. Berkowitz et al., *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1, 26; Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 7–8, 38–39; Bearss, *San Juan Fortifications, 1898–1958, Historic Structure Report*, 317–323, 328.

governor to beautify roads, improve accommodations, establish a tourism bureau, and hire a U.S. public relations firm to advertise the attractions of Puerto Rico. In support of this campaign, Eleanor Roosevelt traveled to San Juan in 1934 with press coverage.[92]

The tourism campaign ultimately failed to take hold during the 1930s, in part because of depressed economic conditions in the United States, but also because of the conflicting commonwealth and independence movements in Puerto Rico and their attendant episodes of unrest and violence (much of which was directed against the United States). However, another opportunity presented itself. While tourism did not present an immediate solution, the attention the campaign brought to the island did attract the eye of the NPS. Eleanor Roosevelt's visit to the island brought visibility to the historic fortifications there, and the NPS took an interest. In 1934, NPS representatives Harold Bryant and George Wright visited Puerto Rico to look for natural and historical properties of significance. The men reported enthusiastically on the San Juan fortifications. Although the War Department, having just expended significant funds on new housing, opposed the idea of transferring any of its San Juan reserve to the NPS, the idea took root. With the president and Congress behind the idea, the War Department expressed some interest in allowing greater tourist access to the fortifications.[93]

As the military build-up in Germany intensified toward the end of the 1930s, federal discussion of transferring the San Juan fortifications in whole or in part to the NPS paused. The potential defensive use and later tourist use of the fortifications led to the site finally receiving some WPA funds in 1938, 1939, and 1940. With the funding, the Army conducted much-needed repairs to La Garita del Diablo, the mapping and rehabilitation of some of the tunnels, repairs to the north sentry box of Castillo San Cristóbal, vegetation and debris removal, and seawall restoration. The future management of the site, however, remained unresolved as war broke out in Europe.[94]

World War II and the Decline of Military Use: 1939–1949

In July 1939, in response to European mobilization, the War Department activated the Puerto Rican Department, which had no coast artillery installations at the time. U.S. military officials recognized the strategic importance of protecting the fortifications in San Juan for controlling access to the Panama Canal, for supporting Atlantic fleets, and for aircraft support of land areas around the Caribbean. Military officials also recognized the danger of allowing potential enemy forces to occupy the island, with its proximity to the mainland U.S., the Panama Canal, and important sea lanes. The War Department projected that the most likely threat to San Juan would be from the air, but that as long as the United States maintained control of the skies, any attack would be limited to small-scale raids by one or a few naval-based aircraft. If the United States lost control of the air, San Juan could face an attack by sea. Thus, the War Department armed San Juan for both possibilities, hoping that sea defenses would prevent any land invasion. In October 1939, the War Department sent antiaircraft artillery and seacoast artillery to

92. Bearss, *San Juan Fortifications, 1898–1958, Historic Structure Report*, 255; Dennis Merrill, "Negotiating Cold War Paradise: U.S. Tourism, Economic Planning, and Cultural Modernity, in Twentieth-Century Puerto Rico," *Diplomatic History* 25, no. 2 (Spring 2001), 186.
93. Merrill, "Negotiating Cold War Paradise: U.S. Tourism, Economic Planning, and Cultural Modernity, in Twentieth-Century Puerto Rico," 188–189; Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 40–41; Bearss, *San* Juan Fortifications, 1898-1958, Historic Structure Report, 256–257; W.P. Crawford, "Profile: San Juan National Historic Site," (1991), Folder 13, Box 39, SJNHSA, 1-2.
94. Bearss, San Juan Fortifications, 1898-1958, Historic Structure Report, 258, 269–293; Foulds and von Bieberstein, Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site, 42–43.

San Juan (and sent more in October 1940), along with artillery troops to operate them.[95]

La Princesa offered one of the best locations in San Juan for the emplacement of new guns. The battery still retained many of its 1897 structures, the magazines had not irrevocably deteriorated, and it was less visible from the air than other fortifications. The only problem with the site was its close proximity to the 1930 housing development, making the storage of explosives near the site impractical. In 1940, Army engineers constructed four gun emplacements at La Princesa and surrounded them with sandbags to prevent widespread damage to the officer housing in the event of an explosion or gun failure. They finished the emplacements just months before the attack on Pearl Harbor.[96]

In addition to La Princesa, the Army made use of the other historic fortifications in the city for additional wartime necessities and renamed the fortifications Fort Brooke. Principal among the changes at Castillo San Cristóbal were the installation of two fire control stations and a radar tower, and the retrofitting of the north casemates to hold the generator and transmitter for the radar tower. In 1942, the War Department funded the construction of the Joint Command Center in the Castillo San Cristóbal moat where Army, Navy, and Marine Corps forces could coordinate efforts. Conveniently, Castillo San Cristóbal was able to house officials from all three branches of the military during the war. A mechanic garage and ship signal tower completed the World War II San Cristóbal harbor defense updates. Plans to build additional housing on the glacis east of El Abanico, which the Army leveled, were never realized.[97]

Although the military base at San Juan was strategically important during World War II, the historic defensive structures were not. In 1945, the Army dismantled the La Princesa gun emplacements. The Army continued to occupy Castillo San Cristóbal in the decade following the war, but there was little need to maintain the historic fortifications for defensive purposes. Indeed, during the war the Army had not spent any funds on repairing the historic structures and they were rapidly crumbling. Federal officials argued that the NPS was better prepared to preserve the historic buildings than the Army was and that NPS management could draw tourism to the island. The War Department remained opposed to any transfer of the military reserve to the NPS, but through negotiation the Department of the Interior and the Department of War worked out an agreement whereby the NPS would provide visitor services at the historic structures and develop a plan for their preservation, while the Army would retain control of the buildings, delegate access to them, and fund any repair or maintenance work. The Department of the Interior and the Department of War signed a cooperative agreement on the management of the fortifications in September 1948, and in 1949, the San Juan fortifications (including El Morro, Castillo San Cristóbal, the city walls from Castillo San Cristóbal to San Juan Gate (inclusive), El Cañuelo, and Casa Blanca) became the San Juan National Historic Site under this joint management agreement.[98]

95. Foulds and von Bieberstein, Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site, 43; Bearss, San Juan Fortifications, 1898-1958, Historic Structure *Report*, 331–333.
96. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 8, 43–46; Bearss *San Juan Fortifications, 1898-1958, Historic Structure Report*, 341–345.
97. Bearss, *San Juan Fortifications, 1898-1958, Historic Structure Report*, 356–359, 365–368, 373–376; Berkowitz et al., *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1, 26; Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 8, 46–48.
98. Foulds and von Bieberstein, *Cultural Landscape Report for the* San Cristóbal Outworks, San Juan National Historic Site, 8, 46–49; Torres-Reyes, "Historical Studies Plan," 9.

Restoration and Preservation: From Military Use to Historic Preservation, the NPS Era: 1950–present

The postwar era brought major changes to the island of Puerto Rico. After several attempts at independence, which failed in Congress, the United States granted Puerto Rico commonwealth status in 1952. The status conferred limited self-government on the island under U.S. oversight and sparked new efforts to improve the island's economy. One pillar of this new focus was a restructured tourism campaign funded by the insular government. In 1948, the tourism bureau hired a public relations firm to enhance Puerto Rico's image by highlighting the island's climate, natural beauty, and historic structures. The following year, coincident with the designation of the San Juan fortifications as the San Juan National Historic Site, the new Puerto Rican legislature passed a law designating Old San Juan as an "ancient and historical zone" and hired advisors from Colonial Williamsburg to help make Old San Juan an attraction while retaining its authenticity.[99] In contrast to the 1930s, this campaign took root and the new Institute of Puerto Rican Culture began investment in the restoration and redecoration of the historic buildings outside of the military reserve. In the late 1950s, approximately 250,000 tourists visited Puerto Rico. Less than a decade later that number had doubled, and the Institute for Puerto Rican Culture had rehabilitated twenty-five of the historic structures in Old San Juan, where tourist shops and restaurants sprang up. By the mid-1960s, Puerto Rico was the most visited island in the Caribbean.[100]

Early Joint Management and the Transition to the NPS

Unlike the Puerto Rican government's coordinated approach to tourism in the late 1940s and early 1950s, the NPS and the Army struggled to effectively merge tourism and military use at the fortifications. Under the new joint management structure of the National Historic Site, the historic structures continued to deteriorate and tourist and NPS access to the fortifications was limited. The Army gave the NPS office space in Building 4 of Fort Brooke when the first superintendent, David J. Jones, arrived in San Juan in December 1949. The first staff of the historic site included Superintendent Jones, Historian Clarence Johnson, an architect, and two Puerto Rican aides. Working with a very limited budget and in cramped quarters, this first NPS staff began collecting historical information to serve as the foundation of interpretive material and programming and started leading tours of El Morro. However, their most urgent task was to encourage the Army, which still held the purse strings on the fortifications, to fund structural stabilization projects. However, the War Department was focused on the developing conflict in Korea during the 1950s and following the Korean War, the Army saw no use for continuing to hold the historic masonry fortifications within the military reserve.[101]

Tourism to San Juan began to increase rapidly in the mid-1950s as cruise ships and conferences included the city in their scheduling, the city opened a new international airport, and local Puerto Ricans took advantage of the new visitation options. The NPS staff under Superintendent Harold Hubler worked to meet the needs of the rising number of tourists, running at least two tours a day of El Morro, conducting driving tours,

99. Merrill, "Negotiating Cold War Paradise: U.S. Tourism, Economic Planning, and Cultural Modernity, in Twentieth-Century Puerto Rico," 199.
100. Merrill, "Negotiating Cold War Paradise: U.S. Tourism, Economic Planning, and Cultural Modernity, in Twentieth-Century Puerto Rico," 179, 189–194, 199–201.
101. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 8–9, 50; Berkowitz et al., *The Fortifications of San Juan National Historic Site, Historic Structure* Report, Volume 1, 11; Gregorio Batista, "Administrative History of San Juan National Historic Site," (1984), Folder 204, Box 14, SJNHSA, 4.

operating an information center, and maintaining a library of books on the site's history for student and professional use. The NPS needed more visitor facilities, more parking options, and more options for tourists beyond the limited number of tours. Through its Mission 66 prospectus, the NPS envisioned acquiring more control over the historic structures and opening more of them, including Castillo San Cristóbal, to the public. The NPS saw further potential in Castillo San Cristóbal for a visitor contract station and administrative offices. The prospectus expressed concern, however, over the state of the historic walls of the site and noted that some of the more recent structures were not in keeping with the historic landscape of the fortifications. Until the buildings transferred to the NPS, however, the agency had to submit all its plans to the Army for approval, had to work around military use of the buildings, and faced restrictions on visitor use of most areas.[102]

In November 1955, the Secretary of the Army approved the transfer of the first three parcels of San Juan National Historic Site to the Department of the Interior. These first structures were part of the south and southwest city walls, some of which the NPS later transferred to San Juan's municipal management. The plan was for the remainder of the buildings, including Castillo San Cristóbal, to transfer over the next ten years.[103] While the NPS waited for other structures to transfer, it received permission in 1959 to do some emergency work on El Abanico to deal with vegetation and drainage problems that threatened the integrity of the structure. This effort began in April 1959 and included construction and installation of a boundary fence, removal of debris, landscaping, removal of vegetation on masonry walls, repair of masonry walls including the stucco finishes, and repairing cracks on stairs and walks. The NPS also demolished twentieth-century additions north of El Abanico and used collected debris to repair a washed-out section of the glacis east of El Abanico. The project was mostly complete (aside from landscaping) by 1960.[104]

Work on El Abanico occurred in tandem with that on the Plaza de Armas at El Morro, both authorized by a deferral of projects planned at Colonial National Historical Park in Virginia. It was some of the earliest restoration the NPS had undertaken in San Juan, and Supervising Architect Charles Peterson noted in a 1960 inspection report that the work, especially on the mortar finish, was not done in accordance with NPS standards. He reflected that this was likely caused by language barriers and the lack of an on-site architect, as the architect supervising the work was stationed at Virgin Islands. Peterson advised that the NPS not conduct any further restoration or preservation work until the NPS could fund an inspector position in San Juan to oversee reproduction of old finishes.[105] Soon after, the regional director requested that the San Juan superintendent find funding (or provide an estimate) for repainting of the El Abanico mortar with a cement paint to match the surrounding older walls.[106]

As the Army was in the process of withdrawing from the historic fortifications several seawalls partially collapsed, including the seawall in front of La Princesa. In response, the Army Corps of Engineers and the NPS agreed that an extensive

102. "Annual Report on Information and Interpretive Services, San Juan NHS, 1955," (February 2, 1956), Folder 358, Box 54, SJNHSA, 1-2; Harold Hubler to Director of the NPS, "Mission 66 Resume, San Juan, National Historic Site," (February 14, 1956), Folder 257, Box 15, SJNHSA; "Prospectus for San Juan National Historical Site," (c. 1956), Folder 257, Box 15, SJNHSA, 3-8.
103. Paul Swartz, "Master Plan of San Juan National Historic Site: Chapter 1," (July 23, 1964), Folder 250, Box 15, SJNHSA, 2.
104. "Completion Report of Construction Project: Rehabilitation of El Abanico Fort," (May 1962), Folder 189, Box 42, SJNHSA; "Annual Narrative Report on Information and Interpretive Service for San Jan National Historic Site, 1959," Folder 358, Box 54, SJNHSA, 2.
105. Charles Peterson to Acting Chief, EODC, "Sample Masonry Restoration, El Abanico, San Juan," (January 28, 1960), Folder 189, Box 42, SJNHSA, 1-3.
106. Regional Director to Superintendent, "El Abanico," (June 30, 1960), Folder 189, Box 42, SJNHSA.

repair program was necessary to protect the buildings. With its decision to withdraw from the buildings, the Army required the NPS to fund the work but agreed to have the Army Corps of Engineers start work immediately, with the NPS to provide reimbursement. The repair program progressed throughout the late 1950s. In 1961, El Morro, Castillo San Cristóbal, the north city wall, and several other structures passed to the NPS for management of all maintenance, care, operations, and improvement. The Army retained control of access to the sites and had the power to reclaim them in the event of a national emergency (Figure 9). The Army retained the La Princesa housing development and the outworks around it but only for a few years. In December 1965, the Army deactivated its Antilles Command (based in San Juan) and its holdings in San Juan became extraneous. The following year the Army vacated most of the structures in San Juan, save a few associated with the Rodriguez Army Hospital. The La Princesa housing, transferred first to the Navy in 1966 and then to the NPS in 1973, was the last of the structures within the larger Castillo San Cristóbal outwork grounds to come under NPS management.[107]

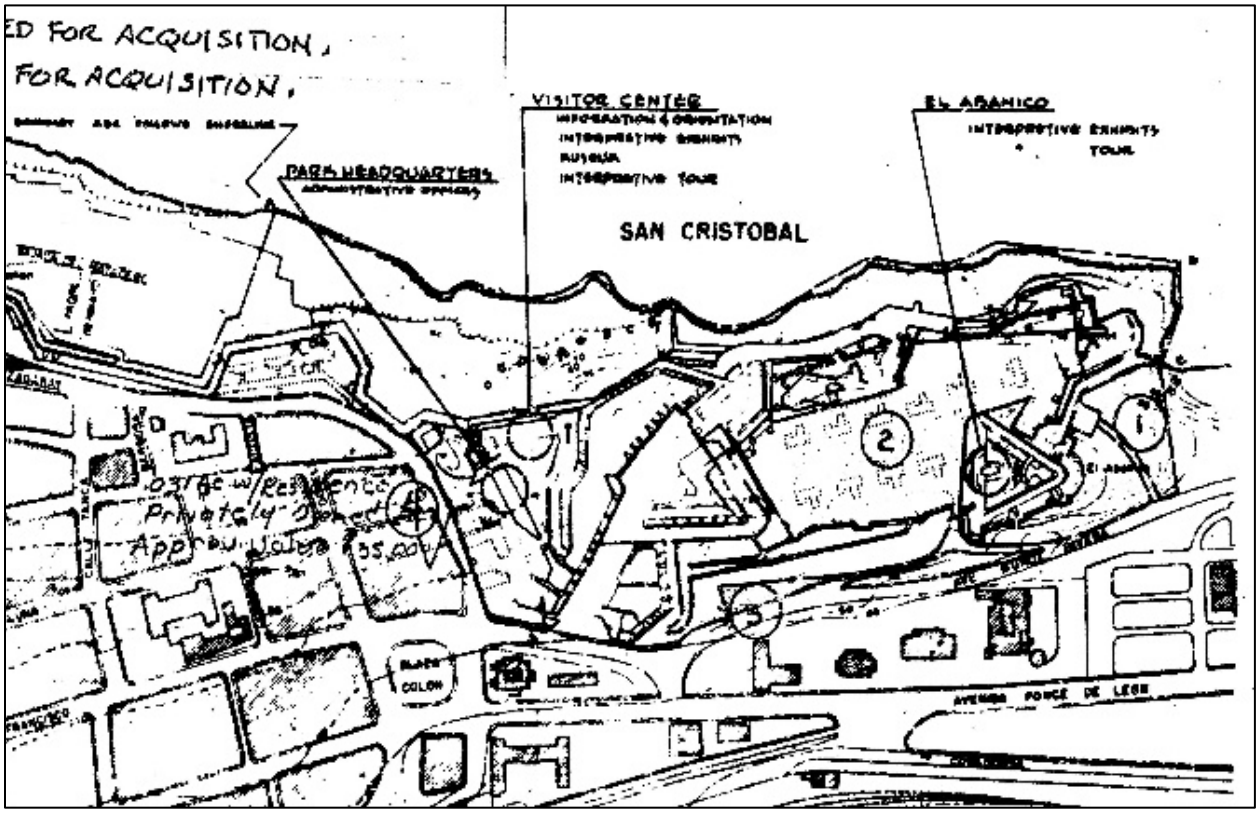


Figure 9. Excerpt from a 1963 map showing Castillo San Cristóbal with NPS and Army areas delineated. Note the presence of La Princesa housing marked with a number 2 at right. (Source: SJNHS, Park Archives, SAJU_393_2001B)

107. Foulds and von Bieberstein, Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site, 50–56; Bearss, San Juan Fortifications, 1898-1958, Historic Structure Report, 391–400; Ricardo Torres-Reyes, "Historical Studies Management Plan," (1972), Folder 331, Box 52, SJNHSA, 9.

Early Restoration, Rehabilitation, and Use by the NPS

By the late 1950s, visitation of San Juan National Historic Site was exceeding 200,000 visitors annually, yet the park's interpretive activities were focused entirely at El Morro, where the only visitor option was a guided walk through the fort. In 1960, the NPS started offering special guided tours of Castillo San Cristóbal and El Abanico.[108] With the transfer of maintenance responsibilities at Castillo San Cristóbal from the Army to the NPS in 1961, the NPS immediately began plans to convert some of Castillo San Cristóbal into NPS office space while adding facilities, such as restrooms, to accommodate higher visitor use of the fort. In July 1961, the NPS authorized an Historic Structure Report (HSR) for the officers' quarters (completed in April 1962) and in August 1961 student architect Ladd Ehlinger submitted Historic American Building Survey (HABS) drawings of the quarters. The NPS approved construction plans by architect Woodrow Wilkins and San Juan Superintendent Kittridge Wing to convert the officers' quarters into NPS offices in the fall of 1961 and work began immediately after the Army formally signed over Castillo San Cristóbal to the NPS. Some of the NPS offices had moved over to Castillo San Cristóbal by November 1961, and the park headquarters fully moved to Castillo San Cristóbal at the completion of construction in June 1964.[109] The officers' quarters work had involved removing masonry between casemate one and two, removing a partition between the fourth and fifth bays of the gallery, removing masonry at the opening between the fourth and fifth casemates, closing the windows flanking the officers' bath, closing the window on the north elevation, and removing a partition at casemate 5. The NPS removed old shutters, doors, and frames in casemates 1 through 5 and rooms 1 and 2 and installed new conduit, fixtures, outlets, and 220v service to the area. Where necessary, the NPS patched and repaired masonry in the former quarters.[110]

While the NPS immediately began making use of the Castillo San Cristóbal officers' quarters for its headquarters, it took longer for the development of visitor use of the site. The NPS simply did not have enough personnel to offer tours of both El Morro and Castillo San Cristóbal. Although the NPS quickly implemented an orientation program at Castillo San Cristóbal in late 1961 and had a small exhibit space in the Castillo San Cristóbal guardhouse, it could only offer tours of the building when it had enough staff to do so. During the early 1960s, the Army approved open public access to El Morro, but Castillo San Cristóbal access was constrained by the need to conduct maintenance and construct visitor service facilities after Army use. By the spring of 1962, the NPS had constructed a parking lot adjacent to the ramp entrance to Castillo San Cristóbal (removing brick walkways and some trees to do so) and was running twice daily tours of Castillo San Cristóbal when personnel and visitors were available. To further interpretation of the site, the NPS acquired cannons for Castillo San Cristóbal, placed liturgical ornaments in the chapel, and focused on improving public relations with the community.[111]

108. "Annual Narrative Report on Information and Interpretive Service for San Jan National Historic Site, 1959," Folder 358, Box 54, SJNHSA, 2; "Annual Narrative Report on Information and Interpretive Service for San Jan National Historic Site, 1960," Folder 358, Box 54, SJNHSA, 3.
109. "Calendar–Construction Program, Officers' Quarters, San Cristobal," Folder 183, Box 41, SJNHSA; "Completion Report: Convert Fort Rooms to Office Space—San Cristobal," (June 1964), Folder 181, Box 41, SJNHSA.
110. "Completion Report: Convert Fort Rooms to Office Space—San Cristobal," (June 1964), Folder 181, Box 41, SJNHSA.
111. Kittridge Wing, "Superintendent's Monthly Narrative Report, December 1961," (January 12, 1962), Folder 9, Box 29, SJNHSA, 1-3; "Annual Narrative Report on Information and Interpretive Service for San Jan National Historic Site, 1961," Folder 358, Box 54, SJNHSA, 1-3; Kittridge Wing, "Superintendent's Monthly Narrative Report, March 1962," (April 11, 1962), Folder 9, Box 29, SJNHSA, 1-3; Julio Marrero-Nuñez, "Superintendent's Monthly Narrative Report," (July 5, 1962), Folder 9, Box 29,

During the latter half of 1962, the NPS turned its attention to the troops' quarters and north casemates at Castillo San Cristóbal. NPS Architect Woodrow Wilkins relocated to San Juan for the summer and oversaw HABS work on the troops' quarters and north casemates while the NPS employed workers to rewire the areas (for air conditioning) and patch damaged plaster and masonry. Wilkins also advised the NPS on which structural features around the fort had no historical value and could be demolished. Wilkins, perhaps using the HSR on the officers' quarters as a guide, used a date of 1861 in determining which structures could be demolished. The final work on the officers' quarters also sought to reproduce an 1861 appearance. Replicas of the 1861 hinges, doors, windows, and shutters were installed in the quarters in 1963.[112]

As the Army continued its withdrawal from Castillo San Cristóbal, the NPS used funding from the Accelerated Public Works Program to conduct a general clean-up and repair of the north wall and Castillo San Cristóbal and its outworks. The labor for this effort, with as many as 878 workers hired for economic relief, was not skilled and did not address the major structural issues, particularly related to foundations, at the historic site. However, it provided much-needed repairs to masonry and excavated some of the outworks covered by earth during wars.[113]

In March 1965, NPS Assistant Superintendent William Bromberg completed Chapter Three of San Juan National Historic Site's Master Plan.[114] This plan outlined programs for "Preservation and Restoration of Historical Features and Environs" and "Maintenance and Protection of Facilities" as well as for interpretation and historic collections. However, the plan did not provide clear guidelines on how to manage the structures built after the Spanish occupancy, nor how to choose a date within the Spanish period to focus restoration efforts on. The aim of the preservation and restoration program, as described in this report was to, "maintain the historical featuers [sic] of the fortifications, restoring whenever possible the original historical structures to conditions during Spanish occupation. In accomplishing this, the architectural style of each construction period will be maintained."[115] The report noted this would allow for "more accurate" interpretation for visitors.[116] The report also stated that the structures were generally in good repair, but that the maintenance team had to contend with erosion and deterioration. The iron and woodwork in doors, windows, rails, and other adornments required frequent attention and the scale of the fortifications required a large team just to keep up with small projects. The most "serious threat" to the buildings was "the erosive effect of wave action against the sand foundation of the city wall. This has required reconstruction of dislodged

SJNHSA, 1-3; Julio Marrero-Nuñez, "Annual Narrative Report on Information and Interpretive Service for San Jan National Historic Site, 1962," Folder 358, Box 54, SJNHSA, 1-7; "Completion Report of Construction Project—Construction of Parking Area," (May 28, 1962), Folder 206, Box 43, SJNHSA.

112. Woodrow Wilkins to San Juan Superintendent, "Demolition of Modern Construction, San Cristobal," (June 18, 1962), Folder 364, Box 54, SJNHSA, 1-2; Julio Marrero-Nuñez, "Superintendent's Monthly Narrative Report," (July 5, 1962), Folder 9, Box 29, SJNHSA, 1-5; Kittridge Wing to Regional Director, "Program Adjustment, San Cristobal Officers' Quarters," (April 3, 1962), Folder 182, Box 41, SJNHSA, 1; Julio Marrero-Nuñez, "Superintendent's Monthly Narrative Report," (November 7, 1962), Folder 9, Box 29, SJNHSA; Julio Marrero-Nuñez, "Superintendent's Monthly Narrative Report, October," (November 7, 1963), Folder 8, Box 29, SJNHSA, 2-3.
113. Foulds and von Bieberstein, Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site, 9–10, 51–53.
114. William Bromberg, "Master Plan of San Juan National Historic Site, Chapter 3," (March 31, 1965), Folder 250, Box 15, SJNHSA.
115. William Bromberg, "Master Plan of San Juan National Historic Site, Chapter 3," (March 31, 1965), Folder 250, Box 15, SJNHSA, 1.
116. William Bromberg, "Master Plan of San Juan National Historic Site, Chapter 3," (March 31, 1965), Folder 250, Box 15, SJNHSA, 1.

masonry."[117] In approaching the maintenance and repair, the report advised "preserving the feel of the forts and their surroundings" such that they did not appear new.[118] The plan also advised that the NPS complete research on how to authentically restore the fortification features and, once research was completed, restore the gates, glacis, drawbridges, and other features for their interpretive value. It did not recommend a period of focus for this restoration.[119]

The Master Plan also outlined responsibilities for the maintenance and protection of facilities. According to the plan, this NPS division was focused on safely moving people through the fortifications and allowing for administration of the site. The maintenance team repaired walls and sidewalks, cleaned the grounds, did general upkeep and signage repair, and mowed and cleaned the grounds of the outworks. The maintenance crew was headquartered in the "utility area" of Castillo San Cristóbal. Telephone, power, water, and garbage disposal was administered out of the Army's facilities. The plan noted that by keeping the maintenance team within the historic fortifications, it could not grow to meet operational needs. The plan therefore recommended that the maintenance base be moved outside the historic fortifications.[120]

Although the initial 1964 Master Plan for San Juan National Historic Site did not provide a cohesive vision for Castillo San Cristóbal and its outworks, by the late 1960s, the San Juan park administration had developed a general vision for the fortress that used the Castillo San Cristóbal Guard House as a visitor contact station and envisioned the troops' quarters and north casemates as San Juan National Historic Site's principal visitor center and museum.[121] The park intended to open more of Castillo San Cristóbal to visitor use, including the fort's outworks and tunnels, but they had to be made safe and accessible first.[122]

As noted in the 1964 Master Plan, it was important to the NPS that the modifications necessary for increasing accessibility of Castillo San Cristóbal look historic, but the NPS was still learning about the history of the buildings under its management and required more funding to move forward with its restoration objectives. In 1966, the NPS administratively listed the San Juan Historic Site structures in the National Register of Historic Places, (improving access to restoration funding) and over the next few years submitting funding requests for additional HSR work on Castillo San Cristóbal.[123] In 1969, the NPS applied for funding of a Castillo San Cristóbal courtyard HSR and an HSR that would cover the troops' quarters and

117. William Bromberg, "Master Plan of San Juan National Historic Site, Chapter 3," (March 31, 1965), Folder 250, Box 15, SJNHSA, 2.
118. William Bromberg, "Master Plan of San Juan National Historic Site, Chapter 3," (March 31, 1965), Folder 250, Box 15, SJNHSA, 2.
119. William Bromberg, "Master Plan of San Juan National Historic Site, Chapter 3," (March 31, 1965), Folder 250, Box 15, SJNHSA, 2.
120. William Bromberg, "Master Plan of San Juan National Historic Site, Chapter 3," (March 31, 1965), Folder 250, Box 15, SJNHSA, 4.
121. Division of Land Acquisition Map, "San Juan National Historic Site," (December 3, 1969), ETIC; Charles Marshall to San Juan Superintendent, "RSP, SANJU H-17, Historic Structures Report, San Cristobal," (March 2, 1970), Folder 345, Box 53, SJNHSA; Charles Marshall to Chief, Office of Archeology and Historic Preservation, "RSP SANJU-H-17, Historic Structures Report, Parts I & II, San Cristobal Courtyard," (February 4, 1970), Folder 345, Box 53, SJNHSA; "Historical Resource Study Proposal, Historic Structure Report, Parts I & II, San Cristobal Courtyard," (September 19, 1969), Folder 345, Box 53, SJNHSA.
122. Julio Marrero-Nuñez, "Superintendent's Monthly Report, February," (March 9, 1967), Folder 10, Box 29, SJNHSA, 4; H. Reese Smith to Southeast Regional Director, "Working Drawing No. NHS-SJ 3021A, Utilities Power Distribution, Fort San Cristobal, San Juan," (September 18, 1968), Folder 218, Box 44, SJNHSA, 3; Julio Marrero-Nuñez, "Annual Narrative Report on Information and Interpretive Service for San Jan National Historic Site, 1963," (January 31, 1964) Folder 358, Box 54, SJNHSA, 4-5.
123. Foulds and von Bieberstein, Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site, 53–55.

north casemates.[124] In 1971, the NPS requested funding for a full Castillo San Cristóbal HSR and an updated HSR for El Abanico, La Princesa, and Santa Teresa that would explain the construction history of the outworks.[125] In 1972, funding for the Castillo San Cristóbal HSR still had not come through when Historian Ricardo Torres-Reyes made it the highest priority research project in the park, noting: "This is the most important research project for the San Juan area. With the exception of the central patio or plaza in the main part of the fort, Castillo San Cristóbal remains undeveloped. An exhaustive historic structures report is needed for planning and scheduling a realistic development and conservation program."[126]

Without a guiding history document, but needing to advance visitor services, in the late 1960s and early 1970s the NPS made modest changes to Castillo San Cristóbal such as removing a wall in the future troops' quarters museum to improve visitor flow; installing historic appearing lamp fixtures in the troops' quarters, north casemates, and tunnels; reconstructing the masonry of the wellheads; replacing the main gates and south gate of Castillo San Cristóbal; removing modern intrusions from the entrance area; and sandblasting exterior surfaces.[127] The work created a jumbled mix of period interpretation. As the NPS noted in its 1973 National Register documentation for San Juan National Historic Site, during its first efforts at restoration of the site, the NPS had restored Castillo San Cristóbal area buildings to the following periods: well houses on the plaza (1775), east loggia of officers' quarters (1775), troops' quarters (1771), El Abanico (1783), north casemates (1785), chapel (1861), and guardhouse at El Abanico (1896).[128]

Major Structural Work and Security Concerns

As the NPS focused its attention on converting Castillo San Cristóbal to its administrative and visitor use purposes, larger structural problems threatened the fort. Although a 1971 U.S. Army Corps of Engineers report had warned of the threat sea erosion presented to the north wall of Castillo San Cristóbal and the outworks, NPS staff had yet to address the problem.[129] In August 1973,

124. "Historical Resource Study Proposal, Historic Structure Report, Parts I & II, San Cristobal Courtyard," (September 19, 1969), Folder 345, Box 53, SJNHSA.
125. "Professional Services Proposal—Historic Structures Report Parts I & II, San Cristobal's Courtyard," (October 12, 1971), Folder 345, Box 53, SJNHSA; "Professional Services Proposal—Historic Structure Report, Architectural Data, Forts El Abanico, La Princesa, and Santa Teresa," (October 12, 1971), Folder 344, Box 53, SJNHSA.
126. Ricardo Torres-Reyes, "Historical Studies Management Plan," (1972), Folder 331, Box 52, SJNHSA, 23.
127. Julio Marrero-Nuñez, "Annual Narrative Report on Information and Interpretive Service for San Jan National Historic Site, 1963," (January 31, 1964) Folder 358, Box 54, SJNHSA, 2-5; "Completion Report—Forts El Morro and San Cristobal, North Wall," (July 1966), Folder 197, Box 42, SJNHSA; Rene Purcell-Bauza, "Superintendent's Monthly Narrative Report for October 1964," (November 4, 1964), Folder 12, Box 29, SJNHSA, 3; "Completion Report—Fort San Cristobal Rehabilitation of Walls, Pavements & Outworks," (June 1967), Folder 197, Box 42, SJNHSA; William Bromberg, "Superintendent's Monthly Narrative Report for April," (May 6, 1966), Folder 11, Box 29, SJNHSA; Julio Marrero-Nuñez, "Superintendent's Monthly Report for April," (May 15, 1967), Folder 10, Box 29, SJNHSA; Lawrence Coryell to San Juan Superintendent, "Utilities Power Distribution, Fort San Cristobal," (March 19, 1969), Folder 217, Box 44, SJNHSA; "Completion Report—Fort San Cristobal, Utilities Power Distribution," (July 9, 1969), Folder 219, Box 44, SJNHSA; "Completion Report—Castillo de San Cristobal Restoration Wellheads," (April 4, 1972), Folder 204, Box 43, SJNHSA; "Specifications for Restoration of Wellheads, El Morro and San Cristobal Addendum 1," (May 30, 1972), Folder 204, Box 43, SJNHSA.
128. F. C. Gjessing and Loretta Schmidt, *San Juan National Historic Site, National Register of Historic Places Inventory-Nomination Form*, (1973), 4, 14 (PDF).
129. F. Ross Holland, Jr., and Russell Jones, "Special History Study: Masonry Forts of the National

at the direction of NPS Director George Hartzog, F. Ross Holland, Jr., and Russell Jones authored a Special History Study of Masonry Forts of the National Park Service. Hartzog wanted the study to guide restoration and rehabilitation of these unique historic structures. In their report, Holland and Jones called attention to the "neglect to which the forts have been subjected" and provided as an example the castillos of the San Juan National Historic Site, which were "seriously threatened by sea erosion, a condition that did not spring up overnight. Yet no other action other than studies of the problem have been programmed."[130] The report mentioned the collapse of some of the city wall and gate in San Juan as well as criticized the approach to structural work at Castillo San Cristóbal:

> The soldiers' barracks in San Cristóbal at San Juan National Historic Site is being rehabilitated, not because the historic fabric is deteriorating, but because room for interpretive development is needed. Meanwhile, the great wall of San Cristóbal is eroding on the exterior and the interior, and no work on it is programmed.[131]

The report noted that historic preservation was "a consistent loser" when forced to compete with other areas of park management, such as recreation and natural resources.[132] The authors concluded that the NPS would have to decide if it wanted to retain the masonry forts in the system, and if so, the agency needed to commit to funding their rehabilitation. Once these forts were "put into good physical condition," the NPS would have to commit to maintaining them.[133] The authors urged the NPS to act on the Army Corps' 1971 recommendations for repairing and preventing seawall damage. They also urged the NPS to work on repairing damaged drains and filling cavities and gullies on the surface of the structures.[134]

Despite the urgency for structural repairs voiced in the Holland Jones report, Congress's first action in response to the document was to authorize the Department of the Interior and the Department of Defense to conduct more studies on the "cause and extent of damage" to the San Juan fortifications.[135] Between 1974 and 1983, while work to establish the Castillo San Cristóbal museum and other services for visitors continued, the Army Corps of Engineers undertook multiple studies of sea erosion, including building scale models, on behalf of the NPS.[136] Following the first studies, and contemporaneous with further studies, the NPS began funding construction work to protect the San Juan fortifications from the sea. A construction contract awarded in October 1978 authorized the filling of caves below La Princesa (which had transferred to NPS ownership in 1973) with cement to protect against failure of its walls. A contract awarded in 1980 funded several retaining walls at La Princesa, a toe wall at the base of Castillo San Cristóbal, filled more caves between La Princesa and Castillo San Cristóbal with concrete, and protected walls around the Devil's Sentry Box with concrete-filled grout bags. As part of the construction activities, workers began building a trail along the foot of Castillo San

Park Service," (Denver: National Park Service, August 1973), 3.

130. Holland and Jones, "Special History Study: Masonry Forts of the National Park Service, iii.
131. Holland and Jones, "Special History Study: Masonry Forts of the National Park Service," iv.
132. Holland and Jones, "Special History Study: Masonry Forts of the National Park Service," v.
133. Holland and Jones, "Special History Study: Masonry Forts of the National Park Service," v-vi.
134. Holland and Jones, "Special History Study: Masonry Forts of the National Park Service," 3.
135. "Water Resources Development by the U.S. Army Corps of Engineers in Puerto Rico and the U.S. Virgin Islands," (Atlanta: US Army Engineer Division, South Atlantic, January 1981), 41.
136. Lloyd, Whitt, "Annual History—San Juan National Historic Site—1973," (February 6, 1974), Folder 10, Box 29, SJNHSA; Robert Stanton to Luis Rodríguez-Morales, [Proposal], (August 28, 1975), Folder 194, Box 42, SJNHSA; "Completion Report—Troop's Quarters, Fort San Cristobal," (July 2, 1976), Folder 186, Box 41, SJNHSA; Robert Bottin, Jr., "San Juan National Historic Site Design for Prevention of Wave-Induced Erosion," (Jacksonville: US Army Engineer District and National Park Service Southeast Regional Office, September 1979).

Cristóbal to improve access for maintenance activities.[137]

While the Army Corps and construction crews were working on protecting the sea walls, other structural repairs were necessary around the fort. The salt air, tropical sun, humidity, and vegetation ate away at the stone and brick of the forts. The effects of the environment required the continual removal of vegetation and patching of walls.[138] By the mid-1970s the deterioration of Castillo San Cristóbal's stonework was threatening the stability of the main gate, prompting the NPS to consider using stone preservatives (sparingly because of expense) in maintaining the structure.[139] In January 1975, the NPS Southeast Region issued new specifications for masonry repair of historic structures. The directive required the use of lime in place of portland cement in all mortar repair and stabilization work. The NPS intended this change to allow repairs to match surrounding masonry while also providing more structural stability.[140] Moving forward into the new millennium, the NPS continued to replace twentieth-century cement with lime mortar.[141]

During the 1970s and early 1980s with no HSR yet completed, the NPS still hesitated to do major restoration or repair work without knowing more about the history of each structure's construction.[142] Instead, repairs and rehabilitation were prompted by emergencies such as the main gate deterioration noted above and, in 1976, the "imminent collapse" of the timber ceiling (the only remaining timber ceiling in the fort) in the north room of the officers' quarters.[143]

In addition to the damage to the structures caused by the environment, San Juan National Historic Site staff faced additional threats to the Castillo San Cristóbal structures—especially the outworks—following the complete withdrawal of the Army from the site in 1973: vandalism. Although the NPS had long considered removing more recent structures from the Castillo San Cristóbal grounds for interpretive reasons, by the mid-1970s increasing incidents of vandalism and illegal activities in the La Princesa housing (especially) and other outworks provided the necessary urgency to have the housing area demolished.[144] In 1979, the NPS contracted for security services on the outworks grounds, and around 1980 demolished the La Princesa housing.[145] However, with the removal of the buildings, vandalism and illegal activity merely shifted to La Princesa, Santa Teresa, and El Abanico. The NPS's chain link fences around the individual outworks were not a deterrent, nor was the daytime security guard.[146] In 1981, the NPS installed a cyclone fence around the outworks, but

137. "Water Resources Development by the U.S. Army Corps of Engineers in Puerto Rico and the U.S. Virgin Islands," (Atlanta: U.S. Army Engineer Division, South Atlantic, January 1981), 41; "Water Resources Development by the U.S. Army Corps of Engineers in Puerto Rico and the U.S. Virgin Islands, 1987," (Atlanta: U.S. Army Engineer Division, South Atlantic, 1987), 22.
138. Gerald Sleater to Frederick Gjessing, (July 15, 1975), Folder 364, Box 54, SJNHSA, 1.
139. Gerald Sleater to Frederick Gjessing, (July 15, 1975), Folder 364, Box 54, SJNHSA, 2.
140. Associate Regional Director to All Southeast Region Field Offices, "Masonry Specifications for Historic Structures," (January 27, 1975), Folder 364, Box 54, SJNHSA, 2.
141. Wayside Exhibit: "Rehabilitating the Troop Quarters of San Cristobal," n.d., ETIC.
142. Gerald Sleater to Frederick Gjessing, (July 15, 1975), Folder 364, Box 54, SJNHSA, 3.
143. "106 Compliance Statement—Repair North Room of Officers' Quarters, Fort San Cristobal," (July 28, 1976), Folder 201, Box 43, SJNHSA, 1-2.
144. Harold Hubler to Director of the NPS, "Mission 66 Resume, San Juan, National Historic Site," (February 14, 1956), Folder 257, Box 15, SJNHSA; Ricardo Torres-Reyes, "Historical Studies Management Plan," (1972), Folder 331, Box 52, SJNHSA, 11; Park Ranger Batista to Superintendent, "Protection of La Princesa," (May 6, 1981), Folder 330, Box 20, SJNHSA.
145. Lloyd Whitt, "Superintendent's Annual Report," (March 14, 1979), Folder 10, Box 29, SJNHSA; "Superintendent's Annual Report," [n.d., 1980?], Folder 10, Box 29, SJNHSA.
146. Park Ranger Batista to Superintendent, "Protection of La Princesa," (May 6, 1981), Folder 330, Box 20, SJNHSA.

vandalism continued to be an issue, preventing any interpretation of the outworks area.[147]

The NPS's challenges with structural repairs and vandalism did not prevent forward momentum on visitor services development during this period. The park's most concentrated effort was on creating a museum on the ground floor of the troops' quarters. The plan for the museum envisioned using one room to recreate historic troop quarters, two rooms for exhibits, a room with an information desk and benches, and a room for audiovisual presentations.[148] The troops' quarters already had air conditioning by the mid-1970s, but creating the museum required rewiring the rooms (from Army-era wiring) and replacing the iron hardware to provide a consistent, historic appearance. This work began in the late 1970s.[149] The NPS also did enough preservation work on the cisterns below the plaza and the two-story magazines just off the plaza to open them to visitation.[150] In the early 1980s, the NPS determined that it was more important to use the officers' quarters for visitation than for NPS offices and storage space. In 1981 and 1982 the NPS moved most of its administration to buildings along Norzagaray Street.[151]

By the 1980s, San Juan National Historical Site consistently received well over a million visitors a year.[152] The structures attracted worldwide attention and presented a general appearance of eighteenth-century fortifications. In 1984, the United Nations World Heritage program listed the San Juan fortifications on its UNESCO World Heritage List.[153] Rehabilitation, preservation, and repair work continued at Castillo San Cristóbal, but still lacked overall direction for restoration activities. This was remedied through four different documents in 1984 and 1985.

Formalizing Preservation at Castillo San Cristóbal

During the 1960s, 1970s, and early 1980s, the NPS operated the San Juan fortifications, including Castillo San Cristóbal, without a cohesive plan for how it wanted to pursue its treatment, interpret, and use the buildings. In 1984, the NPS completed its General Management Plan (GMP) for the site, an administrative history of the site, and a comprehensive History Data Section HSR for the fortifications. In 1985, the NPS completed a Resources Management Plan. Together, these documents provided the historical background on the fortifications necessary for their historical treatment and a plan for how to protect and use them.

Both the GMP and the Resources Management Plan advised the site management team to preserve the conditions of the historic site as they were, rather than attempt to restore it to a certain period. The GMP recognized the value of the World War II defense systems in interpreting the history of the fortifications and therefore did not contemplate the removal of the Joint Operations Center or the fire control stations, for example. Other than for general upkeep, maintenance, and structural stability, the GMP did not call for reconstruction or restoration of any of the site's features. The Resources Management Plan similarly called for representing the historic site as it was at the time the NPS assumed control of the

147. "Annual Narrative Report, 1981," (March 30, 1982), Folder 5, Box 29, SJNHSA, 17-18; "1983 Annual Narrative Report," [n.d.], Folder 5, Box 29, SJHNSA, 10-11.
148. Robert Stanton to Luiz Rodriguez-Morales, [Proposal], (August 28, 1975), Folder 194, Box 42, SJNHSA.
149. Lloyd Whitt, "Superintendent's Annual Report," (March 14, 1979), Folder 10, Box 29, SJNHSA.
150. "Superintendent's Annual Report," [n.d., 1980?], Folder 10, Box 29, SJNHSA, 3-5.
151. "Annual Narrative Report, 1981," (March 30, 1982), Folder 5, Box 29, SJNHSA, 17-18.
152. Lloyd Whitt, "Annual History—1976," (January 7, 1977), Folder 10, Box 29, SJNHSA, 4; Lloyd Whitt, "Superintendent's Annual History Report," (January 4, 1978), Folder 10, Box 29, SJNHSA, 3-4.
153. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 53–55; Berkowitz et al., *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1,12, 27.

fortifications from the Army. These plans reflected the intent of the NPS to interpret the site as a defense system that evolved over centuries and was adapted to new technologies.[154]

Some structural work was still necessary, and limited demolition of more modern structures continued through the 1980s. In 1986, a Structural Inspection of Castillo San Cristóbal by civil engineer Todd Rutenbeck identified concerning cracks in Castillo San Cristóbal's dungeon, outworks tunnels, and on the fortification wall above the Devil's Sentry Box.[155] Work on the wall above the sentry box and stabilization of the shoreline below the box began in 1991 and continued through 1997.[156] A breakwater in front of the Devil's Sentry Box was installed in 1998.[157] It is unclear if or when work on the dungeon and tunnels was accomplished, but in 1991 the park listed tunnel maintenance under the outworks as necessary.[158]

Meanwhile, some of the Army's facilities on the site no longer served a purpose and were not necessary to interpreting the progression of coastal defense systems on San Juan Islet. In 1987, the NPS demolished two valve stations associated with the Joint Operations Center.[159] In 1989, the NPS planned to remove a signal electrical pole from the third level of Castillo San Cristóbal.[160] In 1991, the NPS planned to take out abandoned concrete structures and case iron pipes installed by the Army on La Trinidad.[161]

The GMP and Resources Management Plan did not prevent the NPS from adapting historic structures to new uses to facilitate the NPS's mission of providing an enjoyable visitor experience at the site. One focus of NPS efforts at improving the visitor experience in the 1980s and 1990s was to work towards opening more of the Castillo San Cristóbal outworks to visitation. In 1985, the NPS extended sewer lines to the outworks and, soon after, converted the El Abanico guardhouse (which the Army used as a garage) to restrooms.[162] In 1995, the NPS completed repair work on the La Princesa Bastion and steps.[163] However, the NPS did not open the outworks to visitation for another 14 years.

Another NPS visitor experience focus in the late 1980s and 1990s was the continued improvement of the visitor experience within Castillo San Cristóbal. In 1991, the NPS activated the Castillo San Cristóbal cisterns again for a park water pump system and, soon after, completed the troops' quarters museum.[164] The Historic Furnishings Report for Castillo San Cristóbal, completed in 1993, helped the park reconfigure some of the museum to reflect the experience of Spanish

154. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 60–61; Berkowitz et al., *The Fortifications of San Juan National Historic Site, Historic Structure Report*, Volume 1 14–15.
155. Todd Rutenbeck, "Structural Inspection of Castillo de San Cristóbal," (October 1, 1986), Folder 306, Box 19, SJNHSA.
156. "1991 Superintendent's Annual Narrative Report," (n.d.), Folder 6, Box 29, SJNHSA, 7; "1997 Superintendent's Annual Narrative Report," (n.d.), Folder 6, Box 29, SJNHSA, 7-10.
157. "1997 Superintendent's Annual Narrative Report," (n.d.), Folder 6, Box 29, SJNHSA, 14-15.
158. Park Ranger Batista to Superintendent, "Protection of La Princesa," (May 6, 1981), Folder 330, Box 20, SJNHSA.
159. "106 Compliance Statement on the Effects of the Obliteration of Modern WW II Concrete Valve Stations South of La Trinidad Counterguard at Fort San Cristobal," [n.d. SAJU 87-08], Folder 210, Box 14, SJNHSA.
160. "FY '89 Cultural Resource/Maintenance Preservation Project Planned (In-House)," (n.d.) Folder 34, Box 39, SJNHSA.
161. "1991 Superintendent's Annual Narrative Report," (n.d.), Folder 6, Box 29, SJNHSA, 7.
162. "Superintendent's Annual Report—1985," (n.d.), Folder 5, Box 29, SJNHSA, 1-3; "1992 Superintendent's Annual Narrative Report," (n.d.), Folder 6, Box 29, SJNHSA, 6–7; Foulds and von Bieberstein, Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site, 78, 105.
163. "Rehabilitation La Princesa Bastion and Steps," (June 8, 1995), Folder 229, Box 14, SJNHSA.
164. "1991 Superintendent's Annual Narrative Report," (n.d.), Folder 6, Box 29, SJNHSA, 7; "1992 Superintendent's Annual Narrative Report," (n.d.), Folder 6, Box 29, SJNHSA, 6–7.

soldiers more accurately.[165] The NPS also replaced the Castillo San Cristóbal main gates and fully moved out of its offices in the officers' quarters during the 1990s.[166]

In 1991, San Juan National Historic Site finally received a full HSR on the fortifications. Beyond describing the history of the buildings at the historic site, the 1991 HSR and a contemporaneous El Morro Cultural Landscape Report provided recommendations to the NPS for how to restore the San Juan fortifications--contrary to the recommendations of the 1984 GMP and 1985 Resources Management Plan. The 1991 documents advised the NPS to restore the fortifications to their circa 1898 condition.[167]

In line with the 1991 HSR's recommendations, the NPS began unburying more of the Spanish defensive features covered by Army actions.[168] The NPS also began re-stuccoing the fortification walls in the Spanish style, which—although more historically accurate for an 1898 restoration period—made the fort appear newer. This approach directly contradicted the Puerto Rican State Historic Preservation Office's objective of preserving the aged look of the Old City. The aged look was better maintained by localized repairs, which was the approach the Army had taken and the NPS had, until recently, continued. The stucco debate served as a flashpoint between the NPS and the Puerto Rican government where tensions had long simmered.[169] A third party became involved and recommended the use of stucco but advised the two managing agencies to take a coordinated and consistent approach to preservation that prioritized preservation over aesthetics. [170] This recommendation was more aligned with the GMP than the 1991 Historic Structures Report, and the NPS gradually shifted back in the direction of restoring and interpreting the fortifications to different defensive eras.

The NPS issued a Long-Range Interpretive Plan in 2006 that sought to bridge the divide between eras by focusing on the site's strategic location, the periods of construction and the soldier experience, and the legacy of preservation at the site. In 2009, the NPS opened the Castillo San Cristóbal outworks, allowing for a fuller interpretation of the engineering and design that provided an in-depth defense of the eastern side of Old San Juan, and which served to protect the city and harbor through World War II.[171] The 2015 Cultural Landscape Report on the Castillo San Cristóbal Outworks by the Olmsted Center aligned with this approach to interpreting each of the eras of defensive strategies rather than attempt to show a single era. The 2015 report suggested that by improving the layout of the visitor experience of the outworks (without changes to the extant structures), the NPS could provide a more coherent walk through 200 years of defensive technology.[172]

165. José Ignacio Avellaneda, "Historic Furnishings Report: El Castillo de San Cristóbal," (Harpers Ferry: National Park Service, 1993), ETIC.
166. "1992 Superintendent's Annual Narrative Report," (n.d.), Folder 6, Box 29, SJNHSA, 6–7; "1997 Superintendent's Annual Narrative Report," (n.d.), Folder 6, Box 29, SJNHSA, 14–15.
167. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, 61–63.
168. "1997 Superintendent's Annual Narrative Report," (n.d.), Folder 6, Box 29, SJNHSA, 9–10.
169. The failure of the Puerto Rican Civil Defense to leave the former Joint Operations Center for nearly a decade after their lease expired was another focal point of NPS–Puerto Rican tension during this era. (W.P. Crawford, "Profile: San Juan National Historic Site," (1991), Folder 13, Box 39, SJNHSA, 5-6; Billy Garrett, "Park CRM Overview—Southeast Region," (June 1991), Folder 330, Box 52, SJNHSA, 5; Robert Peccia and Associates, "Traffic Access, Parking, and Safety Study, San Juan National Historic Site," (April 1994), 10–12.)
170. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*,61–63.
171. Foulds and von Bieberstein, *Cultural Landscape Report for the San Cristóbal Outworks, San Juan National Historic Site*, ix–3, 10–11.
172. NPS Harpers Ferry Department of Interpretive Planning, *San Juan National Historic Site Long-Range Interpretive Plan*, (National Park Service, September 2006), 16–17.

The buildings remaining at Castillo San Cristóbal and its outworks are well positioned to tell the stories of coastal defense through the ages and for the way in which the NPS chose to tell, and retell, those stories. The NPS approach to restoration and preservation at Castillo San Cristóbal originally focused only on the Spanish fortifications, but by the 1980s recognized the value of the U.S. Army's coastal defense program. As the world faces increased temperatures and more intense storms due to climate change, the NPS may need to add interpretation of coastal defense in a different form. Since the 1970s, the NPS in partnership with the Army Corps has been working to protect Castillo San Cristóbal's north wall, Devil's Sentry Box, Santa Teresa Battery, and La Princesa Battery from sea erosion. This "coastal defense" of historic buildings is a role the NPS will continue to play at San Juan National Historic Site.

Castillo San Cristóbal Chronology

1625	Dutch attack on San Juan highlighted the need for substantial land defenses on the east end of the city.
1634	Construction began on the original portions of Castillo San Cristóbal including the moat, El Caballero de San Miguel, and the eastern defenses.
c. 1644 to 1662	La Garita del Diablo constructed along the shore north of Castillo San Cristóbal.
1765	Plans developed to expand Castillo San Cristóbal. Construction began on the troops' quarters and La Trinidad.
1766	Construction began on San Carlos Ravelin.
1768	Construction began on the north casemates.
1773	Construction began on the officers' quarters.
1779	Construction began on La Princesa and El Abanico.
1783	Construction began on Santa Teresa Battery.
mid-1860s	Construction of housing and other buildings was authorized outside the San Juan City Wall
1890s	Spanish oversaw improvements of the fortifications at Castillo San Cristóbal and the outer defenses. Santa Teresa and La Princesa were significantly altered at this time.
1898	Spanish-American War
1898	Following the conclusion of the Spanish-American War, the United States took possession of Puerto Rico.
1918	Following the United States' entry into World War I, modifications were made at La Princesa to allow for the installation of new rapid-fire guns.
1930	New military housing was constructed on the outworks resulting in the partial dismantlement of La Princesa and the demolition of defense lines and tunnels.
1940	Four new gun emplacements were constructed at La Princesa.
1942	The Joint Command Center was constructed in the moat resulting in the destruction of the caponier that connected San Carlos to the main fortification.
1945	Gun emplacements at La Princesa were dismantled.

1949	The San Juan fortifications became the San Juan National Historic Site under this joint management agreement between the Department of War and the Department of the Interior.
1963	The NPS oversaw repair of Castillo San Cristóbal and the outworks.
1966	The U.S. Army vacated its structures in San Juan. The La Princesa housing was transferred to the U.S. Navy. Castillo San Cristóbal was administratively listed in the National Register of Historic Places.
1973	The U.S. Navy transferred the housing to NPS.
1980	The La Princesa housing area was demolished.

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Physical Description and Condition Assessment

Site

See Glossary for military fortification terms.

Castillo San Cristóbal and the associated outer defenses is located at the northeastern corner of the historic portion of San Juan and is the easternmost portion of the San Juan National Historic Site (Figure 10). The site is bounded by Calle Norzagaray to the west, Avenida Luis Muñoz Rivera to the south, and the Atlantic Ocean to the north and east. A public plaza and ramp at the northwest corner of San Cristóbal provides public access to the site from Calle Norzagaray (Figure 11 through Figure 14). The San Juan city wall lines the north edge of San Cristóbal along the ocean (Figure 15 through Figure 18).

The 27-acre site consists of several structures, including the main fortification and El Caballero de San Miguel at the west end of the site, with San Carlos Ravelin and La Trinidad Counterguard to the east on the opposite side of the moat (Figure 19 through Figure 30). The outer defenses consist of Santa Teresa battery at the west end of the outer defenses with La Princesa and Fort El Abanico at the east end of the complex. A series of tiered stone walls line the south side of the outer defenses between El Abanico and La Trinidad Counterguard and north of Avenue Muñoz Rivera.

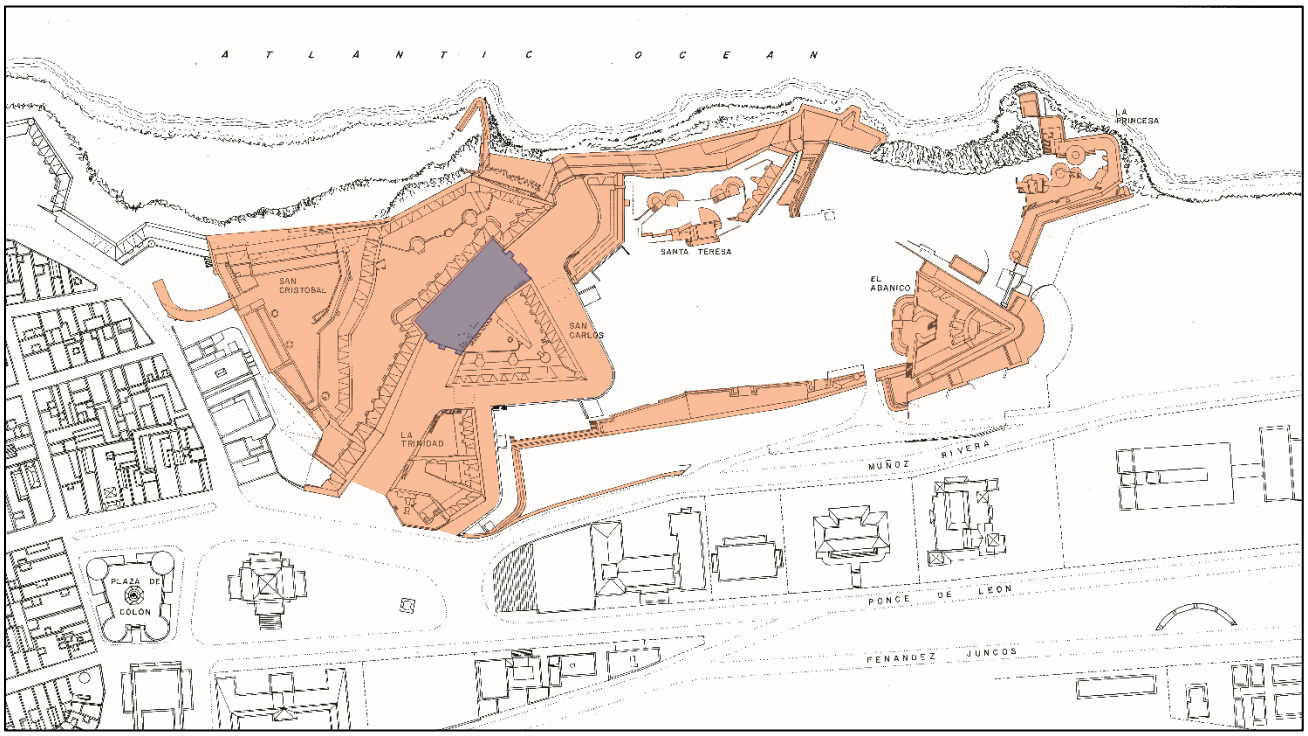


Figure 10. A site plan showing the location of the buildings and structures reviewed as part of this study. Note the World War II Joint Command Center (visitor center) shown in gray is included as part of Volume II of this study (in development). (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Sheet 4 of 17, annotated by authors)



Figure 11. View of the entrance plaza and ramp with Calle Norzagaray in the foreground. View from northwest.



Figure 12. View of the entrance plaza and ramp in 1998 with Calle Norzagaray in the foreground. View from northwest. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 58, 1998)



Figure 13. View of the entrance plaza and ramp. View from northwest.



Figure 14. View of the entrance plaza and ramp in 1938. View from northwest. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 1, 1938)



Figure 15. View of Castillo San Cristóbal along the north edge of the site. View from west.



Figure 16. View of Castillo San Cristóbal along the north edge of the site. View from west. Note the sentry box at left. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 2, 1938)



Figure 17. View of Castillo San Cristóbal along the north edge of the site, with portions of the city wall in the foreground. View from west.



Figure 18. View of Castillo San Cristóbal along the north edge of the site, with portions of the city wall in the foreground. View from west. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 59, 1998)



Figure 19. View of Castillo San Cristóbal from Avenida Luis Muñoz Rivera with La Trinidad Counterguard in the foreground and El Caballero and the main fortification in the background. View from southeast.



Figure 20. View of Castillo San Cristóbal with La Trinidad Counterguard in the foreground and El Caballero and the main fortification in the background. View from southeast. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 3, 1938)



Figure 21. View of Castillo San Cristóbal from Avenida Luis Muñoz Rivera with the main fortification at center. View from southwest.



Figure 22. View of Castillo San Cristóbal in 1960 from Avenida Luis Muñoz Rivera with the main fortification at center. View from southwest. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 20, 1960)



Figure 23. View of Castillo San Cristóbal from Avenida Luis Muñoz Rivera with La Trinidad Counterguard in the foreground and El Caballero in the background. View from southeast.



Figure 24. View of Castillo San Cristóbal in 1938 from Avenida Luis Muñoz Rivera with La Trinidad Counterguard in the foreground and El Caballero in the background. View from southeast. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 4, 1938)



Figure 25. View of Castillo San Cristóbal from Avenida Luis Muñoz Rivera with El Caballero in the background. View from southeast.



Figure 26. View of Castillo San Cristóbal in 1998 from Avenida Luis Muñoz Rivera with El Caballero in the background. View from southeast. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 55, 1998)



Figure 27. View of Castillo San Cristóbal with San Carlos Ravelin at the foreground. View from east.



Figure 28. View of Castillo San Cristóbal in 1998 with San Carlos Ravelin at the foreground. View from east. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 26, 1998)



Figure 29. View of Castillo San Cristóbal with San Carlos Ravelin at the right and La Trinidad Counterguard at left. View from east.



Figure 30. View of Castillo San Cristóbal in 1938 with San Carlos Ravelin at the right and La Trinidad Counterguard at left. View from east. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 6, 1938)

An open space extends from San Carlos Ravelin and the moat east toward El Abanico and La Princesa, with Santa Teresa battery situated to the north (Figure 31). Originally, this area contained a glacis with fortified lines of retreat that ran north-south the width of the glacis. Stone outcroppings running north to south through the open space help interpret where the lines of retreat were located (Figure 32).

The glacis was altered in the 1930s when housing for military personnel was constructed in the area. The National Park Service removed the housing in the early 1980s, restoring the open space.

A series of tiered stone walls extend from the moat east of La Trinidad Counterguard to the gate immediately west of El Abanico generally following the path of Avenida Luis Muñoz Rivera to the south (Figure 33). The walls consist of an outer wall with sloped grade that rises to the inner wall. The wall system connects with the east wall of the great moat southeast of La Trinidad Counterguard (Figure 34).

A paved access road leads from Avenida Luis Muñoz Rivera to the gate west of El Abanico. The road generally runs parallel to Avenida Luis Muñoz Rivera (Figure 35).



Figure 31. View of the open space east of the main fortification where a glacis historically was located. El Abanico and La Princesa are visible in the background. View from west.



Figure 32. Stone outcroppings in the open space representing the locations of lines of retreat. View from south.



Figure 33. Tiered wall system along the southern edge of the site. View from southeast.



Figure 34. The tiered wall system east of La Trinidad Counterguard. View from northeast.



Figure 35. A paved access road along the southern edge of the outer defenses. View from east.

Walls

The San Juan city walls to the north of Castillo San Cristóbal, facing the Atlantic Ocean, extend from past the main fortification to the east end of Santa Teresa Battery and measure approximately 1000 feet in length (Figure 36 and Figure 37). The north walls, bordering the ocean, typically are comprised of two basic parts—the escarpment and the masonry wall (Figure 38). The escarpment is the battered portion visible from the ocean side of the wall. As seen from the ocean side, the masonry structure in the upper portion of the wall extends above the escarpment and is incorporated into the fortification's north casemates.



Figure 36. View of city wall east of Castillo San Cristóbal. View from east.



Figure 37. View of city wall east of Castillo San Cristóbal in 1960. (Source: San Cristóbal Cistern Heads Historic American Buildings Survey No. PR-102, Photo 3, 1960)



Figure 38. Overall view of north walls, including the escarpment and the masonry wall.

The escarpment is mostly comprised of rock with coarse vegetation (Figure 39). A rectangular concrete seawall, constructed by the U.S. Army Corps of Engineers, extends along the base of the escarpment and fills the undercut portions of the escarpment (Figure 40). The top of the concrete sea wall is approximately 5 feet above sea level at the time of this assessment.

The masonry walls constructed above the escarpment are comprised of mass rubble stone and brick masonry (Figure 41). The masonry walls are tapered with a larger base. Within the accessible portions of the north exterior wall, two masonry wingwalls are built perpendicular to the masonry walls of the main fortification and Santa Teresa Battery.



Figure 39. Coarse vegetation on the escarpment.



Figure 40. Concrete sea wall along the base of the escarpment.



Figure 41. Masonry walls constructed above the escarpment.

A sentry box is located at the base of the escarpment directly north of the main fortification (Figure 42). This sentry box is commonly known as La Garita del Diablo. The northernmost outpost of Castillo San Cristóbal, La Garita del Diablo is located at the point of two intersecting mass masonry walls that retain flat infill soil in which access to the sentry box is provided (Figure 43). The intersecting mass masonry walls are battered and constructed of stone and brick rubble. Closest to La Garita del Diablo, the backsides of the retaining walls extend approximately 4 feet above the flat infill soil. A cementitious and sand aggregate parge coat is applied to both sides of the west retaining wall (Figure 44). A through wall scupper directly above the infill soil, measuring approximately 11 inches tall and 9 inches wide, is located approximately 15 feet from the garita in the west retaining wall (Figure 45). A projecting

rectangular-shaped molded surround frames the scupper. A crushed brick aggregate parge coat is applied to both sides of the east retaining wall (Figure 46). A United States Army Corps of Engineers Survey Marker is located next to the east retaining wall (Figure 47). La Garita del Diablo is circular in plan with a domed roof (Figure 48). The walls are constructed of brick laid in mortar with a parge coat on both sides of the wall. Lime wash is applied to the parge coat. The garita is accessible from an opening on the south side. Window openings are located on the north, east, and west sides. The floor of the garita is covered with a crushed brick aggregate parge coat.



Figure 42. Overall view of sentry box (La Garita del Diablo) located at the base of the escarpment directly north of the Main Fortification.



Figure 43. View of La Garita del Diablo.



Figure 44. View of west retaining wall.



Figure 45. Through wall scupper in the west retaining wall.



Figure 46. View of east retaining wall.



Figure 47. A United States Army Corps of Engineers Survey Marker at La Garita del Diablo.



Figure 48. Close-up view of La Garita Del Diablo.

Condition Assessment

The following notable conditions were observed at the north walls and La Garita del Diablo.

- The rocky surface of the escarpment is weathered with large scale efflorescence and dark staining at varying heights from the base (Figure 49).
- Patches in the escarpment of multiple vintages were evident and varied in size and material, including rubble stone masonry, laid stone masonry, cementitious mortar (Figure 50), and sprayed concrete (Figure 51).
- Partial- and full-depth spalls in the parge coat at La Garita del Diablo were observed throughout the exterior and interior surfaces. At full-depth spalls, the brick masonry wall construction was exposed (Figure 52). A similar condition, although more severe, was observed at the east retaining wall. Large portions of the stone rubble construction were exposed on the interior side of the east retaining wall above the infill soil (Figure 53).
- Biological staining on the parge coat was observed on the interior of La Garita del Diablo (Figure 54).
- Delaminated parge coat on the west retaining wall was evident when sounding. Crazed cracking and shallow spalls were widespread at the surface of the cementitious parge coat (Figure 55).



Figure 49. Large scale efflorescence and dark staining at escarpment.



Figure 50. Patches in the escarpment, including rubble stone masonry, laid stone masonry, cementitious mortar.



Figure 51. Patches in the escarpment, including sprayed concrete.



Figure 52. Brick masonry wall construction exposed at full-depth spall.



Figure 53. Large portions of the stone rubble construction exposed on the interior side of the east retaining wall.



Figure 54. Biological staining on the parge coat on the interior of La Garita del Diablo.



Figure 55. Crazed cracking and shallow spalls in cementitious parge coat.

Main Fortification of Castillo San Cristóbal

Measured drawings of Plaza de Armas and the surrounding buildings are included in Appendix A.

The main fortification of Castillo San Cristóbal consists of the north bastion, curtain wall, and south bastion, which comprise the east side of the fort, with the north casemates, officers' quarters, and troops' quarters all situated around the Plaza de Armas on the west portion of the fortification (Figure 56). A curving ramp leads from Calle Norzagaray to the main gate near the northwest corner of the fortification, with the south gate located between the troops' quarters and officers' quarters at the south end of Plaza de Armas.

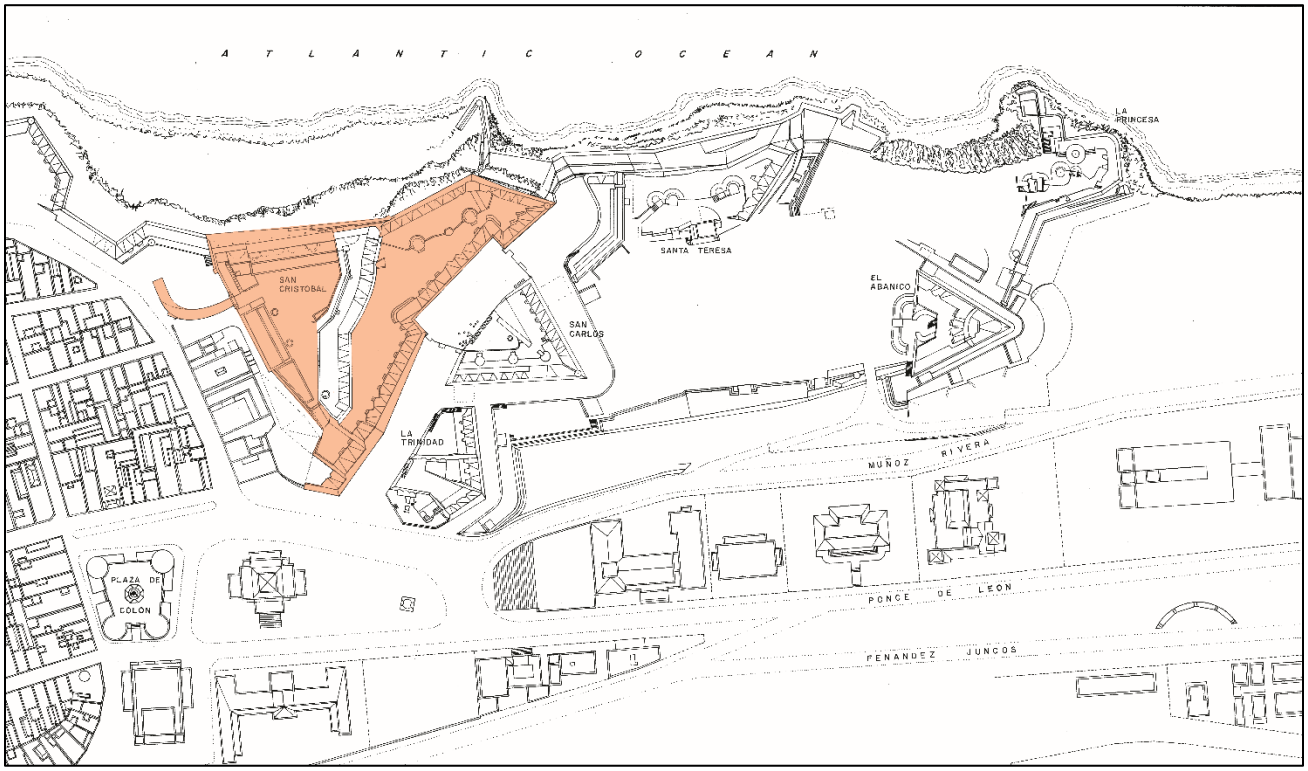


Figure 56. A site plan showing the location of the main fortification (orange shading). (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Sheet 4 of 17, annotated by authors.).

Gates

Main Gate

The main gate consists of a ramp, stone gate, and wood-framed double doors. A pedestrian plaza is located immediately west of the main fortification and is bound by the fortification curtain wall to the north and Calle Norzagaray to the west. The historic main fortification entrance ramp is located at the south end of the pedestrian plaza and extends to the entrance gate of the fortification. The ramp is "J"-shaped in plan and consists of stone and brick masonry walls with a stucco finish. The walls measure approximately 14 inches deep and increase to a height of 18 feet. Along the length of the ramp wall is a non-original rectangular recess that houses a light fixture, a rectangular window opening, and a Moorish arch passageway (Figure 57 and Figure 58). The Moorish arch is defined by soldier brick that creates the pointed arch form (Figure 59). The arch extends underneath the ramp to a mown-turf lawn along the west facade of the officers' quarters. The interior of the arch has a stucco finish, and there is an iron gate at the plaza side of the arch that restricts access to the lawn.



Figure 57. The end of the ramp as it extends north. Note the non-original recess (red arrow).



Figure 58. North facade of main gate ramp wall as seen from pedestrian plaza.



Figure 59. Moorish arch opening under main gate ramp. Note iron gate restricts access through arched opening.

Immediately west of the Moorish arch, the arched pattern of brick masonry indicates there was previously a second arch in the ramp wall that has since been infilled with brick. Within the infilled opening is a rectangular window opening with wood panel infill (Figure 60).



Figure 60. Non-original wood infilled window opening within brick infilled masonry arch.

The ramp walls extend 28 inches above the ramp to form cheek walls. The top of the north cheek wall is squared off, so it is flat, and the top of the south cheek wall is rounded (Figure 61). The ramp measures 12 feet wide and has a concrete surface that crowns at the middle, shedding water to the sides. Numerous iterations of concrete patches and repairs are evidenced by the various concrete colors, textures, and aggregate of the ramp (Figure 62).

The ramp extends from a pedestrian plaza located at a curve in Calle Norzagaray to the northwest corner of the Plaza de Armas (Figure 63). It is constructed of dressed ashlar stone with mortar joints measuring approximately 7/8 inch wide and scored along the middle. The gate measures 22 feet 11 inches tall, 20 feet wide, and 4 feet deep and features a segmental arch opening measuring 12 feet 9-1/2 inches tall and 12 feet wide. The opening aligns with the width of the plaza ramp.



Figure 61. Concrete-paved ramp with the cheek walls on either side. Note the south (left) cheek wall has a rounded top.



Figure 62. Concrete-paved ramp shows the various concrete repairs and patches.



Figure 63. Ramp extending from pedestrian plaza to main entrance gate at northwest corner of Plaza de Armas.

The front facade of the gate faces west and has applied pilasters, measuring 28 inches wide, that

flank the arched opening and extend to a broken pediment that spans the width of the gate. The pilasters have a base, measuring 24 inches tall, and a cap that measures 18 inches tall and projects 10 inches from the plane of the wall.

The stone voussoirs at the segmental arch are wedge-shaped and extend to the broken pediment, approximately 14 inches above (Figure 64). The pediment includes a cornice that projects 18 inches from the plane of the wall. Above the broken pediment and atop the pilasters are finials, approximately 54 inches tall, with stone finial balls.



Figure 64. West facade of main entrance gate.

At the east facade of the gate, the stone and brick masonry have a stucco finish and does not have the carved finishes present on the west facade. Instead, the gate has a rectangular opening with the walls adjacent to the opening angled, creating a wider opening on the east facade measuring 23 feet wide by 24 feet 6 inches tall (Figure 65).



Figure 65. East (back) facade of main entrance gate.

The non-original wood-framed double-leaf gate consists of a wood frame visible on the east facade, wood plank mounted to the west facade of the frame, steel reinforcing straps, and a hinged personnel door within one of the door leaves (Figure 66). The perimeter of the frame is constructed of 2x6s with horizontal and vertical cross members consisting of 2x4s. The west face of the door leaves has vertically oriented 1x10 boards. Steel straps, measuring approximately 2 inches wide, reinforce the horizontal framing members of the east face of the door as well as the framing around the personnel door. The straps are also located at the west facade of the door, over the vertical planks, and align with the horizontal framing members as well as diagonally between straps. The straps are painted black.



Figure 66. West facade of main entrance gate with wood doors closed.

Doors are set on stainless-steel pivot hinges at the top and bottom of each leaf (Figure 67 and

Figure 68). Other hardware on the doors include a stainless-steel slide latch, surface-mounted vertical rods at the upper portion of the door that are attached to turn knobs, and surface-mounted stainless-steel rods at the base of the door frame that extend into drilled holes in the floor that secure the doors in the closed position (Figure 69). The personnel door has an aluminum doorknob with mortise lock.



Figure 67. Non-original top pivot hinge for main entrance gate doors.



Figure 68. Non-original bottom pivot hinge for main entrance gate doors.



Figure 69. Non-original vertical rod door closers.

South Gate (Puerta del Socorro)

Like the main gate, the south gate, historically known as Puerta del Socorro, is accessed from a stone and brick masonry ramp (Figure 70). The ramp measures approximately 15 feet 10 inches wide and has red-color concrete paving and brick edging. The north side of the ramp abuts the fortification wall, and the south side has a guardrail consisting of steel posts set in concrete footings with cables extending through holes in the posts.



Figure 70. View of ramp and gate leading to south end of Plaza de Armas.

The gate consists of masonry piers, measuring roughly 35 inches square and 13 feet 10 inches tall, topped by a rounded cap. The lower half of the piers are dressed ashlar stone masonry with brick fragments used to level the stone at joints. The upper portion of the piers and the cap are brick masonry with a stucco finish (Figure 71). A beam, measuring 30 inches tall, encased in brick masonry and clad with stucco, extends between the piers

(Figure 72 and Figure 73). The beam has a projecting cornice on both sides. At the plaza side of the gate, there is a wood beam that extends below the cornice (Figure 74). The rectangular gate opening measures 10 feet 3 inches wide by 9 feet 9 inches tall and has a stone threshold (Figure 75).



Figure 71. West pier at the south gate.



Figure 72. South facade of the south entrance gate, from ramp.



Figure 73. North facade of the south entrance gate, from the Plaza de Armas.



Figure 74. Wood lintel beam that spans across interior side of gate opening.



Figure 75. Stone threshold at the gate.

The gate door leaves are similar to those at the main gate. They consist of a wood frame upon which vertically oriented 1x10 boards are anchored. There are metal straps, that align with the horizontal framing members, anchored to the

front and back of the door. On the ramp side of the doors, straps are also oriented diagonally across the width of the door between horizontal straps (Figure 76).



Figure 76. Door with straps oriented diagonally.

Typical hardware includes top and bottom pivot hinges, surface-mounted vertical rods at the top and bottom of the door that slide into predrilled holes at the threshold and door head, slide latch, and a mortise lock.

Plaza de Armas

The Plaza de Armas is a polygonal-shaped plaza bound by the north casemates to the north; the officers' quarters to the west; and the troops' quarters, ramp, and El Caballero to the east (Figure 77, Figure 78, and Figure 79). The plaza, which is irregularly shaped, measures approximately 260 feet along the west side, 205 feet along the north side, and 25 feet along the south side.



Figure 77. View of the Plaza de Armas looking north, atop the troops' quarters.



Figure 78. View of the Plaza de Armas looking east, atop the officers' quarters roof.



Figure 79. View of the Plaza de Armas looking south, atop the officers' quarters roof.

The plaza features concrete paving divided into 10-foot squares by offset control joints (Figure 80). The concrete paving, which was added by the National Park Service by 1960, at the north half of the plaza is oriented parallel to the north casemates, and the pattern at the south half of the plaza is oriented perpendicular to the officers' quarters. A strip of grey-colored concrete extends diagonally across the concrete plaza and separates the two concrete patterns. The square concrete sections alternate between gray- and red-colored concrete, forming a staggered pattern across the plaza. Square cast-iron drains are set within the plaza paving (Figure 81). There are numerous patches and previous concrete paving repairs, most of which maintain the staggered grey and red concrete pattern (Figure 82).



Figure 80. View of plaza showing concrete paving pattern.



Figure 81. Iron drain in plaza.



Figure 82. Concrete patch in paving follows the original color and pattern of the concrete.

The plaza is accessed from masonry and wood gates located at the north end of the west facade (main gate) and at the south facade (Figure 83). Three tunnels are located at the north end of the east plaza: one providing access to the dungeon, one to the north bastion terreplein, and one to the World War II Joint Command Center (visitor center) (Figure 84).



Figure 83. View of south entrance gate from plaza.



Figure 84. East facade of plaza showing arched openings to adjacent spaces.

Along the east side of the plaza is a ramp that provides access to El Caballero (Figure 85 and Figure 86). The ramp is constructed of dressed ashlar stone and brick masonry and has a plan consisting of three continuous ramp sections that form a curve from the north end of the troops' quarters to the south end of El Caballero. The concrete-paved ramp measures 12 feet 7 inches wide. The paving is crowned along the center and slopes toward the cheek wall, which measures 24 inches tall and 28 inches deep (Figure 87). The wall of the ramp has a stucco finish with numerous patches and repairs. Ghosting on the stucco at the south end of the ramp wall indicates a gable roof structure at one time abutted the wall (Figure 88).



Figure 85. Ramp at east side of plaza extending from plaza to upper terreplein, above north casemates.



Figure 86. Entrance of ramp is located between the troops' quarters and chapel.



Figure 87. Top of ramp at east side of Plaza de Armas as seen from upper terreplein.



Figure 88. Ghosting at wall indicating a previously existing structure that has been removed.

The Castillo San Cristóbal chapel is a one-story structure that abuts the south end of the ramp wall (Figure 89 and Figure 90). The dressed ashlar stone and brick masonry building has a triangular

plan and consists of two rooms with large wall openings, making the rooms open to the elements.



Figure 89. The Castillo San Cristóbal chapel, north facade.



Figure 90. South facade of the chapel that abuts the south end of the ramp wall.

The exterior of the building is clad with stucco, painted yellow and white, and includes a pronounced horizontal band that wraps around the base of the building, raised door surrounds, a cornice, and a parapet. The base measures approximately 28 inches tall and projects 2 inches from the plane of the wall. Raised stucco door surrounds measure approximately 6 inches wide and also project 2 inches from the plane of the wall. The cornice is located on the west half of the building and projects approximately 20 inches beyond the plane of the wall. The building has a clay tile roof with a parapet measuring approximately 18 inches tall (Figure 91).



Figure 91. The chapel and roof as seen from the ramp to the east.

The building includes a door opening at the east end of the north facade and large rectangular openings at the west end of the north facade and on the east facade. A wood guardrail spans across the large wall openings and the doorway between the two interior rooms.

Within the building, there is black-and-white tile flooring and plaster walls and ceilings, which are painted white. The flooring in the west room is ceramic tile and the east room is marble tile (Figure 92 and Figure 93). The chapel room is located at the west half of the building and includes a domed niche with a statue of St. Barbara, the patron saint of artillerymen, and an altar (Figure 94).



Figure 92. Ceramic tile flooring at the west room of the chapel.



Figure 93. Marble tile flooring at the east room of the chapel.



Figure 94. View of the altar and statue at the west room of the chapel.

A ramp is also located at the northwest corner of the plaza, immediately north of the main gate. The ramp, described in the *North Casemates* section below, is part of the north casemates.

Other features on the plaza include two large cistern enclosures, circular in plan, that abut the arcade of the officers' quarters (Figure 95 and Figure 96). The south cistern enclosure is constructed of stone and brick masonry, clad with stucco, while the north cistern enclosure is a reconstruction dating to 1971–1976, and constructed of concrete masonry units and clad with stucco. The reconstructed cistern enclosure sits atop the original foundations. At the same time the National Park Service was overseeing the reconstruction of the north cistern enclosure, the south cistern enclosure was restored to its late-eighteenth century appearance. As part of this work, the dumbbell-shaped vents at the south cistern enclosure were infilled with masonry with a stucco coating applied (refer to Figure 95 and Figure 96).[174]

Each cistern enclosure measures approximately 7 feet 6 inches tall with an interior diameter of 9 feet 9 inches and an exterior diameter of 12 feet. Each cistern enclosure has a pronounced base, measuring approximately 12 inches tall, and a projecting cornice. At the west side of each enclosure is a door opening with a raised brick threshold and stucco-clad masonry lintel (Figure 97). Within the enclosure is a dressed ashlar stone cistern head, hexagonal in plan, and measuring approximately 36 inches tall and 36 inches in diameter (Figure 98). The top of the cistern head is covered with plywood. A wood beam with hook spans across the enclosure and above the cistern head.

174. Berkowitz et al., *The Fortifications of San Juan National Historic Site: Historic Structures Report*. (Atlanta, Georgia: U.S. Department of the Interior, National Park Service, Southeast Regional Office, 1991), Volume II, 135–136.



Figure 95. Cistern enclosure in Plaza de Armas with officers' quarters in background. View from southeast. Note the dumbbell-shaped vents have been infilled.



Figure 96. Cistern enclosure in Plaza de Armas, 1960. Note the dumbbell-shaped vents at the cistern enclosure and that the officers' quarters arcade has been infilled. (Source: San Cristóbal Officers' Quarters Historic American Buildings Survey No. PR-98, Photo 1, 1960)



Figure 97. View of the cistern enclosure from the officers' quarters arcade.



Figure 98. Stone cistern within the enclosure.

Steel-framed interpretive signs are mounted to the concrete paving at various locations throughout the plaza.

North Casemates

The north casemates define the north side of the Plaza de Armas and share its north and west walls with the fortress curtain wall (Figure 99). It consists of the casemate building, arcade, and a one-story guardhouse. The casemate building consists of a one-story portion that includes nine vaulted casemates, located at the west end of the structure; and a two-story portion consisting of two pairs of upper and lower vaulted powder magazines, located at the east end of the structure. The overall plan of the building measures 291 feet 9 inches by 45 feet with the casemate portion measuring 208 feet long, 45 feet deep, and 25 feet tall, and the powder magazine portion measuring 83 feet 9 inches long, 46 feet 10 inches deep, and approximately 43 feet tall (Figure 100).



Figure 99. View of the north casemates from El Caballero.



Figure 100. South facade of the arcade at the north casemates.

A concrete and stone-paved terreplein extends across the top of the casemates and is accessed from a flight of stairs and ramp built above the westernmost casemate. A terreplein with signal tower and World War II-era fire control station (both part of El Caballero) is located above the powder magazine portion of the building and accessed from a ramp that extends along the east side of the Plaza de Armas.

An arcade extends across most of the south facade of the casemate and has a clay tile low-slope roof. The arcade measures 151 feet 7 inches long by 15 feet 8 inches deep and is divided into six-and-a-half bays by stucco piers and segmental arch openings, each arch aligned with a casemate (Figure 101 and Figure 102). The arcade features concrete floors, stucco walls, and a flat ceiling with support beams.



Figure 101. View from the east looking down the arcade at the north casemates.



Figure 102. Ceiling and wall of the arcade. Note beams that span north-south across the ceiling.

The guardhouse extends southeast from the west end of the south facade of the building and is connected to the casemate by a ramp and flight of stairs. The arcade terminates at the east facade of the guardhouse. The guardhouse has a polygonal-shaped plan with the north facade parallel to the casemate building. The building measures approximately 55 feet along the north facade, 25 feet along the northeast facade, 52 feet along the southeast facade, and 48 feet along the southwest facade. The west half of the guardhouse consists of a flight of stairs and ramp that provide access to the terreplein above the casemates, and the east half is presently used as a park information center and storage area. The guardhouse has an exterior stucco finish, low-slope roof with low parapet walls, concrete floors, and plastered interior walls and ceiling.

Walls

The exterior walls are constructed of San Juan sandstone and hand-pressed clay brick and have a stucco finish. Dressed ashlar stone units are typically used at columns, corners, and around window and door openings. Brick is used at wall areas and corbelled to provide a substrate for projecting features such as cornices, surrounds, and decorative bands. There are numerous layers of stucco finish and previous patch repairs. In general, the walls have a two-coat stucco system consisting of a scratch coat, measuring 3/8 inches thick, and finish coat with limewash, measuring 1/8 inches thick.

The casemate, arcade, and guardhouse were built as part of different development campaigns and, although similar, have slightly different construction. The north and west walls of the casemate building, which is part of the curtain wall for the fort, extends the full height of the fort (approximately 45 feet tall at the west facade and 77 feet at the north facade). The north wall measures 8 feet 7 inches at the casemate level and the west wall measures 6 feet 7-1/2 inches. The east wall of the powder magazine portion of the building measures as much as 20 feet deep and is integrated into the construction of the adjacent El Caballero de San Miguel. The south wall of the casemate measures approximately 20 feet 8 inches

tall and measures approximately 41 inches deep at the casemate level. The wall features a projecting band at the base of the wall that measures approximately 14 inches tall and projects 2-1/2 inches from the field of the wall. The band wraps around door openings, and a similar band is also located around window openings.

The arcade consists of a south and west wall and is located along the south facade of the casemate building. It is constructed of dressed ashlar stone and brick with a stucco finish. The wall features piers, measuring approximately 24 inches square and 9 feet 6 inches tall, with a pier pedestal, measuring 25 inches tall, and pier cap with abacus, measuring 8 inches tall (Figure 103 and Figure 104). The piers are spaced 23 feet 6 inches on center. The segmental arch extends between piers with the peak of the arch measuring 18 feet 9-1/2 inches. A horizontal band with cornice, measuring 2 feet 10 inches tall and projecting approximately 16 inches from the plane of the wall, extends across the top of each facade. Above the cornice is a parapet wall, measuring 1 foot 10 inches tall.



Figure 103. Pier that supports the arches of the arcade.



Figure 104. View of the pier cap with abacus.

The walls at the guardhouse measure as much as 32 inches deep and have stone and brick construction with a stucco finish. There is a curb that extends along the base of the southeast facade that measures 14 inches tall and 18 inches deep, and a raised stucco surround at each door opening. The coping at the roof parapet extends approximately 3 inches beyond the plane of the wall. Door openings are centered on the southeast and southwest facades (Figure 105). A window opening is located to the west of the door at the southwest facade (Figure 106).



Figure 105. East facade of the guardhouse.



Figure 106. South facade of the guardhouse.

Window Openings

There are nine segmental arch window openings along the south facade of the casemate building, one at each casemate and one adjacent to the entrance door. On the exterior face, each window opening measures approximately 37 inches wide by 44 inches tall and has a projecting stucco surround. The surround at the jamb and sill measures 12-1/2 inches wide and projects 2-1/2 inches from the plane of the wall (Figure 107). Above the segmental arch of the window head, the surround widens to measure 14-1/2 inches wide.



Figure 107. Typical segmental arch window opening with surround at the south facade of the casemates.

The interior face of the window openings has angled walls at the jambs and head, making the overall width of the opening 63 inches wide by 56 inches tall as measured from the interior (Figure 108). The interior opening has a wood lug sill with a bullnose profile, measuring 2-3/4 inches deep and 2-3/4 inches tall, that extends 6 inches beyond the opening on each side (Figure 109). Within the depth of the window opening is a wood-framed shutter. The sill to the exterior of the shutter measures between 12 inches and 15 inches deep and consists of brick masonry set in a mortar setting bed. A thin cementitious coating is applied over most of the sill and is sloped to direct water away from the shutter (Figure 110). The interior stool measures 19 inches deep and has mortar set brick.



Figure 108. Interior of the typical window opening at the south facade of the casemates. Note the walls are angled to create a larger interior opening.



Figure 109. Interior wood lug sill at window opening extends into the plaster wall.



Figure 110. Brick sill at exterior of window opening.

The wood-framed shutters are all replacement units to match the historic appearance and consist of a wood frame and two wood shutters that follow the form of the segmental arch of the window opening. All of the window frames and shutters have a clear finish. The wood frame is set into a recess in the plaster finish at the jambs and head and measures 3-3/4 inches deep by 1-5/8 inches wide and has an exterior stop measuring 1-1/8 inches deep by 7/8 inch wide (Figure 111).



Figure 111. Wood window frame. Note brick interior stool and parging at exterior sill.

The shutters have a structure consisting of a framework of wood members, measuring 1-5/8 inches deep by 2-3/4 inches wide, with mortice and tenon joints. The framework is clad on the exterior with 1x10 wood boards nailed to the framework with iron nails. Some of the nails have a large hammer-flattened head intended to match the appearance of the historic iron anchors. The shutters and framing have a clear finish.

Typical hardware at the shutters includes four iron hinges, shutter stays, and surface-mounted brackets. The hinges appear to be hammered into the wood framing and are a pintle type hinge consisting of a lower pintle, attached to the wood frame, and an upper conical cap, anchored to the shutter (Figure 112). The wood at the frame and shutter has been shaved to create an oblong slit around the hinge. Stays consist of two components, a hook and eye. The hook is mounted to the interior framing of the shutters and the eye is mounted to the chamfered plaster wall opposite the hook. The stays are intended to keep the shutters in the open position. Metal "U"-shaped brackets are surface-mounted at the mid-height of the interior jamb framing (Figure 113). The brackets are intended to hold horizontal bracing to keep the shutters in the closed position.



Figure 112. Typical pintle hinge with conical cap at window opening. Note that the wood window frame and shutter frame have both been carved out to form an oblong hollow in which the hinge fits.



Figure 113. Metal bracket surface-mounted to interior face of window frame.

Rectangular window openings with louvers and shutters are located at the north facade of the casemates. The louvered windows are set approximately 3 inches from the interior face of the wall. The exterior of the window opening has angled walls with stucco cladding that frame the window opening. A cementitious parging has been applied to the sill, adjacent to the window framing, to direct water away from the window opening. Abandoned wood framing in the wall indicates that a previous window system may have been located at the mid-depth of the wall but has since been removed (Figure 114). At the interior, the walls around the window opening are angled to create an opening measuring 46 inches wide by 76 inches tall (Figure 115).



Figure 114. Exterior sill at the north facade window opening in the fortification wall. Note the wood framing embedded in the wall of a previous window treatment (arrow).



Figure 115. Corner of typical interior opening at window shutter opening on north facade of casemate. Note that wall is angled to create a larger interior opening.

The window opening has a wood-framed shutter and louvers, measuring approximately 40 inches wide by 70 inches tall (Figure 116). Similar to the south windows, the wood-framed shutters have a perimeter frame measuring 3-3/4 inches deep by 1-5/8 inches wide and have an exterior stop measuring 1-1/8 inches deep and 7/8 inch wide. Each shutter consists of a wood structure consisting of 1-5/8 inch by 2-3/4 inch framing members with mortice and tenon joints and clad on the exterior with two vertically oriented 1x10 boards. The boards are nailed to the framework with iron nails, many of which have large hammer-flattened nail heads (Figure 117). Unlike the south windows, horizontal wood slat louvers are mounted to the exterior face of the framing. The louvers consist of alternating 1x4 and 1x6 boards separated by a space of 4 inches.



Figure 116. Interior of the typical window shutter opening at the north facade of the casemates.



Figure 118. Typical pintle hinge with conical cap at window opening.

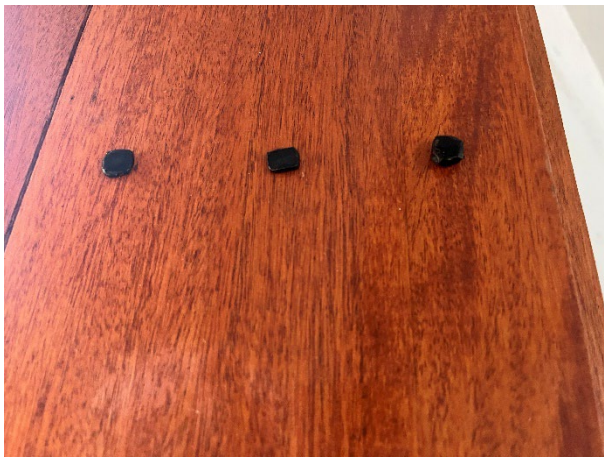


Figure 117. Detail of the hammered nail heads that adorn the shutters.



Figure 119. Typical "T"-shaped slide latch at window shutters.

Typical hardware at the shutters includes four pintle hinges with conical caps and a slide latch. The hinges are similar to those described for the south windows (Figure 118). The slide latch consists of a surface-mounted "T"-shaped latch secured to the interior face of one shutter with straps (Figure 119). An eyehook, aligned with the slide latch, is mounted to the face of the opposite shutter to receive the latch when the shutters are in the closed position.

Instead of the louvered window, a glazed window is located at the north interior facade of the casemate presently used as the gift shop (Figure 120). The window has a wood frame with mortise and tenon construction and set in the opening with wood-framed casement sash. Each sash has four pintle hinges and a pull handle.



Figure 120. Non-original casement window at gift shop portion of north casemate.

Vent channels are located along the south wall of the lower level of powder magazines. The channels consist of an opening, measuring 10-1/2 inches wide by 18 inches tall, at the interior of the magazine that splits into two channels within the depth of the wall to form two vent openings, each measuring 3 inches wide by 18 inches tall, at the exterior of the wall (Figure 121). There are four total sets of vents, two sets per powder magazine.



Figure 121. Pair of vent channels at the south facade of the lower powder magazines.

The window shutters at the guardhouse are the same as at the casemates. However, the window openings are rectangular, there is not a stucco surround, and there are painted stainless-steel grilles installed on the exterior face of the opening (Figure 122 and Figure 123). The grilles are constructed of a metal bar frame with vertical metal rods.



Figure 122. Interior view of window shutters at the guardhouse.



Figure 123. Painted stainless-steel grilles at the exterior of the guardhouse.

Exterior Door Openings

The exterior segmental arch double door openings are located along the south facade of the casemate building and share many features of the adjacent window openings. Each opening measures approximately 62 inches wide and 109 inches at the top of the arch. A stucco band, projecting approximately 2-3/4 inches from the plane of the adjacent wall, wraps around the exterior face of the opening (Figure 124). The band measures 12-1/2 inches wide at the jamb and widens 2 inches at the arched portion of the opening to form a band measuring 14-1/2 inches wide. The interior face of the door opening has angled walls at the jamb and head that create an interior opening measuring 84 inches wide by 120 inches tall (Figure 125).



Figure 124. Typical raised stucco surround at segmental arch door openings.



Figure 125. Interior view of segmental arch door openings at the south facade of the casemates. Note that the walls are angled, and the opening is larger on the interior side of the opening.

The wood-framed double doors all have a clear finish and consist of a wood frame and two door leaves. The wood frame measures 4-1/4 inches deep by 1-5/8 inches wide and has an exterior stop measuring 1-5/8 inches deep and 1-1/4 inch wide. Each door leaf has a wood structure consisting of a framework of wood members, measuring 1-5/8 inches deep by 2-3/4 inches wide, and mortice and tenon joints. The frame is clad on the exterior with 1x10 wood boards nailed to the structure with iron nails. Some of the nails have a large hammer-flattened head intended to match the appearance of the historic iron anchors. The overall thickness of the door measures 2-1/2 inches. Some of the doors have a segmental arch to match the door opening while others have rectangular doors with an arched wood transom occupying the upper portion of the arch (Figure 126). The doors at six of the seven easternmost casemates were replaced with new wood doors as part of rehabilitation work undertaken by the National Park Service in the 1960s. Existing doors were reinstalled at the fourth casemate from the west as part of this work.[175]



Figure 126. Wood transom panel at some door openings. Where present, the wood doors are rectangular instead of arched.

Similar to the windows, typical door hardware includes hinges, door stays, surface-mounted brackets, and a slide latch. There are five pintle-type door hinges per door leaf, each with a conical cap. The wood at the frame and shutter has been shaved to create an oblong slit around the hinge. The door stays consist of a hook and eye (Figure 127). The hook is mounted to the interior face of the framework of the door and the eye is mounted to the plaster wall opposite the door and within the door opening. Brackets are surface mounted at the mid-height of the interior door jamb and positioned to hold a horizontal bracing member. A surface-mounted "T"-shaped slide latch is mounted to the exterior face of one door leaf (Figure 128). The latch is secured with metal straps and a receiver strap at the opposite door leaf. Some of the door hardware was replaced with

175. Berkowitz et al., *The Fortifications of San Juan National Historic Site: Historic Structures Report*. (Atlanta, Georgia: U.S. Department of the Interior, National Park Service, Southeast Regional Office, 1991), Volume II, 59–61.

hardware that is not sympathetic to the original (Figure 129).

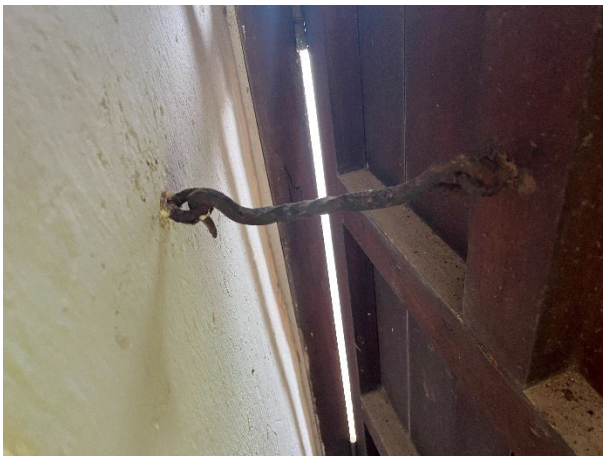


Figure 127. Hook and eye door stay mounted at interior face of door.

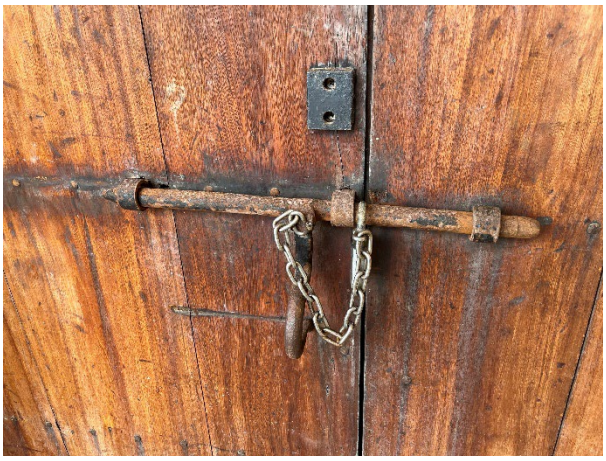


Figure 128. "T"-shaped slide latch surface mounted on exterior face of door.



Figure 129. Non-original five-knuckle ball hinge at some doors.

A non-original door that does not match the historic appearance of the building is located at the entrance to the casemate presently used as the gift shop. The rectangular door opening has a wood-framed double door with vertically oriented wood plank and an upper louvered wood panel, five-knuckle hinges, and a slide latch (Figure 130).



Figure 130. Non-original louvered door at the south facade of the gift shop portion of the north casemate.

Other non-original doors that do not match the historic appearance are located at the lower powder magazines. The rectangular door opening at the east powder magazine includes a stainless-steel double-leaf gate mounted at the exterior side of the opening (Figure 131). The gate consists of a welded stainless-steel frame, measuring approximately 2-1/2 inches wide, and two door leaves, each featuring a stainless-steel perimeter frame with 1-inch-diameter vertical bars. Typical hardware includes an upper and lower five-knuckle hinge, slide latch, and a strap lock.

The west powder magazine has a rectangular door opening with a wood-framed door set at the exterior side of the deep opening (Figure 132). The door has a wood frame, measuring 2-1/2 inches wide, with a single door leaf with a glazing panel at the upper portion of the leaf. The door is clad with vertically oriented wood boards secured to the door framework with iron nails. Typical hardware includes four pintle hinges with conical caps and a slide latch.



Figure 131. Non-original metal gate at the east powder magazine.



Figure 132. Non-original wood door at the west powder magazine.

At the terreplein, there is a wood door constructed of vertically oriented wood planks on a wood frame that provides access to a flight of stairs and the upper powder magazine. The door opening measures 2 feet 7 inches wide (Figure 133).



Figure 133. Wood plank door accessed from the lower terreplein and providing access to the upper powder magazines.

The guardhouse has the same door system and hardware as the casemates. However, door openings are rectangular, measure approximately 4 feet 8 inches wide by 8 feet 4 inches tall, and are accessed from a raised masonry stoop (Figure 134 and Figure 135). The openings have a raised stucco frame measuring 8 inches wide (Figure 136).

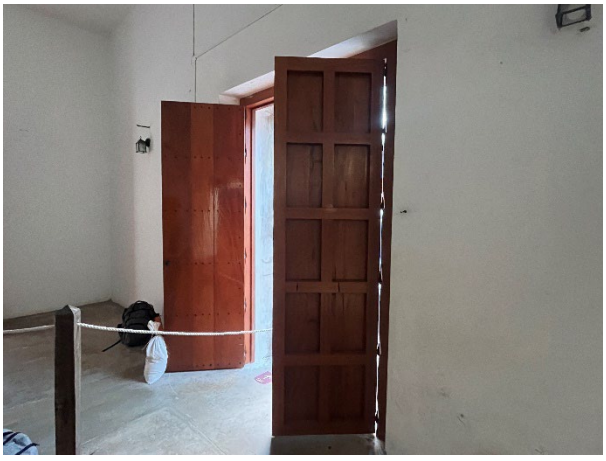


Figure 134. Interior view of the wood doors at the guardhouse.



Figure 135. Masonry steps at the base of the door opening on the guardhouse.



Figure 136. Exterior view of typical door opening at the guardhouse.

Roofs

At the roof of the one- and two-story portions of the casemate are terreplein with red-tinted concrete paving. The lower terreplein, located over the one-story portion of the building, has two semicircular gun emplacements outlined by wedge-shaped stone units along the north parapet wall. Within each gun emplacement, there is black-tinted concrete paving and a surface-mounted gun mount (Figure 137). Along the north parapet wall are recesses in the terreplein, measuring approximately 4 inches wide, 3 feet long, and 6 inches deep, that align with the outline of the semicircular gun emplacements that were historically used to stabilize the guns when in use. Previous patches in the concrete paving indicate the historic location of additional gun emplacements that have since been removed. One concrete gun mount, not within a gun emplacement, still remains at the west end of the terreplein. The mount consists of a raised concrete pad with a metal post upon which the gun was mounted (Figure 138). A ramp and stair landing are located at the west end of the lower terreplein.



Figure 137. Gun emplacement with mount at the lower terreplein.



Figure 138. Gun mount (without semicircular emplacement) at the west end of the lower terreplein.

The north side of the roof is defined by the fortress curtain wall that forms a parapet measuring approximately 17 feet deep and 72 inches tall. The top of the parapet has brick edging with a parge coat and sod over the remainder of the parapet. The top of the parapet is sloped away from the roof (Figure 139). The parapets to the west and south both measure 16 inches tall by 24 inches deep and are constructed of brick masonry with a cementitious parging applied over top. Three roof drains are located in openings in the

south parapet wall and direct water to drains internal to the wall construction and to the cisterns located below the plaza.



Figure 139. Overview of the lower terreplein with the sod-covered parapet on the north (right) and arcade roof to the south (left).

The arcade has a low-slope roof system, the construction of which is visible from the underside of the open-air structure. Stucco-clad beams extend north–south and span between the south wall of the arcade and the south wall of the casemate building (Figure 140). The beams support a cast-in-place concrete roof slab which has a visible form board finish. The low-slope arcade roof system is separated from the terreplein by the low parapet of the south casemate wall. The arcade roof consists of clay brick masonry set in a mortar setting bed and arranged herringbone pattern (Figure 141) The drainage valleys of the low-slope roof are defined by a single course of brick that extends to channels in the parapet wall between the terreplein and arcade roofs and drains at internal wall drains (Figure 142). The parapet wall for the arcade measures approximately 30 inches tall and is 24 inches deep.



Figure 140. The ceiling of the arcade is the underside of the roof deck. It consists of a concrete slab supported on beams.



Figure 141. Clay tile roof with low parapet walls at the arcade.



Figure 142. Channels in the parapet roof between the arcade and the terreplein provide an avenue for draining the arcade roof.

The guardhouse has a low-slope concrete roof with a parapet measuring approximately 24 inches

deep and 8 inches tall. Similar to other copings on the building, it is constructed of brick masonry with a cementitious parging applied over the top (Figure 143).



Figure 143. Low-slope roof and parapet at the guardhouse.

Ramp

The west ramp is constructed above the westernmost casemate and consists of a flight of stairs, measuring approximately 6 feet wide, and a ramp, measuring approximately 12 feet wide. Typical stairs have a 16-inch tread and a 4-inch rise and are constructed of brick masonry with a parging, measuring approximately 1 inch thick, applied over the top. The ramp consists of red-tinted concrete with horizontal bands of black-tinted concrete (Figure 144).



Figure 144. Ramp at the west end of the north casemates that provides access to the lower terreplein.

Interior

The interior of the one-story portion of the casemate building consists of nine casemates, each measuring approximately 19 feet wide by 33 feet 3 inches deep and 13 feet 7 inches tall (Figure 145). The five casemates on the east half of the one-story portion are presently used as exhibit and interpretive space and the four casemates on the west half of the space are used as the park gift shop and kitchen (Figure 146 and Figure 147). The two casemates at the west end of the building, where the kitchen is located, vary in width, one measuring 18 feet wide and the far west casemate measuring 14 feet 3 inches wide. Each casemate has concrete floors, plaster walls, and an arched interior passageway between casemates (Figure 148).



Figure 145. Interior view looking north of typical barrel-vaulted casemate.



Figure 146. Interior view looking north of typical barrel-vaulted casemate. The east casemates are used for exhibits.



Figure 147. Interior view of a casemate at the west end of the building currently used as a gift shop.



Figure 148. Arched interior passageways between casemates.

Upper and lower powder magazines are located at the east end of the building and measure 19 feet 2 inches wide by 30 feet 7 inches deep and approximately 13 feet tall. The upper powder magazines are accessed from a flight of stairs attached to the east powder magazine that measures 4 feet 8 inches wide. There is a passageway that extends between the two upper powder magazines. The powder magazines have plaster finishes and a window opening on the north interior facade.

The interior of the guardhouse has a concrete floor, plaster walls, and a flat ceiling with beam framing. It consists of a main space, presently used as the ticketing and information center for the park, mechanical closet, and a storage closet (Figure 149 and Figure 150). The main space measures 18 feet 4 inches by 28 feet 4 inches. The mechanical space has a polygonal-shaped plan with an area of approximately 144 square feet and accessed from a door at the main space. The storage closet is accessed from the exterior and has a polygonal plan with an area of approximately 100 square feet.



Figure 149. Interior view of the main space in the guardhouse.



Figure 150. Door and walls within the mechanical space of the guardhouse.

Flooring

The interior floors throughout the building are non-original. At the casemates, lower powder magazines, and guardhouse, flooring consists of concrete with a smooth finish and polished surface (Figure 151). The floor appears to have been installed in square sections defined by visible cold joints in the floor slab. In some casemates, there is evidence of previous concrete patches, indicating previous repairs below the concrete flooring (Figure 152).



Figure 151. Concrete flooring with cold joints typical throughout the north casemate.



Figure 152. Previous concrete patching appears to be associated with below-grade repairs.

At the upper powder magazines, the floor consists of non-original wood plank flooring with a wood baseboard (Figure 153). The wood flooring has a clear finish. The arcade also has a concrete floor; however, it has a rougher brushed finish. Each section of concrete measures approximately 10 feet square, is separated by control joints, and alternates between grey and red in color.



Figure 153. Wood plank flooring at the upper powder magazines.

Walls and Ceilings

Each casemate and the upper powder magazine have plaster walls, painted white, and a barrel-vaulted ceiling that extends north-south across the room (Figure 154). Each individual casemate is separated by interior walls extending north-south through the space. Between the powder magazines and at most of the casemates, the interior wall measures between 4 feet and 4 feet 9 inches wide. The separating wall between the two casemates at the west end of the building measures 5 feet 4 inches wide. At the center of each interior wall is a semicircular arched door opening with curved wood frame, set flush with the plaster finish and painted white, and steel reinforcing set within the masonry (Figure 155). Above the door opening is a groin vault that extends approximately a quarter of the way into the space (Figure 156).



Figure 154. Barrel-vaulted interior of casemate.



Figure 155. Semicircular passageway centered on interior walls.



Figure 157. Wood brackets extended from wall and below the perimeter beams.



Figure 156. Groin vault where barrel-vaulted ceiling of casemate intersects the arch of the semicircular passageway.



Figure 158. Wood floor framing with support beams painted white (arrow).

Like the exterior walls, interior walls are constructed of stone and brick and have a multi-coat plaster finish. The lower powder magazine has plastered walls and a ceiling consisting of the exposed wood framing for the floor above. The framing includes a perimeter wood frame that rests on a masonry ledge in the wall, wood beams that span east–west across the width of the room and bear on the frame, and wood floor planks that are oriented perpendicular to the beams. Historically, it appears that there were wood brackets along the top of the wall that supported the perimeter frame (Figure 157). However, many of the brackets have been removed and non-original wood columns, spaced approximately 6 feet apart, have been installed to shore the framing (Figure 158).

At the guardhouse, interior walls separate the building into three spaces. The interior wall measures approximately 24 inches deep and has a plaster finish, painted white (Figure 159). The rooms have a flat plaster ceiling with expressed beams that run north-south across the space (Figure 160).

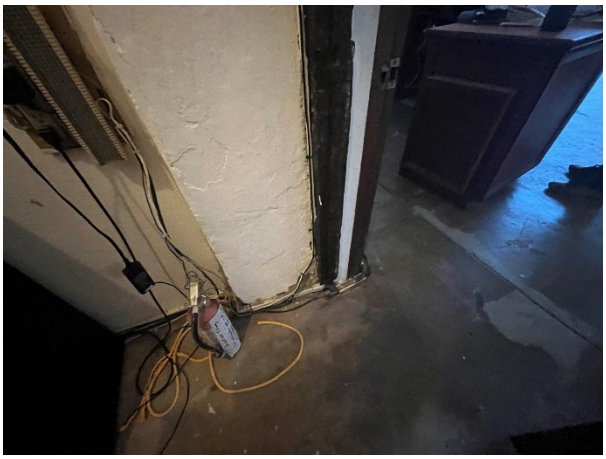


Figure 159. The edge of an interior wall at a door opening in the guardhouse.

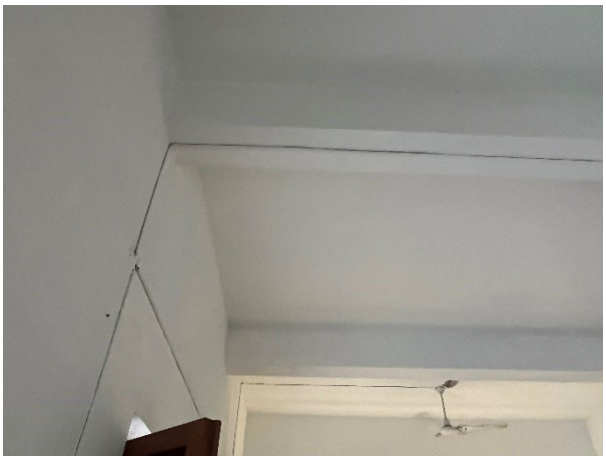


Figure 160. Interior flat ceiling with beams at the guardhouse.

Interior Door Openings

As indicated in the description of the interior walls, door openings located between casemates measure approximately 52 inches wide by 68 inches tall and have a semicircular arch (Figure 161). A similar arched opening between the upper powder magazines is larger and measures 64 inches wide and 96 inches tall. The openings have a plaster finish, painted white, and radius corners. Most of the interior door openings do not have a door system; however, there is a wrought iron gate at the door opening leading to the casemate with the gift shop (Figure 162). The double-leaf gate has a semicircular shape to match the opening. Each leaf has a wrought iron frame consisting of an iron bar measuring 2 inches deep by 1/2 inch thick. Two horizontal bars, one at the spring of the arch and one approximately 24 inches from the bottom of the frame, extend across the width of the door and are welded to the frame. Vertically oriented round bars extend the full height of each leaf. The gates are mounted onto pintle hinges, two per door leaf, anchored into the masonry wall (Figure 163). There is a latch that extends between door leaves and a modern padlock.



Figure 161. An interior door opening between casemates.

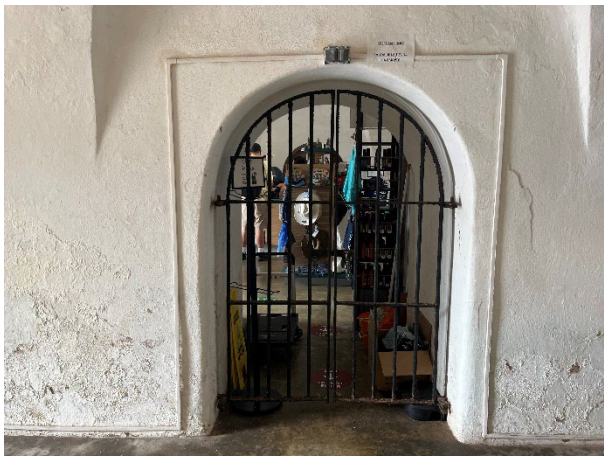


Figure 162. Semicircular door opening with an iron double-leaf gate.

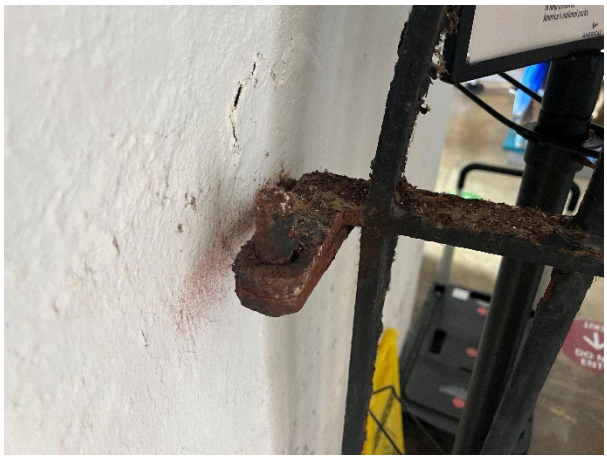


Figure 163. The iron gates, where they are anchored into the adjacent wall.

Other interior door openings include a semicircular arched opening, measuring 57 inches wide and 96 inches tall, at the flight of stairs between lower and upper powder magazines; and a rectangular door opening, measuring 31 inches wide by 70 inches tall, at the flight of stairs between the terreplein and the upper powder magazines (Figure 164). A wood door frame was set in the interior opening for the terreplein flight of stairs, but the hinged door had been removed (Figure 165).



Figure 164. Semicircular arched door opening leading to the flight of stairs between the lower and upper powder magazines.



Figure 165. Door opening (with door removed and set to the side) at the upper powder magazine providing access to the flight of stairs to the lower terreplein.

Non-original interior doors at the mechanical closet and storage closet consist of a wood-framed opening in which there is a wood plank door set on five-knuckle hinges. Wood batts are mounted to one face of the wood planks. The door has a mortise lock, pull handle, and decorative anchor heads where the battens are mounted to the planks (Figure 166).

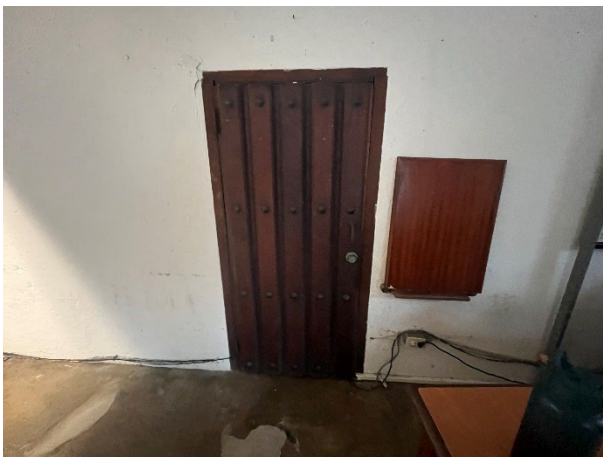


Figure 166. Wood door to the mechanical closet in the guardhouse.

Stairs

There is an interior flight of stairs that extends between the upper and lower powder magazines (Figure 167). The stairs measure 56 inches wide and consist of three lengths of steps separated by square landings. The stairs have an average tread length of 18 inches and an average riser height of 8 inches, with landings measuring 56 inches square.

The stairwell has a barrel-vaulted ceiling with groin vaults above the landings (Figure 168).



Figure 167. Flight of stairs from the lower to the upper powder magazines.



Figure 168. Barrel-vaulted ceiling and groin vault at the powder magazine stairwell.

A straight-line flight of stairs extends from the upper powder magazine to the terreplein and is constructed of brick with plaster walls (Figure 169). The stairs have an average tread length of 8 inches and an average riser height of 12 inches.



Figure 169. Brick flight of stairs from the upper powder magazine to the lower terreplein.

Troops' Quarters

The troops' quarters is a two-story masonry structure located along the east boundary of the Plaza de Armas. The building has an irregular plan similar to an elongated hexagon with a rectangular interior arrangement of spaces and angled end walls at the northeast and southwest facades. The overall plan measures approximately 163 feet wide by 60 feet deep and 36 feet 7 inches tall. The interior plan measures 116 feet 2 inches wide. The west facade faces the plaza, the angled walls of the north facade abut the ramp that extends from the plaza to the El Caballero terreplein, the east facade overlooks the top of the south bastion, and the south facade forms the fortification wall. The interior consists of five casemates at the first floor and five at the second floor with interior passages connecting the casemate, a wood-framed stair between floor levels, and a stone circular staircase extending from the first floor to the terreplein.

Walls

Similar to the north casemates, the exterior walls are constructed of San Juan sandstone and hand-pressed clay brick and have a stucco finish. Stone units are typically used at pilasters and at the base of the building. Brick is used at wall areas and corbelled to provide a substrate for projecting features such as cornices, surrounds, and

decorative bands. The stucco on the building was mostly replaced in 2003 with repairs performed in 2017 and consists of a scratch coat with a thin white stucco finish coat. The overall stucco system is approximately 3/4 inch deep.

At the first-floor level, the exterior wall at the west facade measures approximately 3 feet 6 inches deep and the east wall measures 10 feet deep. The north wall includes a tunnel and measures over 20 feet deep. The south wall forms the fortification wall and measures approximately 50 feet deep at its base.

The west facade has an ornate and symmetrical facade consisting of an upper and lower cornice, projecting base, and a decorative parapet wall that extends the full width of the facade (Figure 170). The lower cornice is located above the second-floor window openings, measures approximately 15 inches tall, and is positioned 18 inches below the start of the upper cornice. The upper cornice measures 27 inches tall and projects 25 inches from the plane of the wall. Above the upper cornice is a parapet wall measuring 42 inches tall and 28 inches deep. At the center of the parapet is an arched opening with a bell that extends 52 inches above the parapet. A band, measuring approximately 13 inches tall, extends along the base of the building.

The facade is divided into five bays by pilasters that extend the full height of the building (Figure 171). The center bay consists of a large casement window with decorative surround and a large double door with transom panel (Figure 172). At the cornice above the window is a decorative stucco festoon. The bays at either end of the building feature a first-floor window opening and door opening and two second floor window openings. Each opening has a plaster surround and is vertically aligned between floors. A projecting stucco water table extends horizontally between the pilasters and denotes the interior floor line. Scuppers extend from the wall above the water table (Figure 173). The second and fourth bays each feature four window openings: two at the first-floor level and two at the second-floor level, each with stucco surrounds.



Figure 170. West facade of the troops' quarters as seen from Plaza de Armas.



Figure 171. Northern two bays of the west facade.



Figure 172. Center bay with main entrance door at west facade.



Figure 173. Scupper above water table and below second-floor windows.

The north facade defines the south edge of the plaza ramp and has a semicircular arched door opening accessed from the ramp.

The lower half of the east facade is concealed by the south bastion. The upper half of the facade looks out onto the parapet and roof of the south bastion. The facade consists of five window openings evenly spaced along the width of the facade with the center opening being slightly smaller than the others. Centered below each window opening is a small vent opening. At the far north end of the facade is a door opening, accessed from the roof of the south bastion, that provides access to a tunnel and the door opening at the north facade.

Window Openings

Window openings are located at the west and east facades. All of the window systems are wood framed and have been extensively repaired or replaced; however, they maintain the historic appearance.

Typical windows at the west facade have a segmental arch and measure approximately 3 feet 6 inches wide by 7 feet 10 inches tall, as viewed from the exterior (Figure 174). There is a raised plaster surround with keystone measuring 11 inches wide and projecting 1-1/2 inches beyond the plane of the wall (Figure 175). The sill is clad with stucco and measures 15 inches deep.



Figure 174. Typical exterior window surround at west facade of troops' quarters.

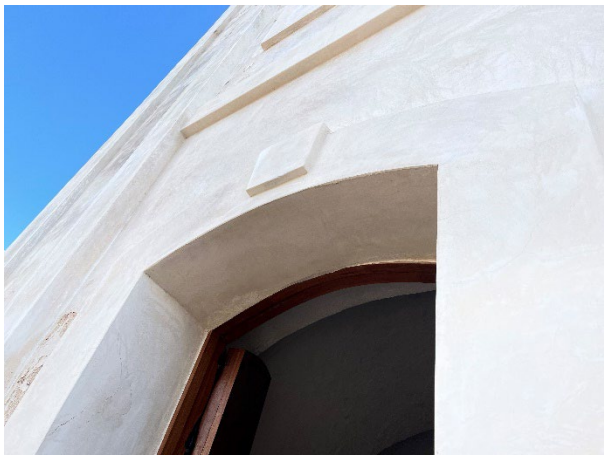


Figure 175. Pronounced keystone at stucco surround of window opening.

The interior window openings have angled walls that splay out from the window system, creating an opening measuring 63 inches wide by 84 inches tall (Figure 176). At the first floor, the window opening includes a brick stool, measuring 23 inches deep and 20 inches above finished floor, and wood stool trim that extends 4 inches on either side into the wall (Figure 177). At the second floor, there is not a stool. Instead, the window sits on a wall with the top edge rounded at a radius of approximately 12 inches (Figure 178 and Figure 179). A scupper is centered at the base of the wall.



Figure 176. Interior view of typical first-floor windows.



Figure 177. Interior view of typical second-floor windows.



Figure 178. Interior wood sill at window opening.



Figure 179. Second-floor window with rounded top edge wall.

The window system is positioned mostly at the center of the wall depth and consists of a wood frame, measuring 4-1/2 inches deep. The shutters have a structure consisting of a framework of wood members, measuring 1-5/8 inches deep by 2-3/4 inches wide, with mortice and tenon joints. The framework is clad on the exterior with 1x10 wood boards nailed to the framework with iron nails. Some of the nails have a large hammer-flattened head intended to match the appearance of the historic iron anchors. Each shutter sash measures 18 inches wide and has a profile that matches the arched opening. The shutters and framing have a clear finish.

Typical hardware at the shutters includes six iron pintle hinges driven directly into the wood frame with conical heads and the wood framing notched around each hinge (Figure 180). The windows also have hook and eye shutter stays and a "T"-shaped slide lock mounted to the interior face of the shutters. The loops that support the slide lock are anchored through the door and have a split tail that is hammered flat with the exterior face of the door (Figure 181).

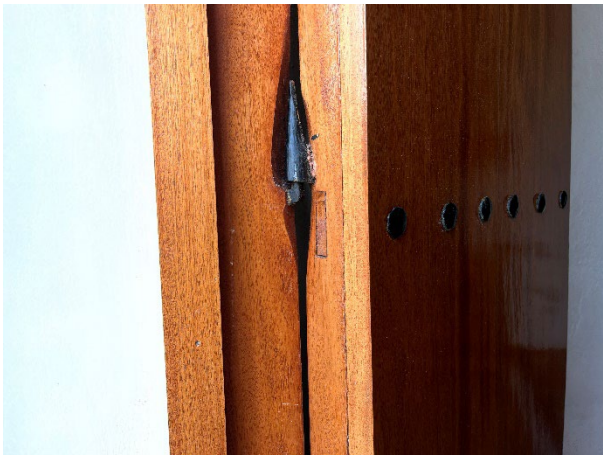


Figure 180. Pintle hinge with conical cap at window shutter.



Figure 181. Split tail anchors for window shutter hardware and hammered flattened nail heads.

A large second-floor window opening is centered at the center bay on the west facade of the building. Like the smaller second-floor window openings, it has a semicircular arch opening with angled interior walls at the jamb and head (Figure 182). The window sits on a wall with a rounded top edge. The window shutters are of the same construction as the other west facade shutters; however, they are slightly wider and taller, measuring 4 feet wide and 8 feet 10 inches tall at the exterior.



Figure 182. Exterior view of center second-floor window.

At the east facade, typical window openings are rectangular and set within the scarp of the wall. The openings measure 6 feet 8 inches wide and 5 feet inches tall. The interior of the window openings has angled walls creating an interior opening measuring 10 feet wide by 6 feet 9-1/2 inches tall, and plaster stool (Figure 183). Below

the opening is a rectangular recess cut into the stool and measuring 30 inches wide by 42 inches tall and 8 inches deep.



Figure 183. Interior view of second-floor window opening at east facade.

The wood-framed window shutters are positioned at the center of the opening and are of similar construction to the west shutters; however, they have small-diameter exposed iron nail heads (Figure 184). There is a wood splash with an integral drip edge that is surface mounted to the bottom of the exterior side of the shutters (Figure 185). Hardware includes four pintle hinges driven into the wood frame, hook and eye shutter stays, and surface-mounted brackets that support interior bracing.



Figure 184. Wood shutters at east window openings.



Figure 185. Wood sill attached to base of wood shutters at east facade windows.

Immediately below the window opening is a rectangular louvered vent opening measuring 28 inches wide. The vent openings extend to the first-floor casemates and consist of angled walls that extend down to the first-floor casemates (Figure 186). The vent openings widen to form an arched opening measuring 7 feet wide and 5 feet 7 inches tall. At the north vent opening, a portion of the sloping sill includes plaster stair treads.



Figure 186. Interior view of louvered vent opening as seen from first floor.

The louvered vents are set at the exterior face of the opening and consist of an arched wood frame with vertical stile and horizontal wood louvers (Figure 187).



Figure 187. Interior of wood louvered vent.



Figure 188. Exterior view of typical door opening.

Exterior Door Openings

There are three types of exterior door openings: two on either end of the west facade, a large main entrance door at the center of the facade, and a door at the rooftop penthouse. The two segmental arch door openings at the end of the facade measure 42 inches wide by 11 feet 6 inches tall and have a set of wood-framed double doors (Figure 188). Similar to the window openings, the doors have a raised stucco surround, measuring 11-1/2 inches wide, with a pronounced keystone. At the interior, the walls are angled, creating an opening measuring 58 inches wide and 12 feet tall (Figure 189). The door is set within the center depth of the door opening and has a profile that matches the arch of the opening. The door has a wood framework onto which vertically oriented wood boards are anchored with iron nails with hammered nail heads measuring 1 inch in diameter (Figure 190 and Figure 191). Each leaf is mounted on seven pintle hinges with conical caps driven into the frame. The door has a "T"-shaped slide lock mounted to the interior face (Figure 192).



Figure 189. Interior view of typical door opening.



Figure 190. Typical wood-framed door leaves.

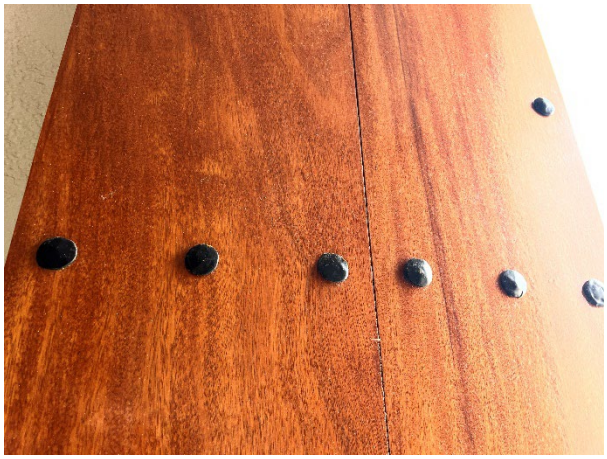


Figure 191. Detail of door cladding with hammer flattened nail heads.

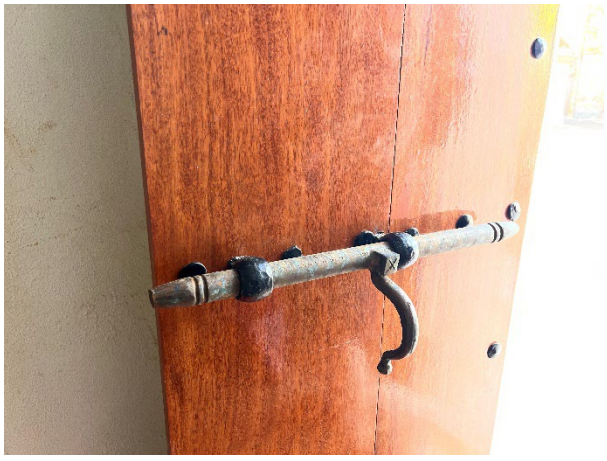


Figure 192. "T"-shaped slide latch mounted to exterior face of door.

The center entrance door opening has a raised stucco surround measuring 32 inches wide and projecting 12 inches from the plane of the wall (Figure 193). The surround features a pronounced bullnose as well as various ogee curve and recessed forms. The opening measures 7 feet 6 inches wide and 13 feet tall. At the interior of the opening, the walls are angled toward the door and the opening measures 9 feet wide and 13 feet 8 inches tall (Figure 194).



Figure 193. Exterior view of main door opening.



Figure 194. Interior view of main door opening.

The wood-framed door consists of a double door and transom shutters. The door frame is constructed of 2x4s that are curved to follow the segmental arch of the opening. The door leaves are constructed of a 1-5/8 inch by 2-3/4 inch frame consisting of stile and rails. Wood planks, measuring 10 inches wide and 7/8 inches thick, are nailed to the exterior face of the frame. Each door leaf is mounted on seven pintle hinges with conical caps.

Above the door and separated by a dividing rail, are wood shutters (Figure 195). The shutters are of similar construction to the door and consist of a frame upon which wood boards are applied. Unlike the doors, there is a vertical astragal between the shutters. Each shutter is mounted on three pintle hinges with conical caps. In addition to the hinges, other hardware present at the doors includes a "T"-shaped slide latch surface mounted to the exterior of one door, and brackets mounted to the frame of the door and transom to support wood bracing that barricades the doors in the closed position (Figure 196).



Figure 195. Wood-framed transom shutters.



Figure 196. "T"-shaped slide latch mounted to exterior face of door.

An exterior door is located at the terreplein penthouse and provides access to the circular staircase. The semicircular arch door opening has a raised stucco surround measuring 11 inches wide and projecting 1-1/2 inches from the plane of the wall. The door is set at the interior side of the opening. Because of the depth of the wall, the door leaves are completely covered from the elements, even when in the open position. The wood-framed double door leaves follow the arched shape of the opening. Each leaf consists of 2x6 wood framework upon which vertically oriented wood planks are nailed. Hardware includes pintle hinges with conical caps and hook and eye door stays mounted to the exterior side of the door.

Roof

The roof of the troops' quarters is an extension of El Caballero (Figure 197). A parapet wraps around the south and west facades measuring approximately 42 inches tall and 28 inches deep (Figure 198). The parapet and embrasures are constructed of stone and brick and have a parging applied over the upward-facing surface and stucco applied to the vertical face. Aligned with the center of the west facade of the troops' quarters is a step in the parapet wall, measuring 52 inches tall, with an arched cutout. A bell is hung from a wood rod within the opening (Figure 199). At the southwest corner of the terreplein is the circular staircase penthouse with a circular plan and domed roof.



Figure 197. Typical embrasure at terreplein.



Figure 198. Parapet wall along east facade of troops' quarters.



Figure 199. Arched opening with bell at center of east parapet.

Interior

The interior of the troops' quarters consists of ten casemates: five at the first floor and five at the second floor. The casemates have vaulted walls and ceilings with a plaster finish. Exterior openings are located at the east and west facades and there are interior passageways that extend between casemates. The center casement is accessed from the main entrance and includes the main wood-framed flight of stairs. There is access to the concrete circular staircase from the west side of the south casemate. The first-floor casemates at the north end of the building are presently used as an exhibit. The other casemates and stairs are open to visitor access but do not house exhibits.

Flooring

There is a wide range of flooring materials throughout the troops' quarters. The original flooring was likely tabby concrete. The original tabby concrete is exposed to view at the north casemates on the first floor (Figure 200). At all other casemates, there is a non-original concrete floor with a smooth and polished finish (Figure 201). The cold joints between sections of the cast-on-place concrete are visible (Figure 202). Previous patching of the concrete flooring is evidenced by variations in concrete color and texture (Figure 203). The concrete flooring at the center casemate on the first floor has a different appearance than the other non-historic concrete flooring. It includes large red brick aggregate and a rough surface finish (Figure 204).



Figure 200. Tabby concrete flooring at first-floor casemate.



Figure 201. Polished concrete flooring at casemates.



Figure 202. Pattern of cold joints in polished concrete flooring.



Figure 203. Previous repairs in polished concrete flooring.

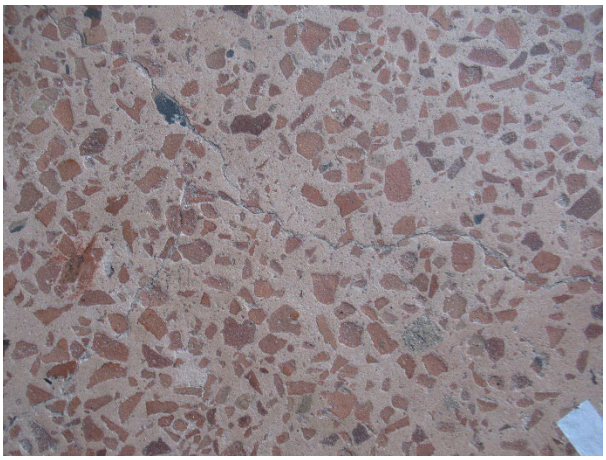


Figure 204. Concrete flooring at first-floor center casemate.

Other non-original floor finishes include a wood plank deck installed over the tabby concrete at the west end of the north casemates (Figure 205). The wood floor appears to have been installed to protect the historic concrete floors from visitor traffic. A wood railing has been mounted along the edge of the flooring to prevent visitors from entering the exhibit area. Cream-colored ceramic tile flooring consisting of square tiles measuring 2-1/4 inches square and half-sized rectangular tiles is located at the first level floor in the second casemate from the north (Figure 206). The casemate also has a red clay tile wall base with each tile measuring approximately 6 inches square.



Figure 205. Wood plank flooring installed as protection over historic tabby concrete flooring.



Figure 206. Beige-colored tile at floor and red clay tile at the wall base.

Walls and Ceilings

The casemates are separated by interior walls, measuring approximately 52 inches deep, constructed of stone and brick. The walls have a plaster finish and are painted white. The walls transition to the vaulted ceiling. At the first floor, the ceiling has a flat segmental arch vault (Figure 207). Semicircular arched passageways are

located at the east and west ends of each interior wall and provide access to the adjacent casemate (Figure 208). The ceiling above the passageways is arched, creating a groin vault with the main ceiling vault. The second floor has barrel-vaulted ceilings with a similar configuration of interior walls and passageways (Figure 209).



Figure 207. Segmental arch vault ceiling at first-floor casemates.



Figure 208. Semicircular interior passageway between casemates.



Figure 209. Barrel-vaulted ceiling at second-floor casemates.

At the north and south interior facades, there are semicircular niches set into the wall (Figure 210). The niches are approximately 18 inches deep and have a stool raised approximately 8 inches above the finished floor. The niches align with the arched passageways that extend between casemates.



Figure 210. Semicircular wall niche at north and south interior facades.

An interior wall, measuring 20 inches deep, extends north–south across the center casemate at the stairwell (Figure 211). The wall has a semicircular arched opening around the entrance to the flight of stairs, two segmental arch door openings, and two oval cutouts, each approximately 24 inches tall, positioned above the doors. At the arched portion of the stair opening is a decorative plaster surround.



Figure 211. Interior wall at first-floor center casemate framing the entrance to the flight of stairs. Note arched opening, door openings, and oval cutouts.

Remnants of decorative stenciling remain on the interior walls of the circular stairwell at the south end of the troops' quarters, primarily on the dome (Figure 212 and Figure 213). The interior of the circular stairwell walls has been partially patched with portland cement (Figure 214). A thin limewash coating is also partially installed on the circular stair tower walls (Figure 215).



Figure 212. Decorative stenciling at the dome interior.



Figure 213. Decorative stenciling at the dome interior.



Figure 214. Cementitious patches at circular stairwell walls.



Figure 215. Lime wash coating application at interior of circular stair tower.

Interior Door Openings

Interior doors are set in arched door openings and include wood-framed double doors as well as metal-framed gates. The wood-framed doors are

located at the closets below the flight of stairs at the center casemate and at the entrance to the circular stairwell (Figure 216 and Figure 217). The door leaves have an arched form that matches the opening and are constructed of a wood framework upon which wood boards are anchored. The boards are secured with iron nails with hammered heads, measuring approximately 1 inch in diameter, and have pintle hinges and a surface-mounted "T"-shaped slide latch.



Figure 216. Semicircular arched door opening with wood door at first-floor center casemate, below stairs.



Figure 217. Semicircular arched door at entrance to circular stairwell.

Like at other buildings within the main fortification, metal-framed gates are located at some of the passageways between casemates. The gates are constructed with an iron bar frame with horizontal bracing and vertically oriented round bars (Figure 218). The gates are set on metal bars with pintles that are set into the masonry of the wall.



Figure 218. Iron gate at semicircular interior passageway.

Stairs

The interior stairs that extend between the first and second-floor casemates consist of a single flight of concrete stairs centered within the casemate (Figure 219). The flight of stairs provides access to an intermediate concrete landing that spans the full width of the casemate. The landing provides access to two flights of stairs, one on either end of the landing, that lead to the second floor (Figure 220). The stairs measure approximately 6 feet 2 inches wide, and the landing is 6 feet 4 inches deep. There is a wood handrail consisting of a wood base and handrail with turned wood spindles and newel posts (Figure 221). The handrail measures 42 inches tall and is painted dark green.

At the first-floor level, the flight of stairs is framed by an interior wall with a semicircular arch opening over the stairs (Figure 222 and Figure 223). The wall encloses the space under the upper flight of stairs. There are door openings and oval cutouts in the plaster wall that provide access to the area under the stairs.



Figure 219. Lower flight of concrete stairs as seen from first-floor center casemate.



Figure 220. Upper flight of concrete stairs as seen from stair landing and looking up to the second-floor casemate.



Figure 221. Wood balustrade at stair.



Figure 222. Concrete circular staircase as seen from entrance at second floor of the troops' quarters.



Figure 223. Concrete circular staircase as seen looking down from the penthouse.

The circular staircase at the south end of the building measures 7 feet 6 inches in diameter and consists of wedge-shaped concrete treads and a center concrete core around which the stairs spiral. The staircase extends from the second floor of the casemates to the El Caballero terreplein.

Officers' Quarters

The officers' quarters define the west boundary of the Plaza de Armas (Figure 224 and Figure 225). The original portion of the building is a two-story structure built into the terrain so that the lower level is accessed from exterior grade and the upper level is accessed from an arcade at the plaza. The building, including arcade, has a rectangular plan measuring 118 feet 7 inches long by 42 feet deep. The arcade extends along the east (plaza) side of the building and consists of piers that support

segmental arched openings, each aligned with and providing access to five individual casemates within the original building. The building has a low-slope roof with tall parapet on three sides. The lower level has large barrel-vaulted recesses in the wall that include window and door openings. An entrance vestibule is located along the north facade of the building and provides access to the north casemates at the upper level of the building. The addition faces to the north and has a rectangular plan measuring 38 feet 7-1/2 inches wide by 7 feet 4 inches deep.

The arcade on the east side of the building was enclosed and subdivided in circa 1835, which created five additional interior spaces. The arcade was restored in 1965 by the National Park Service.[176]

The south addition, which was completed by 1861, is attached to the south wall of the original building. The east facade projects approximately 2 feet beyond the plane of the arcade piers. The building measures 80 feet 5 inches along the east facade, 14 feet along the south facade, and 81 feet 3-5/8 inches along the west facade. The interior of the building is divided into five rooms: two bathrooms, an office, and two storage areas. Typical finishes include plaster walls, flat ceilings with framing beams, window openings along the west facade, and door openings on the east facade.



Figure 224. East facade of the officers' quarters as viewed from across the plaza.

176. Berkowitz et al., *The Fortifications of San Juan National Historic Site: Historic Structures Report*. (Atlanta, Georgia: U.S. Department of the Interior, National Park Service, Southeast Regional Office, 1991), Volume II, 178–191.



Figure 225. Roof of the officers' quarters as viewed from the south end of the troops' quarters roof.

Walls

Similar to the north casemates, the exterior walls are constructed of San Juan sandstone and hand-pressed clay brick and have a stucco finish. Dressed ashlar stone units are typically used at columns, corners, and around window and door openings. Brick is used at wall areas and corbelled to provide a substrate for projecting features such as cornices, surrounds, and decorative bands. There are numerous layers of stucco and previous localized stucco finish repairs layered on top of each other. In general, the walls have a two-coat stucco system consisting of a scratch coat, measuring 3/8 inches thick, and finish coat with limewash, measuring 1/8 inches thick. Throughout all of the facades, there is evidence of previous alterations where electrical conduit and exterior lighting had been installed in the wall. The stucco had been repaired at those locations (Figure 226).



Figure 226. Stucco repair at conduit installation.

The east facade faces onto the plaza and consists of the arcade at the north half and the south addition at the south half. The arcade wall consists of five bays, each featuring a segmental arched opening separated by piers. At the north end of the facade is a wall area with a window that aligns with the north entrance vestibule.

The stone piers are spaced 22 feet 6 inches apart and measure 4 feet 1-1/4 inches by 3 feet 9 inches in plan and have recessed corners, giving the pier a "+" shape in plan. The piers extend the full height of the building and feature a base, measuring 6 inches tall and projecting 1 inch beyond the main face of the pier, and integrate with the profile of the building cornice at the top (Figure 227). The lower portion of the piers have a stucco finish with articulated faux joints and are painted to indicate the stone masonry construction. Segmental arches span between piers and measure approximately 9 feet tall at the apex. A cornice extends the full length of the arcade and measures approximately 22 inches tall and projects 18 inches beyond the plane of the wall. Above the cornice is a low parapet measuring approximately 12 inches tall. Beyond the east facade of the arcade wall is the east facade of the casemates. The stucco wall has pilasters, measuring approximately 6 feet 4 inches tall and aligning with the piers, that support arched openings that span across the arcade and arched door openings. At the roof level is a parapet wall, set back from the low parapet for the arcade, that measures approximately 24 inches tall. To the north of the arcade is a flat wall with a rectangular window opening.



Figure 227. Stone pier that supports the arches of the arcade.

The east facade of the south addition has five rectangular door openings, each with a stucco surround, and an upper louvered vent opening with stucco surround (Figure 228). The facade measures approximately 17 feet tall and consists of a base, which projects 1 inch from the plane of the wall, and a cornice, measuring 22 inches tall and projecting as much as 9 inches from the plane of the wall, that extends the full length of the facade. Above the cornice is a low parapet wall with coping that measures approximately 20 inches tall (Figure 229).



Figure 228. East facade of the south addition.



Figure 229. Cornice at top of wall at south addition

The features of the east facade of the south addition wrap onto the south facade of the building. In addition to the projecting base, cornice, and low parapet, the south facade features two louvered vent openings with stucco surrounds (Figure 230). The west end of the south facade abuts the fortress curtain wall. A non-original water fountain has been mounted to the wall.



Figure 230. South facade of the south addition.

The west facade consists of the two-story building to the north and the addition to the south. The two-story facade measures 39 feet tall and is divided into five bays by pilasters that extend nearly the full height of the building (Figure 231). The pilasters measure 39 inches wide and have a base, measuring approximately 36 inches tall, and a cap, measuring 19 inches tall that abuts the lower cornice. The profile of the lower cornice measures 14 inches tall and projects 9 inches from the plane of the wall. An upper cornice is located 20 inches above the lower cornice and has a profile measuring 26 inches tall and projecting 16 inches from the plane of the wall. Above the upper cornice is a parapet wall, measuring 5 feet 8 inches tall (Figure 232). The parapet has a coping and is articulated with recessed panels.



Figure 231. West facade of the two-story portion of the officers' quarters.



Figure 232. View of the cornice and parapet along the top of the west facade.

At the lower level and centered within each bay are large barrel-vaulted recesses. The recesses measure 17 feet wide by 12 feet tall and are 16 feet 6 inches in height. There are door openings set within the north, south, and center recess. Window openings are centered in the remaining two recesses. At the upper level, there are segmental-arch window openings centered within each bay. The window openings have a decorative stucco surround, pronounced keystone, and sill with a decorative stucco pattern below.

The south addition was constructed on the existing fortress curtain wall. The flat stucco walls are set back approximately 16 inches from the edge of the curtain wall and have five rectangular window openings evenly spaced across the facade with three embrasures and a smaller opening located at the north end of the facade (Figure 233). Projecting scupper outlets are located approximately 36 inches below the top of the wall.



Figure 233. West facade of the two-story portion of the officers' quarters.

The north facade consists of the entrance vestibule with a low roof and abuts a pier for the main entrance gate. The north parapet wall of the two-story portion of the building is visible beyond the entrance vestibule. The west half of the entrance vestibule measures 16 feet 8 inches tall and features a segmental arch roof with projecting cornice and clay tile roofing (Figure 234). There is a segmental arch door opening and evidence of a previously existing window opening that has been patched with stucco. At the east half of the facade, the wall measures 13 feet 6 inches tall and has a low-slope roof with projecting cornice and segmental arch door opening. The parapet for the two-story portion of the building extends approximately 5 feet 6 inches above the entrance vestibule roof.



Figure 234. North facade of the officers' quarters as seen from the ramp and the lower terreplein.

Windows

Window openings include window shutters, louvered vents, and embrasures and are mostly located on the west facade with a few vent openings on the south and east facades. The treatment of the openings and the design of the sash differ between the more historic two-story portion of the building and the south addition. All of the window systems are wood framed and have been extensively repaired or replaced; however, they maintain the historic appearance.

The window openings at the two-story portion of the building have a segmental arch and measure 3 feet 6 inches wide by 7 feet 7 inches. A stucco surround at the exterior jambs and heads of the opening consists of a series of stucco coves, ogees, and steps that measure 18 inches wide and project 4 inches from the face of the wall. The corners of the opening are rounded. A stucco sill extends approximately 10 inches beyond the field of wall and measures 6 inches tall (Figure 235). There is a stucco apron below the sill that measures 4 inches tall and projects 4 inches from the wall. Below the sill and apron is a decorative stucco shield raised 1 inch above the adjacent field of wall. At the interior, the wall area along the full height of the jambs and along the head are angled toward the window so that the interior opening measures 5 feet 11 inches wide and 12 feet tall. The wood frame from a previous window system is surface mounted to the interior wall of the window opening (Figure 236).



Figure 235. Typical exterior window opening at west facade of two-story portion of building.



Figure 236. Previous interior wood frame set within window opening.

Within each window opening is a wood frame set approximately 8 inches from the interior face of the wall that includes louvered casement shutters and a louvered transom. Each shutter measures approximately 5 feet 5 inches tall by 18 inches wide and consists of mortise and tenon 2x4 wood frame with wood slats set into grooves and oriented at an angle within the frame. There is a horizontal rail that spans across the frame and in between slats that measures 2 inches wide (Figure 237). The shutters are secured to the frame with three pintle hinges with conical caps. Portions of the wood frame and shutter are carved out to accommodate the hinge. Other hardware includes a "T"-shaped slide lock mounted to the interior face of one shutter and a receiving eye mounted to the opposite shutter. Above the shutters and separated by a dividing rail, measuring 2 inches wide, is a fixed louvered transom with segmental arch frame. The 2x4 frame includes a vertical stile at the center of the frame with wood slats, set in grooves, on either side. The shutter system has a clear coat finish. At some locations, the louvered transom has been replaced with a wood panel or glazing unit.

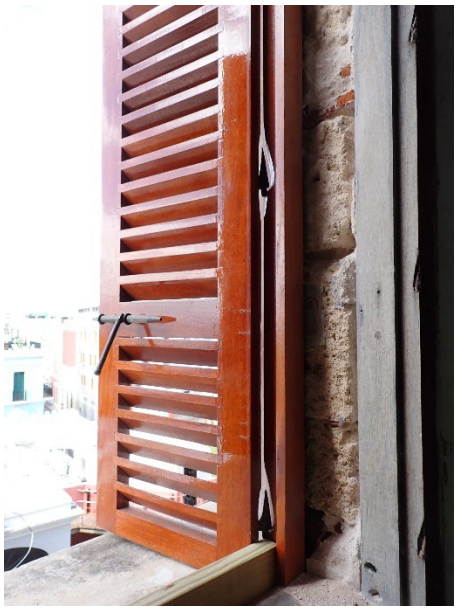


Figure 237. Wood louvered shutters as viewed from the interior of the two-story portion of the building.

At the south addition, window openings are rectangular and measure approximately 48 inches wide by 70 inches tall. There are no exterior surrounds; however, the interior walls at the jamb and head are lightly angled so that the opening measures approximately 64 inches wide by 84 inches tall from the interior (Figure 238).



Figure 238. Window opening with shutters as viewed from the interior of the south addition.

Wood plank shutters set within the opening are of similar construction to those at the north casemates and consist of wood planks mounted to a wood frame constructed with mortise and tenon joinery. The shutters are mounted to the frame with pintle-type hinges with conical caps, slide latches, and have hook and eye shutter stays

(Figure 239 and Figure 240). It appears that the wood originally had a clear coat finish, although much of the finish had worn away. At some windows, the shutter hinges have been replaced with knuckled hinges, and the joinery has been reinforced with screws (Figure 241).



Figure 239. Pintle hinge at south addition window shutters. The wood frames around the hinge have been carved around the hinges.



Figure 240. "T"-shaped slide latch mounted to interior face of shutters.



Figure 241. Knuckle hinges are present at some windows.

Louvered openings measure approximately 42 inches wide by 32 inches tall and feature a raised stucco surround on the exterior, measuring approximately 8 inches wide, that wraps the full perimeter of the window (Figure 242). At the interior, the window is set approximately 6 inches from the interior face of the wall and has a plaster frame, making the interior dimensions of the opening approximately 32 inches wide by 22 inches tall (Figure 243).



Figure 242. Exterior view of louvered windows with raised stucco surround and wood louvers.



Figure 243. Interior of wood louvered window opening with angled walls.

The louvered vents are located at the east and south facades and consist of a wood frame and wood slats that span horizontally and are set at an angle within the frame. The wood has a clear coat finish.

Embrasure openings measure approximately 12 inches wide by 24 inches tall from the interior (Figure 244). The interior walls of the opening are angled so the opening measures approximately 8 inches wide and 18 inches tall when measured from the exterior.



Figure 244. Interior view of embrasure opening at south addition.

Exterior Door Openings

Door openings are primarily located on the north and east facades and include double doors accessed from the arcade, single-leaf doors at the south addition, and single doors with transom at the north facade. Similar to the windows, most of the doors have been extensively repaired or replaced; however, they maintain the character of the historic doors.

The east facade door openings accessed from the arcade have a stucco surround measuring approximately 11 inches wide and raised 1-1/2 inches from the field of the wall. Starting at the springline of the arch, the surround widens to 14-1/2 inches wide (Figure 245). The corner of the jamb is rounded, at a 2-inch radius, up to a height of 57 inches (Figure 246). As measured from the exterior, the opening measures 5 feet 3-1/2 inches wide by 10 feet 2-1/2 inches tall. The door frame is centered in the depth of the wall and the walls to the interior of the door frame are angled out (Figure 247). As measured from the interior, the flared opening in the wall measures 7 feet 1 inch wide by 11 feet tall.



Figure 245. Typical semicircular door opening at east facade of two-story portion of the building with raised stucco surround, wood transom, and wood double doors.



Figure 246. Rounded jamb corner at door surround.



Figure 247. The door frame is centered in the depth of the wall.

The wood-framed door consists of a double door and transom shutters. The door frame is constructed of 2x4s curved to follow the segmental arch of the opening. The door leaves are constructed of a 1-5/8 inch by 2-3/4 inch frame consisting of stile and rails (Figure 248). Wood planks, measuring 10 inches wide and 7/8 inches thick, are nailed to the exterior face of the frame. Each door leaf measures approximately 7 feet 5-1/2 inches tall and 30 inches wide and is mounted on seven pintle hinges with conical caps (Figure 249).

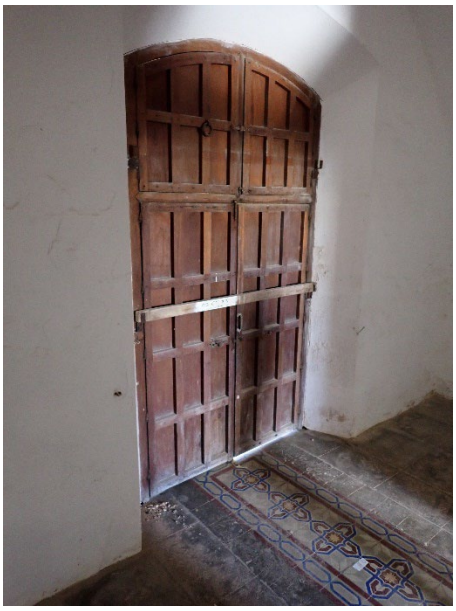


Figure 248. Interior view of door opening at east facade of casemates. Note angled walls create a larger opening at the interior.



Figure 249. Pintle hinge mounted to a door.

Above the door, and separated by a dividing rail, are wood transom shutters. The shutters are of similar construction to the door and consist of a frame upon which wood boards are applied. Unlike the doors, there is a vertical astragal between the shutters (Figure 250). Each shutter is mounted on three pintle hinges with conical caps. In addition to the hinges, other hardware present at the doors includes a “T”-shaped slide latch surface mounted to the exterior of one door, a hook and eye door stay surface mounted to the interior face of each door leaf, brackets mounted to the frame of the door and transom to support wood bracing that barricades the doors in the closed position, and a metal ring mounted to the

interior face of the transom shutters to allow them to be maneuvered open from grade (Figure 251 through Figure 255).



Figure 250. Wood-framed transom shutters with a center astragal (red arrow).



Figure 251. Interior view of transom shutters with horizontal bracing in place.



Figure 252. "T"-shaped slide latch mounted to exterior face of door.



Figure 253. Hook and eye stay mounted to interior face of door.



Figure 254. Iron brackets mounted to interior face of door and transom shutter frame.



Figure 255. Iron ring mounted to interior face of transom shutters (red arrow).

The south addition has rectangular door openings, measuring approximately 80 inches tall and 36 inches wide, with a raised threshold. The exteriors of the openings have a raised stucco surround

measuring 8 inches wide and projecting 1-1/2 inches from the field of the wall (Figure 256). The door frame is centered in the wall opening and the walls to the interior of the door frame are angled out. At two locations, presently being used as restrooms, the door leaves have been removed (the frames remain) and a concrete accessibility ramp with handrail has been installed (Figure 257). At the remaining three door openings, the doors consist of a frame of 1-5/8 inch by 2-3/4 inch wood arranged in rails and stiles upon which 1x10 boards are nailed to the exterior (Figure 258). The door leaves are mounted on non-original iron strap hinges or knuckle hinges and have non-original strap latches, surface-mounted floor and ceiling locks, and handles (Figure 259). At the far north door opening on the south addition, there is a non-original double door consisting of wood plank doors with a louvered panel (Figure 260). The door appears to have been set within a larger door opening with the upper portion infilled with masonry (Figure 261).

Doors at the north facade have a segmental arch door opening and a raised threshold. The openings measure approximately 68 inches tall and vary in width. At the lower 57 inches of the exterior jamb, the stucco has a rounded profile with a radius of approximately 2 inches. The door frame is set back flush with the interior side of the wall.



Figure 256. Wood plank door set in rectangular door opening with raised stucco surround at south addition.



Figure 257. Concrete accessibility ramp and railing at restroom entrances.



Figure 258. Interior view of wood plank doors at south addition.



Figure 259. Non-original door lock and latch.



Figure 260. Non-original louvered door at south addition.



Figure 261. Interior view of non-original louvered door. Note that the upper portion of the opening has been infilled.

The east wood-framed door has a single door leaf, and the west door has a double door; each is constructed with wood plank cladding and separated from a wood transom by a wood dividing rail (Figure 262). The doors are of similar construction to those at the north casemates and includes wood planks mounted to a wood frame; however, a panel at the upper portion of the door is recessed approximately 1/2 inch (Figure 263). Typical hardware includes pintle hinges with a conical cap and a slide latch. The transom follows the profile of the segmental arch opening and is clad with wood planks. A hole is drilled through the wood at the center of the transom and appears to be associated with previous conduit or mechanical systems that have since been removed (Figure 264). The wood doors appear to have had a clear coat finish that has weathered.



Figure 262. Wood plank door set in a segmental arch opening at the north facade. Note the wood transom above the door.



Figure 263. Wood door. Note recessed portion of the door (dashed line).



Figure 264. Opening cut in the wood transoms.

Roof

There are multiple roof areas at the officers' quarters including the roof of the two-story building, the arcade, north entrance vestibule, and south addition. Each roof area is separated by a brick masonry parapet wall that typically measures 18 inches tall by 24 inches to 30 inches deep. A parging, measuring approximately 1/4 inch thick, has been applied over the brick masonry at the parapet (Figure 265).



Figure 265. Overview of the building roofs with the two-story casemate portion and arcade in the background and the south addition in the foreground.

The roof at the north entrance vestibule, two-story building, and arcade consists of brick masonry pavers set in grout (Figure 266 and Figure 267). The brick units measure 5 inches by 10 inches and are set in a running bond. Unlike the other parapets, the south, west, and north parapets at the two-story building measure 69 inches tall and have a stucco finish, painted beige.

At the south addition, the roof has a brick parapet wall and brick masonry pavers (Figure 268). A 1/4-inch parging has been applied over the brick. In addition to the parging, at the roof area, an elastomeric surface coating has been applied over the parging and treated to look like brick paving.



Figure 266. Brick paving at the north entrance vestibule roof.



Figure 267. Brick paving and parapet wall dividing the arcade (left) from the two-story portion of the building (right).



Figure 268. Elastomeric surface coating painted to look like brick at the south addition roof.

Interior

The interior of the two-story portion of the building consists of five casemates at the upper level, each measuring approximately 25 feet 7 inches deep by 17 feet 10 inches wide and featuring a barrel-vaulted ceiling, a window opening centered on the west facade, an interior arched passageway between casemates, and an arched door opening accessed from the arcade (Figure 269). There are passageways centered on the interior wall that connect the casemates. At the center casemate, there is an interior wall that defines an entry vestibule.

At the far north end of the building is a one-story vestibule historically used as an entrance that is divided into two rooms: a storage room and a transformer closet.



Figure 269. Typical barrel-vaulted casemate at two-story portion of building.

The south addition consists of five spaces accessed from doors along the east facade that from south to north include: the men's restroom, custodial office, north office, women's restroom, and a storage room (Figure 270 through Figure 272). A series of small storage rooms at the north end of the south addition are accessed from a door opening in the south casemate at the two-story portion of the building (Figure 273).



Figure 270. Women's restroom at south addition, looking west.



Figure 271. Custodial office at south addition, looking west.



Figure 272. Storage room at south addition, looking northwest.



Figure 273. Corridor between small storage spaces at north end of south addition.

Flooring

The original flooring at the officers' quarters consisted of tabby concrete: a mixture of lime created from burned oyster shells collected from oyster shell middens, sand, and water. However, over the years, the original flooring has been covered with new floor finishes including marble tile, quarry tile, stone tile, and concrete. The construction chronology of the flooring was documented through excavation performed at the arcade and depicted in the Historic American Buildings Survey (HABS) drawings prepared in 1962 (Figure 274, see also Appendix B: Historic American Buildings Survey (HABS) Drawings).[177]

Marble tile flooring is located at the north end of the arcade and consists of 11-inch-square tiles of alternating black and white colors arranged in a diagonal pattern (Figure 275). The tiles measure 7/8 inch thick and are set on a 7/8-inch mortar setting bed and sand and rubble fill measuring 1-7/8 inches thick.

Red quarry tile flooring is located at the two casemates at the south end of the two-story building and at the office of the south addition. There are two quarry tile sizes. The historic tiles are located at the second casemate from the south. The tiles measure 5-1/4 inches square and 3/4 inch thick and are set on a mortar setting bed, measuring 2-1/4 inches thick, applied over the original tabby concrete floors (Figure 276). The tiles are set in a pattern that runs diagonally across the floor with white quarry tiles set within the field of red quarry tiles to form a diamond pattern at the center of the floor (Figure 277). At the south casemate and south addition, quarry tile floors measure 8 inches square and are arranged parallel to the walls (Figure 278).

177. San Cristóbal Officers' Quarters Historic American Buildings Survey No. PR-98, Drawing 3 of 4, 1962.

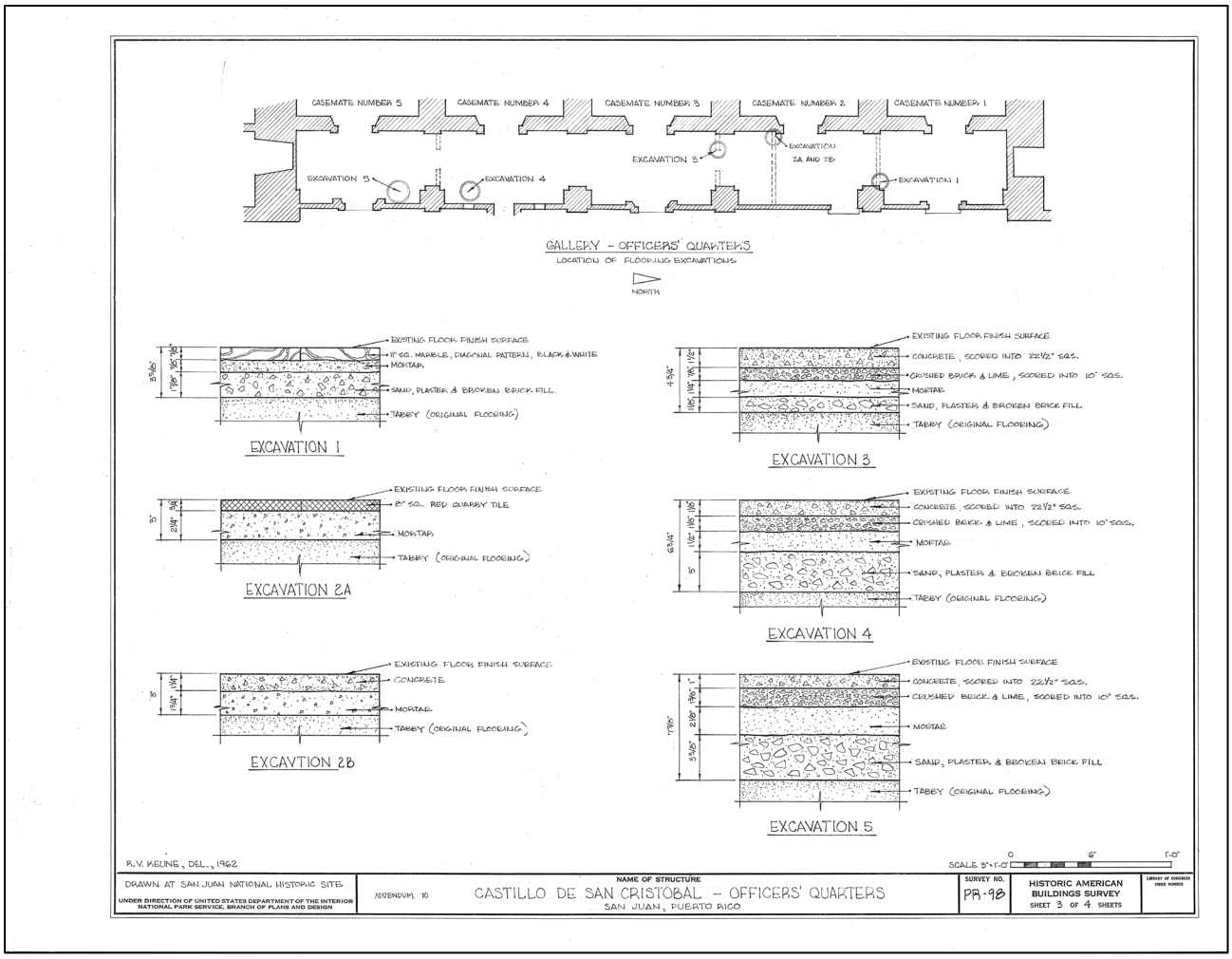


Figure 274. Drawing showing location of floor excavations and chronology of flooring materials at the officers' quarters. (Source: San Cristóbal Officers' Quarters Historic American Buildings Survey No. PR-98, Drawing 3 of 4, 1962)



Figure 275. Marble tile floor at the north end of the arcade. The flooring transitions to concrete at the casemate.



Figure 276. Historic clay tile flooring at one casemate. Tiles are set diagonally across the floor and include red and white tiles.



Figure 277. The tile pattern runs diagonally across the floor with white quarry tiles set within the field of red quarry tiles to form a diamond pattern.



Figure 278. Non-original clay tile flooring at the south casemate of the two-story portion of the building. Tiles are typically set parallel to the walls.

The center casemate, which has a separate foyer, features a painted clay tile band measuring approximately 4 feet by 10 feet that extends east-west down the center of the foyer. The band consists of decorative clay tiles measuring approximately 5-1/4 inches square and painted in a geometric pattern of blue, red, white, yellow, and grey (Figure 279). The tiles are arranged so that the patterns on each tile align to form hexagons and starbursts. The perimeter of the band has dark-grey tiles.



Figure 279. Historic painted clay tile at the center casemate of the two-story portion of the building.

At most locations, including at much of the arcade, the north half of the casemates, and the south addition, there is non-original concrete flooring (Figure 280). The concrete measures between 1 inch and 1-1/2 inches thick and is set on a substrate consisting of crushed brick and lime, a mortar setting bed, and sand and rubble fill over the original tabby concrete. At many locations, the concrete floor finish has been scored into sections, measuring 22-1/2 inches square, or painted (Figure 281 and Figure 282). There were numerous patches and repairs to the concrete indicating previous modifications and alterations to the interior space (Figure 283). Documentation of the historic crushed brick and lime below the concrete flooring indicates that the substrate was scored into 10-inch-square units, indicating that it may have been the exposed finished flooring at one time.



Figure 280. Non-original concrete flooring at the storage room.

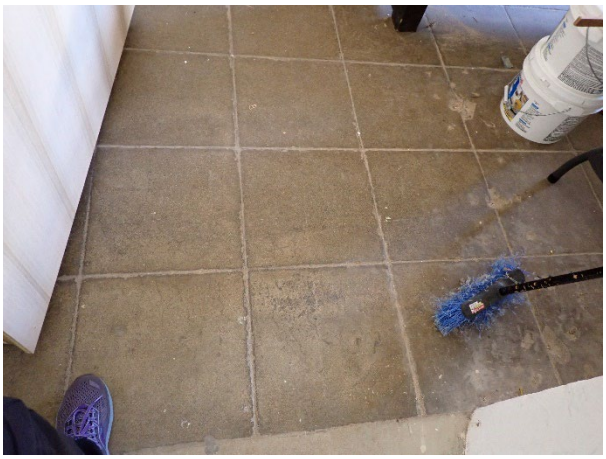


Figure 281. Concrete flooring scored into sections measuring 22-1/2 inches square.



Figure 282. Concrete flooring with remnants of previous paint coating.



Figure 283. Previous repairs and patches in the non-original concrete flooring.

At the interior passageway between casemates, there is red brick flooring with the bricks laid in a herringbone pattern (Figure 284). The concrete and red quarry tile flooring were installed to terminate at the threshold of the passageway.



Figure 284. Brick paving at the passageway between two casemates.

Large stone tiles, measuring 24 inches square, are located at the two restrooms within the south addition. (Figure 285). The north office at the south addition has white vinyl composite tile flooring.

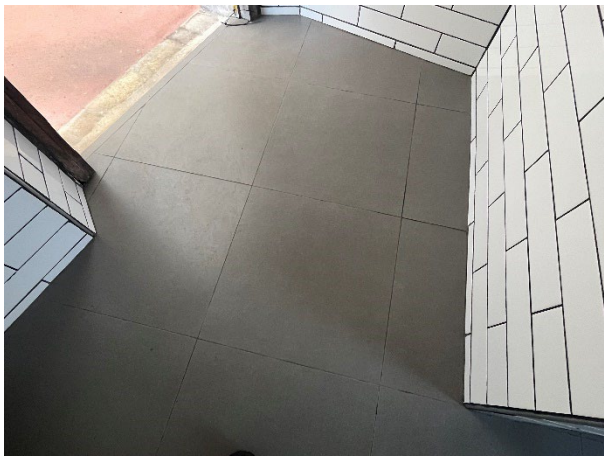


Figure 285. Non-original stone tiles located at restrooms.

Walls and Ceilings

Each casemate has plastered walls, painted white, and a barrel-vaulted ceiling that extends north-south across the room. Each individual casemate is separated by original interior walls constructed of stone and brick masonry that extend east-west through the space. Between the casemates, the interior wall measures approximately 4 feet 4 inches wide and has a semicircular arched passageway centered on the wall. The passageway has a wood frame, measuring approximately 3 inches wide, that is set flush with the plaster and is painted white to match the plaster. A groin vault

extends from above the passageway and approximately a quarter of the way into the space (Figure 286).



Figure 286. Barrel-vaulted casemates with semicircular arched passageways centered on walls, creating a groin vault above openings.

An interior wall, measuring 6 inches deep, extends north-south across the center casemate and forms an entrance foyer measuring 10 feet deep. The interior wall has a rectangular door opening centered on the wall with an oblong oval opening above (Figure 287).



Figure 287. Interior wall with a rectangular opening centered on the wall and an oval cutout in the wall area above.

At the north entrance vestibule, the walls have a plaster finish, painted white. An interior masonry load-bearing wall spans north-south between the two interior spaces and measures 5 feet 8 inches wide. There is a barrel-vaulted ceiling at the portion of the building with the arched roof (Figure 288). The adjacent low-slope roof has a wood ceiling consisting of beams that span north-south across the space and supporting wood purlins that span east-west and wood sheathing (Figure 289). The wood beams and purlins have a natural dark brown finish, and the underside of the wood sheathing is painted white.



Figure 288. Barrel-vaulted ceiling at the west room in the north entrance vestibule.



Figure 289. Wood-framed ceiling at the east room in the north entrance vestibule.

The south addition has plaster walls and a flat plaster ceiling with support beams, clad in plaster (Figure 290). The rooms are separated by masonry load-bearing walls, measuring 18 inches deep, that extend east-west. The ceiling beams extend north-south across each room and bear on the load-bearing wall. At the two restrooms, white ceramic tile, measuring 4 inches by 18 inches, has been applied to the lower 7 feet of the wall (Figure 291).

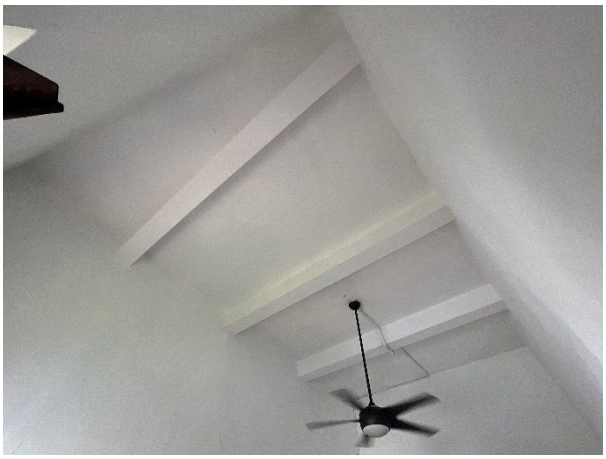


Figure 290. Flat ceiling with exposed beams spanning north-south across the space at the south addition.

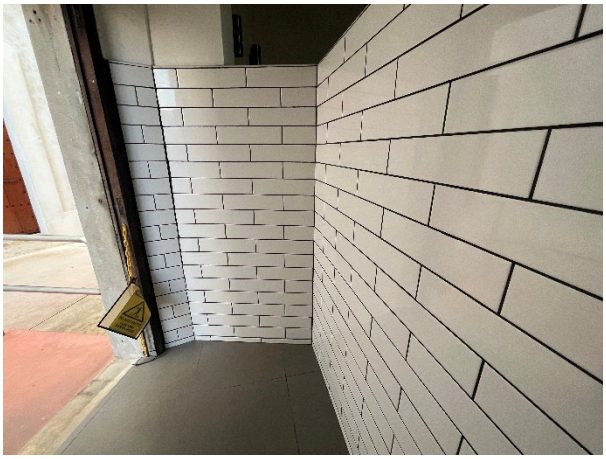


Figure 291. White ceramic tile walls at restrooms.

Throughout the officers' quarters, there is evidence of previous repairs and patches associated with alterations and electrical improvements such as the installation of electrical conduits, junction boxes, and light fixtures (Figure 292).



Figure 292. Plaster walls, painted white, with locations of previous repairs and alteration. It appears that new electrical conduit and a concealed junction box were installed at this location.

Interior Door Openings

Interior doors are non-original and located at the cluster of storage rooms at the north end of the south addition. The doors include a metal gate between the south casemate and the storage room and a hollow core wood door between storage rooms. The rectangular metal gate is similar in construction to the gate at the north casemates building and consists of a rectangular bar frame with vertically oriented metal round bars (Figure 293). The gate has pintle hinges and a slide latch and modern padlock (Figure 294). The non-historic, hollow core wood door has a wood frame, five-knuckle hinges, and a brass knob (Figure 295).



Figure 293. Iron gate at door opening between two-story portion of the building and south addition.



Figure 294. Pintle hinge at gate door is set in masonry at wall.



Figure 295. Non-historic hollow core door.

A previously existing door opening between the north entrance vestibule and the north casemates has been infilled with a wood-framed wall (Figure 296). The framing as well as the groin vault ceiling are visible from the storage room at the north entrance vestibule. The south side of the opening has been plastered over and, although the groin vault remains, the opening is no longer visually apparent.



Figure 296. Infilled door opening between north entrance vestibule and the north casemate.

North Bastion, South Bastion, and Curtain Wall

The eastern defense of the main fortification of Castillo San Cristóbal was constructed by 1766 and is made up of the north bastion located on the northeast end, the south bastion located on the south end, and the curtain wall. El Caballero de San Miguel projects upward from the west section of the eastern defense (Figure 297).



Figure 297. Eastern wall of El Caballero de San Miguel set within the eastern defense.

The walls are primarily composed of limestone rubble with rough-cut ashlar blocks set with brick spacers used at the salient angles, the bastions, the embrasures, and the sentry box. The walls are battered, sloping inward from grade to the top of the structure. The base of the southeast curtain wall is partially concealed by the World War II Joint Command Center (visitor center) infill

(Figure 298 and Figure 299). The terreplein is composed of a masonry platform built against an earlier wall of the San Cristóbal redoubt (Figure 300 and Figure 301). The pavement contains multiple repair campaigns, consisting of patching and crack repairs (Figure 302). The crack repairs often consisted of infilling the crack with brick.



Figure 298. View of the north bastion, curtain wall, and south bastion. San Carlos Ravelin is visible at the left. View from north.



Figure 299. View of the north bastion, curtain wall, and south bastion in 1938 prior to the construction of the World War II Joint Command Center (visitor center). View from north. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 14, 1938)



Figure 300. View of the terreplein at the north bastion. El Caballero can be seen in the background. View from northeast.



Figure 301. View of the terreplein at the north bastion in 1960. El Caballero can be seen in the background. View from northeast. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 24, 1960)



Figure 302. Eastern defense pavement contains multiple repair campaigns.



Figure 303. Tunnel opening on the north end.

Tunnels that extend from Plaza de Armas and under El Caballero de San Miguel, in the east-west direction, provide access to the north and south bastions (Figure 303 and Figure 304). Tunnel 3 provides access to the north bastion, while tunnel 4 provides access to the south bastion.



Figure 304. Tunnel opening on the south end.

Curtain Wall

The curtain wall spans between the north and south bastions making up the west facing wall. The top of the curtain has three embrasures on the salient angle, eight embrasures closest to the north bastion, two embrasures facing northwest, and eight embrasures closest to the south bastion (Figure 305 and Figure 306). Significant masonry repairs to the curtain performed by the Army Corps of Engineers were recorded in the 1991 Historic Structures Report.



Figure 305. View of north bastion embrasures.



Figure 306. View of north bastion embrasures.

North Bastion

The north bastion is located on the northeast end of the main fortification of Castillo San Cristóbal's eastern defense (Figure 307 through Figure 312).



Figure 307. View of the north bastion. View from northeast.



Figure 308. View of the north bastion in 1938. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 13, 1938)



Figure 309. View of the north bastion. View from northeast.



Figure 310. View of the north bastion in 1998. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 35, 1998)



Figure 311. View of the north bastion with San Carlos Ravelin visible at left. View from east.



Figure 312. View of the north bastion in 1938, with San Carlos Ravelin visible at left. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 10, 1938)

North of the north bastion is a gun emplacement tier, known as a barbette, built between 1895 and 1896 (Figure 313 and Figure 314). The barbette is enclosed by retaining walls and two semicircular gun emplacements or platforms constructed of reinforced concrete. A concrete and masonry cover for a ventilation shaft associated with the tunnel is present along the barbette (Figure 315). The coping units at the enclosure walls range from rowlock brick coursing to a sandstone unit (Figure 316). Surrounding the concrete platform is a ramp made of concrete with mid-size aggregate. Originally, a brick drain was located at the center of the circular wall. Between the two semicircular platforms, the wall is recessed. Abutting the recessed wall is a concrete slab supported by four brick piers (Figure 317). The center is concealed with a plywood cover. Historically, this small recess held an ammunition magazine.



Figure 313. View of barbette gun emplacement platforms.



Figure 314. Coping units at the barbette enclosure walls.



Figure 315. Cover over ventilation shaft at the north bastion.



Figure 316. View of the barbette tier located north of the north bastion.



Figure 317. View of the barbette tier located north of the north bastion.

One of the oldest remaining sentry boxes is located on the northeast angle of the north bastion, extending from the salient angle (Figure 318 and Figure 319). The curtain wall to the east of the sentry box has a return or opening that aligns with the World War II Joint Command Center (visitor center) infill outline. The walls on the inside face of the terreplein are curved and are constructed with brick masonry, and the rest of the reveal is composed of square ashlar blocks. At the base of the curtain wall are concrete steps that travel to the roof of the infill.

A ventilation shaft, approximately 19 inches by 19 inches, is located close to the gun emplacement (Figure 320). The shaft is placed on a stone pad with four piers on each corner and runs through the terreplein, approximately 11 feet down, where it connects to a tunnel. The top of the tunnel is concealed with wood planks and wire mesh (Figure 321).



Figure 318. View of the sentry box at the north end of the north bastion, view from southwest.

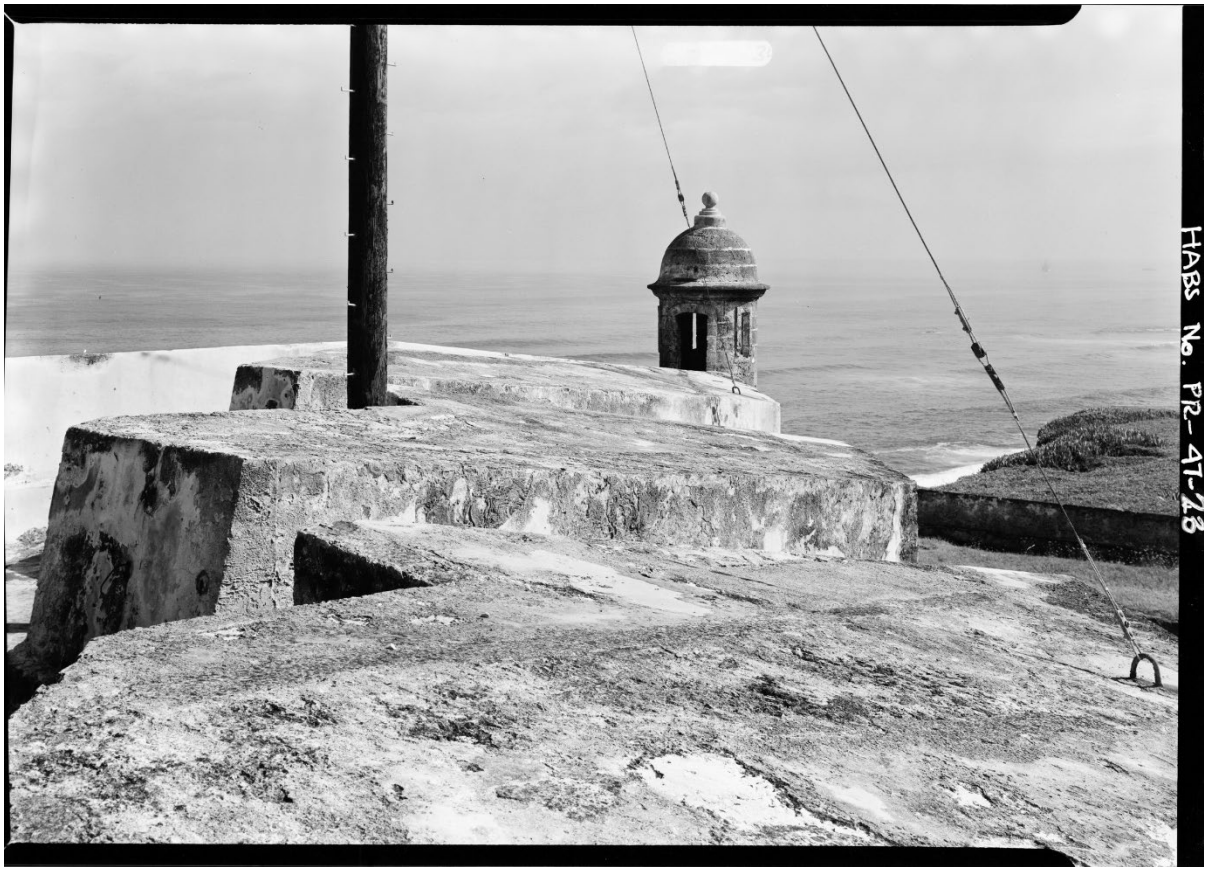


Figure 319. View of the sentry box at the north end of the north bastion in 1960. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 23, 1960)



Figure 320. Ventilation shaft located on the north bastion.



Figure 321. Top of ventilation shaft leading to tunnel is concealed.

A tunnel opening to the east of the retaining wall, approximately 4 feet wide and 6 feet 6 inches in height, leads to World War II Fire Control Station B (Figure 322 and Figure 323). Remnant coating mimicking stone is present on the exterior of the control station (refer to Figure 323).

The walls in the tunnel leading to the control station have a smooth board-form finish with a thick stucco layer applied (Figure 324). The control station is composed of reinforced poured concrete. The walls and ceiling of the tower interior are smooth finished concrete coated with a high-gloss grey paint. There is an open joint in between the tunnel and tower opening (Figure 326). A ladder that leads to the lower level of the tower is located on the southeast corner of the tower. The opening on the concrete floor slab is blocked off by a handrail and chains (Figure 327). The lower level of the control station is similar in plan and finishes, with a high-gloss white paint on the walls (Figure 328).



Figure 322. View of the entrance to the World War II Fire Control Station.



Figure 323. Overall view of the tower from below, near La Garita del Diablo.



Figure 324. The tunnel leading to the control station.



Figure 325. The interior of the upper level of the control tower.



Figure 326. Open joint at the tunnel and tower interface.



Figure 327. View of ladder that leads to lower level of the control station.



Figure 328. The lower level of the control station.

The sentry box is entered through a narrow passageway, approximately 2 feet wide, on the north bastion (Figure 329 and Figure 330). The passageway leading to the sentry box has a stucco coating and is characterized by a rowlock brick coursing. The sentry box is circular in plan, is composed of ashlar blocks, and has three equally spaced embrasure openings (Figure 331). The sentry box has an inside diameter of approximately 4 feet 7 inches.



Figure 329. View of tunnel leading to north sentry box.



Figure 330. View of tunnel leading to north sentry box.



Figure 331. Floor at the interior of sentry box.

South Bastion

The south bastion is located on the south end of the main fortification of Castillo San Cristóbal's eastern defense (Figure 332 and Figure 333).

The south bastion walls have the highest elevations from the moat. The southern end of the south bastion steps down in the north-south direction, creating two lower batteries. The mid-level battery is accessed through the Plaza de Armas, past the officers' quarters and troops' quarters. The perimeter of the mid-level battery has a fence installed. Part of the lower battery on the southernmost end was demolished in 1896 and is filled with vegetation. A reinforced concrete retaining wall is located on the south end of the lowest battery and terminates into the lower slope. Two embrasure openings facing southeast are located on the mid-level battery, and one embrasure opening facing southeast remains on the lower battery.



Figure 332. View of the south bastion with La Trinidad Counterguard and San Carlos Ravelin in the foreground. View from east.



Figure 333. View of the south bastion in 1938, with La Trinidad Counterguard and San Carlos Ravelin in the foreground. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 7, 1938)

A reconstruction of a rectangular concrete cannonball pad is located on the south bastion, across from the south ramp entrance, and holds several metal cannonballs (Figure 334). To the west of the platform is a replica of a cannon centered on an embrasure.



Figure 334. Cannonball pad and cannon replica on the south bastion.

The embrasures throughout the eastern defense batteries are composed of masonry rubble with stucco applied over. The face and edges of the embrasures are similar in dimensions but have slight variations. The north face of the embrasures at the north bastion contains canted brick at the inner face edge, and brick at the inner top edge and at the top edge, and has ashlar stone at the outer face edge, outer top edge, and at the inner corner of the embrasure. The south face of the embrasures at the north bastion contains canted ashlar stone at the inner face edge, brick at the inner top edge and at the top edge and has ashlar stone at the outer face edge, the outer face edge and at the inner corner of the embrasure (Figure 335). The embrasures on the curtain contain brick at the inner face edge, brick at the inner top edge and at the top edge, and have ashlar stone at the outer face edge, outer top edge, and at the inner corner of the embrasure (Figure 336). The embrasures on the south bastion contain brick at the inner face edge, brick at the inner top edge and at the top edge and have ashlar stone with rounded edges at the outer face edge, outer top edge, and at the inner corner of the embrasure. The embrasures on the lower batteries of the south bastion contain canted brick at the inner face edge, brick at the inner top edge, and have ashlar stone at the outer face edge, outer top edge, top edge, and inner corner.



Figure 335. South face of the embrasures located at the south bastion.



Figure 336. Inside face of the embrasures located at the curtain wall.

Drainage system

Sections of the terreplein are slightly sloped to allow for drainage of water into three collection centers that travel through a system of open gutters and drains that connect to the cisterns by the Plaza de Armas. The open gutters are located at the perimeter of the terreplein and are constructed of paver bricks. The gutter travels through the firing steps (Figure 337). The front end of the gun emplacement platforms is set back to allow for water to travel and exist through the gutters facing the barbette (Figure 338). A course of sandstone blocks is also installed along the perimeter of the terreplein walls and assists in directing water towards the gutters located at the

perimeter. Through wall openings at the base of the embrasure walls also allow for water to drain out into the curtain walls (Figure 339).

The collection point for the north bastion is located at the west end and feeds into a culvert that slopes towards the south of the terreplein (Figure 340 and Figure 341). The drains by the curtain travel through a central culvert (Figure 342). The south bastion drains to the west and travels through the El Caballero de San Miguel southern tunnel which drains near the Chapel building (Figure 343).



Figure 337. Open gutter at the curtain.



Figure 338. The gutter between the artillery platform and the embrasure wall.



Figure 339. Drainage opening leading to outer curtain wall.



Figure 340. Drainage channel and opening at the north bastion.

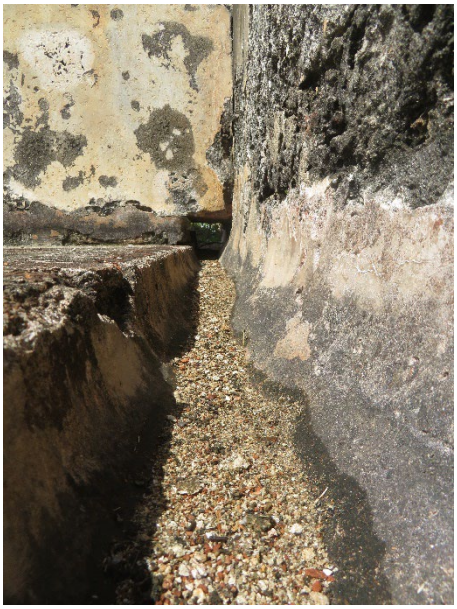


Figure 341. Drainage channel and opening at the north bastion.

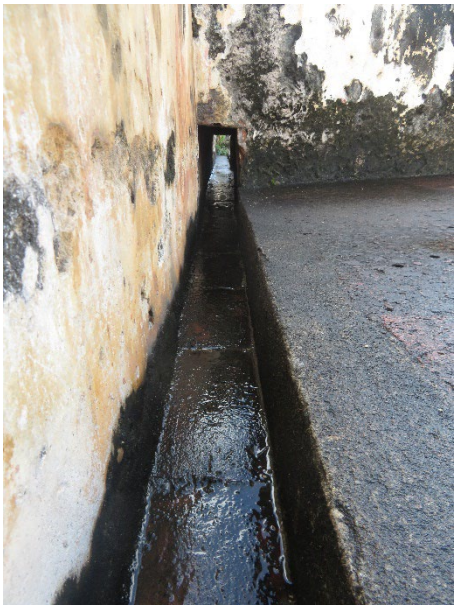


Figure 342. Drainage opening leading to outer curtain wall.



Figure 343. Drain by the Chapel Building in use after rain event (dashed red line).

Tunnels

Six tunnels are beneath the Castillo San Cristóbal main fortification. Figure 344 shows the layout of the tunnels; each tunnel is numbered for reference in this study. A description of each tunnel follows.

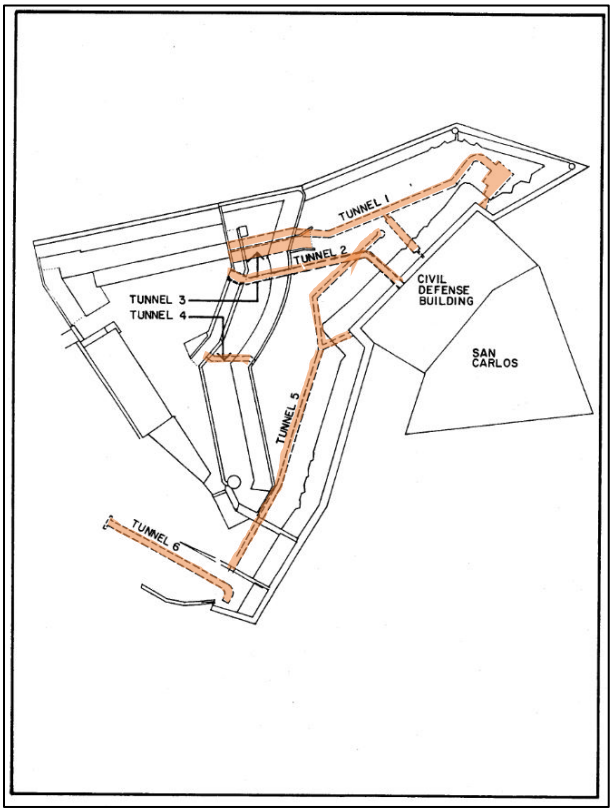


Figure 344. Plan of San Cristóbal showing the locations of the tunnels at the main fortification. (Source: *The Fortifications of San Juan National Historic Site: Historic Structures Report*, Figure 20.1, annotated by authors).

Tunnel 1

The west entrance/exit to Tunnel 1 is located at the northeast corner of Plaza de Armas and extends northeast beneath the north casemates and north bastion of the main fortification. The tunnel slopes downward from west to east. The arched entryway from the Plaza houses a wrought iron grated double door comprised of curved and straight steel bars (Figure 345). The barrel hinges and bent bar anchorages are embedded into the tunnel side walls (Figure 346). The door and its hardware are coated in black paint. Above the opening is a painted relief sculpture of a firing weapon with flames (Figure 347).



Figure 345. Wrought iron grated double door at Tunnel 1 entrance.



Figure 346. Barrel hinges and bent bar anchorages embedded into the tunnel side walls.



Figure 347. Painted relief sculpture of a firing weapon with flames above the opening.

The ceiling of the tunnel is a barrel vault (Figure 348). The longitudinal walls are approximately 4 feet in height and comprised of rubble stone and brick with a lime-washed parge coat applied to the surface (Figure 349). The bottom of the arched roof is approximately 4 feet from the top of the longitudinal walls. The arch ceiling is comprised of brick masonry with a lime-washed parge coat (Figure 350). The floor of the tunnel is mostly packed earth or cementitious overlay (Figure 351).



Figure 348. Barrel-vaulted ceiling at Tunnel 1.



Figure 349. View of typical wall construction in Tunnel 1.



Figure 350. View of typical ceiling construction in Tunnel 1.



Figure 351. View of typical floor in Tunnel 1.

At approximately 22-foot intervals, on average, a 6-inch-deep by 6-inch-wide groove is cut out of the walls and ceiling (Figure 352). An additional notch in the walls is spaced at approximately 40-foot intervals. A modern lighting fixture is housed in some notches (Figure 353). A brick masonry flat arch spans across the top of this opening.



Figure 352. Typical grooves cut out of the walls and ceiling.



Figure 353. Modern lighting fixture in Tunnel 1.

A rectangular opening, with a wrought iron grated door, in the south wall of the main tunnel leads to the dungeon (Figure 354). A masonry flat arch frames the top of the opening. The dungeon also has a barrel-vaulted ceiling (Figure 355). The walls and ceiling are comprised of stone rubble. The south wall has an embrasure window opening and appears to be of a different vintage in construction from the remaining walls (Figure 356). The ceiling immediately adjacent to the south wall is partially comprised of stone rubble. A parge coat, with a red colored patina, is applied to only the walls of the dungeon. A wayside exhibit is located in the dungeon near the showcased drawings of galleons on the east wall of the dungeon (Figure 357 and Figure 358).



Figure 354. View of entrance to the dungeon.



Figure 355. Overall view of the dungeon.



Figure 356. South wall of the dungeon.



Figure 357. Wayside exhibit in the dungeon.



Figure 359. Rectangular air shaft in Tunnel 1.



Figure 358. Exhibit of drawings of galleons on east wall of dungeon.



Figure 360. Overall view of casemate on the east end of the tunnel.

A rectangular air shaft is located through the main tunnel ceiling directly adjacent to the dungeon entrance (Figure 359). A metal grate is set at the opening of the shaft.

A casemate, rectangular in plan, is located on the east end of the tunnel (Figure 360). The walls and arched ceiling are covered with a lime-washed parge coat. The floor of the casemate is comprised of concrete. An arched doorway, set in a recessed opening, is located on the south wall of the east casemate that leads to the dry moat (Figure 361). An additional arched doorway is located on the north wall of the casemate (Figure 362). A metal grated doorway with a plastic barrier is housed in this opening.



Figure 361. Arched doorway in south wall of casemate leads to the dry moat.



Figure 362. Additional arched doorway located on the north wall of the casemate.

Tunnel 2

Tunnel 2, a ramped passageway, connects Plaza de Armas to the World War II Joint Command Center (visitor center) between the main fortification and San Carlos Ravelin (Figure 363). The tunnel has a barrel-vaulted ceiling.



Figure 363. Overall view of Tunnel 2.

The tunnel is accessed from Plaza de Armas at the west end by a recessed arched doorway that houses a wrought iron grated double door comprised of curved and straight steel bars (Figure 364). The door and its hardware are coated in black paint. The perimeter frame of the door has embedded steel bars at each jamb. Above the opening is a painted relief sculpture of a firing weapon with flames. Entry into the tunnel from the east end, in the World War II Joint Command Center, is provided by a rectangular opening that houses a steel door.



Figure 364. West entrance of Tunnel 2.

The walls and arched ceiling of the tunnel are covered with a whitewashed parge coat (Figure 365). Finishes of various color (red, beige, and white) are typically observed throughout the tunnel walls. A cementitious patch in the parge coat at the center of the ceiling is located where a steel conduit pipe is anchored to the arch (Figure 366). Intermittent lighting fixtures along this conduit are located along the tunnel's length. A two-gang electrical outlet was observed at the base of the north wall (Figure 367). Additional electrical conduits service a security camera at the west entrance of the tunnel.



Figure 365. View of typical wall construction in Tunnel 2.



Figure 366. Cementitious patch in the parge coat at the center of the ceiling in Tunnel 2.



Figure 367. Electrical outlet in Tunnel 2.

Near the entrance to the World War II Joint Command Center, the wall construction transitions to cut sandstone set in mortar in a running bond. The ceiling of the tunnel also transitions from a barrel vault to a flat ceiling (Figure 368).



Figure 368. Rectangular cross section of Tunnel 2 at east end.

The floor of the tunnel is concrete throughout its length (Figure 369). Concrete patches of various vintages were observed on the floor.



Figure 369. View of typical floor in Tunnel 2.

Tunnel 3

Tunnel 3 is a ramped passageway that connects Plaza de Armas to the north bastion (Figure 370). The east entrance is formed by a recessed stone masonry arch opening. Remnants of a wood door assembly are evident by the embedded wood members at the top corner beyond the east entrance, as well as notches in the jamb (Figure 371). Beyond the east entrance and lining the ramp up to the main firing battery of the north bastion are two retaining walls. The walls are comprised of cut stone laid in mortar with curved coping stones on top (Figure 372). The west entrance of the tunnel is arched with a molded projecting surround along the top half of the

opening. A keystone detail is located at the top of the arch.

Similar to the other tunnels, the walls of the tunnel are comprised of stone masonry while the arch ceiling is constructed of brick masonry. A white-washed parge coat is present at the arch with a red-pigmented stucco coat at approximately the bottom 6 feet of the wall (Figure 373 and Figure 374). A modern handrail is mechanically anchored to the south wall (Figure 375).



Figure 370. East entrance of Tunnel 3.



Figure 371. Embedded wood members at the top corner beyond the east entrance and notches in the jamb.



Figure 372. Retaining walls beyond east entrance.



Figure 373. View of typical wall construction in Tunnel 3.



Figure 374. Coating on tunnel walls is red in patina.



Figure 375. Modern handrail on south wall.

The floor of this tunnel is concrete (Figure 376). Multiple patches of various vintages are present throughout the area of the tunnel. Notches of concrete are cut out and roughened at the center of the tunnel along its length (Figure 377).



Figure 376. View of typical floor construction in Tunnel 3.



Figure 377. Square indentations on the floor of Tunnel 3

Tunnel 4

Tunnel 4 is a ramped passageway south of Tunnel 3 and connects Plaza de Armas to the south bastion (Figure 378). The east entrance is formed by a rectangular opening framed by cut stone units (Figure 379). A stone flat arch spans across the top of the opening. The west entrance of the tunnel is an arched opening (Figure 380).

The walls and arched ceiling of the tunnel are covered with a white-washed parge coat. At a few isolated locations, the brick masonry in the arch construction is visible in the ceiling. The floor of the tunnel is concrete. A modern handrail is mechanically anchored to the south wall.



Figure 378. Typical view of Tunnel 4.



Figure 379. View of east entrance of Tunnel 4.



Figure 380. The arched opening at the west entrance to Tunnel 4.

Tunnel 5

Tunnel 5 has a barrel-vaulted ceiling and extends in the northeast-southwest direction below the eastern defenses of the main fortification. A branch of the main tunnel extends east to the World War II bunker. The only entrances to Tunnel 5 are from the World War II bunker and the south wall of the south bastion. The entryway from the World War II bunker is comprised of a small rectangular opening with a modern steel door (Figure 381), which is accessed by a flight of brick masonry stairs. The entryway from the south wall of the south bastion is an arched opening containing a rectangular opening with a modern double door.



Figure 381. Entryway into Tunnel 5 from the World War II bunker.

The walls of the tunnel are comprised of brick masonry laid in mortar in a running bond, or rubble stone (Figure 382). The ceiling is constructed of a brick masonry arch. A parge coat, which includes crushed brick aggregate, with a lime wash coating covers all surfaces of the main tunnel (Figure 383), except the branch that leads to the World War II bunker entrance. Areas of cementitious patches of various vintages are located throughout the tunnel walls and ceiling. The floor is comprised of packed earth. Numerous bunched conduit lines run along the bottom of the south wall between both entrances. An additional conduit line runs along the apex of the arch through some stretches of the tunnel.



Figure 382. Typical view of Tunnel 5 at east end.



Figure 383. Typical view of Tunnel 5 at west end.

Tunnel 6

Tunnel 6, which also has a barrel-vaulted ceiling, is accessed from the street level on Avenue Muñoz Rivera, south of the south bastion, or from the Superintendent's residence. The entrance from street level, at the east end of the tunnel, is comprised of a rectangular opening with a modern

steel swing door in a retaining wall (Figure 384). From the doorway, a flight of concrete stairs leads to the tunnel level below grade (Figure 385).



Figure 384. Entrance from street level into Tunnel 6 at south end.



Figure 385. Typical wall and ceiling construction in Tunnel 6.

The walls and ceiling are covered in a lime-washed parge coat (Figure 386). At isolated locations of spalled parge coat, the brick masonry construction of the arched ceiling is evident (Figure 387). Graffiti from different vintages is present on the parge coat (Figure 388). Modern light fixtures and conduits are anchored to the ceiling of the tunnel.

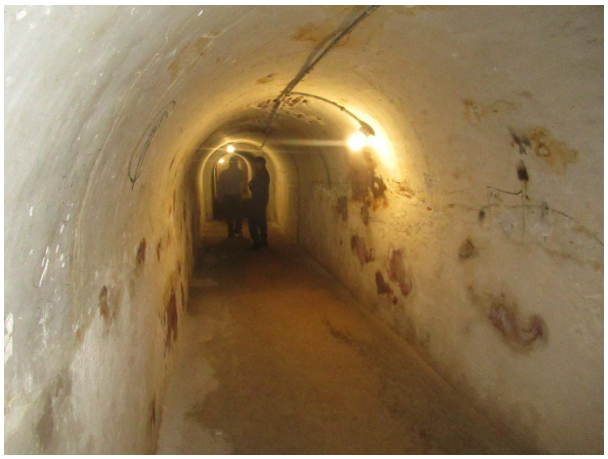


Figure 386. Typical wall and ceiling construction in Tunnel 6.



Figure 387. Brick masonry construction visible at spalled parge coat.



Figure 388. Graffiti from different vintages present on the parge coat.

At the south end of the tunnel, just north of the stairway that leads to the street level, is a flat arched rectangular portal frame comprised of cut sandstone laid in mortar in a running bond

(Figure 389). A series of right turns through the ramp and stairs lead to the stairway to the street level. The walls and ceiling at the stairway are comprised of board-formed concrete (Figure 390).



Figure 389. Sandstone arch at south end of Tunnel 6.



Figure 390. Board formed concrete walls and ceiling at south end of Tunnel 6.

Condition Assessment

Plaza de Armas

Concrete

- Cracking, spalling, and failure of previous cementitious patches in the concrete paving (Figure 391). The distress was typically located along control joints; however, it sometimes extended into the concrete panels. Cracking was often observed along the perimeter of previous patch repairs (Figure 392).
- Localized areas of ponding water at the concrete paving (Figure 393). Following a rain event, water was observed to pond at low areas along the center of the plaza.
- Open joint in the concrete paving where it abuts the cistern enclosure (Figure 394). The mortar within the joint had cracked and failed or was missing and the joint was open.



Figure 391. Previous patch repairs at concrete paving exhibit cracks and are spalled.



Figure 392. Cracking and spalling along edge of previous patch repairs in concrete.



Figure 393. Localized areas of ponding at low areas on the plaza.



Figure 394. Open joint between cistern and concrete paving.

Stone and Brick

- Spalled, eroded, cracked, and missing stucco at large portions of the ramp wall and localized areas on the cistern enclosure (Figure 395 and Figure 396). At numerous areas the finish stucco was observed to have been eroded or missing and the underlying scratch coat, a previous stucco application, or the brick substrate was exposed to view.
- Diagonal cracking extending across the west facade of the chapel (Figure 397 through Figure 399). A crack, measuring approximately 1/16 inch wide, extended from the south side of the wall, where it abuts the ramp wall, and diagonally to the upper corner of the wall opening.
- Large vertical cracks, some of which were previously repaired, extended the full height of one cistern enclosure at multiple locations spaced evenly around the structure (Figure 400). The cracks were also visible at the interior of the structure and measured approximately 3/16 inches wide.
- Horizontal cracks wrap around the mid-height and top of the interior cistern enclosure (Figure 401). The cracks measured approximately 1/16 inch wide and had efflorescence and evidence of moisture infiltration.
- Cracking along the bearing end of the masonry lintel (Figure 402). The crack wrapped around the bottom and end of the lintel, measured approximately 1/8 inch wide, and exhibited some displacement.
- Spider cracking, consisting of a network of interconnected hairline cracks, was observed at the stucco on the cistern enclosure (Figure 403). The cracks appeared darker in color than the adjacent stucco.
- Open and cracked mortar joints between stone masonry units at the cistern (Figure 404). The mortar had separated from the stone.



Figure 395. Spalled and eroded stucco at walls that surround plaza.



Figure 396. Spalled and eroded stucco at walls that surround plaza.



Figure 397. Cracking in stucco across west elevation of chapel (red lines and arrows).



Figure 398. Cracking at west facade begins at wall where it is in contact with the ramp parapet and extends diagonally (red arrows).



Figure 399. Diagonal cracking extends to corner of wall opening (red arrows).

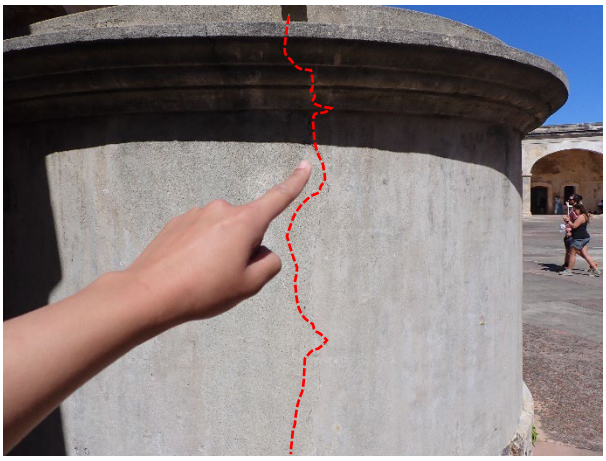


Figure 400. Vertical cracking in stucco on exterior facade of cistern enclosure (dashed red line).

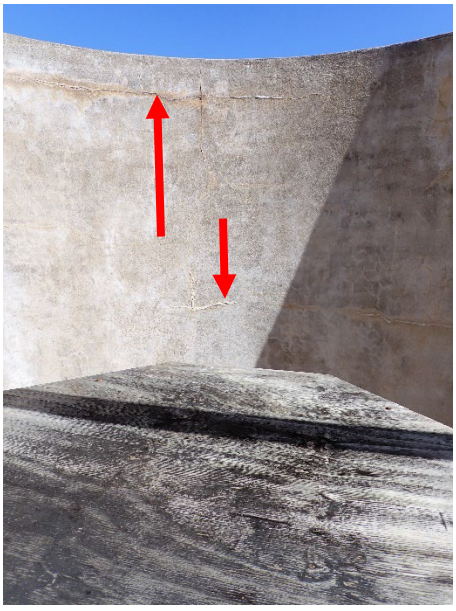


Figure 401. Horizontal cracking at interior face of cistern enclosure (red arrows).



Figure 402. Cracking at corner of door opening at cistern enclosure.



Figure 403. Spider cracking in stucco at cistern enclosure.



Figure 404. Debonded mortar at joint in stone cistern (red arrow).

Finishes

- Cracked, chipped, and spalled floor tiles and parging (Figure 405 and Figure 406). The distress was mostly located at the floor finishes along the edge of the building that are most exposed to exterior conditions. The deterioration was most pronounced near the base of guardrail posts and along the transition between the parge coating to the tile flooring.
- Flaking and peeling coating at the stucco on the chapel building (Figure 407). Localized areas of the coating had peeled, exposing the underlying layer.



Figure 405. Cracked and spalled marble tile flooring



Figure 406. Cracking and spalling of the ceramic tile flooring and concrete near balustrade posts.



Figure 407. Peeling paint coating at stucco finish on chapel.

Gates

Concrete

- Cracking of the concrete paving at both entrance ramps (Figure 408). The cracking was located along the crown of the ramp and perpendicular at regular intervals along the length of the ramp. Cracks varied in width and had small chips and spalls along the edge.



Figure 408. Cracking of the concrete paving at ramps, typically along the crown of the ramp and extending perpendicular.

Stone and Brick

- Open mortar joints between stone units at both entrances (Figure 409). At large portions of the gate the mortar between the stone units is missing and the joints are open.
- Erosion at the face of the stone units at both entrance gates (Figure 410 and Figure 411). The surface of many of the stone units, specifically those at the top half of the gate, have eroded. The tool marks are no longer visible and the stone exhibited efflorescence and had a rougher and more irregular surface.
- Spalling of stone units along the jamb of the main gate opening (Figure 412). The spalls were typically located near a hole in the stone, likely where previous anchor supports were located and have since been removed.
- Spalled, eroded, cracked, and missing stucco at large portions of the main gate ramp wall (Figure 413). At numerous areas the finish stucco was observed to have been eroded or missing and the underlying scratch coat, a previous stucco application, or the brick substrate was exposed to view.
- Cracked previous cementitious repairs at cheek walls along the main gate ramp and at the ramp paving (Figure 414 and Figure 415). The repairs had localized spalling and hairline cracking. At some locations, portions of the underlying brick substrate were exposed to view.
- Peeling paint and surface corrosion of the iron rods at the arched gate set within the Moorish arch opening below the main gate.
- Black-colored paint coating applied to the stainless-steel hardware for both of the wood-framed gate doors (Figure 416).



Figure 409. Open mortar joints between stone units at the main gate.



Figure 410. Erosion at face of stone units at main gate. Stone no longer has the combed surface finish.



Figure 413. The stucco at the ramp wall is spalled and eroded with portions of the brick substrate visible.

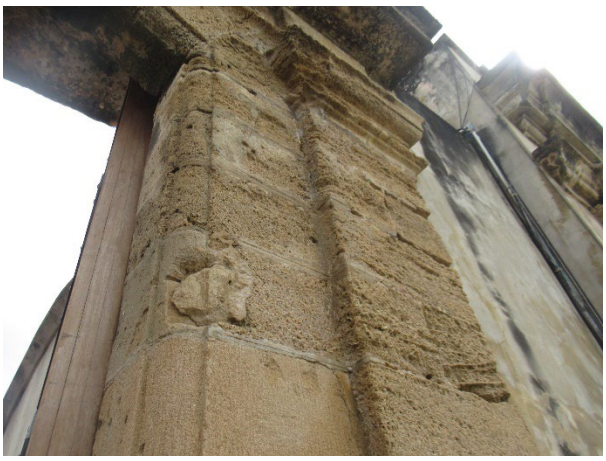


Figure 411. Erosion of face of upper stone units at gate.



Figure 414. Previous cementitious repair and cracking of repair at main gate ramp parapet (red arrow).



Figure 412. Spalled stone jamb unit indicating location of previous door anchorage.



Figure 415. Previous cementitious repair and cracking of repair at main gate ramp parapet (red arrow).



Figure 416. Flaking paint at stainless-steel hardware such as the door closures at the north gate.

North Casemates

Concrete

- Cracking at the underside of the concrete arcade ceiling extended north-south, parallel to the beams and perpendicular to the span of the concrete slab (Figure 417). The cracks extended the full width of the ceiling and, although hairline, were visually apparent from the moisture staining and efflorescence around each crack.
- Pitting of the concrete floor finish (Figure 418). Pits and divots in the concrete ranged in size from approximately 1/4 inch to 6 inches in diameter and were approximately 1/8 inch deep. The depth of the pits seemed to be determined by a previous concrete floor finish under the existing concrete finish.
- Ponding water at the concrete paving at the arcade (Figure 419). Following a rain event, water was observed to pond at low areas along the center of the arcade, mostly at a portion of the arcade aligned with the east casemate and the west powder magazine.



Figure 417. Cracking running perpendicular to the span of the concrete slab with some discoloration (red arrow).



Figure 418. Shallow and localized pitting of the concrete at the floors.



Figure 419. Localized ponding of water at the concrete paving in the arcade.

Stone and Brick

- Spalled, eroded, cracked, and missing stucco at large portions of the building including

exterior walls, columns, and at the underside of arches (Figure 420 and Figure 421). At numerous areas the finish stucco was observed to have been eroded or missing and the underlying scratch coat, a previous stucco application, or the brick substrate was exposed to view.

- Extensive cracking and patching of the stucco walls (Figure 422). The patches appeared to be from various repair campaigns and of different material compositions, giving the wall a patchwork appearance. Cracks were typically located around repair areas or at the stucco between repair areas. Some of the patches had failed and were cracked and displaced or had spalled (Figure 423). Corroded embedded steel was observed at some of the failed patches (Figure 424). At some locations, the brick masonry behind the patch was observed to have deteriorated (Figure 425).
- The parging at the west ramp flight of stairs was spalled and missing at some locations, leaving the brick that forms the treads exposed (Figure 426).
- Incipient spalls, spalls, and chips along the edges of columns and arched window and door openings (Figure 427). Where spalls were removed, the underlying masonry was exposed to view.
- Efflorescence and evidence of moisture infiltration at the vent openings of the lower west powder magazine (Figure 428). White-colored deposits had accumulated on the lower portion of the exterior vent opening, and there was discoloration, likely mildew, on the stucco adjacent to the opening.
- Spalled and eroded brick masonry at window sills (Figure 429). The spalls were approximately 3/8 inch deep and occurred along the edge of brick units where exposed along exterior window sills.
- Spalled and eroded brick at parapet copings (Figure 430). The brick units were set in a soldier course along the top of the wall and were eroded as much as a few inches. The adjacent mortar joints remained intact and were not deteriorated.



Figure 420. Significant loss and deterioration of the stucco cladding and numerous previous repairs.



Figure 421. Significant loss and deterioration of the stucco cladding with areas of the brick substrate exposed to view.



Figure 422. Cracking of the stucco at building corners and adjacent to previous repairs.



Figure 423. Cracking of the stucco adjacent to previous repairs.



Figure 424. Spalling of stucco with corroded embedded metal exposed to view.



Figure 425. Loss of stucco and deterioration of the brick masonry substrate below a previously applied patch.



Figure 426. Portions of the west ramp stairs where the parging is no longer present and the brick is exposed to view (red arrow).



Figure 427. Incipient spall at the stucco corner at the top of an arched opening.



Figure 428. Efflorescence extending from a vent channel (red arrow).



Figure 429. Shallow spalling of a brick window sill unit and the adjacent stucco at the wall (red circle).



Figure 430. Eroded and spalled brick units along the edge of a parapet. Note that the mortar at joints remains intact.

Windows and Doors

- Cracking and spalling of the wall plaster adjacent to an interior iron gate (Figure 431). The diagonal cracking extended from the embedded anchor for the iron gate hinge. The hinge exhibited some surface corrosion.
- Cracking of the plaster and corrosion staining along the jamb of the wood louvered window units (Figure 432). The crack appeared to follow the joint between the plaster and concealed wood wall framing around the window opening. The corrosion staining was located near the bottom of the crack and may be indicative of embedded steel in the wall system.
- Split, checked, and deteriorated wood at window shutters at the one-story wing (Figure 433). The distress ranged from small checking near the end grain to large splits and deterioration within the wood planks. The surface finish had almost entirely weathered away and the wood had acquired a grey patina and exhibited areas of black-colored biological growth.
- Horizontal cracking of the stucco above one exterior door opening (Figure 434). The crack appeared to align with a previous stucco repair or framing for the arched door.
- Deterioration of the wood at one interior lug sill (Figure 435). The wood had weathered, decayed, and deteriorated, resulting in gaps and voids between the lug sill and adjacent plaster and brick stool. The distress was mostly located at the end of the sill.
- Surface corrosion of pintle hinges and iron gates resulting in loss of the surface coating and localized areas of section loss (Figure 436 and Figure 437).
- Black-colored staining extending from small holes and exposed nail heads at doors and shutters (Figure 438). The staining was concentrated around each hole and fades as it extends downward.
- The black-colored paint coating applied to the stainless-steel window grille was peeling and missing at 50 percent of the grille (Figure 439). The exposed steel where the coating had been removed appeared to be in good condition.



Figure 431. Cracking at the masonry and plaster extending diagonally from an embedded iron anchor.



Figure 432. Vertical cracking and corrosion staining along the jambs of a louvered window opening.



Figure 433. Checked and deteriorated wood plank cladding at the window shutter.



Figure 434. Horizontal crack at the stucco above an arched door opening (red arrow).



Figure 435. Deterioration of the wood at the end of the interior lug sill.



Figure 436. Corrosion and section loss of the pintle hinge and cap.



Figure 437. Corrosion and section loss of the pintle hinge.
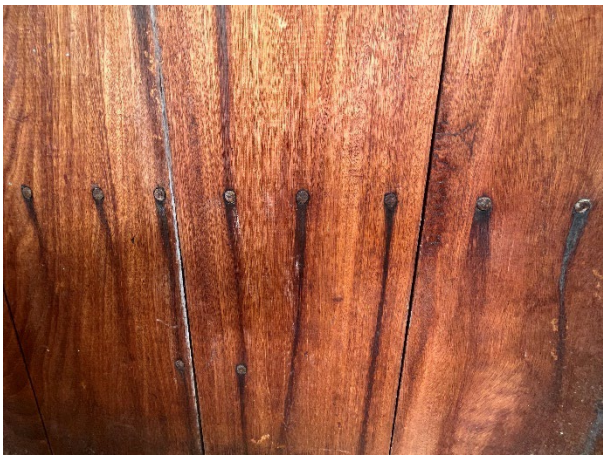


Figure 438. Corrosion of nail heads and staining of the wood below.



Figure 439. Loss of paint at stainless-steel grilles.

Roofing

- Open joints and corrosion were detected at the storm drain system during a storm event (Figure 440 and Figure 441). During a rain event, water leakage and ponding water was observed at an elbow in the storm drain. The stucco adjacent to the drain exhibited a dark discoloration.
- Spalled parging at parapet walls (Figure 442). The thin parging applied over the top of the brick at parapet walls was spalled and missing at many locations, leaving the brick coping exposed.
- Shallow concrete spalls and cracks in the terreplein (Figure 443). The spalls were approximately 1/4 inch deep and varied to as much as 12 inches in diameter. Cracks were as much as 1/4 inch wide and extended north–south across the terreplein.
- Plant and biological growth at mortar joints between brick units and cracks in the parging at the roof parapet (Figure 444) as well as at cracks and joints in the concrete terreplein. Small, rooted plants and other growth was observed at mortar joints and along the edge of the parging at the top of parapet walls.



Figure 440. Disconnected storm water drainpipe connection.



Figure 441. Corroded storm water drainpipe.



Figure 442. Missing and spalled parging at a roof coping. Note the exposed and deteriorated brick coping.



Figure 443. Shallow concrete spalls and previous repairs at the terreplein.



Figure 444. Grass and plants growing from cracks and opening joints in the terreplein and copings.

Interior Finishes

- Moisture staining, hairline vertical cracking, and flaking paint were observed at the plaster above the door opening at the southwest facade of the one-story wing (Figure 445). The moisture staining consisted of a brown discoloration that extended the full width of the opening. The hairline cracking was centered above the opening and aligns with a vertical crack in the stucco on the exterior side of the wall (Figure 446). The staining may be associated with water infiltration from above.
- Moisture staining, peeling paint, and efflorescence were observed at the storage room in the one-story wing (Figure 447). The distress was located at the upper portion of the northwest and northeast walls and may be associated with water infiltration from above.
- Moisture staining, peeling paint, plaster cracking, discoloration, and efflorescence was located at the plaster finish along the base of the walls as well as along the spring of the vault. Distress along the base of the wall typically included the lower 24 inches of the wall; however, it extended up to the spring of the vault at some casemates (Figure 448). At other casemates, the distress was located only at the upper portion of the walls and above windows (Figure 449 and Figure 450). The staining at the upper walls may be associated with water infiltration from above.



Figure 445. Moisture staining and vertical cracking (red arrow) above the east door at the one-story wing.



Figure 446. Vertical cracking (red arrow) in the exterior stucco opposite the observed interior distress.

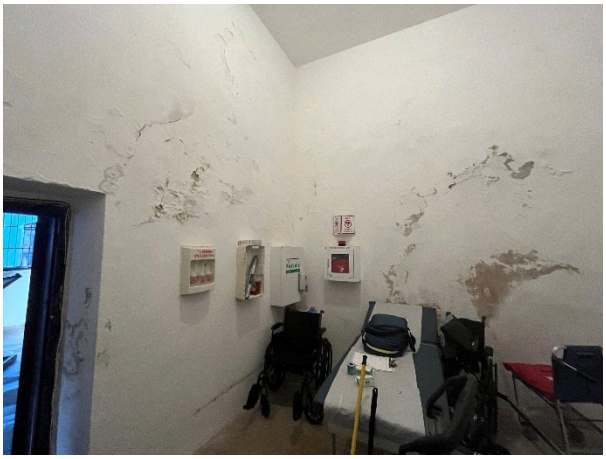


Figure 447. Peeling paint and efflorescence at the southwest corner of the mechanical room in the one-story wing.



Figure 448. Peeling paint, moisture staining, and discoloration at the lower portion of the plaster wall at some casemates.



Figure 449. Significant discoloration, moisture staining, and deterioration of plaster at the upper portion of many casemates.



Figure 450. Significant discoloration, moisture staining, and deterioration of plaster at the upper portion of many casemates.

Troops' Quarters

Stone and Brick

- Spalling, sugaring, and deterioration of the stucco finish coat at the west facade of the building (Figure 451 and Figure 452). The distress was most pronounced at those areas which had reportedly been repaired in 2017. At these locations, the finish coat could be brushed away by hand and the underlying scratch coat included red brick aggregate.
- Dark-colored biological growth along upward-facing surfaces such as the parapet, cornice, and projecting surrounds on the west facade (Figure 453).
- Spider cracking, consisting of a network of interconnected hairline cracks, was observed

at the stucco on the west facade and appeared to be most prevalent at the stucco installed as part of repairs performed in 2003 (Figure 454). There were visually apparent cold joints between the different iterations of stucco repairs.



Figure 451. Spalling and deterioration of stucco finish coat.



Figure 452. Where the finish has been completely removed, the scratch coat, indicated by red aggregate, is exposed to view.



Figure 453. Biological growth at east facade cornice.



Figure 454. Spider cracking at finish coat of stucco (red arrow).

Windows and Doors

- Spalled and eroded brick masonry at interior window stools (Figure 455). The spalls were as much as 2 inches deep, creating large divots where water collects. The adjacent mortar at joints remained intact and were not deteriorated.
- Corrosion of pintle hinges resulting in full section loss of portions of the conical cap and pintle that connects the door to the frame (Figure 456).
- Corrosion of nail heads at east window shutters and black-colored staining extending from nail heads (Figure 457). Some surface corrosion was also detected at nail heads at the main entrance door (Figure 458).
- Overall weathering of the surface finish at the shutters and vents on the east facade and the exterior door to the circular staircase

(Figure 459). Much of the clear coating applied to these features appears to have weathered, and where it has faded, the wood has acquired a grey patina.



Figure 455. Spalled brick masonry at interior window stools. The adjacent mortar remains intact.



Figure 456. Corrosion and section loss at iron pintle hinges at window shutters on the east facade.
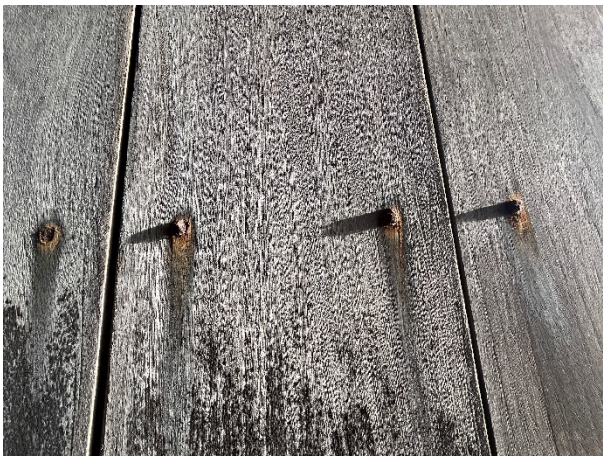


Figure 457. Corrosion of nail heads at east facade shutters.

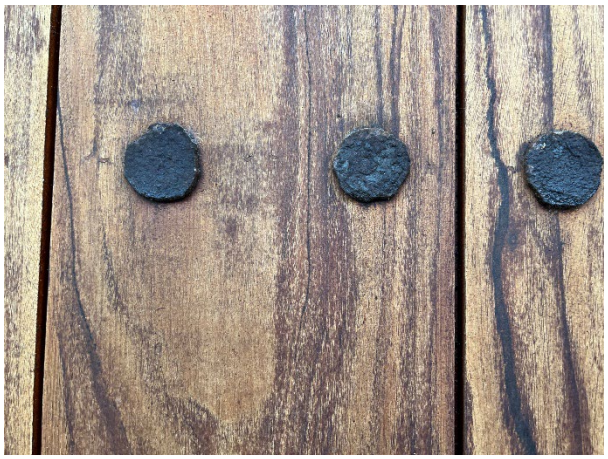


Figure 458. Mild corrosion at hammer flattened nail heads at main door.



Figure 459. Weathering of wood finish at main door.

Roofing

- Cracking at the parging and stucco finish applied to the parapet wall. The cracks extended over the top face of the parapet wall (Figure 460).
- The finish coat of stucco applied to the back side of the embrasures has eroded (Figure 461). Generally, the scratch coat remains but has also significantly eroded, giving the surface of the wall an irregular texture and color. The brick and stone substrate have been exposed at some locations, specifically at corners. Where exposed, the brick has eroded.



Figure 460. Cracking at parging on parapet wall.



Figure 461. Deteriorated parging at embrasure with localized areas eroded and missing brick.

Wood

- Localized deterioration of the wood at the stair handrails (Figure 462). At a few locations, the wood at the handrail was soft when probed with an awl. These areas also typically exhibited peeling paint.



Figure 462. Soft and deteriorated wood at the stair balustrade. Note peeling and failing paint.

Interior Finishes

- Efflorescence, discoloration, moisture staining, and bubbling paint at the interior walls and ceiling (Figure 463). The distress was typically located at the spring and top of the vaulted ceiling, specifically at the east side of the building and at the interior face of the south wall, indicating water infiltration. At some locations the paint coating applied over the plaster has trapped and collected water from the wall (Figure 464).
- Spalling and cracking of plaster adjacent to interior door openings and passageways (Figure 465 and Figure 466). The distress was most pronounced at the east side and along the south interior wall and followed patterns of moisture staining. The condition included the loss of plaster along door openings to a depth that the underlying stone and brick substrate were exposed to view.
- Corrosion, staining, and cracking associated with embedded steel anchors in the wall (Figure 467 and Figure 468). Corrosion was observed at the perimeter of passageways and was typically associated with embedded anchors, likely previous anchors for door systems installed at the passageways. The plaster adjacent to the corroded anchors was typically cracked and spalled.
- Moisture staining and spalled plaster at the base of walls, specifically walls at the west side of the building (Figure 469). The distress was most pronounced at a zone approximately 18 inches above finished floor.

- A small concrete spall with exposed reinforcing bars was observed at the floor in the corner of one casemate (Figure 470). The spall was approximately 1 inch deep and there was surface corrosion at the reinforcing bar.



Figure 463. Efflorescence and moisture staining at the top of the vaulted ceiling at a second-floor casemate.



Figure 464. Bubbling and peeling paint at a wall in a first-floor casemate.



Figure 465. Spalled plaster at the corner of a wall. Note that the brick substrate is exposed to view.



Figure 466. Spalling of the plaster in the field of the wall.



Figure 467. Corrosion and staining of embedded steel in the wall.



Figure 468. Cracking of the plaster adjacent to embedded steel.



Figure 469. Spalling of plaster along the base of the wall.



Figure 470. Localized areas of spalled concrete flooring with embedded steel exposed to view.

Officers' Quarters

Stone and Brick

- Vertical cracking and displacement at the stucco on the south addition (Figure 471). The cracking extended vertically from the upper corners of all window and door openings through the cornice and through the parapet (Figure 472). Although less prevalent, cracking was also observed to extend from window and door openings to grade (Figure 473). Portions of the cracks appeared to have been previously repaired; however, the repairs had failed. The north door on the east facade and the east vent opening on the south facade appeared to have the most significant cracking (Figure 474). At these locations the stucco on either side of the crack appeared to be displaced. The staining may be associated with water infiltration from above.
- A large spall and evidence of moisture infiltration was observed above the exterior door opening at the north storage room in the south addition (Figure 475). The spall measured approximately 12 inches wide, and the underlying brick substrate was exposed to view. Biological growth and discoloration were observed at the plaster above and adjacent to the spall. Paint loss and deterioration of the plaster at the jambs of the door opening was also documented (Figure 476). The staining may be associated with water infiltration from above.
- Spalled, eroded, and missing stucco at large areas of the two-story portion of the building (Figure 477 and Figure 478). Numerous iterations of patches and previous repairs were observed and are visually apparent (Figure 479). At some locations, the underlying stone and brick substrate is exposed to view. Along with the stucco, the surface coatings are also flaking and peeling or have deteriorated.
- Spider cracking, consisting of a network of interconnected hairline cracks, was observed throughout the stucco at the south addition (Figure 480).



Figure 471. Diagonal cracking in the stucco extending from the corner of window and door openings throughout the south addition.



Figure 474. Cracking extending from the corners of the door opening appears to have been previously repaired.



Figure 472. Vertical cracking and displacement of the stucco at the southeast corner of the south addition.



Figure 475. Large spall in the masonry and discoloration of the interior plaster above a door opening in the south addition.



Figure 473. Cracking extending between the fortification wall and the corner of window openings at the south facade of the building.



Figure 476. Masonry deterioration and efflorescence extends down the jamb of the door opening.



Figure 477. Large areas of stucco loss and repair throughout the two-story portion of the building.



Figure 478. Loss of the stucco finish coat and erosion of the scratch coat.



Figure 479. Loss of the top coat of stucco reveals previous underlying patches and applications of stucco, many of which are not intact or well bonded to the substrate.

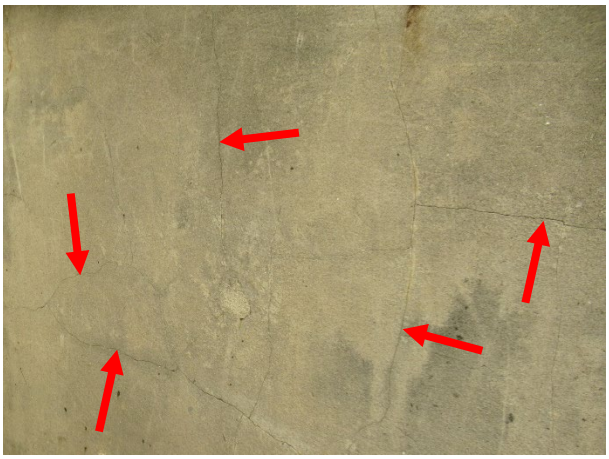


Figure 480. Network of hairline cracks in the stucco at the south addition (red arrows).

Windows and Doors

- Displaced window frame at the women's restroom in the south addition (Figure 481). Portions of the window shutter frame were displaced outward approximately 1 inch. There was a gap between the frame and the finish plaster, and the underlying stone and brick substrate were exposed to view. Sandbags had been set at the sill to keep the window unit in place (Figure 482).
- Split, checked, and deteriorated wood at window shutters on the south addition (Figure 483 through Figure 485). The distress ranged from small checking near the end grain to large splits and deterioration within the wood planks. The surface finish had almost entirely weathered away and the wood had acquired a grey patina and exhibited areas of black-colored biological growth (Figure 486).
- Localized areas of chipped wood at doors (Figure 487). Where observed, portions of the wood plank at doors were broken. Deterioration of the surface finish was observed near the lower portion of the doors.
- Corrosion of pintle hinges resulting in full section loss of portions of the conical cap (Figure 488).
- Black-colored staining extending from small holes and exposed nail heads at doors and shutters (Figure 489). The staining is concentrated around each hole and fades as it extends downward.



Figure 481. Significant displacement of a wood-framed shutter at the south addition.



Figure 484. Checking and splitting of the wood boards at the shutters.



Figure 482. Sandbags are used to keep the displaced frame in place.



Figure 485. Ongoing deterioration of the clear coat finish has resulted in an irregular patina to the wood.



Figure 483. Deteriorated and split wood framing at one south addition window frame.



Figure 486. Deterioration of the clear coat finish at the base of the door and moisture staining.



Figure 487. Wood doors have localized areas of chipped wood.



Figure 488. Corrosion and significant section loss at the pintle hinge and conical cap.



Figure 489. Corrosion of nail head and staining of the wood below.

Roofing

- Vertical cracks at parapet wall of the south addition. The vertical cracks were located on the west, south, and east parapet walls and extended over the top face of the parapet wall (Figure 490). The cracks aligned with observed cracks in the stucco walls. Some of the cracks had been previously repaired; however, the repairs had failed (Figure 491).
- The parging and elastomeric coating at the south addition roof was cracked, debonded, and spalled (Figure 492). Cracks were typically hairline but exhibited discoloration along the edges (Figure 493). Spalls were typically 1/4 inch deep and located along the cracks. The cracks were typically aligned with visible cracks in the parapet wall (Figure 494).
- Spalled parging at parapet walls (Figure 495). The thin parging applied over the top of the brick at parapet walls was spalled and missing at most locations, leaving the brick exposed. At some areas, the corners of brick coping units had cracked and chipped and mortar joints between units were open (Figure 496).
- The finish coat of stucco applied to the back side of the parapet walls has eroded (Figure 497 and Figure 498). The scratch coat remains but has also significantly eroded, giving the surface of the wall an irregular texture and color.
- Plant and biological growth at mortar joints between brick paving units at the roof (Figure 499). Small, rooted plants and other growth was observed at mortar joints and along the edge of the parging at the top of parapet walls.



Figure 490. Cracking at the parapet and parging at the coping.



Figure 491. Cracking at the parapet and parging at the coping.



Figure 494. Cracking at the elastomeric coating aligns with cracking at the parapet and coping.



Figure 492. Peeling, spalling, and debonding of the elastomeric coating applied to the south addition roof.



Figure 495. Spalling of the parging applied over the brick parapet coping.



Figure 493. Cracking of the elastomeric coating applied over the south addition roof.



Figure 496. Cracked and chipped units with open mortar joints.



Figure 497. Loss of the stucco finish coat and erosion of the scratch coat at the back face of parapet walls.

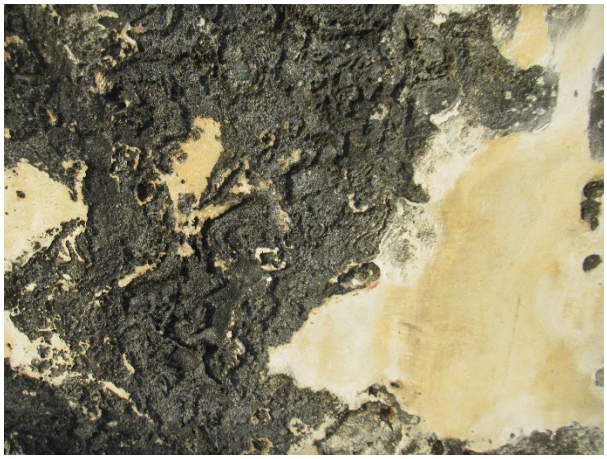


Figure 498. Loss of the stucco finish coat and erosion of the scratch coat at the back face of parapet walls.



Figure 499. Plants and biological growth at cracks and joints in the roof parapet.

Interior Finishes

- Deterioration of the plaster and exposed wood framing at the perimeter of passageways between casemates (Figure 500 and Figure 501). The plaster around many of the passageways was cracked. At the center casemate, the cracking aligned with the joint between the arched wood frame and plaster. At portions of the wood frame, the paint was peeling, and the wood was observed to have split and had missing sections around anchor locations (Figure 502). At other passageways, the plaster had cracked and spalled, and the embedded steel was exposed to view and observed to be corroded (Figure 503).
- Moisture staining and evidence of active water infiltration at the north storage room. Discoloration, peeled paint, and concrete spalling was observed at ceiling (Figure 504 and Figure 505). Corroded reinforcing bars were observed at locations where the concrete had spalled. Vertical cracking, measuring 1/16 inch wide, was observed at the plaster walls below the ceiling (Figure 506). A large dark-colored stain was observed on the vinyl composite tile flooring (Figure 507). The staining may be associated with water infiltration from above.
- Moisture staining, peeling paint, concrete spalling, and efflorescence were observed at the storage room in the south addition (Figure 508 and Figure 509). The distress was located at the ceiling and extended down the north and west walls. The staining may be associated with water infiltration from above.
- Cracked, broken, chipped, and pitted quarry tile at the second casemate from the south (Figure 510). Some tiles were cracked or broken with portions of the tile missing and mortar setting bed exposed. At some locations, broken and cracked tiles had been repaired with concrete patches. Where present, pitting was as much as 1/4 inch deep and included small pits along edges as well as widespread pitting over the full face of the tile (Figure 511).
- Chipped and cracked quarry tile flooring at the south addition (Figure 512). The corner of some tiles had cracked or was missing. Chips

were typically located along the edges of tiles. Cracks were located near corners of tiles as well as near drains in the floor (Figure 513). Large chips were previously repaired and filled with a white-colored grout.

- Staining, consisting of brown-colored drips, extended from wall-mounted light fixtures at the restroom in the south addition (Figure 514). The staining appeared to be associated with corrosion of anchors.
- Flaking and peeling paint throughout the building interior (Figure 515). The distress was typically located near window openings and at the mid-height of barrel-vaulted walls (Figure 516).
- Hairline cracking at the plaster walls adjacent to window opening (Figure 517). The cracks were typically located below sills.



Figure 500. Separation of the plaster finish and wood door framing with an area of deteriorated wood framing.



Figure 501. Cracking along the jamb of one door opening.



Figure 502. Separation of the plaster finish and wood door framing with an area of deteriorated wood framing (red arrow).



Figure 503. A spall and cracking in the plaster revealing corroded embedded steel.



Figure 504. Cracking and incipient spalls at the underside of the roof deck (red arrow).



Figure 505. Discoloration, moisture staining, and spalling at the underside of the roof deck. Reinforcing bar is exposed to view at the spalls.



Figure 506. Vertical cracking at the walls and extending to the ceiling where there is more significant spalling and cracking (red arrows).



Figure 507. Moisture staining at vinyl tile flooring below area of distress at ceiling.



Figure 508. Peeling paint and efflorescence at the ceiling.



Figure 509. Spall with exposed corroded reinforcing bar at the ceiling.



Figure 510. Hairline cracks and shallow spalls along the edges of historic quarry tile flooring.



Figure 511. Pitting was as much as 1/4 inch deep and included small pits along edges as well as widespread pitting over the full face of the tile.



Figure 512. Cracks and previous repairs at non-original clay tile flooring.



Figure 513. Cracks, chips, and patches along the edges of tiles and near floor penetrations.



Figure 514. Brown staining extending down the wall from wall-mounted light fixtures.



Figure 515. Flaking paint over interior plaster walls.



Figure 516. Moisture staining and discoloration at the upper portion of barrel-vaulted ceilings.



Figure 517. Vertical cracking extending across a plaster window sill.

North Bastion, South Bastion, and Curtain Wall

- Vertical cracking of the stucco layers and masonry was observed extending from the coping units (Figure 518). Horizontal, diagonal, and vertical cracking of the stucco layers was also observed throughout the walls and embrasure corners (Figure 519). At some locations, efflorescence is leaching from the cracks (Figure 520). At other locations, cracking originates at locations where steel is embedded into the wall (Figure 521).
- Spalling of the stucco finish, exposing the underlying brick and ashlar block masonry, was observed at the inside walls of the tunnel opening closest to the north bastion (Figure 522).
- Delaminated sections of the stucco layer were observed throughout the fort walls (Figure 523). Delamination of the stucco was also noted on the inside face of the passageway that leads to the sentry box (Figure 524).
- Spalling and incipient spalling of the concrete vent shaft at the north bastion (Figure 525). The reinforcement bars are visible and are heavily corroded and have section loss (Figure 526). Large incipient spalls were also observed at the inside of the World War II Fire Control Station, particularly on the sill and apron of the openings (Figure 527 and Figure 528).
- Erosion of both the stucco and the exposed stone was observed throughout the walls and the sentry box. At these locations, the surface has a rough and uneven texture forming several peaks and valleys. Circular ridges of the stone surface form a circular pattern around the lower areas of the surface.
- Eroded and partially missing mortar joints in between the stone blocks of the sentry box (Figure 529).
- Signs of water infiltration are visible on the tunnel walls that lead to the north bastion, as evidenced by active water drips on the walls following a rain event, and biological growth staining on the ceiling (Figure 530). The water infiltration was coming in approximately 6 feet up the base of the wall (Figure 531).
- Previous crack repair at the concrete was observed at the gun emplacement platforms (Figure 532).
- Cementitious patches were observed throughout the walls. Spalling of the patched surface, in the form of circular dents, was also noted (Figure 533).
- Debris and sedimentation were observed at some of the drainage paths (Figure 534).
- Historic graffiti in the form of etching over the parge coat is visible on the curtain and south bastion embrasure walls (Figure 535). The graffiti has been inscribed on the stucco layer and reads “F. MALO”.
- Biological growth staining observed on the ceiling of the sentry box and efflorescence observed leaching from the ashlar block joints (Figure 536 and Figure 537).



Figure 518. Vertical cracking of the enclosure walls at the south bastion (red arrow).



Figure 519. Diagonal cracking of stucco and masonry at top inner corner of embrasure (red arrow).



Figure 520. Efflorescence leaching from the barbette walls.



Figure 521. Cracking extending from steel embedment.



Figure 522. Spalling of stucco layers at the tunnel walls.



Figure 523. Delamination and missing sections of stucco coating at merlons.



Figure 524. Missing sections of stucco coating at passageway walls.



Figure 525. Incipient spalling of the concrete vent shaft.



Figure 526. Exposed reinforcement bars following spalling of concrete.



Figure 527. View of incipient spalls and exposed reinforcement bars.



Figure 528. View of incipient spalls and exposed reinforcement bars.



Figure 529. Missing mortar joints at the sentry box cornice.



Figure 530. Biological growth staining on the ceiling of the tunnel.



Figure 531. Water infiltration in the tunnel.



Figure 534. Blocked drainage system.



Figure 532. Crack repair at corner of gun emplacement platform located on the north bastion.



Figure 535. Etching on the stucco that reads "F.Malo" on the embrasure walls.



Figure 533. Spalling of the previously patched section of the wall, particularly along cracks.



Figure 536. Biological growth on the ceiling of the sentry box.



Figure 537. Efflorescence leaching from the mortar joints inside the sentry box.

Tunnels

The six tunnels beneath the main fortification exhibited typical conditions, with a few isolated locations with unique conditions. The following summarizes notable conditions that were observed in the tunnels.

- Weathered and peeling lime wash was generally observed at the parge coat on all surfaces of the tunnels (Figure 538).
- Partial- and full-depth spalls in the parge coat were observed at the walls and ceiling of all tunnels (Figure 539). Masonry construction was exposed at full-depth spalls.
- Heavy efflorescent staining and formation of calcites was present in all tunnels (Figure 540 and Figure 541)
- Minor to moderate levels of atmospheric staining and biologic soiling of the parge coat were observed at the walls and ceiling near the entrances of the tunnels (Figure 542).
- Corrosion staining in masonry walls and ceilings was observed at miscellaneous embedded steel in multiple tunnels (Figure 543). This occurred at conduits, anchorages, and other miscellaneous embedded steel.
- At multiple locations in the dungeon in Tunnel 1, numerous cracks extend through the section of the dungeon room, parallel to the span of the arched ceiling (Figure 544). The width of the cracks varied from 1/4 to 1 inch wide. Faulting was observed in some locations and measured to be 3/8 inch relative displacement. All cracks had rounded edges along their length (Figure 545). Signs of previously installed cracks gauges on the walls were present.
- At Tunnels 1 and 2, corrosion staining and spalled and cracked parge coat was present at embedded steel in the jambs of the entrances with wrought iron steel doors (Figure 546).
- At Tunnel 4, missing or corroded handrail anchorages were found at multiple locations (Figure 547).



Figure 538. Weathered and peeling lime wash at the parge coat.



Figure 539. Partial- and full-depth spalls.



Figure 540. Heavy efflorescent staining and formation of calcites.



Figure 543. Corrosion staining at miscellaneous embedded steel.



Figure 541. Heavy efflorescent staining and formation of calcites.



Figure 544. Crack in masonry at the dungeon room, parallel to the span of the arched ceiling.



Figure 542. Atmospheric staining and biologic soiling on parge coat.



Figure 545. Rounded edges along length of crack.



Figure 546. Spalled and cracked parge coat at embedded steel at wrought iron steel doors.



Figure 547. Missing or corroded handrail anchorages at Tunnel 4.

El Caballero de San Miguel

El Caballero de San Miguel is the uppermost battery located between Plaza de Armas and the north bastion, curtain, and south bastion (Figure 548). It was part of the initial construction phase, which began in 1634 with later extensions completed between 1768 and 1771. The tallest structure of the main fortification at 148 feet above sea level, El Caballero de San Miguel is accessed from the ramp located at Plaza de Armas between the troops' quarters and the north casemates (Figure 549 and Figure 550).

El Caballero de San Miguel is elongated in plan with the north and south walls being the shorter sides, and the east and west walls forming the longer sides (Figure 551). The walls are battered, sloping inward from grade to the top of the structure. The west wall of El Caballero is shared with the ramp, and the north wall of El Caballero terreplein abuts the steep ramp. The east wall is located within the south bastion terreplein, and the south wall is located next to the South Gate (Figure 552 and Figure 553).

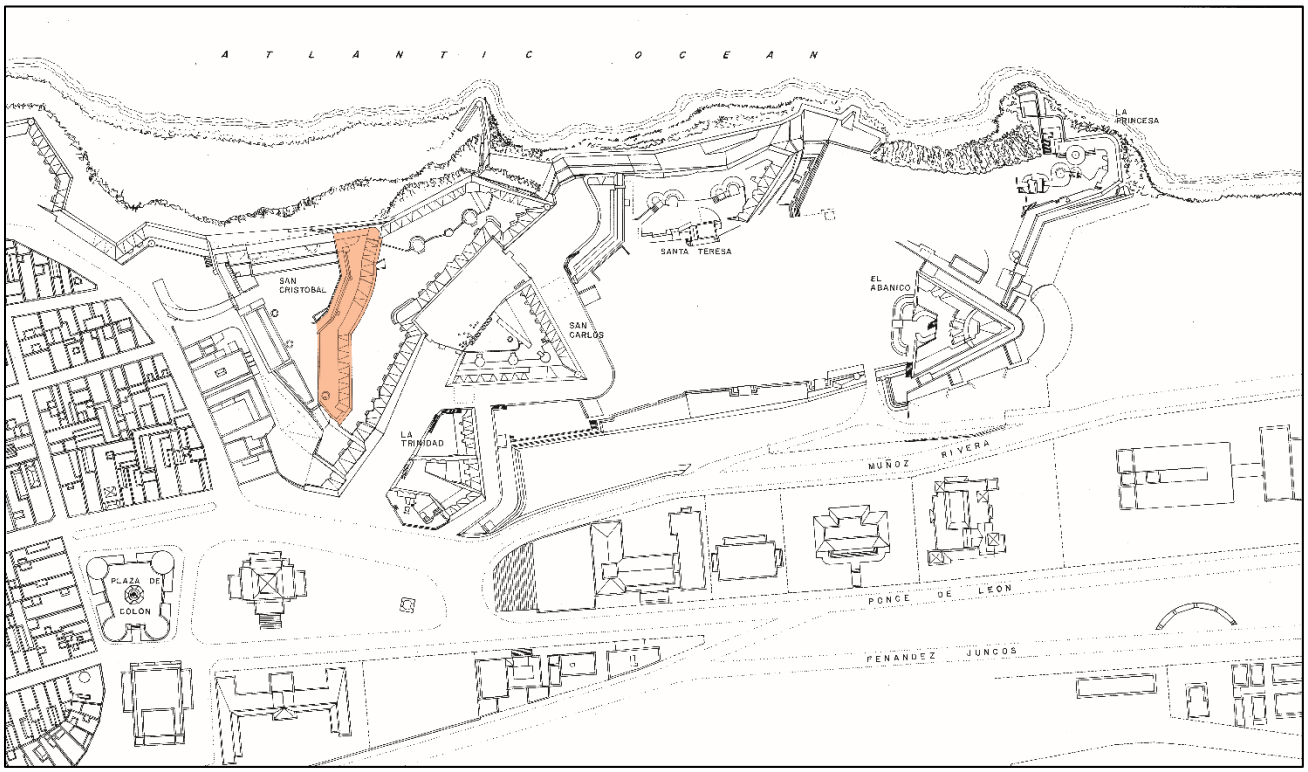


Figure 548. A site plan showing the location of El Caballero de San Miguel (orange shading). (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Sheet 4 of 17, annotated by authors)



Figure 549. The terreplein at El Caballero de San Miguel. Note the ramp and chapel at the right. View from north.



Figure 550. Terreplein at El Caballero de San Miguel in 1960. (Source: San Cristóbal Cistern Heads Historic American Buildings Survey No. PR-102, Photo 1, 1960)



Figure 551. Overall view of the terreplein looking south.



Figure 552. West curtain wall of El Caballero de San Miguel.



Figure 553. West curtain wall of El Caballero de San Miguel.

There are several layers of cement stucco installed over the limestone block and rubble substrate. Brick masonry is used at copings, merlons, and the firing steps. The terreplein flooring consists of cement with areas that contain brick and stone masonry, as well as areas with red pigmented patches (Figure 554).



Figure 554. Red patches at terreplein paving.

Five window openings and four ventilation ducts are located on the east wall, and fourteen embrasures on the east parapet walls. A gun emplacement, dating from the late nineteenth century, is located at the north section of the terreplein. The emplacement is characterized by basalt tracks, iron rails, and an iron pintle (Figure 555). Also on the north end is the signal flag house, a flagstaff, and a fire control station at the north end of the bastion.



Figure 555. View of gun emplacement at north end.

Ramp

The ramp that connects Plaza de Armas with the terreplein runs alongside the west facade of El Caballero de San Miguel (Figure 556). The ramp paving is composed of brick and stone rubble with

decorative horizontal stone band spacing. The ramp wall, approximately 2 feet wide, is composed of masonry rubble with portland cement (Figure 557 and Figure 558). Two arched openings leading to tunnels are located on the north end of the ramp wall. Several concrete repairs appear to have been made to the ramp paving. At the terreplein level, the west wall has three niches and a projecting concrete enclosure that houses a bell installed over the parapet (Figure 559 and Figure 560).



Figure 556. View of ramp.



Figure 557. Portland cement applied over masonry ramp wall.



Figure 558. Portland cement applied over masonry ramp wall.



Figure 559. Niches at the west wall of the terreplein.



Figure 560. Concrete bell enclosure installed over the west wall parapet.

Flag House

To the east of the ramp is a one-story brick structure, known as the flag house (Figure 561).

The building structure consists of wooden roof joists and a masonry roof. A flag was originally located at the signal pole. The window openings are blocked with crossbars.



Figure 561. View of the flag house exterior.

Wall Remnants at Corner

At the northwest corner of the terreplein, a section of wall extends past the parapet (Figure 562). Formerly a base for a signal flag, the wall is composed of brick masonry with a portland cement parge coat. Directly above the parapet level is a through-wall opening.



Figure 562. Remnants of a wall at northwest corner of the parapet.

Fire Control Station A

The San Cristóbal Fire Control Station A was built at the northeast end of El Caballero de San Miguel in 1942 by the U.S. Army (Figure 563). The station is a rhombus in plan, consists of a two-story reinforced concrete observation post, and is accessed through a doorway at the terreplein. A ladder is located at the interior to move between the two levels. The upper level is approximately 160 feet above sea level and the lower level is approximately 155 feet above sea level. The roof slopes towards the north. There are two wide horizontal observation openings, one at each level; at the north wall with deep sills, and a window on the south facade of the second level (Figure 564).



Figure 563. View of Fire Control Station A building.



Figure 564. Window opening at the south facade of Fire Control Station A.

Cisterns

The earlier vaulted cistern, dating to the early seventeenth century, was located underneath El Caballero de San Miguel. Two octagonal cistern heads corresponding to the earlier cistern system are visible on the north end of the terreplein (Figure 565).



Figure 565. View of cisterns at terreplein.

A drainage trench is located below the parapet, facing the eastern defense wall. The paving facing the embrasure walls is set back to allow for water to travel and exit through the gutters (Figure 566). Through-wall openings at the base of the embrasure walls also allow for water to drain out into the curtain wall downspouts (Figure 567). Portland cement is used as a patching material at the gun emplacement tracks and the drainage (Figure 568).



Figure 566. Drainage channels at terreplein.



Figure 567. Downspout on the west wall draining towards the eastern defense terreplein (red arrow).



Figure 568. Portland cement applied over the drainage channel.

Circular Stair Tower

A circular staircase located on the southwest end of El Caballero projects from the El Caballero terreplein and connects the terreplein to the first and second floor of the troops' quarters (Figure 569 through Figure 571). The circular stair tower was built in 1773 and is composed of brick masonry and stone rubble covered with a red pigmented stucco layer followed by a white stucco layer. Sandstone is used at the cornice, the doorway, and at the circular window.



Figure 569. Stair penthouse at roof over troops' quarters. View from southeast.



Figure 570. Stair penthouse at roof over troops' quarters in 1960. (Source: San Cristóbal Cistern Heads Historic American Buildings Survey No. PR-102, Photo 2, 1960)



Figure 571. View of circular stair tower.

Condition Assessment

- Vertical cracking of the stucco layers and masonry was observed at the ramp walls (Figure 572). Horizontal, diagonal, and vertical cracking of the stucco layers was also observed throughout the walls and embrasure corners. At some locations, efflorescence is leaching from the cracks.
- Spalling of the stucco finish and masonry, exposing the underlying brick and other masonry rubble, was observed at the embrasure walls (Figure 573).
- Delaminated sections of the stucco layer were observed throughout the fort walls (Figure 574).
- Multiple repair campaigns dating from 1921 onward have been completed at El Caballero, based on information included in the Historic Structure Report completed on San Cristóbal in 1991. The previous repair campaigns include the following:
  (1) Small stones embedded into a lightly pigmented stucco layer.
  (2) Rectangular stone veneer, 1 inch thick, with cement joints, installed in 1938-1940 by the Army Corps of Engineers (Figure 573 and Figure 574).
  (3) Yellow-orange pigmented cement stucco scored to resemble an ashlar coursing installed around the previous 1938-1940 campaign (Figure 577).
  (4) Grey portland cement used as a patch material to infill spalled areas (Figure 578 and Figure 579).
- The faces of the brick masonry are eroded and partially missing, particularly where a cement-rich mortar has been installed at upward facing joints (Figure 580).
- Erosion of both the stucco and the exposed stone was observed throughout the walls. At these locations, the surface has a rough and uneven texture forming several peaks and valleys. Circular ridges of the stone surface form a circular pattern around the lower areas of the surface.
- Historic graffiti over the parge coat is visible on the stair tower interior walls (Figure 581).



Figure 572. Vertical cracking of the west parapet wall.



Figure 573. Spalling of stucco and masonry at the embrasure walls.



Figure 574. Delamination and missing sections of stucco coating.



Figure 577. Example of stucco scored to resemble blocks on the east wall.



Figure 575. Example of rectangular stone veneer installed to resemble blocks on the east wall.



Figure 578. Previous patching using portland cement at the Flag House.



Figure 576. Rectangular stone veneer repairs used at embrasure walls.



Figure 579. Portland cement patches installed at cheeks of embrasure walls.



Figure 580. Eroded brick masonry at the embrasures.



Figure 581. Writing over the finish coat of the dome interior of the stair tower.

Great Moat

The great moat, or *gran foso*, at Castillo San Cristóbal extends along the eastern face of the main fortification and around San Carlos Ravelin and La Trinidad Counterguard (Figure 582). The World War II Joint Command Center (visitor center) is located in what was originally part of the moat between San Carlos and the curtain wall. Historically, the moat separated the main portion of the fortifications from the outer defenses to the east. San Carlos Ravelin and La Trinidad Counterguard are located within the moat.

The great moat generally extends from the Atlantic Ocean to the north to Avenida Luis Muñoz Rivera to the south. The west wall of the moat is comprised of the scarp wall of the main fortifications of San Cristóbal. The portion of the moat that runs along the main fortification ranges in width from 60 to almost 100 feet.

Much of the great moat is used as a parking lot and roadway with asphalt paving present between the moat counterscarp walls and the walls of the adjacent fort structures. The north portion of the great moat, immediately adjacent to the ocean, contains Garita del Diablo Lookout, a small, paved plaza that overlooks the sentry box to the west known as La Garita del Diablo (Figure 583). The counterscarp at the north end of the great moat is the west wall of the north covered way at the west end of Santa Teresa. South of the north covered way, the counterscarp walls turn toward the east, running parallel to the north wall of San Carlos Ravelin to the south (Figure 584). The counterscarp wall continues to run parallel to San Carlos Ravelin, curving back toward the west (Figure 585 and Figure 586). The width of the great moat where it runs north and south of San Carlos Ravelin is approximately 50 feet. The east counterscarp continues south around La Trinidad Counterguard (Figure 587 and Figure 588). The great moat extends to Avenida Luis Muñoz Rivera at the south side of the site on each side of La Trinidad Counterguard (Figure 589 through Figure 593). The portion of the moat that runs east of La Trinidad Counterguard is only 20 feet wide.

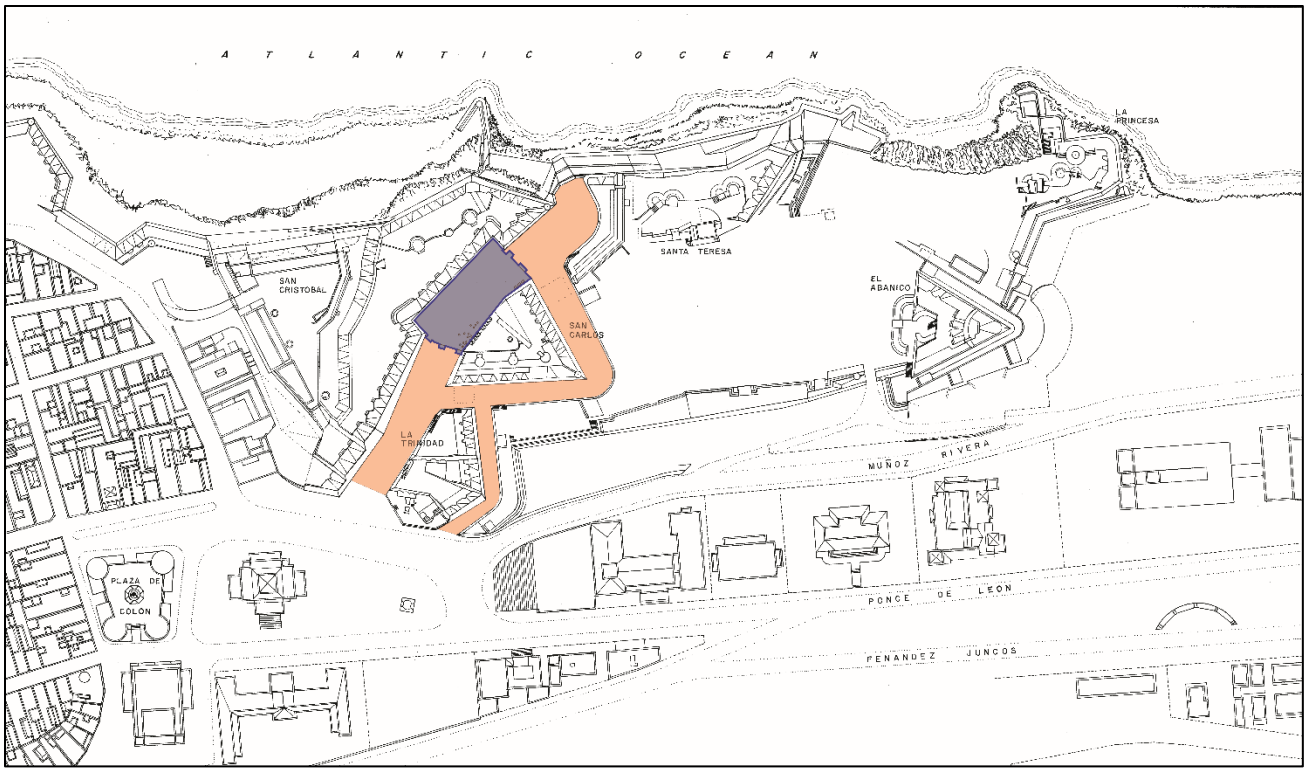


Figure 582. A site plan showing the location of the great moat. Note the World War II Joint Command Center (visitor center) shown in blue. (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Sheet 4 of 17, annotated by authors)



Figure 583. Garita del Diablo Lookout at the north end of the great moat. View from southeast.

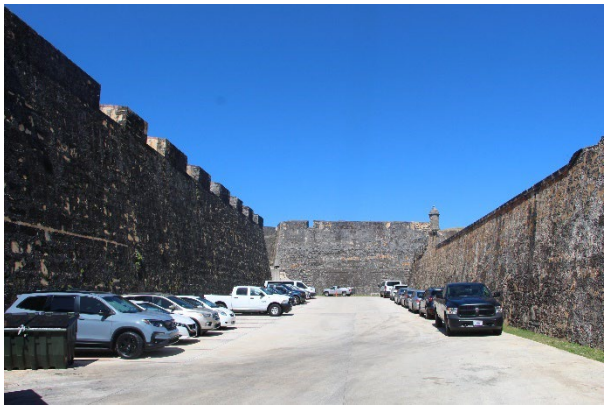


Figure 584. View of the great moat from east. San Carlos Ravelin is at left with the main fortifications of San Cristóbal in the background. A counterscarp wall of the moat is at right.



Figure 585. The great moat as it curves around San Carlos. View from east.



Figure 586. The great moat as it curves around San Carlos in 1960. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 21, 1960)



Figure 587. Great moat at the east side of La Trinidad Counterguard. This is the narrowest portion of the moat. View from north.

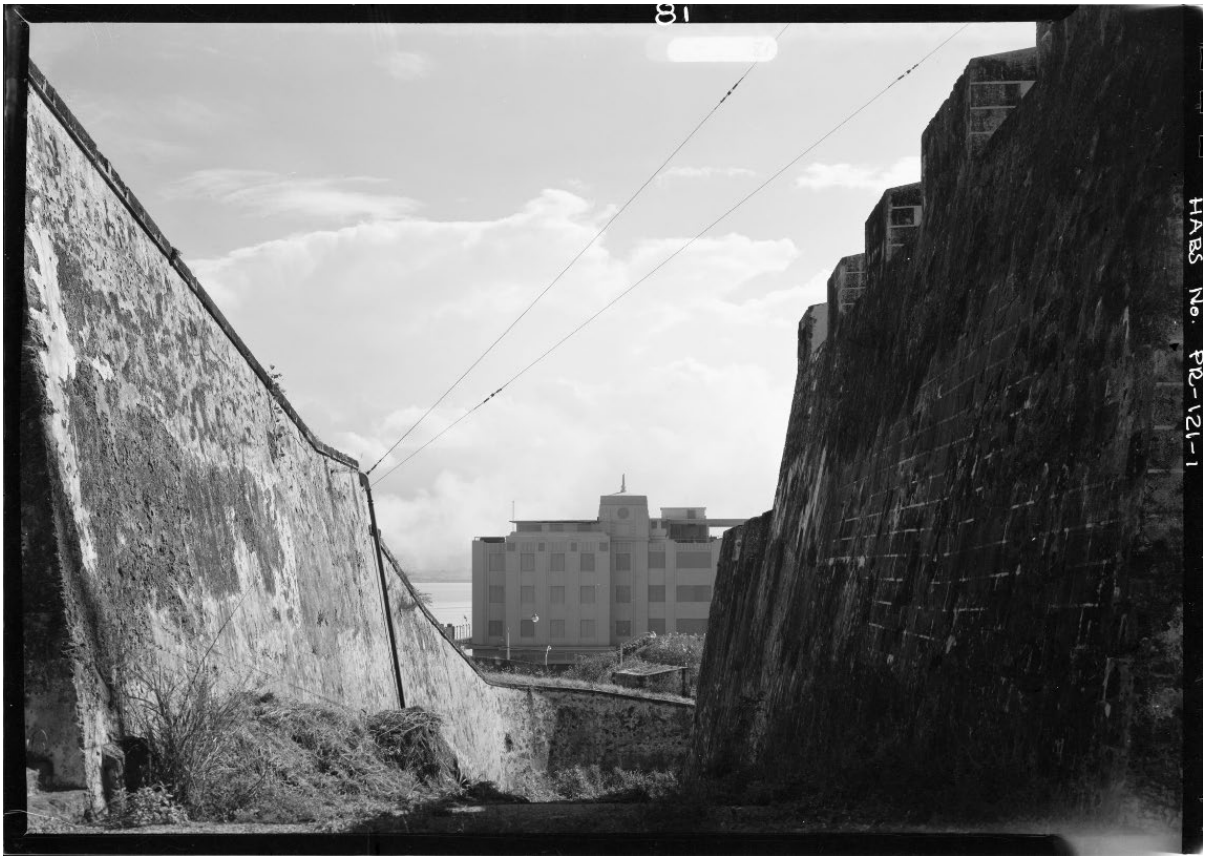


Figure 588. Great moat at the east side of La Trinidad Counterguard in 1960. (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Photo 1, 1960)



Figure 589. The main portion of the great moat along the east side of the main fortifications near where it meets Avenida Luis Muñoz Rivera. The World War II Joint Command Center is visible in the background with La Trinidad Counterguard at right. View from south.

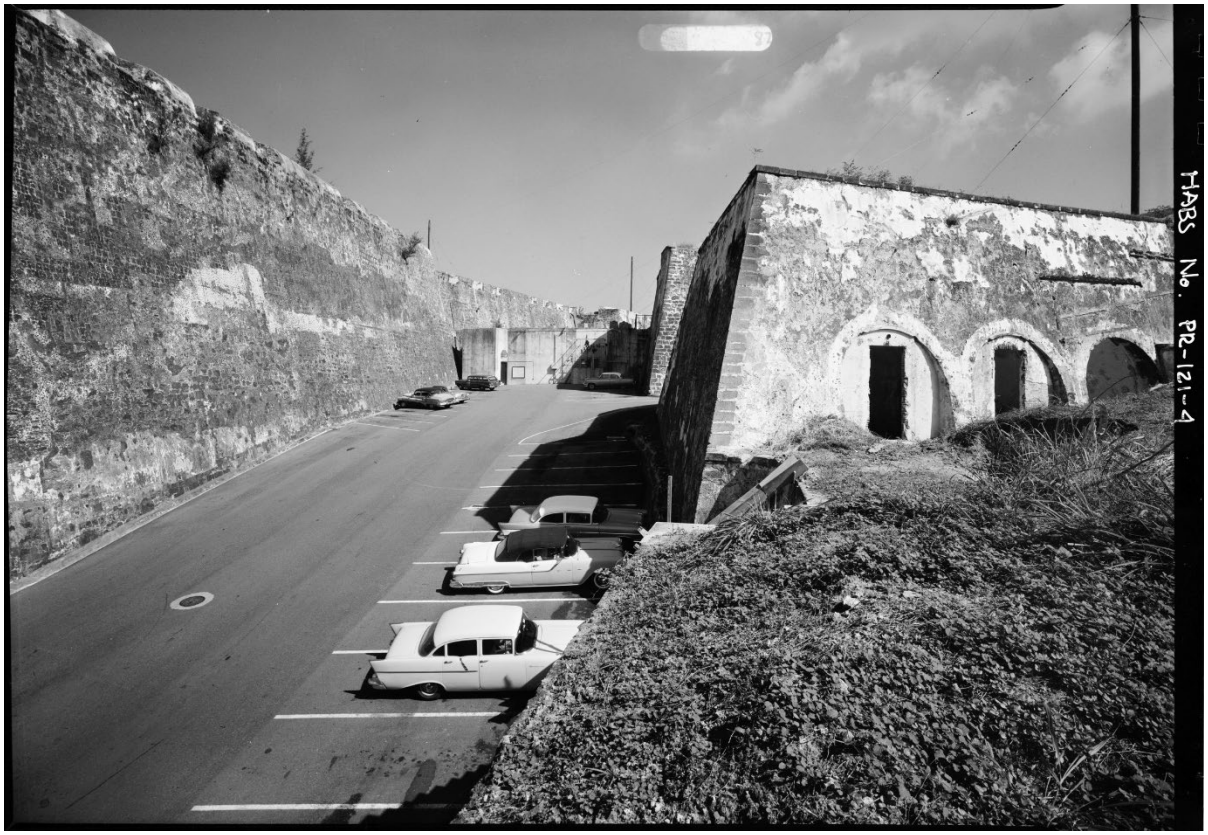


Figure 590. The main portion of the great moat along the east side of the main fortifications in 1960. The World War II Joint Command Center is visible in the background with La Trinidad Counterguard at right. (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Photo 4, 1960)



Figure 591. The main portion of the great moat along the east side of the main fortifications. The World War II Joint Command Center is visible in the background with La Trinidad Counterguard at right. View from south.



Figure 592. The main portion of the great moat along the east side of the main fortifications near where it meets Avenida Luis Muñoz Rivera in 1960. The World War II Joint Command Center is visible in the background with La Trinidad Counterguard at right. (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Photo 5, 1960)

The counterscarp walls at the east side of the great moat are stone with remnant stucco in some locations (Figure 594). The construction and finish of the walls is similar to what is seen at San Carlos Ravelin and La Trinidad Counterguard. The walls are battered, sloping inward from grade.



Figure 593. The moat where it meets Avenida Luis Muñoz Rivera on the east side of La Trinidad Counterguard. View from south.



Figure 594. A typical counterscarp wall at the moat. View from northeast.

San Carlos Ravelin

Constructed between 1766 and 1770, San Carlos Ravelin is located east of the main fortifications of Castillo San Cristóbal and is largely surrounded by the former great moat, which now serves as a parking lot and roadway (Figure 595). The visitor center sits in the moat between San Carlos and the main fortifications of the Castillo San Cristóbal to the west.

San Carlos is triangular in plan, with raised parapets along the northeast and south walls of the structure. The lower terreplein is located at the west end of San Carlos between the parapets. The walls of the structure are masonry.

Prior to the construction of the World War II Joint Command Center (visitor center) in 1942, a sunken passageway or caponier connected the west curtain wall of Castillo San Cristóbal with San Carlos (Figure 596). A set of two exterior stairs originally led from the caponier up to the terreplein of San Carlos. Today, the terreplein is accessed from the roof of the visitor center via a flight of concrete stairs that lead down to the terreplein of San Carlos from the roof of the visitor center (Figure 597).

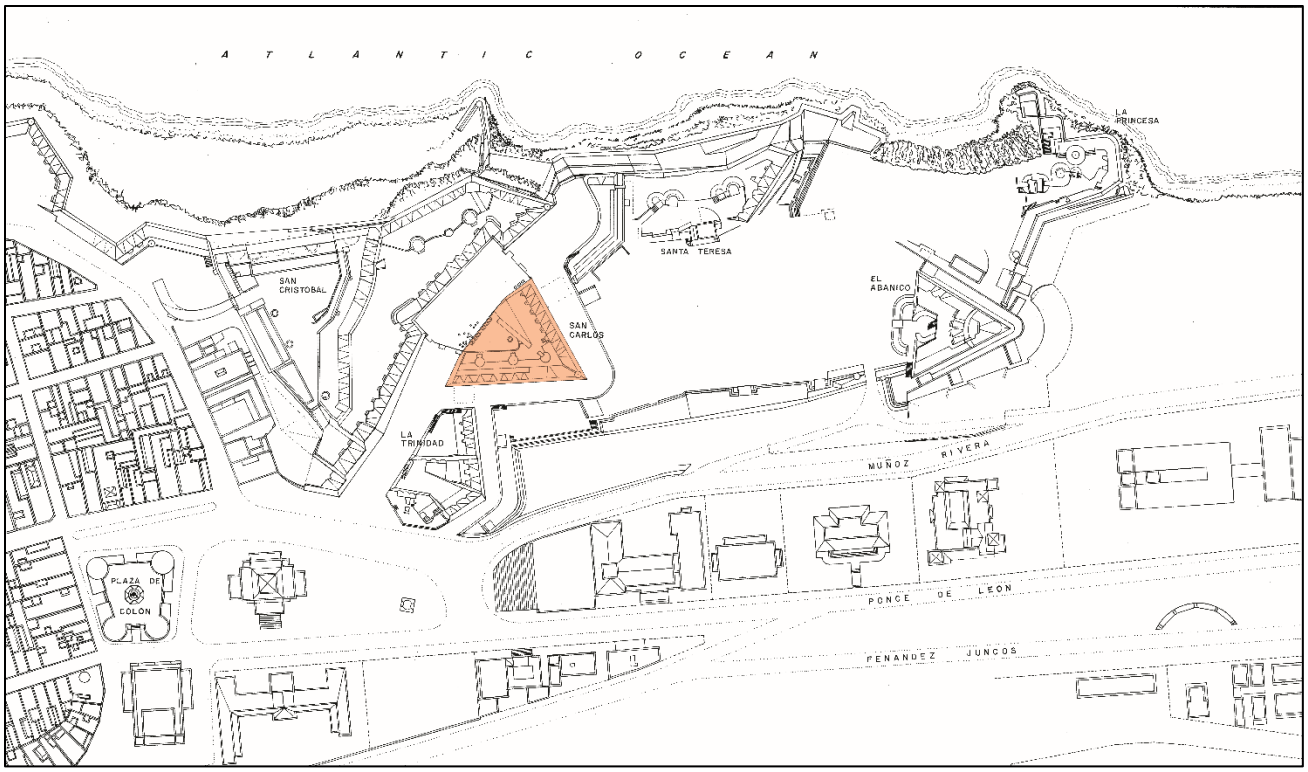


Figure 595. A site plan showing the location of San Carlos Ravelin. (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Sheet 4 of 17, annotated by authors)

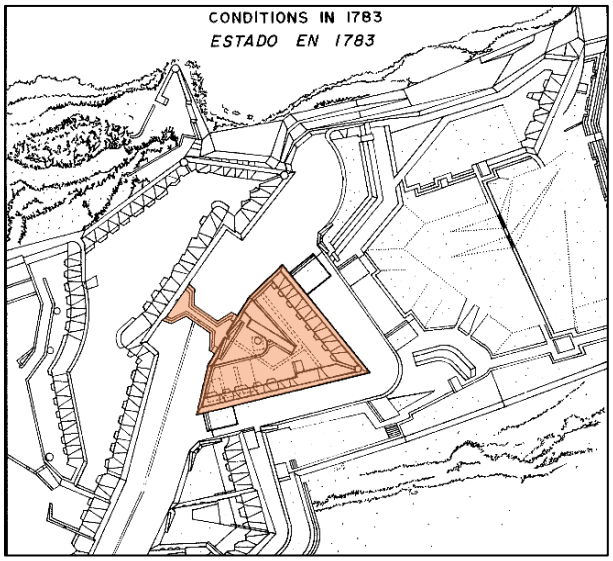


Figure 596. A site plan showing San Carlos Ravelin in 1783 and the associated sunken passageway or caponier that was present to the west. (Source: San Carlos Ravelin Historic American Buildings Survey No. PR-93, Sheet 2 of 14, annotated by authors)



Figure 597. The roof of the adjacent World War II Joint Command Center (visitor center). View from northeast.

A ramp leads from the terreplein of San Carlos up to the top of the parapet. The ramp runs along the inside face of the north parapet. The north and south parapets both feature seven embrasures, and a sentry box is located at the eastern point of San Carlos, where the north and south parapets meet (Figure 598).



Figure 598. The sentry box at the eastern point of San Carlos. View from east.

Walls

The exterior walls of San Carlos are limestone with remnant stucco parging visible in some locations. The stucco is most prevalent on the south facade of the structure. The extant stucco at the south facade has a stippled finish (Figure 599). The walls are battered, sloping inward from grade to the top of the structure (Figure 600 and Figure 601).



Figure 599. Stucco at the south facade of San Carlos.

The north facade of San Carlos, approximately 200 feet long, features seven embrasures along the top of the structure (Figure 602 through Figure 609). A sentry box is located at the west end of the facade, where it intersects with the south facade (Figure 610 and Figure 611). The sentry box, dating to 1939, is a reconstruction of the original. The existing sentry box is constructed of concrete and features three small rectangular openings. A drainage pipe extends outward from the base of the sentry box. The roof of the sentry box is ogee shaped with a decorative finial at the top, while there is a corbeled base at the bottom of the projecting element.

The sentry box is on the east end of the south facade of San Carlos. Like the north facade, seven embrasures line the south facade (Figure 612 through Figure 616). Two arched window openings are present near the west end of the facade (Figure 617). The window openings correspond to the two casemates at the south parapet.



Figure 600. San Carlos Ravelin showing the battered stone walls. View from east.



Figure 601. San Carlos Ravelin in 1960. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 18, 1960)



Figure 602. San Carlos Ravelin showing the battered stone walls along the north facade. View from northwest.



Figure 603. San Carlos Ravelin in 1960, showing the north facade. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 19, 1960)



Figure 604. San Carlos Ravelin showing the battered stone walls along the north facade. View from northwest.

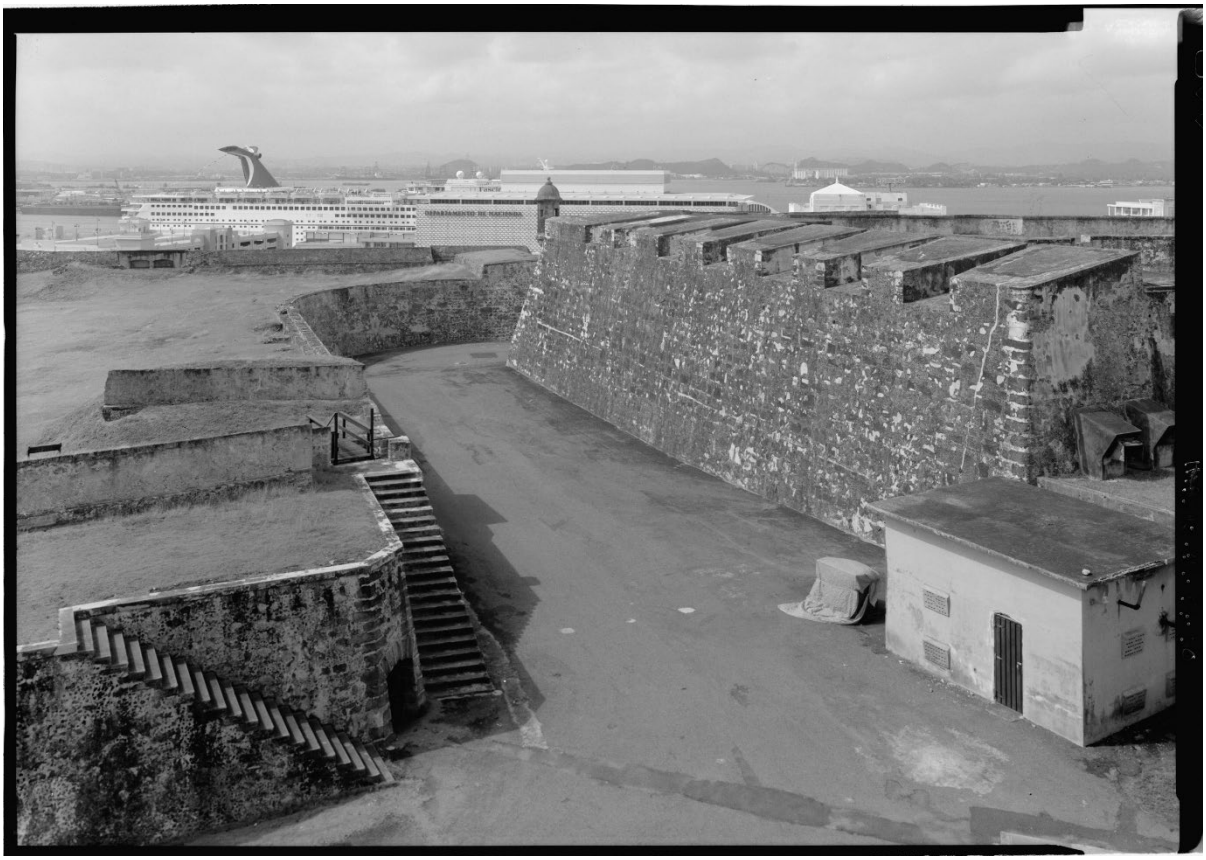


Figure 605. San Carlos Ravelin in 1998. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 30, 1998)



Figure 606. San Carlos Ravelin showing the battered stone walls along the north facade. View from northwest.

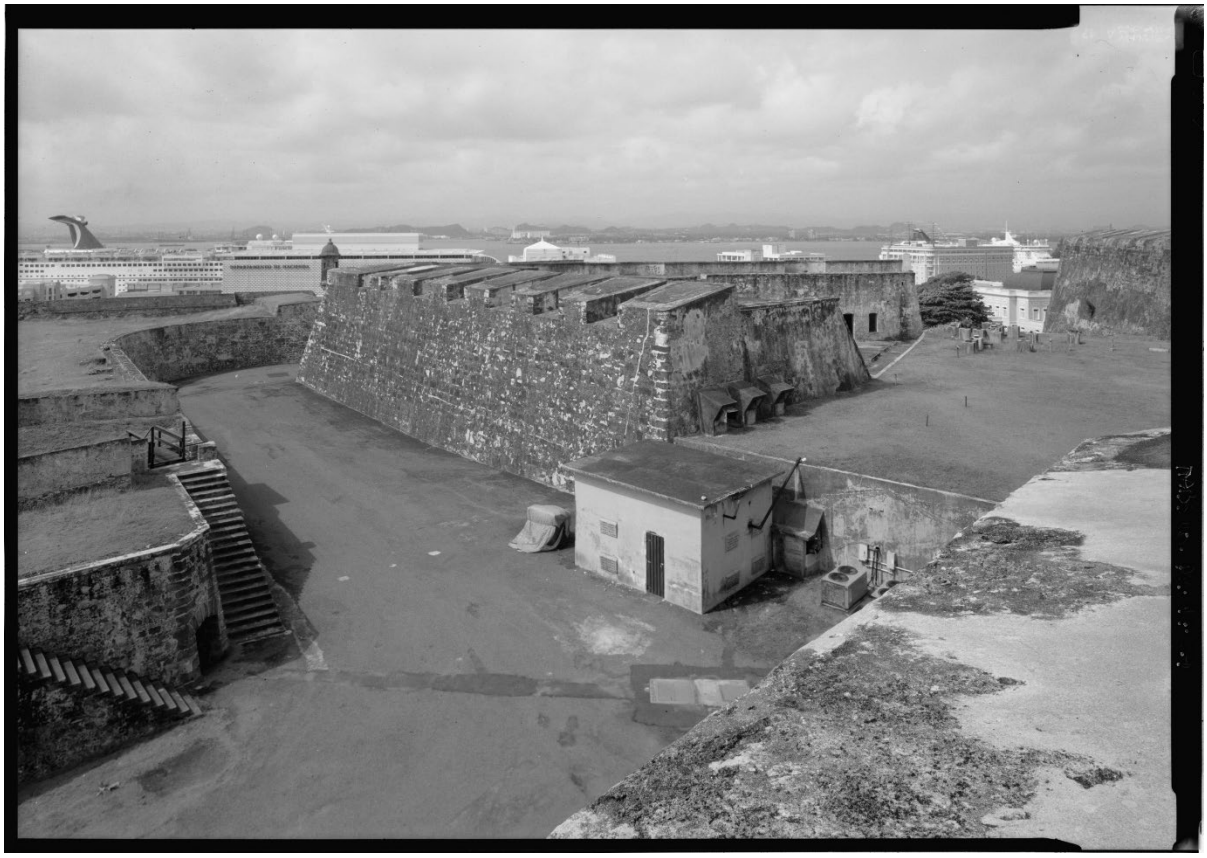


Figure 607. San Carlos Ravelin in 1998. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 29, 1998)



Figure 608. East end of the north facade. View from northwest.

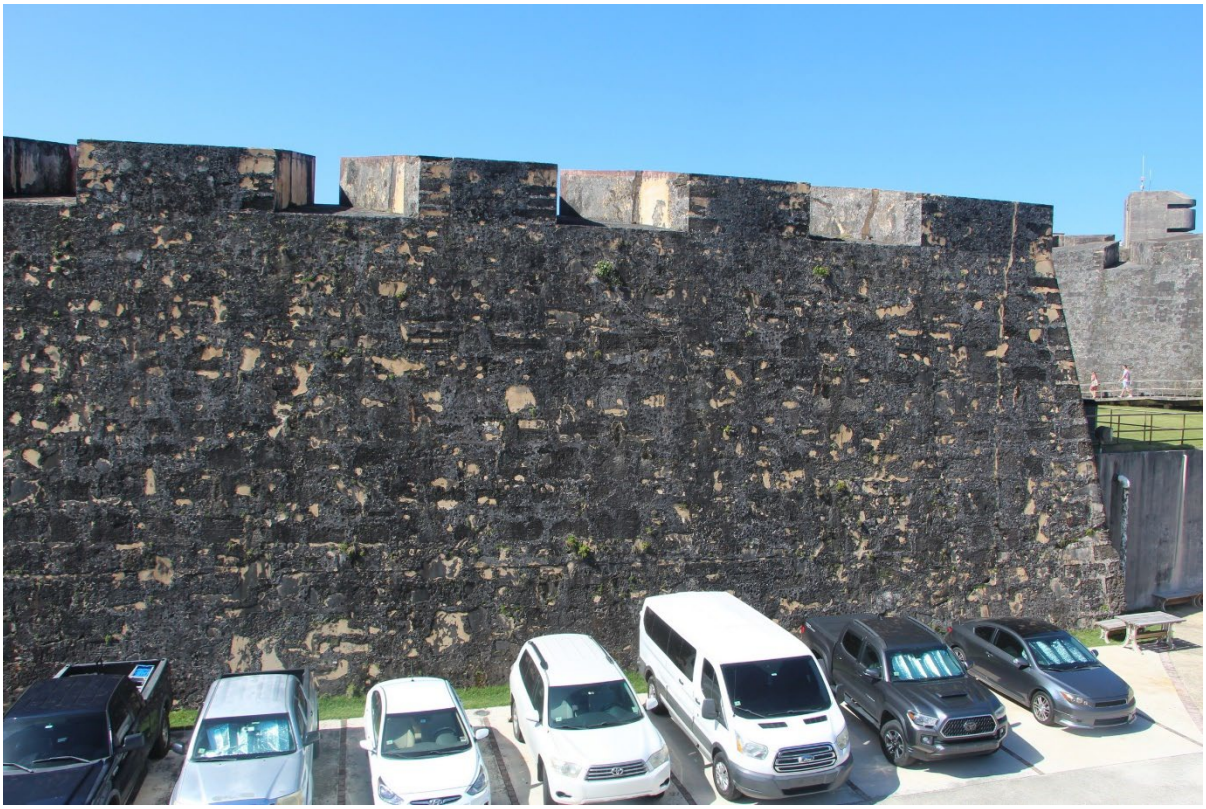


Figure 609. West end of north facade. View from north.



Figure 610. The sentry box at the east end of San Carlos Ravelin. View from southeast.



Figure 611. San Carlos Ravelin in 1938. Note the sentry box is not present. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 9, 1938)



Figure 612. The sentry box and south facade of San Carlos Ravelin. View from southeast.



Figure 613. The south facade of San Carlos Ravelin in 1938. Note the sentry box is not present. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 5, 1938)



Figure 614. The sentry box and south facade of San Carlos Ravelin. View from southeast.



Figure 615. San Carlos Ravelin in 1960. (Source: San Cristóbal Historic American Buildings Survey No. PR-47, Photo 17, 1960)



Figure 616. East end of the south facade of San Carlos. View from southwest.



Figure 617. West end of the south facade of San Carlos showing the two window openings. View from south.

The west facade of San Carlos is largely obscured by the visitor center. The interior-facing walls of the north and south parapet are visible at the terreplein (Figure 618). A window opening which corresponds to the casemates is located on the south end of the west facade (Figure 619). The opening is rectangular in shape, with ashlar stone units at its perimeter.



Figure 618. West facade of San Carlos from the roof of the visitor center. View from southwest.



Figure 619. Partial west facade of San Carlos. View from west.

Terreplein

The terreplein at San Carlos is triangular in plan and is situated slightly below the roof of the adjacent visitor center (Figure 620). A flight of concrete stairs leads from the roof of the visitor center down to the terreplein. A concrete platform raised slightly above the concrete floor of the terreplein is present along the west edge of the space. A low brick wall with a cementitious parge coating at its face lines the east edge of the raised platform (Figure 621). Brick units are exposed at the top of the wall. An opening in the wall aligns with the concrete flight of stairs to the west, which provides access to San Carlos from the roof of the visitor center. Moveable wood posts set in a concrete base with rope extended between were placed atop the wall in 2024, when San Carlos was reopened to the public (Figure 622).

A cistern sits below the terreplein at San Carlos, with a circular well situated at the east end of the terreplein adjacent to the ramp (Figure 623). The stone well is coated with a cementitious parge. The cap atop the well is sealed closed.

Battered walls line the north and south sides of the terreplein. Both walls are stone with a parge coat applied. Repairs to the parge coat were undertaken in 2024 (Figure 624). A ramp directly south of the north wall leads from the terreplein to the top of the north parapet (Figure 625). At the west end of the wall is an inset stone gutter that supports drainage of the parapet above (Figure 626). Five wood and concrete posts added in 2024 line the south edge of the ramp. Rope extends between the wood posts (Figure 627).



Figure 620. View of the terreplein from the south parapet. View from south.



Figure 621. The raised platform at the west end of the terreplein. View from northeast.



Figure 622. View of the moveable wood posts atop the wall along the west edge of San Carlos.



Figure 623. View of the well atop the cistern at the east end of the terreplein. View from southeast.



Figure 624. Repairs made in 2024 to the parge coating along the battered wall at the north side of the terreplein.



Figure 625. Wall along the north side of the terreplein. View from south.



Figure 626. Inset stone gutter at the west end of the north wall.



Figure 627. View of the ramp from the west, showing the wood posts installed in 2024.

The south edge of the ramp is largely open. The stone wall along the south side of the terreplein gently turns and terminates near the top of the ramp (Figure 628). At the top of the ramp, the wall

slopes downward with a short column topped by a finial (Figure 629).



Figure 628. Ramp along the northside of the terreplein.



Figure 629. Column with finial at the top of the ramp along the north wall.

The south wall contains a set of two doors and two windows at the east end that lead to the casemates under the south parapet (Figure 630). The double wood doors and wood shutters at the windows are set in arched openings and consist of vertical wood planks (Figure 631). The doors and shutters both swing inward (Figure 632).



Figure 630. Wall at the south side of the terreplein.



Figure 631. Door and window openings at the wall on the south side of the terreplein.



Figure 632. Inside view of wood doors at the south side of the terreplein.

Casemates

The casemates at the south end of San Carlos are comprised of three interconnected rooms. The rooms, which are rectangular in plan, have stone walls and barrel-vaulted ceilings covered with

plaster (Figure 633). The floors are typically concrete.



Figure 633. Plaster walls and ceilings in the central casemate.

Two wood doors lead into the casemates from the terreplein to the north: one into the east casemate and one into the central casemate.

The east casemate contains a generator that is installed on a concrete pad (Figure 634). A slip sheet is present between the concrete pad and the historic concrete floor below (Figure 635).



Figure 634. Generator at the east casemate.



Figure 635. Slip sheet under concrete pad at east casemate.

A window opening is present at the south wall of the casemate (Figure 636). The opening has a wood frame. A metal pipe extends from the generator through the window opening.



Figure 636. Window opening on the south wall of the east casemate. Note the pipe that extends through the opening.

A fluorescent light and associated conduit are present at the center of the barrel-vaulted plaster ceiling in the east casemate (Figure 637).

An arched opening at the north end of the west wall leads to the central casemate (Figure 638).



Figure 637. Lighting at the ceiling of the east casemate.



Figure 638. Arched opening between the east and central casemates.

The central casemate features similar finishes to the east casemate, with plaster walls and a plaster barrel-vaulted ceiling (Figure 639). The floor in the central casemate is concrete, with two types of concrete present (Figure 640). Rough finished concrete is present throughout most of the space, with smoother concrete strips running from east to west at the floor of the room. A series of tanks line the east wall of the space. A window opening with wood framing is centered on the south wall of the casemate.



Figure 639. The central casemate.



Figure 640. Floor of central casemate. Note the different concrete.

The west casemate is accessed through a flat-arched opening at the south end of the west wall of the central casemate. L-shaped in plan, the west casemate has plaster walls and a plaster barrel-vaulted ceiling (Figure 641). Its floor is concrete, similar to what is seen in the central casemate. An arched window opening is present at the west leg of the room (Figure 642). Conduit extends from the interior of the casemate out the opening.



Figure 641. West casemate.



Figure 642. Window opening at west casemate.

North Parapet

The north parapet is accessed from the ramp along the north edge of the terreplein (Figure 643). Seven embrasures, original to the structure, line the north parapet (Figure 644).



Figure 643. Ramp leading to north parapet. View from west.



Figure 644. Interior side of parapet wall. Note the embrasure openings.

The walking surface of the parapet is concrete (Figure 645). The surface slopes southwest toward the downspout at the south wall. A stone knee wall extends along the west facade of the north parapet, rising to the height of the base of a typical embrasure. A short concrete wall extends slightly above the sloped walking surface at the south edge of the north parapet.



Figure 645. View of the north parapet showing walking surface.

A typical embrasure, which is rectangular in shape, flares out toward the exterior wall of the structure (Figure 646). The corners of the embrasures are brick and stone with a plaster coat resembling quoining applied to the surface. The three easternmost embrasures were partially filled in as part of modifications made to San Carlos in 1897. A deep concrete and brick wall approximately equal in height to the north parapet wall covers the three easternmost embrasures (Figure 647).



Figure 646. Typical embrasure at north parapet.



Figure 647. Concrete and brick wall inboard of the exterior wall covering three embrasures.

Five stone banquettes are present between the embrasure openings along the north parapet (Figure 648). The top of the banquettes is in line with the base of the embrasure openings and slope down toward the interior of the parapet to the floor level. The easternmost banquette includes a flight of concrete stairs set within the stone ramp (Figure 649). This modification appears to have been completed in 1897.



Figure 648. Stone banquette between embrasure openings.



Figure 649. Modified banquette. Note the stair at center.

A drainage gutter lines the base of the north parapet wall, extending below the banquettes (Figure 650). The gutter slopes toward the east.



Figure 650. Drainage gutter at the base of the north parapet wall.

South Parapet

The south parapet was heavily modified in 1897 when three-gun emplacements were added to the top of the parapet (Figure 651). The gun emplacements are set within a revetment wall, approximately 20 feet deep, that prevents direct access to the seven embrasures that line the south wall of the south parapet (Figure 652). The wall slopes down toward the embrasures at the exterior wall. The top of the wall is covered with a concrete parge coating, while the face of the wall consists of plaster with stone and brick coping units (Figure 653 and Figure 654).



Figure 651. Gun emplacements along the top of the south parapet.



Figure 652. Revetment wall at south parapet.



Figure 653. Interior of gun emplacement. Note plaster wall with stone and brick coping.



Figure 654. Interior of gun emplacement. Note plaster wall with stone and brick coping.

The walking surface of the south parapet is concrete. A short concrete wall lines the inside face of the parapet (Figure 655). The wall extends along the west facade where it intersects with the revetment wall along the south part of the parapet. A non-original concrete support with sloped sides projects upwards from the short concrete wall on the west side of the parapet (Figure 656).



Figure 655. Concrete wall along the inside face of the parapet.



Figure 656. Concrete support column at west end of south parapet.

The easternmost gun emplacement is directly west of the sentry box at the east point of San Carlos (Figure 657). A narrow walkway leads from the base of the revetment wall at the south parapet to the sentry box (Figure 658). The walls on each side of the walkway are stone. The sentry box is a reconstruction made of concrete block (Figure 659). The block is exposed at the interior of the sentry box. A scupper is present at the base of the sentry box (Figure 660).



Figure 657. Gun emplacement at east end of south parapet. Note walkway to sentry box.



Figure 658. Walkway to sentry box.



Figure 659. Interior view of sentry box.



Figure 660. Scupper at the base of the sentry box.

Condition Assessment

The following notable conditions were observed at San Carlos Ravelin:

- Organic growth and standing water at the terreplein generally beneath through-wall scuppers (Figure 661). Vegetation is also present in the through-wall scupper (Figure 662).
- Vegetation is present at cracks observed at San Carlos (Figure 663). This condition is most prevalent at the sloped wall on the south side of the north parapet, the adjacent ramp, and at horizontal surfaces on the north and south parapets (Figure 664).
- Deteriorated and missing stucco, particularly at embrasure openings (Figure 665). Stone and brick masonry is exposed at locations of missing stucco.
- Eroded stone at the skyward-facing surfaces along the top of the south parapet walls (Figure 666). The mortar at the adjacent joints is not eroded and rises above the stone. It is likely the mortar was installed as part of twentieth-century repair campaigns and contains portland cement.
- Eroded stucco was observed throughout the exterior of the north parapet. At these locations, the surface has a rough and uneven texture forming several peaks and valleys. Slivers of the pigmented stucco layer remain along ridges forming a circular pattern around the lower areas of the surface (Figure 667).
- Cracked concrete at the nineteenth-century revetment wall along the south parapet (Figure 668).
- Cracked plaster at casemate interiors (Figure 669). The cracks are typically vertical.
- Spalled and missing plaster finish in the casemates (Figure 670). In some locations the masonry walls were visible (Figure 671).
- Standing water adjacent to tanks at the central casemate (Figure 672). The liquid appears to have originated in the tanks.
- Efflorescence at the plaster walls of the casemates. This condition was most prevalent in the central casemate (Figure 673). Efflorescence was also noted at the west casemate (Figure 674).



Figure 661. Organic growth and standing water at the terreplein.



Figure 662. Vegetation at scupper at wall along south side of terreplein.



Figure 663. Vegetation at cracks along sloped wall at the north end of the terreplein.



Figure 666. Eroded stone at the top of the south parapet wall. Note the raised mortar joints.



Figure 664. Vegetation at the top of the revetment wall at the south parapet.



Figure 667. Eroded stucco at the north parapet wall. Note the circular pattern.



Figure 665. Deteriorated and missing stucco finish at an embrasure opening along the north parapet.



Figure 668. Cracked concrete at the top of the revetment wall along the south parapet.



Figure 669. Cracked plaster at the interior of the casemates.



Figure 672. Standing water adjacent to the tanks in the central casemate.



Figure 670. Spalled and missing plaster at the casemate interior. Note the visible brick and stone.



Figure 673. Efflorescence at the lower portion of the central casemate wall.



Figure 671. Spalled and missing plaster at the casemate interior. Note the visible brick and stone.



Figure 674. Efflorescence at the west casemate walls.

La Trinidad Counterguard

La Trinidad Counterguard was constructed in 1773 and is located on the south end of the San Cristóbal Outworks (Figure 675). La Trinidad Counterguard is located to the south of San Carlos Ravelin, and both outworks are located within the San Cristóbal moat (Figure 676 through Figure 679). The outworks were constructed to defend the south bastion and the exposed sections of San Carlos Ravelin. In 1897, a section of La Trinidad Counterguard was demolished following the removal of a portion of the San Juan City Wall.

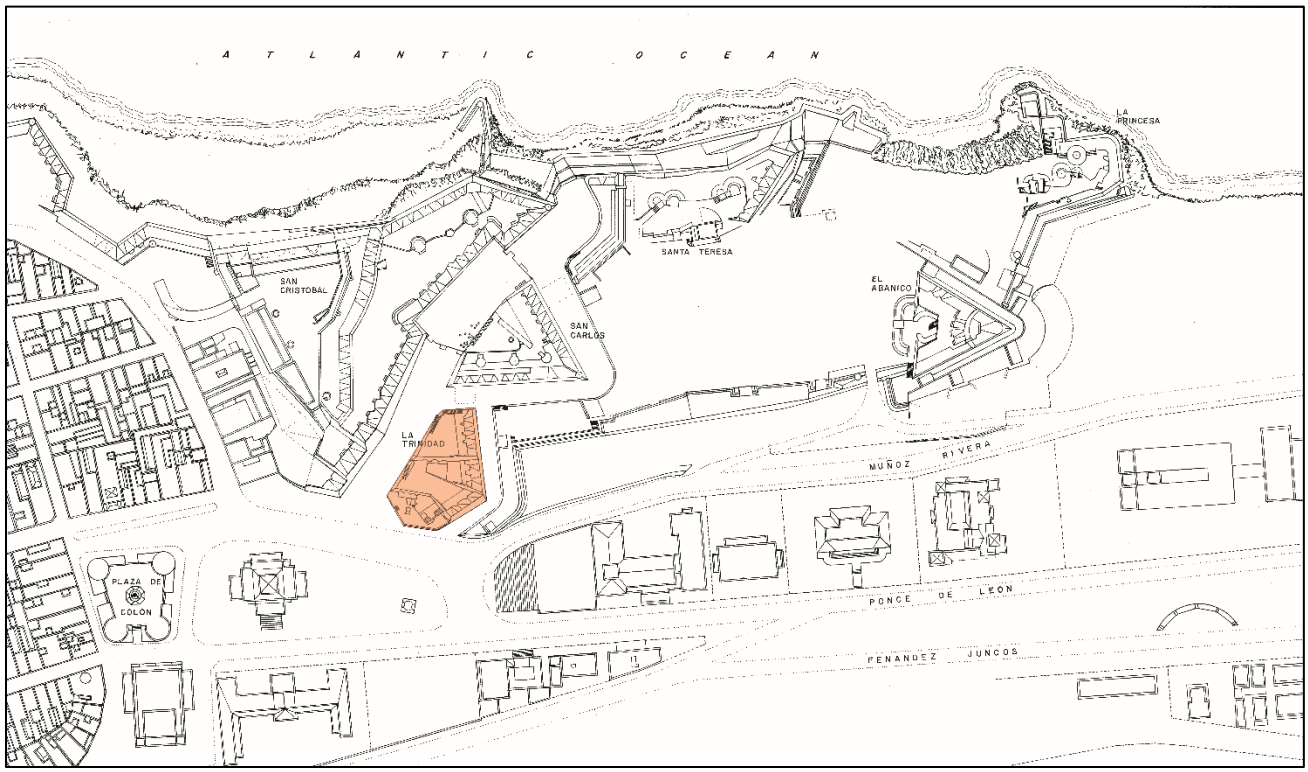


Figure 675. A site plan showing the location of La Trinidad Counterguard. (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Sheet 4 of 17, annotated by authors)



Figure 676. The west facade of La Trinidad Counterguard and moat. View from northwest.



Figure 677. The west facade of La Trinidad Counterguard and moat in 1960. (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Photo 2, 1960)



Figure 678. View of La Trinidad Counterguard and San Cristóbal moat from the northwest corner.

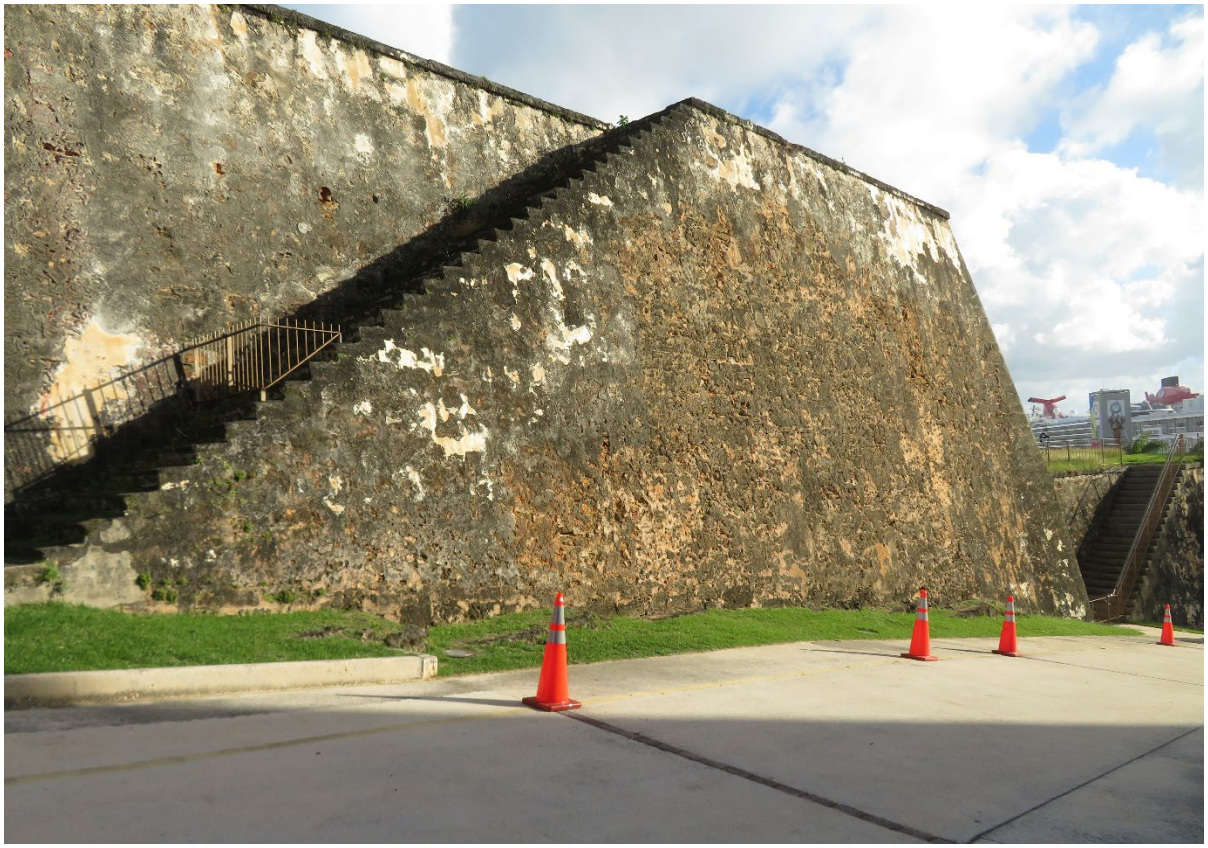


Figure 679. View of La Trinidad Counterguard and San Cristóbal moat from the west.

La Trinidad Counterguard is bound by a dry moat and counterscarp wall to the east, which currently contains a paved road (Figure 680).



Figure 680. View of the moat and outer walls east of La Trinidad Counterguard.

La Trinidad Counterguard is irregular in plan and contains multiple levels that hold three independent batteries, one on each level. The levels step down in the north-south direction. The middle level battery has an intermediate level, accessed from a ramp, and a lower level (Figure 681 and Figure 682).



Figure 681. View of embrasures and firing steps at intermediate level of middle battery.



Figure 682. View of ramp at intermediate level of middle battery.

The upper and middle level batteries have an esplanade, and a set of nine embrasures on the east and southeast perimeter of the outwork, as well as cannon tracks, firing steps, and a brick drainage ditch (Figure 683). Four embrasures are located on the upper battery, two on the intermediate level of the middle battery, and three on the lower level of the middle battery.



Figure 683. View of embrasures, cannon tracks, and firing steps at upper battery.

The base level battery, partially demolished in the late nineteenth century, has remnants of the firing steps and stone tracks. The upper and middle batteries are accessed by a flight of stairs that abut the scarp walls on the north and west facades, and the base battery is accessed directly from the San Cristóbal moat. There is a metal gate installed at the eighth tread to block visitor access. The limestone flight of stairs on the north scarp wall lead to a curved stone landing on the upper

battery. The embrasure wall on the north end of the upper battery follows the curved outline of the stair landing (Figure 684).



Figure 684. North stair landing leads to upper battery.

The flight of stairs located on the west scarp wall are composed of concrete with a metal handrail (Figure 685). The metal handrail is installed at the perimeter of the west and south facing sections of the middle battery (Figure 686).

The limestone stairs on the north and west facade share a landing on the San Cristóbal moat. Centered in the landing is a door opening surrounded by limestone blocks (Figure 687). The door leads to a tunnel, approximately 5 feet 3 inches wide, and ranges between 5 feet 9 inches to 9 feet 11 inches in height.



Figure 685. Concrete flight of stairs abut the west facade scarp walls.



Figure 686. Metal handrail installed at the middle battery.



Figure 687. Doorway located on the northwest corner of the Counterguard.

Casemates

Barrel-vaulted casemates, made of limestone, are accessed from the middle level and the base level (Figure 688 and Figure 689). The set of three barrel-vaulted casemates accessed from the middle battery are open to the esplanade, and the three barrel-vaulted casemates accessed from the base battery are locked with a set of wooden doors and hinges that follow the outline of the vault. The depth of the barrel vaults varies with the two east vaults being the longest (Figure 689 and Figure 690). The casemates accessed from the middle level range from 12 feet 7 inches to 27 feet 11 inches in depth, and from 10 feet 9 inches to 11 feet in height. The casemates accessed from the base level range from 9 feet 11 inches to 28 feet 8 inches in depth, and from 11 feet to 11 feet 3 inches in height.



Figure 688. Barrel-vaulted casemates accessed from the middle level. View from southwest.



Figure 689. Casemates at the middle level of La Trinidad Counterguard in 1960. Note the infilled openings. (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Photo 3, 1960)



Figure 690. Barrel vault opening closest to the east accessed from middle battery.



Figure 691. Barrel vault opening closest to the west accessed from middle battery.

Walls

The exterior walls of the La Trinidad Counterguard are primarily composed of limestone rubble with rough-cut limestone ashlar blocks used for the corners, as quoins, with a stucco parge coat (Figure 692 and Figure 693). Brick masonry is also used at copings, vaulted openings, merlons, and the firing steps (Figure 694). Brick masonry is also present at the middle level battery ramp (Figure 695). The ramp is composed of poured concrete with multiple layers of a red coated cementitious layer applied.

The walls are battered, sloping inward from grade to the top of the structure. Areas with yellow stucco are present around the embrasure and merlons as well as the easternmost section of the north scarp walls (Figure 696). Some of the stucco coating was likely applied as part of a previous restoration campaign. The finish at the inside and outside face of the south parapet wall of the upper battery and on the sides of the banquette, or firing steps, have an ashlar coursing and 1-inch masonry joints drawn on the stucco (Figure 697 through Figure 699).



Figure 692. Ashlar blocks on the corner of the upper battery walls.



Figure 693. Quoins on the southeast corner.



Figure 694. Brick masonry used on the side of the firing steps.



Figure 697. Stucco finish with ashlar coursing and joints scored on the finish.



Figure 695. Brick masonry visible at the middle battery ramp.



Figure 698. Stucco finish with ashlar coursing and joints scored on the finish.



Figure 696. Yellow stucco coating at the easternmost corner of the north scarp wall.



Figure 699. Stucco finish with ashlar coursing and joints scored on the finish.

Condition Assessment

- Spalling of the rubble wall, in the form of circular dents, was observed throughout the walls, particularly on the lower half of the scarp walls (Figure 700 and Figure 701).
- Spalling of the stucco finish, in the form of circular dents, was observed at the upper and middle battery embrasure walls (Figure 702).
- At locations where a stucco coat has been installed over the wall, there are circular spalls evenly distributed throughout the stucco layer (Figure 703).
- In some locations, cracks have been routed and sealed, and missing areas of the top stucco layer have been infilled with stucco (Figure 704).
- Areas previously infilled with portland cement patches generally show a higher degree of deterioration.
- Along with cementitious patches and pigmented stucco installation, other previous repair iterations include the infilling of small sections of the east facade walls with a red pigmented cementitious material. The patches are square and are stacked to represent ashlar units and have faux joints scored into the finish (Figure 705 and Figure 706).
- Erosion of both the stucco and the exposed stone was observed throughout the walls. At these locations, the surface has a rough and uneven texture forming several peaks and valleys. Circular ridges of the stone surface form a circular pattern around the lower areas of the surface (Figure 707). Overall, gradual loss of stucco, approximately ten percent, was observed when comparing the existing plaster remaining on the facades to HABS documentation completed in 1984, which illustrates the stucco coating outlines.
- Exposed brick masonry at the merlon ends of the middle battery. A cementitious patch is applied over the brick masonry. The faces of the brick masonry are eroded and partially missing (Figure 708).
- Cement-rich mortar installed at upward facing joints in between the limestone treads and limestone blocks set in the esplanade (Figure 709). The face of the limestone is heavily eroded at the interface between the mortar joints. Eroded areas of parge coat also noted on the risers (Figure 710).
- Spalling and eroded cementitious coating and concrete base at the middle battery ramp (Figure 711).
- Vegetation was noted growing along the base of the masonry stairs located on the southwest section of the fort (Figure 712).
- Vegetation overgrowth observed at the esplanades, particularly the middle battery.



Figure 700. Spalling of the masonry wall.



Figure 701. Spalling of the masonry wall.



Figure 702. Spalling of stucco layer.



Figure 703. Circular dents or spalls on stucco finish.



Figure 704. Stucco infilling at walls.



Figure 705. Base of east scarp wall with square repair patches.



Figure 706. Square repair patches at the base and bottom of the embrasure openings of the east scarp wall.



Figure 707. Erosion of the stone surface in a circular pattern.



Figure 708. Eroded brick masonry at the merlons.



Figure 709. Eroded face of limestone blocks at middle battery.



Figure 710. Eroded face of limestone treads.



Figure 711. Eroded and spalled cementitious coating over concrete ramp.



Figure 712. Vegetation growth on the limestone stair treads and risers.

Santa Teresa Battery

Santa Teresa Battery is located on the northern glacis and is surrounded by the outer works of Castillo San Cristóbal to the east and south and Castillo San Cristóbal's North Bastion to the west (Figure 713). Santa Teresa Battery is first noted in engineer Thomas O'Daly's existing condition plan of Castillo San Cristóbal dated 1765. The oldest existing portion of the battery is the covered way, which dates to 1770, on the west side of the battery. In 1779, a temporary works of wood and earthen fill known initially as Redoubt 1 (later Santa Teresa) was constructed. By 1783, the works were made permanent. Santa Teresa Battery was later modernized by the Spanish in 1897.[178] The battery area consists of several brick masonry and concrete structures situated amongst earthen embankments (Figure 714).

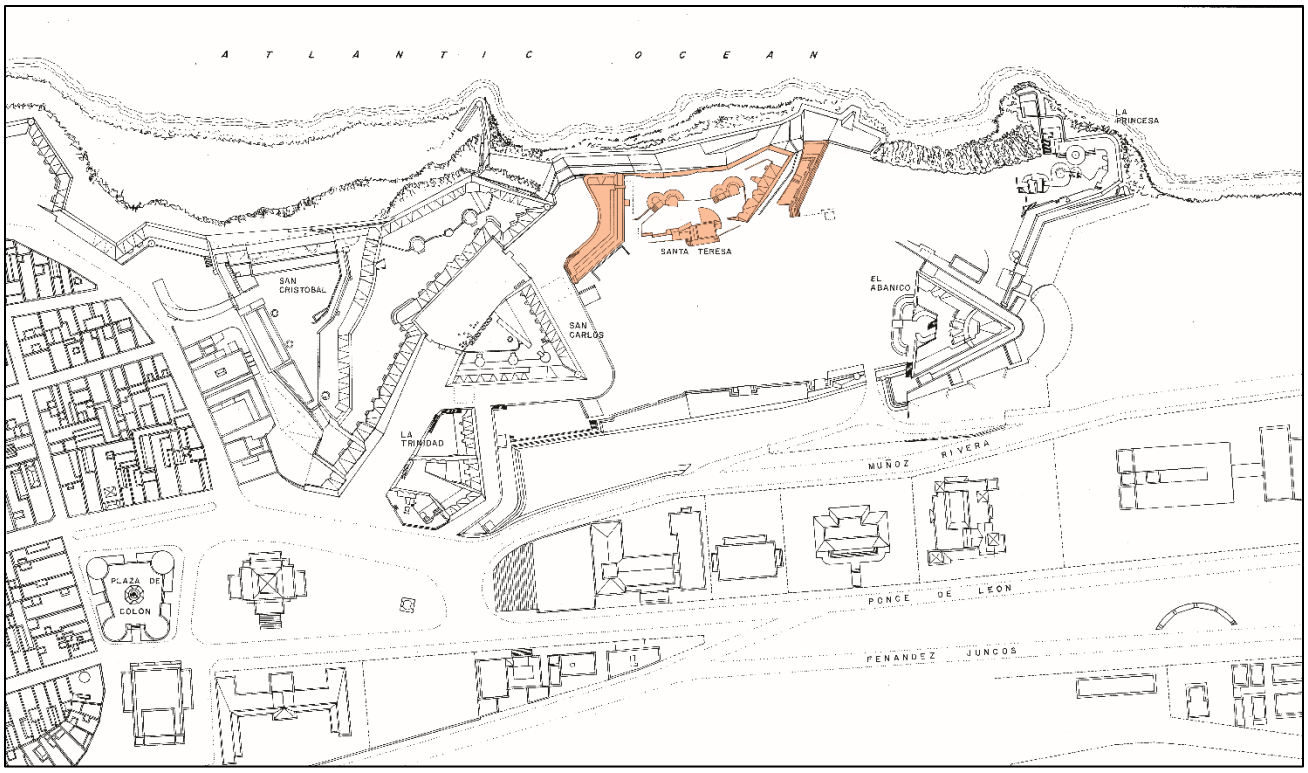


Figure 713. A site plan showing the location of Santa Teresa Battery. (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Sheet 4 of 17, annotated by authors)

178. Berkowitz et al., *The Fortifications of San Juan National Historic Site: Historic Structures Report*. (Atlanta, Georgia: U.S. Department of the Interior, National Park Service, Southeast Regional Office, 1991), Volume II, 317–327.

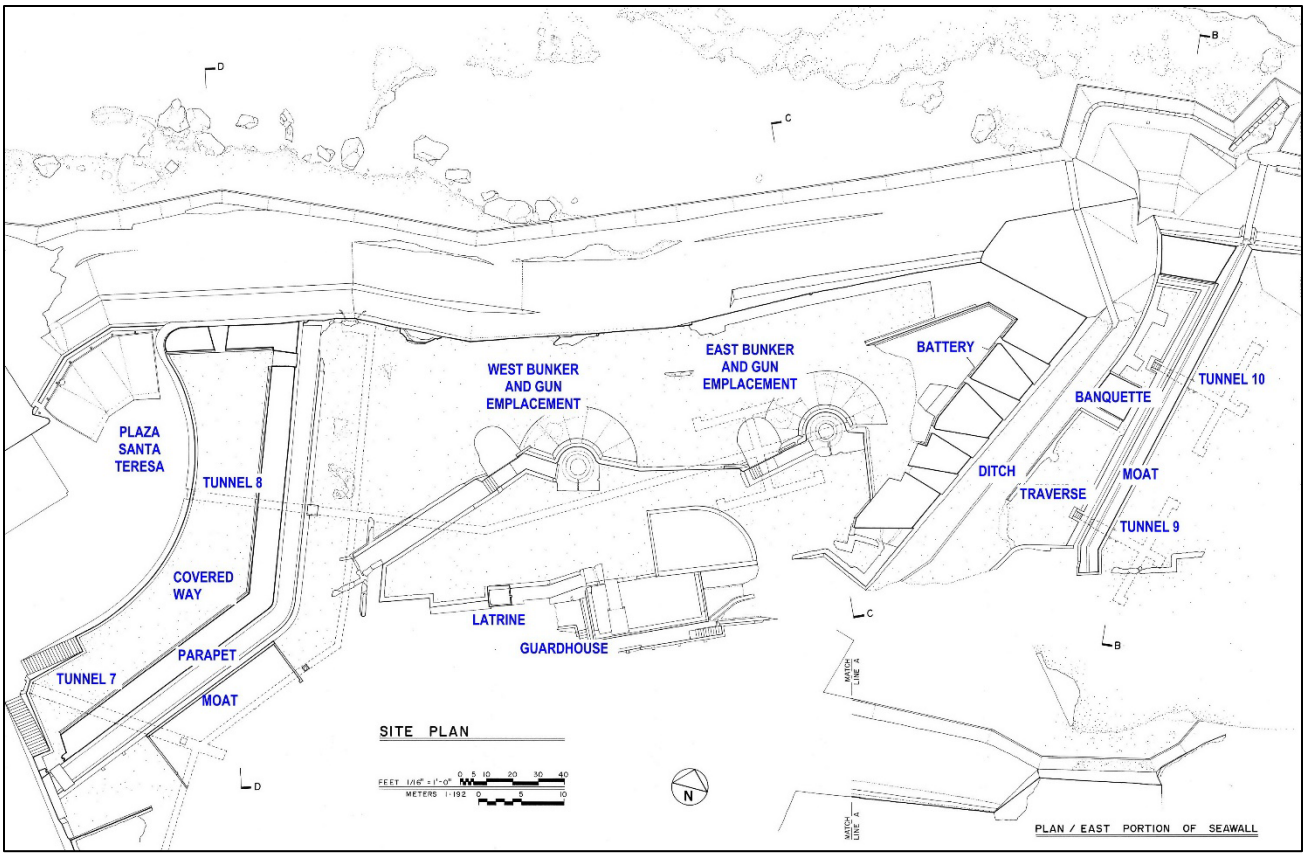


Figure 714. A site plan showing the different components of Santa Teresa Battery. (Source: Santa Teresa Battery Historic American Buildings Survey No. PR-91, Sheet 2 of 11, annotated by authors).

Guardhouse

The guardhouse, added during the 1897 modernization, is located inland of the bunkers and gun emplacements (Figure 715). The guardhouse is rectangular in plan with an vaulted roof; the arch spans across the shorter dimension of the building (Figure 716). The north face of the guardhouse is integral with an earthen embankment such that the roof level is even with grade at the north. The west facade of the guardhouse is exposed only above the earthen embankment (Figure 717). The east facade is built into a sloped retaining wall supporting the north embankment (Figure 718) and spanning perpendicular to the east facade. The south facade is exposed along its full height (Figure 719). All guardhouse walls are comprised of brick masonry and sandstone rubble with cementitious mortar and lime-washed parge coat at the exterior and interior faces. A scratch coat layer of the parge coat was visible at isolated locations (Figure 720). The building is accessed by two staircases in the southeast and southwest corners that enter an approximately 10-foot-deep by 6-foot-wide trench surrounding the south and east walls (Figure 721). The south wall of the trench along the south facade retains the south earthen embankment. The east half of the retaining wall is brick masonry and sandstone rubble with cementitious mortar, covered with lime-washed parge coat at the vertical surface. At approximately half the length of the guardhouse, the retaining wall steps up approximately 8 inches and is comprised of board-formed concrete. Board form lines are visible in the concrete surface and spaced approximately 1 foot vertically (Figure 722). The southeast flight of stairs has brick treads and are covered with cementitious parge coat; the edges of the treads have a beveled profile (Figure 723). The southwest flight of stairs is curved and spans between the south trench wall and the southwest corner of the guardhouse (Figure 724). Brick masonry units are inlaid in the board-formed concrete retaining wall at approximately 3 feet above the treads. Brick masonry coping follows the profile of the curved

flight of stairs at the southwest corner of the guardhouse.



Figure 715. Overall view of the guardhouse.



Figure 716. Vaulted roof of the guardhouse.



Figure 717. Exposed portion of the guardhouse west facade.



Figure 718. East facade of the guardhouse.



Figure 719. South facade of the guardhouse.



Figure 720. Scratch coat at interior of guardhouse.



Figure 721. Southwest guardhouse flight of stairs.



Figure 722. Board form lines in the retaining wall.



Figure 723. Southeast guardhouse flight of stairs.



Figure 724. Brick masonry coping at southwest guardhouse flight of stairs.

At the south facade, three arched openings provide entrance into three separate gallery rooms (Figure 725). Gibbs surrounds comprised of projecting cementitious material are located around each opening at the south facade (Figure 726). A parge-coated cornice with a molded profile follows the exposed perimeter of the guardhouse roofline (Figure 727). Two projecting concrete scuppers are located at the east facade below the cornice (Figure 728).



Figure 725. Gallery room entrances at the guardhouse south facade.



Figure 726. Gibbs surrounds at gallery room entrance.



Figure 727. Cornice at guardhouse roofline.



Figure 728. Projecting scupper at guardhouse east facade.

The east and west gallery rooms have barrel vault ceilings with profiles perpendicular to the roof arch. Overhead shelves with molded profiles are located along the north wall at the base of the arch (Figure 729). The center gallery room also has a barrel vault ceiling with a profile parallel to the roof arch. Shelves with molded profiles are located on the east and west walls at the base of the arches (Figure 730). The interior faces of the walls are finished with a similar parge coat assembly as the exterior face. The floor of the building, as well as the trench, is comprised of concrete.



Figure 729. Overhead shelves in barrel vaulted east and west gallery rooms.



Figure 730. Overhead shelves in barrel vaulted center gallery room.

A concrete pad, quarter-circle in shape, is located at grade above the guardhouse at the northeast corner. The south edge of the concrete-surfaced pad is comprised of a retaining wall that extends from the guardhouse floor grade to roof grade. At grade above the guardhouse, a modern guardrail is installed at the perimeter of the south retaining wall.

Latrine

A latrine is located west of the guardhouse (Figure 731). The latrine is rectangular in plan with a flat roof and consists of brick masonry with lime-washed parge coat at the exterior and interior faces. A rectangular entrance opening is located at the south facade. The latrine bisects the parapet wall connecting the guardhouse to the remains of the 1783 covered way leading to the bunkers and gun emplacements.



Figure 731. South facade of the latrine.

Bunkers and Gun Emplacements

Two pairs of bunkers and gun emplacements, constructed in 1897, are set in earthen embankments and are situated between the battery and guardhouse. The east gun emplacement and bunker is identical to the west gun emplacement and bunker in appearance and construction.

The vaulted bunkers have arched profiles (Figure 732); the top surface of the bunkers slope away from the arch towards the earthen embankment to the north (Figure 733). The exterior wall and top surface of the bunkers are concrete with exposed aggregate. Formed concrete cornices with molded profiles follow the arched profile of the bunker (Figure 734). The headers of the bunker entrances are arched with formed stepped accents and keystone (Figure 735). Cast concrete plaques, dated 1897, are located over the bunker entrances at the south face (Figure 736). Ramps slope towards each bunker and provide access from the gun emplacements. Stairs provide access to each bunker from the west. Lime-washed parge coat is applied over the concrete interior walls and floor surfaces (Figure 737).



Figure 732. South facade of vaulted bunker.



Figure 733. Sloped top surface of vaulted bunker.



Figure 734. Formed concrete cornice at the vaulted bunker.



Figure 735. Bunker header.



Figure 736. Concrete plaque dated 1897 at bunker entrance.



Figure 737. Bunker interior with lime-washed parge coat.

The gun emplacements consist of circular concrete platforms surrounded by raised semicircular concrete rifle mounts (Figure 738 and Figure 739). The rifle mounts, consisting of evenly sized flared panels separated by construction joints, are sloping away from the gun emplacements towards the earthen embankment to the north (Figure 740). Retaining walls separate the gun emplacement platform and rifle mounts and are comprised of concrete with a lime-washed parge coat applied to the surface. Sandstone coping units are located at the top of this retaining wall (Figure 741).



Figure 738. Circular gun emplacement.



Figure 739. Semicircular rifle mount.



Figure 740. The rifle mounts showing the flared panels separated by construction joints.



Figure 741. Sandstone coping units at the semicircular rifle mount retaining wall.

An additional retaining wall extends from the east end of the east gun emplacement to the west end of the west bunker and retaining the earthen embankment north of the bunkers (Figure 742). Exposed brick masonry coping, laid in a variety of orientations, is present at wall sections between bunkers and gun emplacements. Some brick masonry units are embossed with 'SAN PATRICIO' (Figure 743).



Figure 742. Retaining wall between gun emplacements and bunkers.



Figure 743. Embossed brick masonry unit.

An additional retaining wall is located west of the west bunker and gun emplacement and connects to the remains of a covered way, part of the original 1770s construction (Figure 744). The remains of the covered way walls consist of brick masonry and sandstone rubble walls with concrete parge coat. The walls are approximately 4 feet tall.



Figure 744. Retaining wall between the remaining covered way and west bunker and gun emplacement.

Battery

The battery structure, located east of the bunkers and gun emplacements, is part of the original 1783 construction. The battery structure is V-shaped in plan, with its point in the northeast direction (Figure 745). The north portion of the battery consists of a brick masonry and sandstone rubble wall with a lime-washed parge coat (Figure 746). At the crest of the V-shaped profile, the slope of the glacis is covered with a concrete overlay. The

inland portion of the battery consists of four projecting trapezoidal embrasures, facing east, that form the redoubt (Figure 747); the embrasures are made of brick masonry and sandstone rubble with cementitious mortar and lime-washed parge coat. The embrasures are approximately 20 feet wide by 20 feet long by 6 feet tall, and they narrow in width moving east. Narrow, trapezoidal inlets are located between the embrasures (Figure 748). The north, south, and west edge of the embrasures have brick masonry coping with sandstone cornerstones (Figure 749). The east faces of the embrasures are adjoined below the inlets to form a continuous wall (Figure 750).



Figure 747. Trapezoidal embrasures at the inland battery structure.



Figure 745. Overall view of the battery structure.



Figure 748. Trapezoidal inlets between the battery embrasures.



Figure 746. North wall of battery structure.



Figure 749. Brick masonry coping with sandstone cornerstones at the trapezoidal battery embrasures.



Figure 750. Adjoined east faces of the battery embrasures form a continuous wall.

The region between the north and inland portions of the V-shaped battery is sunken, providing defensive protection. Coarse vegetation and isolated concrete overlay patches cover the sunken infill. At two locations, two rubble concrete steps lead from the sunken portion to the trapezoidal projecting portions of the embrasures to the east (Figure 751).



Figure 751. Rubble concrete steps at the battery embrasures.

Traverse

A depression separates the inland portion of the battery and the traverse area (Figure 752). The traverse, part of the 1783 construction, parallels the east face of the inland portion of the battery and generally runs in the north-south direction. A retaining wall is located at the west side of the traverse, adjacent to the depression, and extents north towards the Atlantic Ocean where it intersects with the sea wall. A moat is located along the east edge of the traverse (Figure 753). The traverse and moat walls are all brick masonry and stone rubble with cementitious mortar and lime-washed parge coat. Brick masonry units are laid in a stepped profile along the east edge of the traverse (Figure 754). A drain inlet is located at the south end of the moat (Figure 755), and the moat slopes north with an outlet towards the Atlantic Ocean.



Figure 752. Depression separating the inland battery structure and the traverse.



Figure 753. Moat at east edge of the traverse.



Figure 754. Brick masonry steps at east edge of the traverse.



Figure 756. Tunnel entrance within brick masonry steps.



Figure 755. Drain inlet at south end of the moat.



Figure 757. Rubble concrete tunnel entrance pads with brick masonry accents.

Two tunnel entrances are set within the brick masonry steps along the east edge of the traverse – one at the south end of the traverse and one near the center of the traverse (Figure 756). Projecting, quarter-circle shaped side walls, made of brick masonry and stone rubble with cementitious mortar and lime-washed parge coat, frame the entrance. Rectangular rubble concrete pads are located outside the tunnel entrances; brick masonry units in rowlock orientation are laid at the front edge of the entrance pad between the side walls (Figure 757). The stairs within the tunnel entrances also have exposed brick masonry treads.

The banquette, a raised firing platform, is located on the traverse, between the two tunnel entrances (Figure 758). Two steps are located at the south edge of the banquette and lead to the raised platform (Figure 759). The banquette and adjacent steps are brick masonry and stone rubble with cementitious mortar and lime-washed parge coat on all visible surfaces. Brick masonry units are laid on the stair treads (Figure 760).



Figure 758. Banquette between traverse tunnel entrances.



Figure 759. Steps at south edge of the traverse banquette.



Figure 760. Brick masonry units at traverse banquette stair treads.

Covered Way

The covered way, constructed in 1770, is situated between the bunkers and gun emplacements and Castillo San Cristóbal's North Bastion. The covered way is abutted by a U-shaped moat (Figure 761) and parapet wall to the east and a semicircular retaining wall to the west (Figure 762). Both the moat and integral parapet wall extend south from the Atlantic Ocean and then turn west at latitude approximately even with the guardhouse. The walls are comprised of brick masonry and sandstone rubble concrete with cementitious mortar and lime-washed parge coat, exposed brick masonry coping units, and sandstone cornerstone units (Figure 763). The west side of the moat is integral with the parapet wall, and the top of the parapet wall slopes upwards away from the moat along its length. The parapet is approximately 6 feet thick. The west edge of the parapet also has brick masonry coping. A brick rubble concrete step follows the west perimeter of the parapet (Figure 764). A modern metal guardrail is located along the east perimeter of the moat (Figure 765).



Figure 761. Moat at covered way.



Figure 762. Semicircular retaining wall at covered way.



Figure 763. Moat wall composition.



Figure 764. Brick rubble concrete step at west perimeter of covered way parapet.



Figure 765. Modern guardrail at covered way moat perimeter.

Two rectangular embrasures are located at the north end of the covered way (Figure 766). The embrasures are comprised of sandstone units laid in cementitious mortar (Figure 767). The top surface of the covered way is covered with grassy vegetation (Figure 768). The semicircular retaining wall separates the upper top surface of the covered way from the lower plaza (Figure 769). The retaining wall consists of sandstone units covered by a crushed brick aggregate parge coat. Two flights of stairs lead from the upper covered way to the lower plaza area at the south end of the semi-circular retaining wall. Modern metal handrails are located at each flight of stairs.

Arched entrances to the tunnels located within the covered way are set in the west retaining wall; one is located near the apex of the semicircle and the other between the two flights of stairs at the south end of the retaining wall (Figure 770). Metal gates, comprised of steel bars and plates, are located at the tunnel entrances.



Figure 766. Embrasures at north end of covered way.



Figure 767. Sandstone units at covered way embrasures.



Figure 768. Grassy vegetation at top surface of covered way.



Figure 769. Semicircular retaining wall between upper covered way and lower plaza.



Figure 770. Arched tunnel entrances.

Garita del Diablo Lookout

The Garita del Diablo lookout is located between the covered way and Castillo San Cristóbal's North Bastion (Figure 771). Accessible through the Visitor Center or paved drive from the south, the plaza has a manicured green lawn with multiple concrete benches and a concrete sidewalk. A modern guardrail is located at the north perimeter of the plaza.



Figure 771. Overall view of Plaza Santa Teresa.

Tunnels

Tunnel 7

Tunnel 7 extends from the only entrance located between the two flights of stairs at the south end of the covered way. The arched entrance of the tunnel is framed with cut stone set in mortar (Figure 772). A wrought iron grated double door comprised of straight steel bars is placed in this opening. The barrel hinges of the door are embedded in the stone masonry at the jambs (Figure 773).



Figure 772. Overall view of entrance to Tunnel 7.



Figure 773. Embedded hinges of door at Tunnel 7.

The tunnel runs under the parapet and moat at the covered way before branching north and south. The north branch follows the profile of the moat and parapet and terminates before the sea wall at the Atlantic Ocean. The tunnel extending from the apex of the semicircular retaining wall crosses over the north branch of the southern covered way tunnel. The south branch of the tunnel extends southwest and terminates at the extent of the Santa Teresa Battery area.

This tunnel is D-shaped in cross section. The walls and ceiling are comprised of brick masonry (Figure 774). A lime-washed parge coat is applied to all surfaces (Figure 775). The floor is comprised of packed earth.



Figure 774. View of Tunnel 7.



Figure 775. Lime-washed parge coat at Tunnel 7.

Tunnel 8

The only entrance to Tunnel 8 is located at the apex of the semicircular retaining wall of the covered way (Figure 776). Similar to Tunnel 7, a wrought iron grated double door comprised of straight steel bars is placed in this opening. The tunnel extends east and terminates at the east bunker and gun emplacement. The tunnel branches to the north and south near the termination of the primary tunnel.



Figure 776. Overall view of entrance to Tunnel 8.

This tunnel is D-shaped in cross section. The walls are comprised of stone rubble and the barrel vault ceiling is constructed of brick masonry (Figure 777). A lime-washed parge coat is applied to all surfaces (Figure 778). Full height notches in the walls are located periodically, typically at right turns (Figure 779). A rectangular air shaft is located through the main tunnel ceiling (Figure 780). The floor is comprised of packed earth.



Figure 777. Typical view of Tunnel 8.



Figure 778. Lime-washed parge coat at Tunnel 8.



Figure 779. Full height notches in the walls (red arrows).



Figure 780. Air shaft located through the main tunnel ceiling.

Tunnel 9 and Tunnel 10

Two tunnels with similar profiles are located under the traverse. The tunnels extend east from the entrances located at the west side of the moat at the traverse. Each tunnel branches into a T-shape with countermining galleries located at the ends of the branches. No access was provided to the interior of Tunnels 9 and 10.

Condition Assessment

Guardhouse

The following notable conditions were observed at the guardhouse exteriors:

- Partial- and full-depth spalls in the parge coat were observed throughout the exterior surfaces (Figure 781). Spalls were typically full depth, such that the brick masonry wall construction was exposed. At partial depth parge coat spalls, scratch coat with hatched pattern was observed (Figure 782).
- Vegetation growth was observed at the concrete slab on the south side of the guardhouse and at the guardhouse roof (Figure 783).



Figure 781. Typical partial- and full-depth spall at guardhouse exterior surface.



Figure 782. Scratch coat with hatched pattern at partial depth spall.



Figure 783. Vegetation growth at the guardhouse roofline.

The following notable conditions were observed at the guardhouse interiors:

- Partial- and full-depth spalls in the parge coat were observed throughout the interior surfaces (Figure 784). Efflorescence was observed below the spalled parge coat at isolated locations. At full-depth spalls in the parge coat, the brick masonry wall construction was visible (Figure 785).
- Atmospheric and biologic soiling was observed throughout the interior surfaces, typically near the base of walls and at corners (Figure 786).
- Graffiti was observed at the interior walls of the center and east gallery rooms (Figure 787).



Figure 784. Typical partial depth spall at the guardhouse interior surface.



Figure 785. Brick masonry construction visible at full-depth parge coat spall.



Figure 786. Typical staining at guardhouse interior surface.



Figure 787. Graffiti at guardhouse interior surface.

Latrine

The following notable conditions were observed at the latrine exteriors:

- Spalls in the parge coat were observed throughout the exterior surfaces (Figure 788). Spalls were typically full depth, such that the brick masonry wall construction was exposed. At locations of full-depth parge coat spalls, the exposed brick masonry was weathered (Figure 789).



Figure 788. Typical spalls at latrine exterior surface.



Figure 789. Weathered brick masonry visible at full-depth parge coat spall.

Bunkers and Gun Emplacements

The following notable conditions were observed at the bunker exteriors, gun emplacements, and adjacent parapet walls:

- Vegetation growth was observed at joints between structures (Figure 790) and at areas of spalled concrete slabs (Figure 791).
- Vertical cracks near the edges of the facade and horizontal cracks at the lift lines were observed in south facades of the bunkers (Figure 792and Figure 793).
- Cracks with vegetation growth and faulting were observed in the flared rifle mount slab panels (Figure 794 and Figure 795).
- Vertical cracks in the parge coat extended into the backup wall construction on the vertical face of gun emplacement perimeter walls (Figure 796).
- Parge coat on the remains of the covered way extending from the west bunker is weathered (Figure 797). Brick rubble construction is visible at isolated locations. Various vintages of parge coat patches have been installed on the vertical faces of the walls (Figure 798).
- Heavily weathered exposed brick masonry units were observed at the coping (Figure 799).
- Crazed cracking was observed in the exposed concrete top surface of the bunker (Figure 800). Faulting was observed at isolated cracked locations (Figure 801).



Figure 790. Vegetation growth at joints between structures.



Figure 791. Vegetation growth at spalled concrete slab.



Figure 792. Vertical crack near edge of bunker south facade.



Figure 793. Vertical crack at lift lines on bunker south facade.



Figure 794. Vegetation growth at cracks in the flared rifle mount slab.



Figure 795. Faulting at cracks in the flared rifle mount slab.



Figure 796. Vertical cracks in parge coat and backup wall construction at gun emplacement perimeter wall.



Figure 797. Weathered parge coat at remains of the covered way.



Figure 798. Parge coat patches on vertical face of covered way remains.



Figure 799. Weathered brick masonry units at wall coping.



Figure 800. Crazed cracking in top surface of the bunker.



Figure 801. Faulting at cracks in top surface of the bunker.

The following notable conditions were observed at the bunker interiors:

- Partial- and full-depth spalls in the parge coat were observed at the bunker interiors (Figure 802). At locations of full-depth spalls, the brick masonry and stone rubble was exposed.
- Atmospheric and biologic soiling was observed at the bunker interiors (refer to Figure 802).



Figure 802. Typical partial- and full-depth spalls at bunker interior surfaces. Note the atmospheric and biologic soiling.

Battery

The following notable conditions were observed at the battery structures:

- Partial- and full-depth spalls in the parge coat were observed throughout the battery

structures (Figure 803). At locations of full-depth spalls, the brick masonry and sandstone rubble construction were visible (Figure 804).

- The brick masonry coping and wall elements and sandstone cornerstones are heavily weathered and eroded (Figure 805). Hard mortar between brick and sandstone units remains between eroded masonry (Figure 806).
- Vegetation growth was observed at construction joints and parge coat spalls on the upward surfaces of the embrasures (Figure 807).



Figure 803. Typical partial- and full-depth parge coat spalls at the traverse structures.



Figure 804. Brick masonry visible at full-depth parge coat spalls.



Figure 805. Weathered brick masonry and sandstone coping units at battery walls.



Figure 806. Hard mortar between masonry units at battery walls.



Figure 807. Vegetation growth at construction joints and parge coat spalls at the battery embrasures.

Traverse

The following notable conditions were observed at the traverse structures:

- Partial- and full-depth spalls in the parge coat were observed throughout the traverse structures (Figure 808). At locations of full-depth spalls, the brick masonry and sandstone rubble construction were visible. Various vintages of cementitious parge coat repair patches have been installed on the vertical faces of the walls (Figure 809).
- Brick masonry units at the banquette stairs and the stairs outside the western edge of the moat are heavily weathered (Figure 810).
- The easternmost brick masonry stair at the west perimeter of the moat is displaced and rotated downwards (Figure 811). The mortar joint between the displaced step and the adjacent upper step is cracked with sections missing.



Figure 808. Typical partial- and full-depth parge coat spalls at the traverse structures.



Figure 809. Parge coat patches at vertical faces of traverse walls.



Figure 810. Weathered brick masonry units at banquette stairs.



Figure 811. Displaced and rotated brick masonry stair at traverse moat perimeter.

Covered Way

The following notable conditions were observed at the covered way structures:

- Parge coat on west face of the parapet is weathered (Figure 812). Brick rubble construction is visible at isolated locations. Various vintages of parge coat patches have been installed on the vertical faces of the walls (Figure 813).
- Vertical cracks were observed on the west face of the parapet, extending through the wall construction (Figure 814). The cracks were filled with cementitious material.
- Vegetation growth was observed at construction joints and parge coat spalls on the upward surfaces of the parapet (Figure 815).



Figure 812. Weathered parge coat on covered way parapet.



Figure 813. Parge coat patches on vertical faces of covered way walls.



Figure 814. Vertical crack in traverse parapet wall construction filled with cementitious material.



Figure 815. Vegetation growth at construction joints and parge coat spalls at traverse parapet.

Tunnels

The two accessible tunnels beneath Santa Teresa Battery exhibited typical conditions with isolated locations of unique conditions. The following summarizes notable conditions.

- Weathered and peeling lime wash was generally observed at the parge coat on all surfaces of the tunnels (Figure 816).
- Partial- and full-depth spalls in the parge coat were observed at the walls and ceiling of all tunnels (Figure 817). Masonry construction was exposed at full-depth spalls.
- Heavy levels of atmospheric staining and biologic soiling of the parge coat were observed at the walls and ceiling near the entrances of the tunnels (Figure 818).

- At the south end of Tunnel 7, the tunnel is obstructed by earthen fill and stone (Figure 819).



Figure 816. Weathered and peeling lime wash at parge coat.



Figure 817. Partial- and full-depth spalls in the parge coat.



Figure 818. Heavy efflorescent staining and formation of calcites.



Figure 819. Obstructed passageway at south end of Tunnel 7.

La Princesa

La Princesa is the easternmost structure within the Castillo San Cristóbal outworks (Figure 820). Since initial construction of La Princesa between 1779 and 1783, the structure was modernized by the Spanish in 1896 and 1897, and again in 1940 by the U.S. Army at the onset of World War II. La Princesa was originally constructed as a bastion fort for artillery defense. Figure 821 shows the overall plan view of La Princesa with labeled structures.

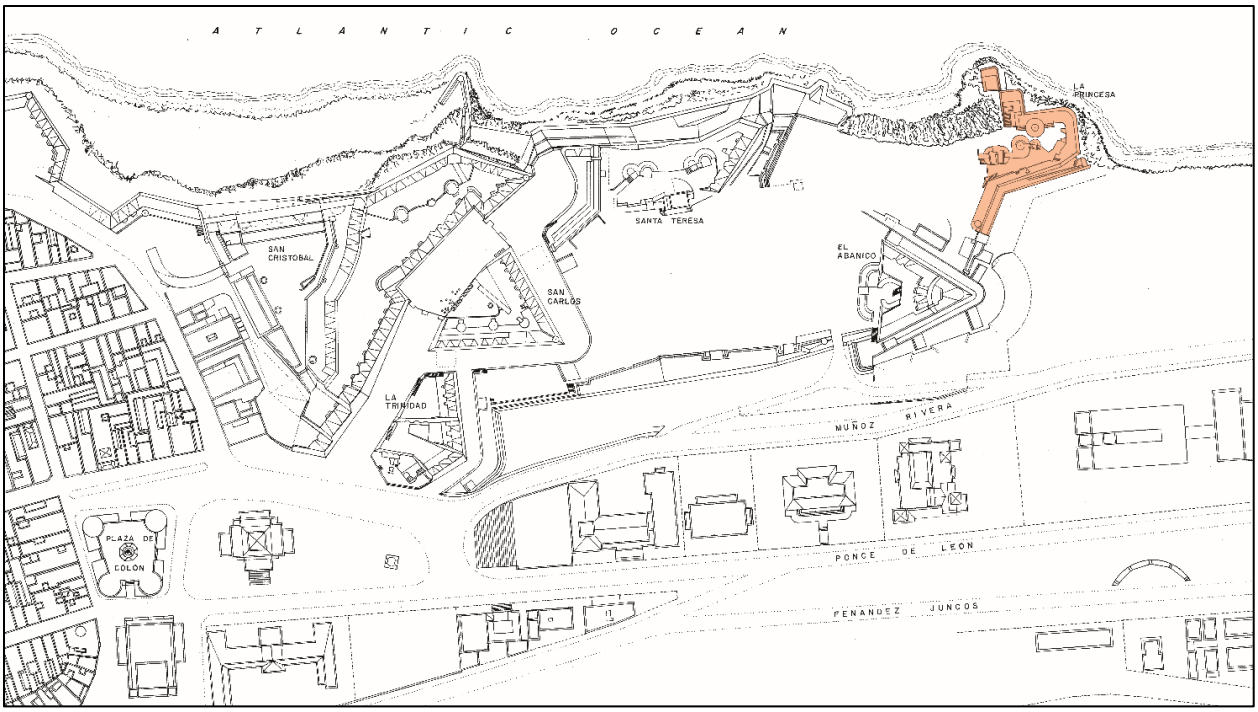


Figure 820. A site plan showing the location of La Princesa. (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Sheet 4 of 17, annotated by authors)

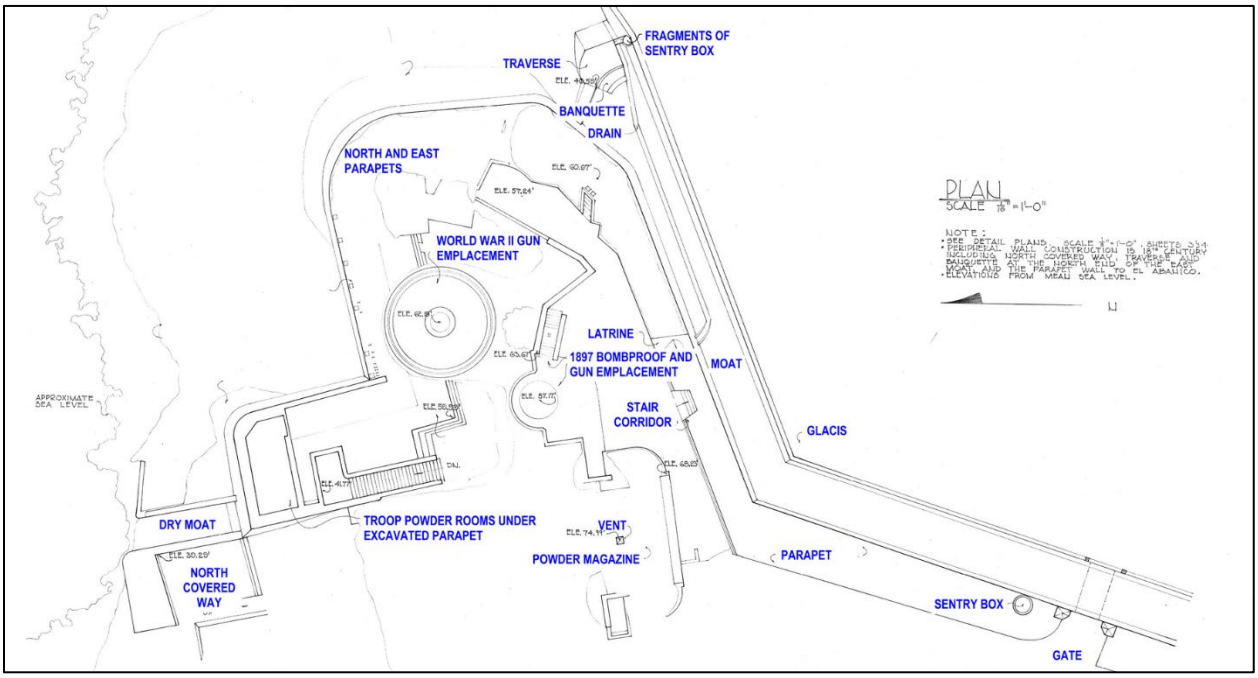


Figure 821. A site plan showing the different components of La Princesa. (Source: La Princesa Historic American Buildings Survey No. PR-95, Sheet 2 of 7, annotated by authors)

North and East Perimeter Walls

The north and east perimeter wall follows the shape of the coastline and stairsteps south and east around the eastern extents of La Princesa. The walls are comprised of stone and brick masonry rubble with lime-washed parge coat. The parapet walls extend from above grade to the glacis at the Atlantic Ocean. The eastern wall turns west to form the north wall of the moat that defines the southern extents of La Princesa. A modern metal

pipe guardrail is located along the north and east walls at the upper perimeter (Figure 822).



Figure 822. Modern metal pipe guardrail at perimeter walls.

Troop Powder Rooms

The troop powder rooms are located below grade at the northeast corner of the north parapets. Stairs located in an L-shaped opening in plan provide access between the outer works and the below grade rooms (Figure 823). Stone and brick rubble retaining walls with lime-washed parge coat are located on both sides of the flight of stairs. The stairs have brick masonry units on the risers and treads (Figure 824). The stairs are covered with parge coats of varying vintages.



Figure 823. Stairs to troop powder rooms.



Figure 824. Brick masonry units at troop powder room stair risers and treads.

At the base of the stairs, an arched opening spans over the entrance to the troop powder rooms—a primary room and three side rooms (Figure 825). The archway is outlined with a cementitious molding at the south facade. Notches are located within the archway at the base of the arch on both sides of the opening (Figure 826). The primary room is approximately 22 feet in the north-south direction, and 13 feet in the east-west direction. The bottom half of the walls in the primary room, below the vault ceiling, are comprised of sandstone laid in mortar (Figure 827). The arched walls and ceiling are comprised of brick masonry. Both the brick and sandstone are covered in a lime-washed parge coat.



Figure 825. Arched opening over entrance to troop powder rooms.



Figure 826. Notches at the base of the arch with the archway opening.



Figure 827. Sandstone units laid in mortar at lower portion of primary room walls.

Two rooms, each approximately half the size of the primary room, are located to the east of the primary room and are connected to the primary room by narrow, rectangular openings. In the south room, a concrete curb is located along the north wall and a 2-foot-6-inch-deep cavity is located on the east wall (Figure 828). Vents extending through the thicknesses of the walls are located on the north and east walls of the north room (Figure 829). Both rooms have barrel vault ceilings and multiple layers of crushed brick aggregate parge coat on the interior surfaces (Figure 830).



Figure 828. Concrete curb at north wall and cavity at east wall of the south troop powder room.



Figure 829. Vent in north troop powder room.



Figure 830. Barrel vault ceiling of troop powder room with crushed brick aggregate parge coat.

A corridor, leading to the north covered way, is located on the west side of the primary room across from the north room (Figure 831). The entrance is covered with plywood sheathing. The rectangular openings of the west corridor and the

north room are set in lancet arch-shaped projections.



Figure 831. Entrance of corridor leading to north covered way.

Excavated Parapet

An excavated parapet covered with coarse vegetation is located above the troop powder rooms. The excavated parapet wall is 3-feet-4-inches tall and 4-feet-2-inches thick on the west, north, and east sides (Figure 832). The north and east parapet walls are integral with the perimeter walls (Figure 833). The parapet walls are comprised of rubble stone and brick masonry.



Figure 832. Overall view of excavated parapet.



Figure 833. Integral parapet and perimeter walls.

A concrete slab on grade with brick masonry aggregate is located east of the flight of stairs and south of the excavated parapet (Figure 834). Stairs at the south end of concrete pad extend east to the gun emplacement. The stairs resume at the east side of the World War II gun emplacement before terminating at an additional concrete slab on grade. The stairs to the east of the gun emplacement have exposed brick masonry units with a parge coat on the risers (Figure 835).



Figure 834. Concrete slab on grade near troop powder room flight of stairs and excavated parapet.



Figure 835. East gun emplacement stairs with exposed brick masonry risers.

Dry Moat

At the base of the excavated parapet north perimeter wall on the seaward side, a dry moat extends north over the glacis to the Atlantic Ocean. The dry moat is rectangular in plan and slopes towards the Atlantic Ocean.

North Covered Way

The dry moat abuts a north covered way to the west. The north covered way is integral with the west parapet wall of the dry moat. Two elliptical brick vaults with arched openings are located in a rectangular structure at the south end of the covered way. A rectangular parapet is located at the north end of the covered way; the north wall of the parapet extends to the concrete seawall below.

Modern concrete seawalls, rectangular in profile, are located below the north covered way and the excavated parapet north perimeter wall.

World War II Gun Emplacement

The World War II-era concrete gun emplacement is circular in plan. The cog track consists of a concrete ring with an embedded iron track at the interior circumference of the ring and an iron rail centered within the ring (Figure 836). Iron keys are spaced at every 8 inches at the inner circumference iron track (Figure 837). A circular, concrete gun mount is centered within the cog track (Figure 838). The center circular projection has an iron band at its circumference (Figure 839). A metal rod is located at the center of the gun mount (Figure 840).



Figure 836. World War II gun emplacement cog track.



Figure 837. Iron keys at inner circumference of cog track.



Figure 838. Gun mount centered within cog track.



Figure 839. Iron band at circumference of center gun mount projection.



Figure 840. Metal rod at center of gun mount.

Moat

A V-shaped moat with a U-shaped section profile extends along the south perimeter of La Princesa. The moat walls are stone and brick masonry rubble with cementitious mortar and parge coat. The north parapet of the moat is approximately 10 feet thick.

Traverse and banquette structures are located at the outlet of the moat on the east end. Also at this location, remnants of the upper portion of a brick masonry sentry box are located above the traverse at the south wall of the moat (Figure 841 and Figure 842).



Figure 841. Remnants of a brick masonry sentry box.



Figure 842. Close-up view of remnants of brick masonry sentry box.

A stair corridor bisects the south parapet of La Princesa (Figure 843). Concrete stairs with faux masonry joints (Figure 844) provide access from the upper terreplein to the moat grade. A rectangular doorway with a wood door and metal hardware is set at the base of the stairs (Figure 845). A brick masonry arched opening is located above the door at the top of the parapet wall (Figure 846). The north wall of the moat is integral with the south parapet and comprised of similar material.

A historic drawing is present on the west wall of the stair corridor. The drawing dates to 1943, when four members of the 51st Coast Artillery

Battalion were stationed at La Princesa during World War II (Figure 847).



Figure 843. Stair corridor within south parapet.



Figure 844. Faux masonry joints at concrete stairs.



Figure 845. Rectangular door with wood door and metal hardware in stair corridor.



Figure 846. Arched brick masonry opening at the top of the parapet in stair corridor.



Figure 847. Historic drawing at west wall of stair corridor, dating to the presence of the 51st Coast Artillery Battalion at La Princesa during World War II.

Latrine

A latrine is integral with the south parapet east of the stair corridor (Figure 848). The brick masonry structure, laid in a running bond, is rectangular in plan with two rooms. The exterior surfaces are covered with a parge coat; brick masonry is exposed at the interior. Rectangular entrances are located on the north facade, accessed from the terreplein. The south wall of the latrine has an arched vent with a bisecting vertical column at the wall. At the base of the south wall, a drain extends from the latrine and slopes towards the center of the moat (Figure 849). The drain has a U-shaped profile and continues east along the center of the moat towards the Atlantic Ocean.



Figure 848. Overall view of the latrine.



Figure 849. Drain at north facade of the latrine.

1897 Bombproof Structure and Gun Emplacement

A bombproof structure and gun emplacement, constructed circa 1897, are positioned south of the World War II gun emplacement (Figure 850). The retaining walls and bombproof structures are concrete with a parge coat. The coping is a combination of exposed brick masonry and concrete with a parge coat.



Figure 850. Overall view of 1897 bombproof structure and gun emplacement.

The bombproof structure is set in an earthen embankment. Flights of stairs on both sides of the arched entrance lead from the terreplein. The stairs are brick masonry with cementitious parge coat (Figure 851). A stone masonry parapet wall, with a curved top surface, spans between the two flights of stairs (Figure 852). The entrance to the bombproof structure is arched with formed accents and keystone framing the entrance header. The bombproof structure consists of brick and stone aggregate concrete with parge coat; the aggregate is exposed on the underside and the topside of the roof slab (Figure 853 and Figure 854).



Figure 851. Brick masonry stairs with cementitious parge coat at the bombproof structure entrance.



Figure 852. Brick masonry stairs with cementitious parge coat at the bombproof structure entrance.



Figure 853. Exposed aggregate at underside of bombproof structure.



Figure 854. Exposed aggregate at topside of the bombproof structure roof.

A circular gun emplacement is located to the west of the bombproof structure (Figure 855). A semicircular retaining wall at the north perimeter of the gun emplacement is located between the gun emplacement and the adjacent bombproof structure (Figure 856). The concrete pad that encircles the gun emplacement has radial construction joints. Multiple rectangular steel plates are anchored to the concrete pad in a circular pattern at the center of the gun emplacement (Figure 857).



Figure 855. Overall view of circular gun emplacement.



Figure 856. Semicircular perimeter wall at gun emplacement.



Figure 857. Rectangular steel plates in gun emplacement concrete pad.

Powder Magazine

The powder magazine is located at the southwest corner of La Princesa, north of the moat (Figure 858). The structure is rectangular in plan and part of the 1897 construction. The powder magazine is set against an earthen embankment such that the roof of the powder magazine aligns with grade at the north. The roof and walls consist of brick masonry with a cementitious parge coat applied to the interior and exterior. Two arched doorways are located on the south facade (Figure 859). The doorways are framed by cementitious formed Gibbs surrounds (Figure 860). The openings house an arched wooden board double door with the boards oriented vertically. A projecting cornice is located at the roofline on the exposed facades.

An arched corridor extends in the east-west direction through the powder magazine (Figure 861). The corridor connects the 1897 gun emplacement to a flight of stairs at the west end of the powder magazine (Figure 862). Two rooms are located south of the corridor and can be accessed through arched doorways in the corridor, as well as through the arched doorways at the south facade. One room is located north of the corridor and is only accessible through a rectangular door in the corridor. A floor drain is located at the center of the corridor along the north edge of the corridor (Figure 863). The concrete floor of the corridor slopes toward the drain.

The rooms south of the corridor have barrel vault ceilings with thrust blocks (concrete ledges) on the east and west walls at the base of the arches (Figure 864). Arched wood double doors with metal hardware are located at the exterior (Figure 865) and corridor doorways of the southern rooms (Figure 866). The interior parge coat has multiple layers of coating in grey and blue (Figure 867). Rectangular-shaped tiles were grouted to the floor slab in one room (Figure 868). The north room has a flat ceiling and rectangular wood double doors with metal hardware (Figure 869). The floor of the north room was comprised of concrete without a tile finish.



Figure 858. Overall view of powder magazine structure.



Figure 859. Arched doorways at powder magazine south facade.



Figure 860. Gibbs surrounds at powder magazine arched doorways.



Figure 861. Arched corridor through powder magazine.



Figure 862. Arched corridor through powder magazine viewed from the west.



Figure 863. Floor drain at center of powder magazine corridor.



Figure 864. Thrust blocks (concrete ledge) at south powder magazine rooms (red arrow).



Figure 865. Exterior arched wood double door at powder magazine doorway.



Figure 866. Interior arched wood double door at powder magazine doorway.



Figure 867. Grey and blue coating on parge coat.



Figure 868. Rectangular-shaped floor tiles in powder magazine.



Figure 869. Interior rectangular double door at powder magazine doorway

Two square vents are located on the south wall of the corridor between the two doors leading to the south rooms (Figure 870). The vents turn upwards and terminate at hooded vents on the roof. The hooded roof vents, square in plan, are comprised of masonry and cementitious parge coat and are located at the center portion of the roof (Figure 871).

The concrete with parge coat roof of the powder magazine has three distinct sloped areas (Figure 872); the east and west portions slope towards the roof edges and the center portion slopes north towards grade (Figure 873). The south edge of the roof is lined with brick masonry units (Figure 874). A built-in gutter is located on the east and west edges of the roof. The gutters, U-shaped in profile, lead to a round opening in the roof that drains to the exterior of the building (Figure 875).



Figure 870. Square vents at south wall of powder magazine corridor.



Figure 871. Hooded vent at powder magazine roof



Figure 872. Sloped areas of the powder magazine roof.



Figure 873. Center sloped area of powder magazine roof.



Figure 874. Brick masonry units at the south powder magazine roof edge



Figure 875. Built-in gutter on powder magazine roof.



Figure 876. View from the northwest of the gate and bridge.

Gate

The gate consists of piers that flank the entrance to a non-original bridge that crosses the dry moat, a wood-framed double-leaf gate, and wing walls that define the path leading up to the gate (Figure 876). There are also two stone piers at the east entrance of the bridge on the opposite side of the moat. All of the piers are constructed on the brick masonry structure of the dry moat walls. Each pier has a mostly rectangular plan, measuring approximately 4 feet 7 inches by 3 feet 7 inches, with a chamfered corner, measuring 2 feet 4 1/2 inches wide (Figure 877 and Figure 878). The chamfer is located at the corner adjacent to the gate, on the west facade of each pier. The piers consist of a shaft, measuring 12 feet 1 inch tall; a cornice band, measuring 14 inches tall and projecting 3 inches beyond the face of the shaft; and a pyramidal cap, measuring approximately 1 foot 4 inches tall (Figure 879), and are constructed of coursed ashlar limestone units with 1/2 inch mortar joints. There are remnants of a previously applied stucco coating on the shaft with a faux stone masonry pattern and faux joints that did not align with the actual masonry joints (Figure 880 and Figure 881). The projecting cornice and cap have a stucco coating consisting of a rough brown coat, 1/4 inch finish coat, and a surface treatment, most likely a limewash.



Figure 877. West facade of the gate.



Figure 878. Gate pier with chamfered corner.



Figure 879. Projecting cornice band at top of pier.



Figure 880. Piers are constructed of coursed ashlar stone units with mortar joints.

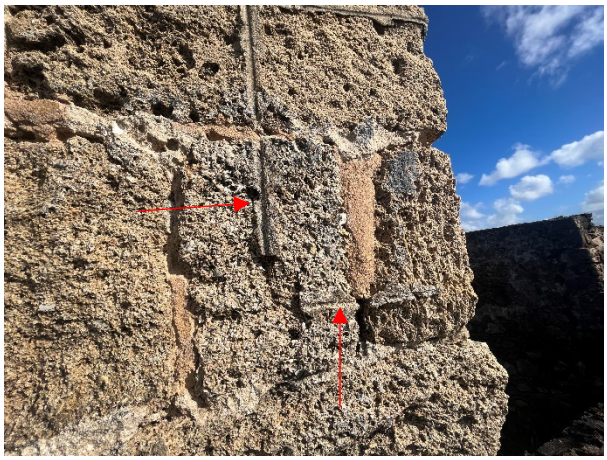


Figure 881. Remnants of the stucco have faux joints in the stucco that do not align with the actual mortar joints.

A gate spans between the piers and has framing consisting of tubular steel columns, measuring 3 inches square, set in a concrete foundation; and a wood beam, measuring approximately 8 inches tall by 12 inches deep (Figure 882 through Figure 884). The beam bears on the masonry pier and aligns with the height of the projecting cornice band. A metal plate is mounted to the underside of the wood beam and supports the top of the steel column. The steel column is clad with wood boards.



Figure 882. Wood-framed gate between stone piers.



Figure 883. Steel structure for gate is encased in wood.



Figure 884. Concrete foundation for gate structure.

The gate doors are non-original and have a frame consisting of a 4x4 wood perimeter frame and cross bracing with mortice and tenon joints and stainless-steel anchor bolts. Vertical wood slats, measuring 1 inch by 2 inches, are anchored to the moat side of the door frame. Each door leaf measures approximately 10 feet tall and is 5 feet 6 inches wide. Typical hardware includes a surface-mounted vertical door lock and a horizontal slide latch (Figure 885 and Figure 886).



Figure 885. Metal slide latch.



Figure 886. Surface-mounted vertical rod intended to secure door in the closed position.

The top of the moat wall abuts the piers and forms wing walls that define the entrance to the gate from the fortress (Figure 887). The wing walls are curved in plan, extending approximately 15 feet 6 inches from the piers, and taper in height, measuring approximately 3 feet 3 inches tall near the pier and 14 inches tall at the end. The walls are of rubble limestone construction and have a limestone coping, measuring 4 inches tall. The tops of the walls are sloped away from the gate and toward the moat wall.



Figure 887. Stone wing wall at north side of gate entrance.

The bridge is a non-original steel-framed structure with a wood plank deck and guardrails (Figure 888). At the east end of the bridge are two stone piers, rectangular in plan and constructed of limestone masonry (Figure 889 and Figure 890). The piers measure approximately 4 feet tall.



Figure 888. Steel and wood bridge across moat as viewed from the south.



Figure 889. Stone pier at north side of east end of the bridge.



Figure 890. Stone pier at south side of east end of the bridge.

Sentry Box

The sentry has a circular plan measuring 7 feet 10 1/2 inches in diameter at the base and 11 feet 2 inches tall. It consists of a base and a tapered shaft with a crenelated parapet and cornice that wraps the top. An arched door opening with expressed voussoirs is oriented on the south facade and faces the entrance gate and bridge that spans the dry moat. Arched embrasures with expressed voussoirs are located on the three remaining facades (Figure 891). The interior space of the sentry measures 3 feet 7 1/2 inches in diameter and is 9 feet 8 inches tall. The structure sits on top of the brick masonry wall for the dry moat and has a cementitious parging measuring approximately 1 inch thick.



Figure 891. Sentry located immediately north of the gate and bridge.

Foundation

The sentry sits on a base measuring approximately 16 inches tall and is set into the irregular topography at the top of the moat wall. It is constructed of brick masonry units, measuring 5-1/2 inches long and 1-1/2 inches tall, with 1/2 inch mortar joints (Figure 892). There is a stucco finish that consists of a brown coat directly applied to the brick masonry to create a uniform surface followed by a finish coat. The brown coat varies in thickness but typically measures 1/2 inch thick and the finish coat measures 1/4 inch thick. The base extends approximately 2 inches on all sides beyond the circular plan of the sentry.



Figure 892. Area of sentry showing brick construction clad with stucco.

Walls

The sentry wall measures 1 foot 11 1/2 inches thick and, like the foundation, is constructed of brick masonry with a stucco finish. The wall has a gentle tapered curve at the base, a projecting cornice with dentils, and is capped with a crenelated parapet. There is a projecting frame around the door opening that is detailed with faux masonry units with recessed joints suggesting a masonry surround and voussoirs. The faux masonry units project approximately 1-1/2 inches from the face of the wall. The embrasures also feature faux masonry with joints. The cornice projects approximately 10 inches from the field of the wall and is 6 inches tall. Dentils, measuring approximately 5 inches square, are located below the cornice. Above the cornice is a parapet wall capped with stucco-clad blocks that extend approximately 10 inches, giving a crenelated appearance (Figure 893). The construction is similar to the base and consists of brick masonry and a stucco finish. At projecting features such as the faux masonry and cornice, the brick units are corbelled to create the general profile of the feature. Stucco is applied directly to the masonry and tooled to form the shape of the decorative elements.



Figure 893. Crenelated parapet at sentry box.

Window and Door Openings

There is a semicircular door opening located on the south facade (Figure 894). The opening measures 2 feet 2 inches wide and 6 feet 11 inches to the top of the arch. The outer edge of the wall is chamfered, giving the appearance of a wider opening that is accentuated by the faux masonry surround. Embrasures are positioned so they are across from each other when viewed in plan. The exterior opening for the embrasures features a faux masonry semicircular surround. The exterior side walls and sill of the embrasure are angled so that the exterior opening measures 10 inches wide and 3 feet tall and reduces in size with the smaller interior opening measuring 9 inches tall and 2 inches wide (Figure 895).



Figure 894. South facade and entrance to sentry box.



Figure 895. Interior view of embrasure at sentry.

Interior

The interior of the sentry has a circular plan and includes a cementitious floor parging, painted red, and stucco walls and ceiling, painted white (Figure 896). There is a domed interior ceiling with an oculus. The oculus is filled with concrete and recessed approximately 1-1/2 inches from the surface of the dome (Figure 897).



Figure 896. Interior cementitious flooring of sentry box.



Figure 897. Interior oculus (ceiling) of sentry box.

Condition Assessment

North and East Perimeter Walls

The following notable conditions were observed at the north and east parapets:

- The parge coat was weathered and spalled on all faces of the brick masonry and stone rubble parapet walls, exposing the brick and stone rubble wall (Figure 898). The weathering was most severe on the seaward faces.
- The corner of the parapet wall directly north of the fun emplacement abruptly ends unevenly, likely demolished during the modernization construction (Figure 899).



Figure 898. Weathered and spalled parge coat at parapet walls.



Figure 899. Partially demolished parapet wall

Troop Powder Rooms

The following notable conditions were observed at the troop powder room exterior and adjacent structures:

- Graffiti was observed at several locations on lime-washed parge coat (Figure 900).
- Partial- and full-depth spalls in the parge coat were observed throughout the troop powder room exterior walls (Figure 901). At locations of full-depth spalls, the brick and stone rubble construction was visible (Figure 902).
- Parge coat was weathered at the brick stair treads (Figure 903).
- Crazed cracking in the lime-washed parge coat was observed at the troop powder room exterior walls (Figure 904 and Figure 905).



Figure 900. Graffiti is present at the parge coat.



Figure 901. Spalling of the parge coat at the exterior walls.



Figure 902. Brick and stone rubble visible at the location of a full-depth spall of the parge coat.



Figure 903. Weathered parge coat at brick stair tread.



Figure 904. Crazed cracking in the lime-wash parge coat at the exterior walls.



Figure 905. Crazed cracking in the lime-wash parge coat at the exterior walls.

The following notable conditions were observed at the troop powder room interiors:

- Partial- and full-depth spalls in the lime-wash parge coat were observed throughout the troop powder room interiors (Figure 906). Multiple layers of parge coat were visible at spalled sections (Figure 907).
- Atmospheric staining and biologic soiling were observed at the troop powder room interiors (Figure 908). The staining is green and black in color and was most severe at the base of walls, around openings, and at wall corners (Figure 909).



Figure 906. Spalls in the lime-wash parge coat.



Figure 907. Multiple layers of parge coat visible at spalls.



Figure 908. Staining at the walls and ceiling of the troop powder room.



Figure 909. Staining around the troop powder room door.

Excavated Parapet

The following notable conditions were observed at the excavated parapet:

- The parge coat was weathered at upward facing concrete surfaces (Figure 910). Brick aggregate was exposed throughout the surface of the concrete slab.
- Vegetation growth was observed at the perimeter of the excavated parapet (Figure 911).



Figure 910. Weathered parge coat at excavated parapet.



Figure 911. Vegetation growth at perimeter of excavated parapet.

North Covered Way

The north covered way and adjacent dry moat were not accessible for a close-up survey from the upper grade of the La Princesa area. Conditions were typically consistent with those observed at other structures, including areas of weathered parge coat and exposed brick aggregate concrete.

World War II Gun Emplacement

The following notable conditions were observed at the World War II gun emplacement:

- Exfoliated or delaminated corrosion was observed at the embedded steel elements at the cog track and center gun mount (Figure 912). At some locations, the embedded steel elements had full section loss (Figure 913).
- Radial cracks were observed in the top surface of the concrete cog track at isolated locations (Figure 914).
- Isolated spalls with exposed steel reinforcement were observed at the base of the outer perimeter of the concrete cog track (Figure 915).
- Undermining was observed at the east side of the outer perimeter of the concrete cog track (Figure 916).



Figure 912. Corrosion at embedded steel in cog track.



Figure 913. Full section loss at embedded steel at center gun mount.



Figure 914. Radial cracks in top surface of the concrete cog track.



Figure 915. Spall with exposed reinforcement at base of concrete cog track.



Figure 916. Undermining at base of concrete cog track.

Moat

The following notable conditions were observed at the moat walls and adjacent structures:

- Weathering of the parge coat and brick masonry and stone rubble wall construction was observed at the inner faces of the moat walls (Figure 917). Weathering was the most severe at the east moat inlet near the remnants of the sentry box.
- Concrete masonry unit (CMU) infill was observed at the south moat wall near the outlet (Figure 918). The CMU was heavily weathered with full section loss of the exterior shell at some locations.
- Weathered wood was observed at doors at the integral stair corridor (Figure 919). The steel door hardware was corroded, resulting in

ferrous staining on the wood doors (Figure 920).



Figure 917. Weathered parge coat at inner faces of moat walls.



Figure 918. CMU infill in arch at south wall of moat near outlet.



Figure 919. Weathered wood doors at integral stair corridor.



Figure 920. Corroded steel door hardware with adjacent ferrous staining.

Latrine

The following notable conditions were observed at the latrine exterior:

- Partial- and full-depth spalls in the parge coat were observed at the north facade (Figure 921). At locations of full-depth spalls, brick masonry construction was visible (Figure 922).
- Cracks in the parge coat and brick masonry structure were observed at the northeast corner of the latrine below the roofline (Figure 923).

- Weathered and peeling limewash was generally observed at the parge coat on the latrine exterior (Figure 924).



Figure 921. Typical partial- and full-depth parge coat spalls at latrine exterior surfaces.



Figure 922. Cracked parge coat and brick masonry construction below latrine roofline.



Figure 923. Cracked parge coat and brick masonry construction below latrine roofline.



Figure 924. Weathered parge coat and lime wash at latrine exterior surfaces.

1897 Bombproof Structure and Gun Emplacement

The following notable conditions were observed at the 1897 bombproof structure and gun emplacement and adjacent structures:

- Crazed cracking with efflorescence was observed in the parge coat on the south facade of the bombproof and the perimeter wall of the gun emplacement (Figure 925).
- Vegetation growth was observed between construction joints in the gun emplacement terreplein slab and at the gun emplacement perimeter (Figure 926).



Figure 925. Crazed cracking with efflorescence at gun emplacement perimeter wall.



Figure 926. Vegetation growth at joints at the gun emplacement structure.

The following notable conditions were observed at the 1897 bombproof structure interior:

- Partial- and full-depth spalls in the parge coat were observed at the walls and ceiling underside (Figure 927). Brick masonry aggregate was visible at locations of spalled parge coat. The spalling was most severe at the ceiling underside.
- Atmospheric staining and biologic soiling were observed at the walls and ceiling underside (refer to Figure 927). The staining was typically green and black in color.
- Graffiti was observed on the parge coat at the walls and ceiling underside (Figure 928).



Figure 927. Typical partial- and full-depth parge coat spalls at the bombproof interior surfaces. Note the staining on the walls.



Figure 928. Graffiti at bombproof structure interior surfaces.

Powder Magazine

The following notable conditions were observed at the powder magazine exterior:

- Weathered parge coat and peeling lime wash was observed at the exposed facades (Figure 929). Crazed cracks were typically also observed in the parge coat at the exposed facades (Figure 930).
- Isolated areas of atmospheric soiling and biologic soiling were observed on the parge coat at the exposed facades (Figure 931). The staining was the most severe at areas with peeling lime wash and spalled or heavily weathered parge coat.
- Isolated partial- and full-depth spalls were observed at the underside of the cornice on the south facade (Figure 932). Brick masonry units were visible at locations of full-depth parge coat spalls.
- Isolated full-depth spalls in the parge coat with exposed steel reinforcement were observed at the south facade (Figure 933).
- Vertical and diagonal cracks were observed at isolated locations at the exposed facades (Figure 934). The interior surface of the cracks was typically stained and weathered.
- Insect damage was observed in the wood doors at the south facade (Figure 935).
- Metal hardware at the exterior and interior wood doors was typically corroded (Figure 936). Ferrous staining was observed on the wood doors around the hardware.



Figure 929. Weathered parge coat and lime wash at powder magazine exterior surfaces.



Figure 932. Partial- and full-depth parge coat spalls at the powder magazine exterior surfaces.



Figure 930. Crazed cracks in parge coat at powder magazine exterior surfaces.



Figure 933. Full-depth parge coat spall with exposed reinforcement at powder magazine exterior surfaces.



Figure 931. Staining at the powder magazine exterior surfaces.



Figure 934. Cracks in powder magazine exterior surfaces.



Figure 935. Insect damage at exterior surface of powder magazine exterior wood doors.



Figure 936. Corroded metal door hardware with adjacent ferrous staining.

The following notable conditions were observed at the powder magazine interior:

- Peeling blue- and grey-colored coating was observed over the lime-washed, parge-coated interior walls of the south powder magazine rooms (Figure 937).
- Biologic soiling was observed at isolated locations at the interior wall and ceiling surfaces of the south powder magazine rooms and corridor (Figure 938). Heavy efflorescence was typically observed at these locations. The biologic soiling and efflorescence were most severe at the interior and exterior corners at the ceiling line (Figure 939).
- Weathered parge coat and peeling lime wash was observed at the corridor (Figure 940).
- Signs of insect nests at the wood doors were in the form of mud trails (Figure 941).
- At isolated locations, wood elements of the doors had full section loss (Figure 942).



Figure 937. Peeling coating at powder magazine room interior surfaces.



Figure 938. Staining with efflorescence at powder magazine interior surfaces.



Figure 939. Severe staining at corners and at the ceiling lines of the powder magazine room interiors.



Figure 940. Weathered parge coat and lime wash at the powder magazine corridor interior surfaces.



Figure 941. Insect mud trails at powder magazine wood doors.



Figure 942. Full section loss at powder magazine wood doors.

Gate and Sentry Box

Stone

- Significant erosion of stone units at the base of both piers. The erosion was observed at approximately four stone units and consisted of a loss of over 1/2-inch depth of face material (Figure 943).
- Open mortar joints between stone units at the piers and wing walls (Figure 944). Many of the joints had been previously repointed; however, there are localized areas where mortar was missing, and the joints were open.
- Displacement and missing stone units at the base of one stone pier at the east side of the bridge (Figure 945). The distress may have been associated with the replacement of the bridge.
- Dark-colored biological growth at the face of many of the stone units, specifically those at the wing walls (Figure 946).
- Infestation of ants at the south pier and wing wall. The ants appeared to be nesting in open mortar joints in the wall.



Figure 943. Erosion of lower courses of stone at south pier.



Figure 944. Open mortar joints between stone units at north wing wall.



Figure 945. Displacement of stone at base of north pier of east side of bridge.



Figure 946. Black-colored organic growth at face of stone on south wing wall.

Brick

- Deterioration of the brick foundations at gate piers. The brick foundation under the piers was observed to be spalled (Figure 947 and Figure 948). The damage may have been associated with replacement of the moat bridge. It was also observed that the existing foundation at some locations may not be wide enough to support the full dimensions of the pier. At this location the brick foundation is setback approximately 5 inches from the face of the stone at the pier.
- The cementitious parging at the top of the wing walls was eroded and the underlying brick structure was exposed to view (Figure 949).



Figure 947. Deteriorated brick masonry foundation below the south stone pier.



Figure 948. Deteriorated brick masonry foundation below the south pier at the east side of the bridge.



Figure 949. Eroded parging at the top face of the wing walls. Note areas where the brick is exposed to view.

Stucco

- Spalling and erosion of the stucco at the sentry box along corners and at projecting features, specifically at the faux masonry surrounds at embrasure and door openings and along the top edge of the base. The distress included erosion and loss of the finish coat, and sometimes the brown coat, so that the underlying brick was exposed to view (Figure 950 and Figure 951).
- Horizontal cracking at the sentry box extending between the start of the arch for the door opening and over the arched opening for the embrasures (Figure 952). The crack was approximately 1/8 inch wide and was located at the jamb and wall on both sides of the door opening.
- Cracking of the stucco at the pier caps above both gate piers (Figure 953). The cracking appeared to originate from the pocket in the masonry that supports the beam for the door framing and stepped up through the parapet.
- Vertical cracking, typically hairline in width, extending below projecting features such as the cornice and base at the sentry box (Figure 954).
- Spalled and debonded stucco finish coat at localized areas of the sentry box. Where spalled, the underlying scratch coat was exposed to view (Figure 955). Where debonded, the stucco had a pattern of hairline cracks.
- Previous cementitious patches at the pier caps included patching or corners and were observed to be cracked and separated from the substrate (Figure 956).
- Previous repairs to the stucco on the guardhouse structure included the application of a cementitious parging at sills and upward-facing surfaces (Figure 957). At some locations the non-original parging had cracked or spalled (Figure 958).
- Biological growth at cracks and along recessed corners in the stucco at the sentry box (Figure 959). The growth included small plants and dark-colored surface mold and was mostly located on the northeast face of the structure.
- Graffiti, consisting of handwritten lettering in ink and marker, at the interior walls of the sentry box (Figure 960). The graffiti appeared to date to the 1990s.



Figure 950. Erosion of the stucco finish at an embrasure surround. The scratch coat is exposed to view.



Figure 951. Spalling of the stucco. Note the brick substrate is exposed to view.



Figure 952. Horizontal cracking extending between openings in the wall.



Figure 955. Spalling of stucco finish coat with the scratch coat exposed to view.



Figure 953. Cracking in stucco adjacent to beam pocket that supports top of gate.



Figure 956. Failed previous patch in the stucco finish at the gate pier.



Figure 954. Hairline vertical crack in stucco extending down face of projecting feature.



Figure 957. Failed previous patch in the stucco finish at the base of the sentry box.



Figure 958. Spalling of a previous patch at the sentry box.



Figure 959. Biological growth at cracks and spalls in the stucco.

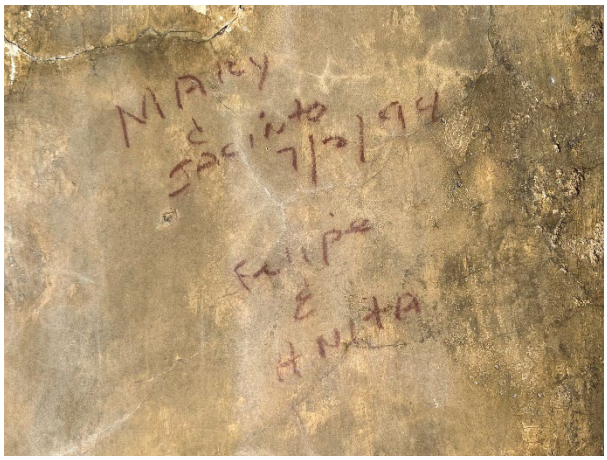


Figure 960. Handwritten graffiti at interior and sentry box.

El Abanico

Constructed between 1779 and 1783 under Thomas O'Daly followed by Juan Francisco Mestre, El Abanico is located at the southeast corner of the Castillo San Cristóbal Outworks, south of La Princesa. El Abanico, Santa Teresa Battery, and La Princesa, as well the gates, moats, and fortified lines of retreat were completed by 1783 (Figure 961). The three outwork structures were built in tandem to use the site as part of a military strategy of defense by preventing any enemy attacks coming in from the east and the north coast. Prior to the construction of El Abanico, the site consisted of an open glacis.

There are two gates on either side of El Abanico that connect to the curtain walls, referred to as the Northeast Gate and the South Gate. The South Gate leads to an internal road, used by NPS personnel, and the Northeast Gate, which is located between El Abanico and La Princesa.

El Abanico is triangular in plan. A 25-foot dry moat and scarped walls outline the fortification, and a covered way is located at the northwest and southeast of the two-story structure (Figure 962 through Figure 964). The west facade is approximately 196 feet long, the southeast facade is approximately 204 feet long, and the northeast facade is approximately 204 feet long.

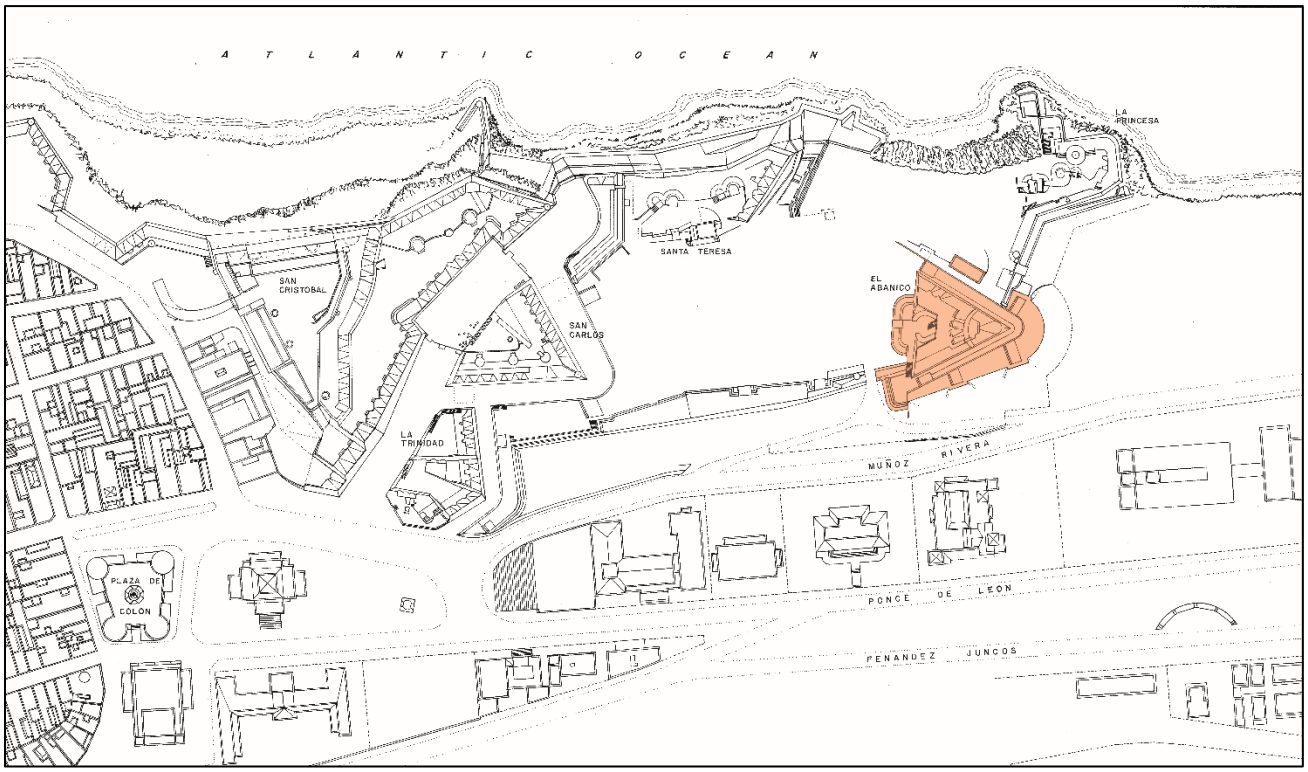


Figure 961. A site plan showing the location of El Abanico. (Source: La Trinidad Counterguard Historic American Buildings Survey No. PR-121, Sheet 4 of 17, annotated by authors)



Figure 962. The dry moat at the southwest corner of El Abanico. View from southwest.



Figure 963. The dry moat at the southwest corner of El Abanico. (Source: Fuerte El Abanico Historic American Buildings Survey No. PR-94, Photo 5, 1998).



Figure 964. View of dry moat outside of El Abanico.

Dry Moat

El Abanico is currently accessed through a wooden bridge on the west end that travels over a dry moat, approximately 8 feet wide, connecting the glacis and the lower terreplein (Figure 965).



Figure 965. View of bridge over the dry moat at the west side of El Abanico.

A set of vaulted passageways are located within the dry moat closest to the south terreplein. The wall above the vaulted openings is composed of brick masonry while the bottom half is constructed of stone masonry partially covered with a parge coat. The exterior of the vaulted passageways is outlined with red brick (Figure 966).



Figure 966. Exterior of vaulted passageways.

A flight of masonry stairs are located on the southwest section of the fort and connect the dry moat to the ground level of the fort (Figure 967). Another flight of masonry stairs is located on the south end of the dry moat and leads to the covered way (Figure 968). Three masonry traverses, to provide protection against firing, are located on the covered way (Figure 969). In 1896, a section of the covered way and a traverse were demolished on the north end of the structure in order to build the guardhouse.



Figure 967. View of masonry stairs on the southwest section of the fort.



Figure 968. View of masonry stairs on the south end of the dry moat.



Figure 969. View of the masonry traverse.

Terreplein and Parade

Two wide masonry ramps situated on the north and south ends are located on either side of the redoubt, following the curved outline of the fort to connect the crossfire terreplein (upper level) and parade (lower terreplein) (Figure 970). The north and south ramps elevate approximately 16 feet from the parade ground. The perimeter of the ramp is outlined with a smooth finish stucco layer (Figure 971). Two decorative neoclassical style masonry brackets outline the upper section of the ramp, connecting the higher parapet wall outside of the crossfire terreplein with the ramp walls (Figure 972).

Drainage openings are located on the lower terreplein, adjacent to the firing steps (Figure 973).

On the upper level of the redoubt is the battery. Two embrasures are located on the north parapet wall (north terreplein), and three crossfire embrasures are located on the east side (crossfire terreplein), at the salient angle of the fort. No embrasures are found on the south parapet wall.



Figure 970. View of ramps to the upper level and west side of the lower terreplein, seen from the lower terreplein.



Figure 971. Smooth stucco finish applied to edges of ramp wall.



Figure 972. View of masonry brackets at the upper section of the ramp.



Figure 974. View of north terreplein from crossfire terreplein.



Figure 973. Drainage opening near firing steps at lower terreplein.



Figure 975. View of the narrow moat at the salient angle.

The north terreplein has a ramp to facilitate transportation of artillery between the five-gun emplacements (Figure 974). There is a narrow moat further east of the salient angle where a demi-bastion is located (Figure 975). A wooden bridge crosses the dry moat that separates the single embrasure from the three embrasures (Figure 976). The three embrasures at the crossfire terreplein allowed for cross-firing through one common embrasure (Figure 977 through Figure 980). The gun emplacements are separated by raised platforms. A gutter runs along the perimeter of the terreplein.



Figure 976. Wooden bridge that joins the single embrasure with three embrasures to the west



Figure 977. Single embrasure at the east end of El Abanico. View from southwest.



Figure 978. Single embrasure at the east end of El Abanico in 1960. (Source: Fuerte El Abanico Historic American Buildings Survey No. PR-94, Photo 3, 1960)



Figure 979. View of crossfire embrasures and merlons.



Figure 980. View of single crossfire embrasure.

Walls

The exterior walls of the fort are primarily limestone block, and rubble masonry with remnant stucco parging visible in some locations (Figure 981 through Figure 983). The extant stucco has a stippled finish and has a yellow-tan pigmentation, and the brick copings are typically coated with a red stucco layer (Figure 984). Areas of the yellow stucco were likely applied during previous restoration campaigns, primarily on the west facade parade walls. The red-coated coping units are more prevalent on the south end of the structure. The walls are battered, sloping inward from grade to the top of the structure. At isolated locations, such as the corners of the curtain walls or corbeled sections of the parapet, or within the field of the wall, the stucco finish has 1 inch masonry joints scored on to the finish to imitate an ashlar unit coursing (Figure 985 and Figure 986). There is a higher degree of remaining pigmented stucco at the upper terreplein walls. The stucco has red pigmented quoins and coping courses drawn on the merlons and embrasure openings (Figure 987).



Figure 981. View of the exterior walls at the east end of El Abanico.

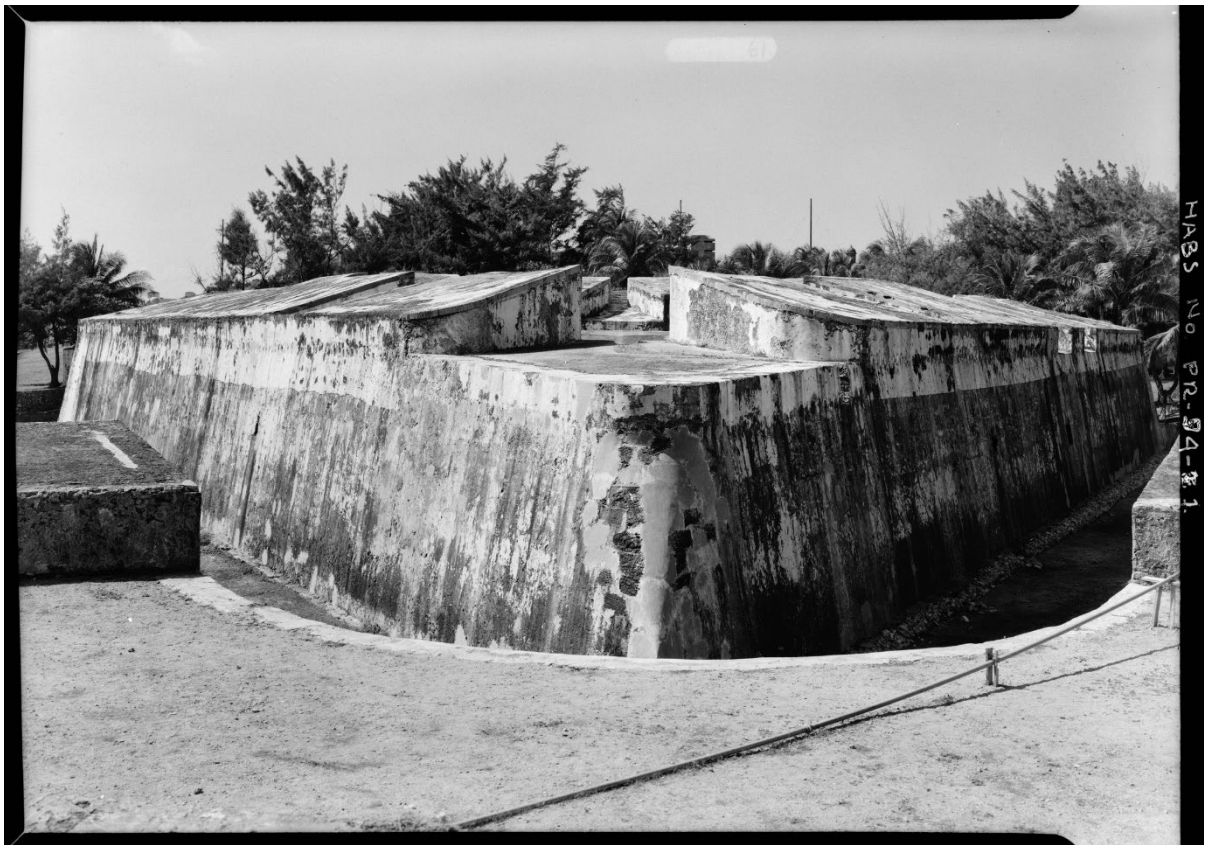


Figure 982. View of the exterior walls at the east end of El Abanico in 1960 (Source: Fuerte El Abanico Historic American Buildings Survey No. PR-94, Photo 1, 1960)



Figure 983. View of the exterior walls.



Figure 984. Red stucco coating applied at copings.



Figure 985. Masonry joints scored on the stucco finish.



Figure 986. Joints scored on the stucco are 1 inch wide.



Figure 987. Decorative stucco at the upper terreplein walls.

Approximately 6 feet down from the coping of the exterior walls of the parade is a distinct horizontal demarcation where the upper half of the wall is missing most of the pigmented stucco while the bottom half still retains the yellow-tan stucco (Figure 988). Similarly, on the northeast facade, there is a raised horizontal marking approximately 6 feet down from the coping of the exterior walls (Figure 989). One window opening with a metal grille, approximately 3 feet wide and 2 feet 2 inches in height, is located on the northeast facade. Concrete blocks are installed on the inside face of the through wall opening (Figure 990). The window opening was historically used to ventilate the powder room located under the crossfire terreplein.



Figure 988. Yellow-tan stucco coating applied to the bottom half of the exterior wall.



Figure 989. Horizontal marking on the curtain wall.



Figure 990. Through-wall opening with iron grill.

The majority of the flooring is composed of poured concrete. Brick masonry is found at the ground level terreplein, the embrasure surrounds, the redoubt wall copings, merlon copings, the scupper lining, the interior casemate vaults, and the mining galleries (Figure 991 and Figure 992). The brick at the firing steps is laid vertically with the top of the longer edge face exposed, and the edges of the brick masonry are chamfered (Figure 993). Multiple brick-lined scupper openings are located throughout the curtain walls and the vaulted passageway wall (Figure 994 and Figure 995). At the southeast and northeast wall, there are a set of square openings leveled with the height of the scuppers (Figure 996 and Figure 997).



Figure 991. View of red coated merlon copings on the upper terreplein.



Figure 992. View of red coated merlon copings on the upper terreplein.



Figure 993. Brick masonry at the firing steps.



Figure 996. Partial view of the northeast elevation.



Figure 994. Scuppers at the southeast facade.



Figure 997. Partial view of the northeast facade, showing the top of the wall.



Figure 995. Brick lined scupper at curtain wall.

Interior

The interior spaces of the lower level are accessed through a door opening, approximately 5 feet 5 inches wide, located on the wall further east of the parade and opening into a vaulted room, historically known as the "Troop's Vault" (Figure 998).



Figure 998. Door leading to the "Troop's Vault".

Room A

This vaulted space, roughly 18 feet wide by 36 feet in length, is currently used as a storage space for lime putty and replacement brick units. The flooring consists of a four-inch concrete slab. The elliptical vaulted ceiling and walls have a stucco finish coated over with an elastomeric paint.

Room B

Past the wooden door frame north of the "Troop's Vault" is the former Powder Magazine (Figure 999 and Figure 1000), approximately 14 feet wide by 12 feet 9 inches in length. The flooring consists of a mix of earth and cement. The vaulted ceiling and walls have a stucco finish applied and are partially coated with lime wash, and the door jambs have exposed masonry. The room is currently used to store material.



Figure 999. Wooden door frame leading to Powder Magazine.



Figure 1000. Access opening to Powder Magazine.

Mine Galleries

On either side of the "Troop's Vault" are two mining galleries, approximately 2 feet 9 inches wide, that are currently obstructed (Figure 1001).



Figure 1001. View of mining gallery tunnel.

Guardhouse

El Abanico guardhouse, sometimes referred to as the guardhouse for La Princesa, was part of a modernization project that took place in the 1890s (Figure 1002). The guardhouse is located on the northeast section of the site, at the covered way (Figure 1003). From the northeast dry moat of Fort Abanico, the guardhouse is accessed through the Northeast Gate. The building was constructed in 1896 to store munitions and to provide visual access to La Princesa and the ocean. Multiple changes to the building were made by the United States Army in 1902, and from 1922 through 1947. However, the building was restored back to its

original configuration in 1983. Currently, the guardhouse is used for storage and restrooms.



Figure 1002. Exterior view of the guardhouse.



Figure 1003. Exterior view of the guardhouse.

El Abanico guardhouse is a one-story rectangular building designed in a Classical Revival style. The longer sides measure approximately 54 feet long and the shorter sides measure approximately 20 feet wide. The Guardhouse is constructed of brick masonry walls infilled with limestone rubble and mortar and is all coated with a cementitious stucco layer. A waist-high masonry wall abuts the building on the west facade and two retaining walls extend from either side of the north facade.

The ceiling is composed of clay tile supported by wood beams, and the roof has a projecting cornice and a parapet wall with recessed panels that align with the door openings below (Figure 1004). A contemporary roof membrane is installed over lightweight concrete, which is supported by the clay tile and wood beam ceiling.[179] Three door openings with double-leaf wood doors are located on both the north and south facades, and one window opening is located on both the west and east facades (Figure 1005). The door openings are each framed with a decorative stucco surround and architrave. The three door openings on the south were originally window openings. The interior spaces have a mix of non-historic tiles.



Figure 1004. Clay tile and wood beam ceiling. Note termite infestation on the walls directly below the wood beam.



Figure 1005. Southeast view of the guardhouse facade.

179. El Abanico guardhouse. CRIS-HS Single Record Report. National Park Service. Report generated on: 01/11/2024.

The storage room and restrooms have a stucco finish applied to the wall and non-historic flooring tile (refer to Figure 1004).

As of February 2024, interior finishes and partition walls were removed as part of an interior rehabilitation project to make the restrooms accessible (Figure 1006). New concrete masonry unit (CMU) walls are being added to the interior. Prior to the commencement of the work, the women's and men's restroom had tile work partially installed on the walls (Figure 1007). The work is scheduled to be completed in 2024. *[NPS – photos to be added for final submittal.]*



Figure 1006. View of the interior of the guardhouse showing the removal of finishes and partition walls. Reinforcement for new CMU walls is visible in the foreground.



Figure 1007. View of women's restroom, February 2023, prior to interior rehabilitation work.

Gate

West of El Abanico is a gate and sentry box that is integrated into the walls that line the south edge of the site.

The gate consists of two piers that flank a paved entrance, a wood-framed double-leaf gate, and wing walls that define the path leading up to the gate from the fortress (Figure 1008).



Figure 1008. North facade of gate as viewed from inside the fortification walls.

Park staff noted that the piers have been substantially rebuilt. Each pier has a mostly rectangular plan, measuring approximately 4 feet 7 inches by 3 feet 7 inches, with a chamfered corner, measuring 2 feet 4 1/2 inches wide. The chamfer is located at the corner adjacent to the gate, on the west facade of each pier. The piers consist of a shaft, measuring 13 feet 1 inch tall, cornice band, measuring approximately 14 inches tall and projecting 3 inches beyond the face of the shaft, and a sloped cap with finial ball, measuring approximately 2 feet 4 inches tall (Figure 1009 and Figure 1010). The piers are constructed of coursed ashlar limestone units. Some stone units have mortar joints measuring as much as 1/2-inch wide while others appear to have been set directly on top of each other, without a mortar joint (Figure 1011).



Figure 1009. Ashlar stone masonry piers.



Figure 1010. Sloped cap with finial ball at top of piers.



Figure 1011. Dry set stone units without mortar joints.

A gate spans between the piers and has framing consisting of tubular steel columns, measuring 3 inches square, set in a concrete foundation and anchored at the top to the stone pier. The steel column is clad with wood boards (Figure 1012).

The gate doors are non-original and have a frame consisting of a 4x4 wood perimeter frame and cross bracing with mortice and tenon joints and stainless-steel anchor bolts. Vertical wood slats, measuring 1 inch by 4 inches, are anchored to the face of the door frame. Each door leaf measures approximately 10 feet tall and is 5 feet 6 inches wide. Typical hardware includes a surface-mounted vertical door lock and a horizontal slide latch (Figure 1013).



Figure 1012. North elevation of gate as viewed from inside fortification.



Figure 1013. Surface-mounted steel vertical rods to secure doors in the closed position.

Wing walls extend from the fortress side of the piers, framing the approach to the gate (Figure 1014). The walls measure 1 foot 9 inches deep, extend approximately 11 feet 2 inches from the piers, and taper in height, from approximately 10 feet at the pier down to 7 feet. The walls and copings have a stucco finish and are integrated with the fortress curtain wall that abuts the piers.

There is a concrete drive that extends so the south of the gate and a concrete apron on the north side of the gate (Figure 1015).



Figure 1014. West wing wall of the gate.



Figure 1015. Concrete apron at fortification side of gate.

Sentry Box

The sentry is located along the fortress wall, approximately 40 feet west of the gate. It has a circular plan, measuring 8 feet 1-1/2 inches in diameter at the base, and is 10 feet 4 inches tall (Figure 1016). The structure consists of a base and a tapered shaft with a crenelated parapet and cornice that wraps the top. The base of the sentry sits on top of the masonry fortress curtain wall and the south elevation of the sentry is integrated into the construction of the fortress parapet wall. An arched door opening with a faux masonry surround is located on the west elevation and arched embrasures with faux masonry surrounds are located on the three remaining elevations. The interior space of the sentry measures 3 feet 5-1/2 inches in diameter and is 9 feet 8 inches tall.



Figure 1016. Sentry box to the east of the gate.

Foundation

The sentry sits on a base measuring approximately 6 inches tall. It is constructed of brick masonry units, measuring 5-1/2 inches long and 1-1/2 inches tall, with 1/2-inch mortar joints. There is a stucco finish that consists of a brown coat directly applied to the brick masonry to create a uniform surface followed by a finish coat. The brown coat varies in thickness but typically measures 1/2 inch thick and the finish coat measures 1/4 inch thick. The base extends approximately 3 inches on all sides beyond the circular plan of the sentry.

Walls

The wall measures 1 foot 11 inches thick and, like the foundation, is constructed of brick masonry with a stucco finish. The wall has a gentle tapered curve at the base, a projecting cornice with dentils, and is capped with a crenelated parapet. There is a projecting frame around the door opening that is detailed with faux masonry units with recessed joints suggesting a masonry surround and voussoirs (Figure 1017). The faux masonry units project approximately 1-1/2 inches from the face of the wall. The embrasures also feature faux masonry with joints. The cornice projects approximately 10 inches from the field of the wall and is 6 inches tall. Dentils, measuring approximately 5 inches square, are located below the cornice. Above the cornice is a parapet wall capped with stucco-clad blocks that extend approximately 10 inches, giving a crenelated

appearance. A non-original stainless-steel band wraps around the top of the crenelated parapet and appears to be a previous repair (Figure 1018). The construction is similar to the base and consists of brick masonry and a stucco finish. At projecting features such as the faux masonry and cornice, the brick units are corbelled to create the general profile of the feature. Stucco is applied directly to the masonry and tooled to form the shape of the decorative elements.



Figure 1017. East elevation and entrance to the sentry box.



Figure 1018. Crenelated parapet and stainless-steel ring (arrow) at top of sentry box.

Window and Door Openings

There is a semicircular door opening located on the west elevation. The opening measures 2 feet 3 inches wide and 7 feet 6 inches to the top of the arch. The outer edge of the wall is chamfered, giving the appearance of a wider opening that is accentuated by the faux masonry surround. Embrasures are positioned so they are across from each other when viewed in plan. The exterior opening for the embrasures features a faux masonry semicircular surround. The exterior side walls and sill of the embrasure are angled so that the exterior opening measures 8-1/2 inches wide and 3 feet 3 inches tall and reduces down in size to the smaller interior opening measuring 2 inches wide and 13 ½ inches tall (Figure 1019).



Figure 1019. Interior view of embrasure at sentry box.

Interior

The interior of the sentry has a circular plan and includes a cementitious floor parging with stucco walls and ceiling, painted white (Figure 1020). There is a domed interior ceiling with an oculus. The oculus is filled with concrete and recessed approximately 1-1/2 inches from the surface of the dome (Figure 1021). Potentially historic graffiti consisting of handwritten lettering is present on the interior walls (Figure 1022).



Figure 1020. Cementitious flooring within sentry box.



Figure 1021. Oculus (ceiling) within sentry box.

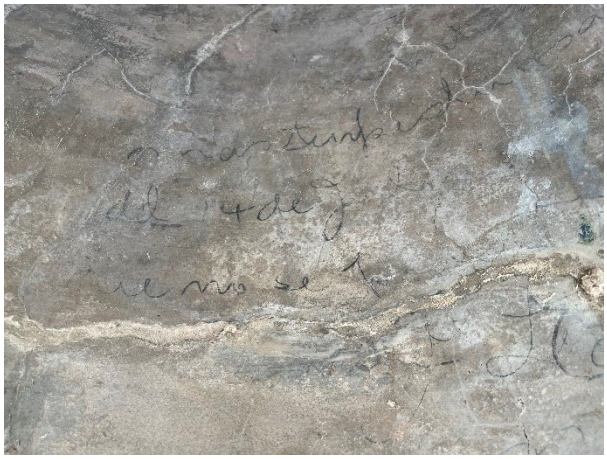


Figure 1022. Historic handwritten graffiti within sentry box.

Condition Assessment

El Abanico

Exterior

- Efflorescence over the stucco was noted at the curtain walls (Figure 1023).
- Horizontal cracks with efflorescence at the curtain walls were observed throughout the exterior of the structure, particularly at the upper half portion of the wall (Figure 1024). Efflorescence was observed near the base of the wall at the southeast facade.
- Significant horizontal cracking through the stucco and stone was observed below the ramp walls (Figure 1025). Areas with incipient spalling were noted at corners, below the coping units (Figure 1026)
- In some locations, cracks had been routed and sealed, and portland cement patches were evident at cavities (Figure 1027).
- Cementitious patches were observed primarily at the corners of the fort (Figure 1028 and Figure 1029). Different iterations of patches were observed primarily around the ravelin (Figure 1030).
- Delaminated sections of the stucco layer were observed throughout the fort walls (Figure 1031). There is a higher degree of missing eroded and delaminated stucco layers on the southeast elevation (Figure 1032).
- Spalling of the stucco layer, in the form of circular dents, was observed throughout the walls, particularly on the lower half of the curtain walls (Figure 1033).
- Erosion of both the stucco and the exposed stone was observed throughout the walls. At these locations, the surface has a rough and uneven texture forming several peaks and valleys. Slivers of the pigmented stucco layer remain along ridges forming a circular pattern around the lower areas of the surface (Figure 1034).
- Vegetation was noted growing out of joints at areas where cracked and missing mortar is present at vertical portions of the walls (Figure 1035). Vegetation was also growing out of portions of the top of the wall.
- Historic graffiti in the form of etching over the stucco coat is visible throughout the structure, particularly at the upper terreplein (Figure 1036 through Figure 1038). The graffiti has been inscribed on the stucco layer, and the origin dates vary from one to another. The inscriptions etched on the stucco vary from dates, names, and more elaborate sketches, such as ships.
- Most notably, an illustration of two ships is etched on the center of the northeast curtain wall and on the upper terreplein walls (Figure 1039 and Figure 1040).
- Eroded mortar joints and brick masonry was observed throughout the vaulted opening of the dry moat passageways and at the lower terreplein firing steps (Figure 1041). A cementitious coating was previously applied to the front edges of the weathered firing steps (Figure 1042).

- Vegetation was noted growing along the base of the masonry stairs located on the southwest section of the fort (Figure 1043).



Figure 1023. White deposits over stucco finish.



Figure 1024. Efflorescence leaching from previous cementitious crack repairs.



Figure 1025. Horizontal cracking at the terreplein ramp wall.



Figure 1026. View of incipient spall at west elevation.



Figure 1027. Cementitious patching and infilling of cracks in the walls.



Figure 1028. Cementitious patches applied during previous repair campaigns.



Figure 1029. Cementitious patches applied during previous repair campaigns.



Figure 1032. Southeast elevation has a higher degree of delaminated stucco.

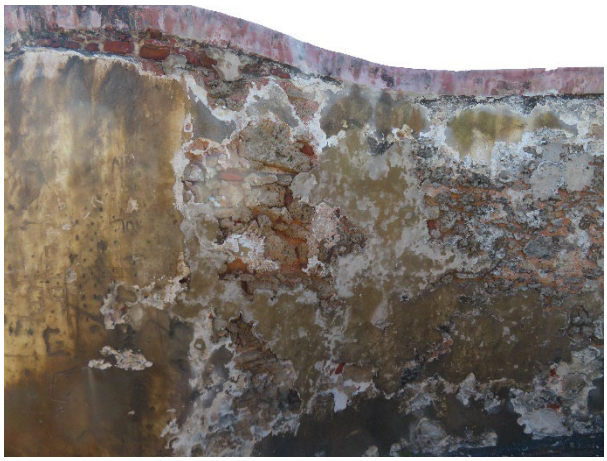


Figure 1030. Multiple types of patches on the upper terreplein and ravelin walls.



Figure 1033. Spalling of stucco layer near the base.



Figure 1031. Delaminated sections of the stucco layer.



Figure 1034. Erosion of the stucco.



Figure 1035. Vegetation growing through cracks and joints at the northeast corner.



Figure 1036. Historic graffiti at the upper terreplein.



Figure 1037. Historic graffiti at the upper terreplein.



Figure 1038. Historic graffiti at the upper terreplein.



Figure 1039. Etching of two ships on the northeast wall of the fort.



Figure 1040. Etching of ship that reads "Bill, William Orton, George Orton" on the upper terreplein walls.



Figure 1041. Eroded mortar and brick masonry at the vaulted openings.



Figure 1042. Cementitious patch applied over the lower terreplein firing steps.



Figure 1043. Vegetation overgrowth on masonry stairs.

Interior

- The doors leading to the galleries are no longer present; however, the door hinges remain on the masonry jambs (Figure 1044).
- Corrosion of the door frame at the lower-level entrance (Figure 1045)
- Significant peeling of elastomeric coating over stucco finish on the "Troop's Vault" (Figure 1046).
- Evidence of ongoing termite infestation (Figure 1047).



Figure 1044. Remnants of door hinges.



Figure 1045. Corrosion of the door frame.



Figure 1046. Peeling paint at "Troop's Vault."



Figure 1047. Termite damage on the wood framing.

Guardhouse

Exterior

- Hairline spider cracking of the stucco finish throughout the building (Figure 1048).
- Horizontal cracking of the stucco finish was observed extending from the corner openings, i.e., door openings.
- Delaminated sections of the stucco layer were observed throughout the walls. There is a higher degree of missing eroded and delaminated stucco layers on the southeast corner and west facade (Figure 1049).
- Cementitious patches were observed primarily at the cornice and decorative bands (Figure 1050). Areas where the stucco layer had been partially replaced were noted on the south facade (Figure 1051). At these locations, the brick rubble is exposed.
- Significant staining was noted throughout the parapet walls and projecting cornice (Figure 1052).



Figure 1048. Hairline cracking of the stucco finish.



Figure 1049. View of the west facade. Note the delaminated stucco finish and previously patched locations.



Figure 1050. Cementitious patches installed at the guardhouse.



Figure 1051. Areas of the wall have been previously patched. Note the brick rubble is exposed.



Figure 1052. Staining of the parapet walls and cornice.

Interior

As of February 2024, rehabilitation work on the interior of the guardhouse was ongoing. The following conditions were noted in February 2023:

- Signs of heavy water infiltration are visible on the clay tile and wood beam ceiling at the men's restroom, as evidenced by efflorescence and drip marks (Figure 1053).
- Evidence of termite infestation.
- Partial replacement of the clay tile on the ceiling (Figure 1054).
- Isolated cracking of clay tile units (Figure 1055)
- Spalling and cracking of stucco and masonry wall observed at metal embedments near doorways (Figure 1056).



Figure 1053. Water infiltration in the men's restroom.



Figure 1054. Different colored clay tile units supported on the wood beams.



Figure 1055. Cracked clay tile.



Figure 1056. Spalling of stucco and masonry at metal embedments.



Figure 1057. Previously repaired vertical cracks at the east gate pier.

Gate and Sentry Box

Stone

- Large previously repaired vertical cracks at the east elevation of the east gate pier (Figure 1057). The cracks extended the full height of the pier and had been previously repaired with a cementitious fill. Cracking was observed along the edge of the previous repair.
- Open mortar joints between stone units at the piers (Figure 1058). Where observed, the joints did not have a setting mortar. Portions of the wall where open joints were observed were reportedly rebuilt.
- Cracking of stone units at both gate piers. The cracking consisted mostly of vertical cracks that extended the full height of the stone (Figure 1059). Many of the cracks had been previously repaired or overcoated with a cementitious patch (Figure 1060). The patches were typically less than 1 inch deep.
- Dark-colored biological growth at the face of many of the stone units on all elevations of the piers (Figure 1061).



Figure 1058. Open mortar joints between stone units.



Figure 1059. Vertical cracks at stone units.



Figure 1060. Cementitious patch at crack.



Figure 1061. Biological growth at the stone units.

Brick

- Large vertical cracks and previous cementitious crack repairs extend the full height of the sentry box on the east and west elevations (Figure 1062 and Figure 1063). The crack and repair are also visible at the interior of the structure. In general, the existing crack repair is in good condition.
- Horizontal cracks and previous crack repairs wrap around the sentry box and is visible from the exterior and interior (Figure 1064 through Figure 1066). There are two cracks; one located 3 feet above the base, and one located 7 feet above the base. The upper crack exhibited some displacement on either side of the crack. Efflorescence and evidence of moisture infiltration was observed at the interior of the crack. Portions of the crack have a cementitious repair that appears to be in good condition.
- Cracked and displaced masonry at the bottom corner of the west wing wall (Figure 1067). The brick masonry and stucco were cracked, spalled, and had displaced at the bottom corner of the wall. This portion of the wall abuts the fortress curtain wall and the areas above the corner consist of exposed brick.
- Large open joint between the concrete drive apron and the bottom of the wing wall (Figure 1068). The joint measured approximately 2 inches wide and extended a few inches into the brick structure of the wing wall.



Figure 1062. Vertical cracks and cementitious crack repairs at the sentry box.



Figure 1063. Vertical cracks and cementitious crack repairs at the interior of the sentry box.



Figure 1064. Horizontal cracking with previous repair at the sentry box.



Figure 1065. Horizontal cracking with previous repair at the sentry box.



Figure 1066. Horizontal cracking with previous repair at the interior of the sentry box.



Figure 1067. Cracked and displaced masonry at the base of the west wing wall.



Figure 1068. Open joint at base of wall.

Stucco

- Previous cementitious patches at the pier caps included patching at corners and were observed to be cracked and separated from the substrate (Figure 1069).
- Dark-colored biological growth on the face of the stucco of the sentry box (Figure 1070). The growth was mostly located on the northeast face of the structure, adjacent to the parapet wall.
- Graffiti, consisting of lettering etched into the stucco at the interior and exterior of the sentry box as well as at the wing walls (Figure 1071 and Figure 1072).



Figure 1069. Previously installed patches at the pier caps.



Figure 1070. Biological growth on the face of the sentry box.

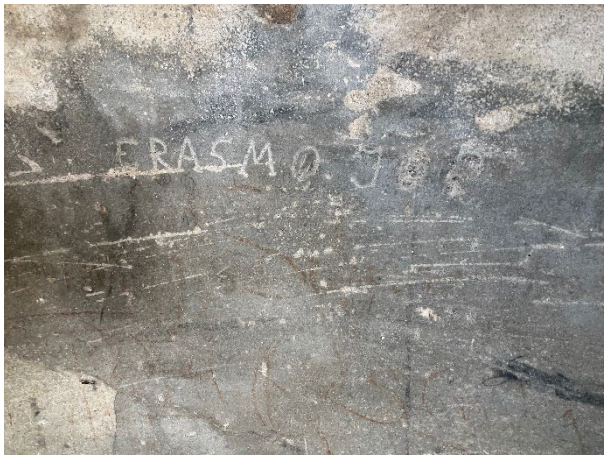


Figure 1071. Graffiti at the stucco on the exterior of the sentry box.



Figure 1072. Graffiti at the stucco on the interior of the sentry box.

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 detailed report of the analysis is included in Appendix C: Structural Analysis.

Methodology

Section strength was evaluated for minimum loadings and load combinations per the requirements of the current governing code for new construction, the 2018 Puerto Rico Building Code, which references the following standards: American Society of Civil Engineers "Minimum Design Loads for Buildings and Other Structures," dated 2016 (ASCE 7-16), and The Masonry Society "Building Code for Masonry Structures," dated 2016 (TMS 402-16).

The lateral loading considered in this preliminary structural analysis was limited to hurricane wind loading only. Although the structures at Castillo San Cristóbal are also exposed to seismic loading, a seismic analysis of the representative components was not within the scope of work of this study.

The design basic wind speed of 160 mph is taken from the current governing building code for a Risk Category II and corresponds to a 3-second gust speed at 33 feet above ground for Exposure Category D. As part of the wind load analysis, the wind pressure is factored to accommodate for height, topographic, and exposure effects. This design wind load corresponds to 700-year return period and a Saffir-Simpson Hurricane Category 4.

The design flood load per ASCE 7-16 has a 100-year return period. The site-specific design base flood elevation (BFE) is the elevation of flooding, including wave height. Puerto Rico is included in Region 2 of the Federal Emergency Management Agency (FEMA). The flood map for this location, produced by FEMA, shows a BFE of 4.6 meters, or 15 feet (based on North American Vertical Datum of 1988). The required freeboard for San Juan, height between the BFE and the lowest floor level, is 1 foot. The design flood elevation (DFE) is the addition of the BFE and required freeboard height.

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

Findings

WJE analyzed the section strength of the masonry walls of the following structural elements to resist gravity and lateral loading. The findings for each element are summarized below.

Officers' Quarters West Parapet

The parapet at this location was found to have tensile stresses due to the maximum transient applied load, but the tensile stresses are below the reduced code-permitted allowable stress. Based on the preliminary analysis and associated assumptions, the as-built construction of the west parapet at the officers' quarters is demonstrably adequate to meet the gravity and lateral load demand.

El Caballero de San Miguel Northwest Corner Parapet

Similar to the officers' quarters west parapet, the as-built construction of the west parapet at the officers' quarters is demonstrably adequate to meet the gravity and lateral load demand, based on the preliminary analysis and associated assumptions.

La Garita at North Bastion

Based on the preliminary analysis and associated assumptions, the masonry wall of the garita exhibited large tensile stress due to dead and wind loads, which significantly exceeds the reduced code-permitted allowable stress.

La Garita del Diablo

WJE analyzed the section strength of the masonry wall to resist gravity and lateral loading, including wind and flood loads.

Based on ASCE 7-16, the design flood elevation was found to be below the elevation of the base of the garita walls. Therefore, the garita walls are not exposed to flood loading in present-day operational conditions. However, the wave analysis at El Cañuelo provided an assumed relative sea level rise of 2.02 feet by 2062, at a site approximately 1.75 miles west of La Garita del Diablo. WJE assumed the same relative sea level rise at la garita and added the extra depth to the design flood elevation to estimate future flood loading. Including relative sea level rise, the lower 0.2 feet of the garita wall would be impacted by flood loading.

WJE analyzed two load combinations. The first combination included dead load and wind load (negative pressure). The negative wind pressure acts away from the wall surface and is the most extreme wind case (compared to positive pressure). The second combination included dead load, wind load (positive pressure), and flood load including relative sea level rise. The positive wind pressure and flood wave force both act in the same direction toward the garita wall.

Based on the preliminary analysis and associated assumptions, the as-built construction of the masonry wall at La Garita del Diablo is demonstrably adequate to meet the gravity and lateral load demand.

Conclusions

Components and cladding wind forces were used to assess these components of the structure. Based on commentary in ASCE 7-16, a basic wind speed of 160 miles per hour for a Risk Category II structure corresponds to 700-year return period and a Saffir-Simpson Hurricane Category 4. From historic data collected by the NOAA and the National Weather Service, it is evident that hurricanes with wind speeds at or close to the ASCE 7-16 design wind speed have occurred multiple times since the construction of Castillo San Cristóbal, without significant recorded damage. This shows that the structural elements analyzed in this study, parapets and garitas, have historically performed adequately during a design event, as they are still standing and in serviceable condition.

The structural component that is most exposed to flood loading is La Garita del Diablo. The design flood load per ASCE 7-16 has a 100-year return period. During operational conditions, offshore waves typically do not reach higher than 6 feet, based on Station 41053 data, which is 0.8 miles northeast of la garita. However, it is likely that during extreme weather events, the sea level rises, and wave heights increase with the storm's high wind speeds. During Hurricane Maria in 2017, an 18.4-foot-tall wave was measured at the same location, Station 41053. It is unknown how the offshore wave heights translate to shoreline wave heights. An extreme wave height measured more than 0.5 miles from a project site does not correlate to the structure being exposed to the same wave condition. Site specific bathymetry and topography affect wave action between offshore and shoreline locations. A wave analysis study could be completed for the offshore and shoreline conditions at La Garita Del Diablo to provide further information regarding wave impact on the structure, outside the design flood loads provided in ASCE 7-16.

The analyzed parapets demonstrated sufficient capacity to meet self-weight and design wind load demand. La Garita del Diablo masonry walls are also constructed adequately to meet dead load and design wind and flood loading, including an assumed relative sea level rise of 2 feet, based on the wave analysis study at El Cañuelo. Without the assumed sea level rise, the height of the garita is above the design flood elevation, according to current mean sea level and code requirements.

The analysis of the masonry walls of the garita at the north bastion showed high tensile stresses due to dead and design wind loads. However, the one-way analysis of the garita wall is a conservative method to analyze the garita. The walls, in reality, exhibit two-way action, due to the construction of the ashlar stone units laid in running bond, and the

circular shape of the garita walls. Two-way action refers to the load path from applied loads extending in two orthogonal directions in the plane of the wall. Two-way analysis yields a lower applied flexural stress in the masonry walls, which more accurately represents the in-situ condition of the garita. The preliminary analysis is also conservative based on assumed low material strength properties. The flexural capacity of the masonry may increase if the in-situ material exhibits stronger properties than initially assumed. This would be confirmed through destructive testing, which involves removal of masonry material and/or load testing. Also, since construction, this garita has most likely experienced several hurricane events with wind speeds at or close to the ASCE7-16 design wind speed and successfully resisted the high wind loads. In conclusion, a more advanced structural analysis, such as finite element modeling of the entire garita, and/or material property confirmation, will provide a more accurate assessment of the garita.

Generally, given the stiffness of the main structures comprising Castillo San Cristóbal, visual observations and structural analysis of these components suggests that significant damage is unlikely to occur to the main structural elements in a high wind event, based on the assumptions made above and the as-built conditions observed. Further analysis and investigation are required to determine the adequacy of isolated components, such as the garita at the north bastion and areas of isolated cracking (for example, the roof slab of the north casemates), as recommended in the Treatments chapter.

Summary of Laboratory Material Studies

Laboratory studies were performed by petrographers and chemists from the Janney Technical Center, our in-house laboratory and testing facility, on material samples extracted from the troops' quarters, officers' quarters, north casemate, Santa Teresa, El Abanico, Garita del Diablo, and La Princesa during our field investigation in January 2023. The samples included mortar from interior window sills and exterior site walls, cementitious roof coatings, cementitious parging and stucco at building exteriors, interior plaster, and non-original stucco repair material.

A detailed report of the observations and evaluations performed as part of the laboratory studies is provided in Appendix D: Materials and Finishes Analysis. Below is a summary of the field observations and laboratory studies, together with analysis of our findings.

Methods

For each sample, the material was set in tinted epoxy, sliced, and ground down to a thin cross section of the sample that was mounted to a slide for close-up examination under a microscope.

Petrographic studies were conducted in accordance with the petrographic examination portion of ASTM C1324, *Standard Test Method for Examination and Analysis of Hardened Masonry Mortar*, using the appropriate methods and procedures outlined in ASTM C856, *Standard Practice for Petrographic Examination of Hardened Concrete*, which also applies to mortar. Techniques from both of the ASTM standards can be applied to other materials, such as the cementitious coatings, stucco, and plaster samples examined as part of the studies.

Mortars

Samples were extracted from the mortar at the first-floor window stool at the troops' quarters (Sample F) and the exterior wall at Santa Teresa Battery (Samples G and H). Distress was observed

at the brick masonry adjacent to the locations where Samples F and G were removed. The Sample H location was selected as there was the potential that the mortar was original to the construction of Santa Teresa Battery. Petrographic analysis was performed to assist in characterizing the mortars and to determine if the material comprising Samples F and G may be contributing to brick deterioration. The following is a summary of conditions observed in the field and under laboratory analysis.

- Sample F included a grey mortar with a 1/4-inch red repointing mortar and was extracted from a joint between brick units at a window stool (Figure 1073). Prior to removal of the sample, the grey mortar was intact; however, the brick masonry adjacent to the mortar was spalled and eroded as much as 3/4 inch, exposing the side of the mortar joint. The mortar was hard and required a chisel and hammer to extract in the field. Based on the conditions observed, the brick units at the stool may have been originally constructed with the grey mortar. Laboratory analysis indicated that the grey mortar contained a high volume of white portland cement. The red repointing mortar had a mostly hydrated lime paste with a low volume of portland cement and aggregate that included brick dust, which gave the mortar its red color, as well as quartz sand and shell fragments.
- Sample G was extracted from between brick coping units at the battery wall and appeared to be a repointing or repair mortar. The sample included a grey mortar applied over an older (historic) mortar joint treatment. Some of the mortar from the previous joint treatment was extracted as part of the sample. In general, the grey mortar was intact; however, the brick masonry adjacent to the mortar sample was observed to be spalled and eroded as much as 3/4 inch, exposing the side of the mortar joint (Figure 1074).

  When viewed under a microscope, the older mortar joint treatment deeper within the joint was a cement-lime mortar consisting of mostly hydrated lime paste with a low volume of portland cement. The grey repointing mortar applied over the historic mortar was similar to Sample F and contained a high volume of grey portland cement.
- Sample H was extracted from between stone coping units at the Santa Teresa battery wall and included a grey mortar. The mortar appeared to be the original mortar upon which the stone coping units were set (Figure 1075). No significant distress was observed at the stone coping units adjacent to the mortar joints. The mortar contained a mix of hydrated lime with a high volume of portland cement. There was also high sand content consisting of siliceous sand and shells and fossil fragments. The portland cement particles were large and irregular in size.

In 1890, advances in technology allowed for increased production of portland cement in the United States, resulting in its more widespread of the product use in mortars and other cementitious materials. By the 1930s, standardized practices in the production of portland cement led to a more consistent and homogenous material. The presence of portland cement in a mortar sample indicates that it was likely installed after the 1890s. By characterizing the size and shape of the portland cement particles, additional conclusions may be made about the date of installation.

Based on the petrographic analysis, the grey mortar at Sample F and G contains a high volume of portland cement. The composition indicates it is a contemporary mortar installed after the 1930s. Portland cement creates a dense, less permeable, and harder mortar than more traditional lime-based mortars but is typically added to mortar to improve strength and durability. When used with historic brick, which is typically more porous and softer than contemporary brick, mortars with a high volume of portland cement may accelerate deterioration of the brick, resulting in spalling and cracking of the face of the brick.

The red repointing mortar at Sample F, historic mortar joint treatment at Sample G, and the mortar at Sample H each contained a mix of hydrated lime and lower proportion of portland

cement than the other samples. Based on laboratory studies, the red mortar is a contemporary repointing mortar. The characterization of portland cement at Samples G and H suggests that the mortar was installed after the 1890s and may be associated with efforts to rebuild portions of the walls at Santa Teresa Battery.



Figure 1073. Deteriorated brick masonry and intact mortar joints at widow stool where Sample F was removed.



Figure 1074. Deteriorated brick masonry and intact mortar joints at wall coping where Sample G was removed.



Figure 1075. Site wall at Santa Teresa where Sample H was extracted.

Cementitious Roof Parging

Sample J was extracted from the roof of the bunker, constructed circa 1898, at Santa Teresa Battery. Petrographic study was performed to assist in determining if the coating was original to construction of the battery. The sample measured 3/8 inch thick and consisted of a cementitious coating with a black-colored liquid-applied coating over top (Figure 1076). Upon laboratory examination, Sample J was observed to have a mix of portland cement and hydrated lime and included quartz sand and shell or fossil fragments. The hydrated lime and portland cement particles were quite large and coarse when compared to the sand aggregate, indicative of a cementitious material installed between the 1890s and 1920s (Figure 1077).

Based on the petrographic analysis, it is likely that the cementitious coating dates to the period between 1890 and the 1920s and is potentially original to the construction of the bunker in 1898.



Figure 1076. Location at Santa Teresa roof where Sample J was extracted.

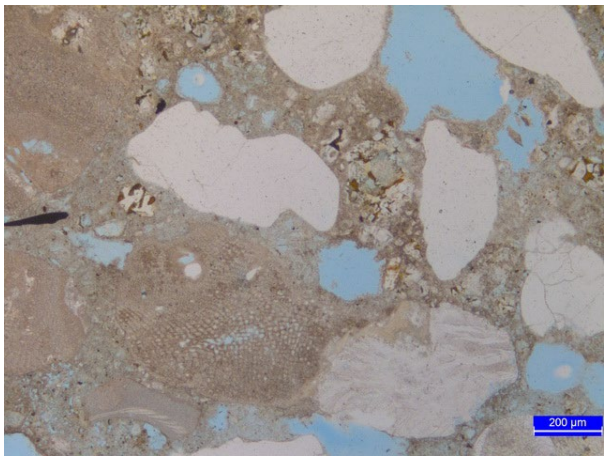


Figure 1077. Sample J under magnification, with visible shell fragments and large lime and portland cement particles visible.

Stucco and Parge Coatings

Samples for petrographic evaluation were extracted from the exterior stucco walls at Santa Teresa Battery (Sample I), El Abanico (Samples L and M), San Carlos (Sample N), La Princesa (Sample 18), and Garita del Diablo (Sample O). The intent of the assessment was to characterize the composition of the sample and assist in identifying historic coatings and finishes. Information from the petrographic evaluation can be used in conjunction with material finishes analysis in developing a chromochronology and identifying the earliest extant materials and finishes. The following is a summary of the stucco and parge coating conditions observed on site and during the laboratory evaluation:

- Sample I was removed from a site wall at Santa Teresa Battery (Figure 1078). The stucco was applied to a stone substrate and had an orange color. The sample was removed by hand and may potentially represent the original stucco finish. When evaluated as part of laboratory analysis, the stucco consisted of hydrated lime paste with quartz sand and crushed aggregate with large and coarse lime nodules within the mix. The ochre color appears to be from a crushed aggregate within the stucco mix (Figure 1079).
- Samples L and M measured approximately 1/4 inch thick and were removed from the brick exterior walls of El Abanico as potentially representative of the original finish. Ochre, red, and black finishes had been applied over the stucco (Figure 1080). In general, the finishes at El Abanico were well bonded to the brick substrate. When viewed close-up under microscope, the samples consisted of two layers of stucco; a potentially original stucco, consisting of a portland cement-hydrated lime paste, and a non-original skim coat applied at a later date. The base layer of stucco contained infrequent but large portland cement particles and exhibited widespread shrinkage cracking. The skim coat consisted of portland cement with a trace amount of quartz sand aggregate. The portland cement within the mix was coarse.
- Sample N measured 3/8 inch thick and was removed from the wall along the flight of stairs at San Carlos. The stucco had a white finish and potentially represents the original stucco finish (Figure 1081). Sample N was similar to Samples L and M and appeared to consist of a historic hydrated lime stucco with a non-original stucco coat with cement. There was widespread shrinkage cracking within the hydrated lime base layer of stucco.
- Sample 18 measured 3/8 inch thick and was removed from the stone and brick perimeter wall at La Princesa. The stucco in this vicinity was partially debonded and the sample was removed by hand. The stucco appeared to have a natural patina but could have also been

a weathered white or ochre finish (Figure 1082). Extensive graffiti, including handwritten markings with graphite or marker and etching, was observed at the stucco. The sample potentially represents original stucco. Sample 18 was also similar to Samples L and M and appeared to consist of a historic hydrated lime stucco with a non-original stucco coat with cement (Figure 1083). There was widespread shrinkage cracking within the hydrated lime base layer of stucco.

- Sample O measured 1/2 inch thick and was removed from the perimeter wall near Garita del Diablo (Figure 1084). The stucco was well bonded to the rubble masonry substrate and appeared to have either a natural patina or weathered ochre finish. The sample potentially represents original stucco. Sample O consisted of hydrated lime with quartz sand aggregate. The proportion of sand to paste was greater in Sample O than in Samples L, M, N, and 18 and there was less evidence of shrinkage cracking.

Based on the petrographic analysis, the hydrated lime stucco documented at each of the samples is a historic finish, likely predates the 1890s, and may be original to the structure. The portland cement skim coat applied over base layer at Samples L, M, N, and 18 was likely applied between 1890 and 1930.



Figure 1078. Site wall near where Sample I was removed.

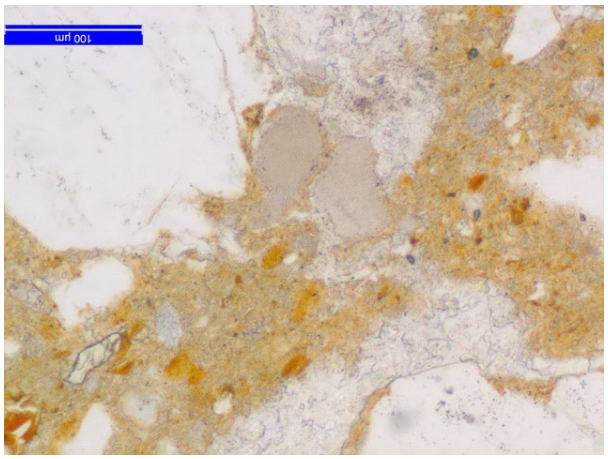


Figure 1079. View of Sample I under magnification, with ochre color from crushed aggregate visible.

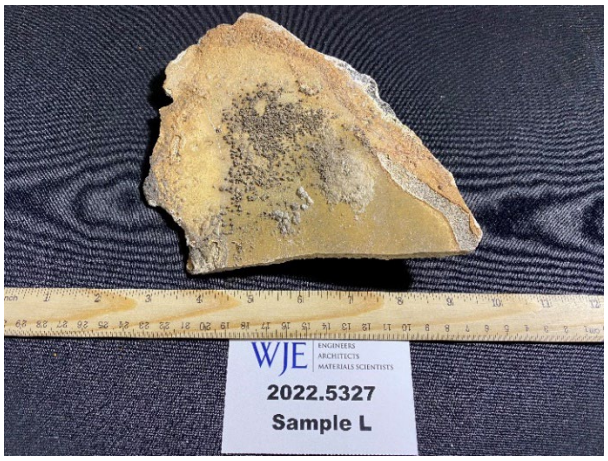


Figure 1080. View of Sample L prior to preparation for laboratory analysis.

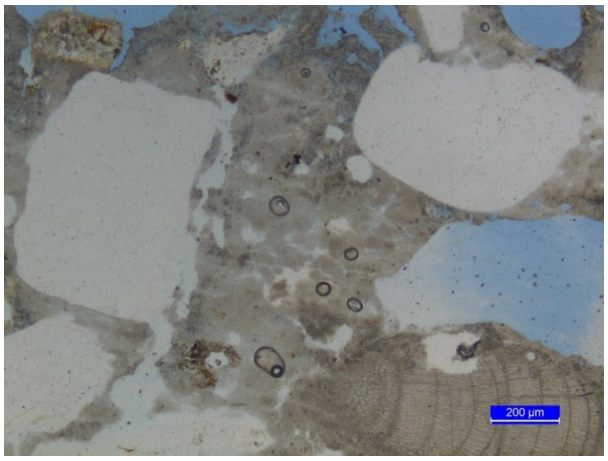


Figure 1081. View of Sample N under magnification



Figure 1082. Location on wall where Sample 18 was extracted.

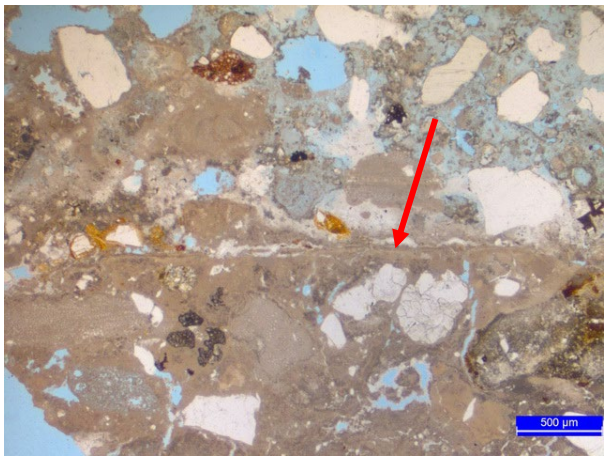


Figure 1083. View of Sample 18 under magnification. Note the bond line between the two layers of stucco (red arrow).



Figure 1084. View of Sample O prior to preparation for laboratory analysis.

Interior Plaster Coatings

Plaster samples were extracted from the interior of Santa Teresa Battery (Sample K), the partially enclosed portico at the officers' quarters (Samples 4A and 6), and the interior of the troops' quarters (Samples E and 10). Petrographic study was performed to assist in identifying remaining historic material and developing a chromochronology of finishes. The following is a summary of the conditions observed on site:

- Sample K was extracted from an interior chamber at Santa Teresa and measured 3/8 inch deep (Figure 1085 and Figure 1086). It appeared to have a green or blue surface coating and may represent an original interior finish. During petrographic examination, the sample was observed to contain hydrated lime with a natural quartz sand and shell and fossil fragments and had a thin lime finish coat indicative of an interior plaster that has not been exposed to the elements.
- Samples 4A and 6 were extracted from the portico that extends along the east elevation of the officers' quarters. This portion of the building was originally a covered exterior space; however, it was enclosed in the mid-nineteenth century and subdivided into multiple office spaces. In the early twentieth century, the walls were removed, and the covered portico restored. As a result of these alterations, there are numerous plaster repairs and finishes.
    - Sample 4A represents some of the most historic plaster repair material. It was a fragile brownish-red material observed at numerous locations, often under more recent (less historic) plaster repair treatments (Figure 1087 and Figure 1088). When viewed under magnification, the stucco sample was observed to have hydrated lime with crushed limestone and brick aggregate, which appeared to give the stucco its dark red appearance.
    - Sample 6 was the base layer of plaster within a large sample extracted from the north end of the portico. It represents the

scratch coat of plaster, was applied to a brick substrate, and may be an original finish material. A finish coat with a red coating was poorly adhered to the scratch coat and was not included in the petrographic evaluation (**Error! Reference source not found.**). When viewed under magnification, sample 6 had hydrated lime stucco consisting predominately of paste with large lumps of lime, similar to Sample 4A but without the added brick and stone aggregate.

- Sample E was extracted from the second floor of the troops' quarters. The sample consisted of multiple layers of plaster applied and well adhered to a brick substrate (Figure 1090). The sample was difficult to cut and remove from the substrate. Laboratory studies indicated that the sample consisted of coarse portland cement.
- Sample 10 was extracted from the first floor of the troops' quarters. It was applied over a stone substate and black coating, presumably a waterproofing system, that extended up the lower portion of the walls (Figure 1091). Information about the plaster can assist in understanding the chronology of repairs and installation of the waterproof coating. "Laboratory Studies" indicated that the sample consisted of finely ground portland cement.

The petrographic analysis indicates that Sample K may be original to the construction of Santa Teresa Battery, circa 1898. Samples 4A and 6 contain lime and were likely applied prior to 1890. Sample 6 may represent the original exterior finish or an early repair or resurfacing after the portico was enclosed. Sample 4A is an early repair material that postdates Sample 6 and could have been applied before or after the portico was enclosed. Samples E and 10 are non-original plaster finishes, with Sample E likely applied between 1890 and 1930 and Sample 10 applied after 1930. The approximate date of installation for Sample 10 indicates that the waterproof coating, over which the plaster was applied, may have been original to the building or installed as late as the mid-nineteenth century.



Figure 1085. Interior chamber at Santa Teresa where plaster Sample K was extracted.

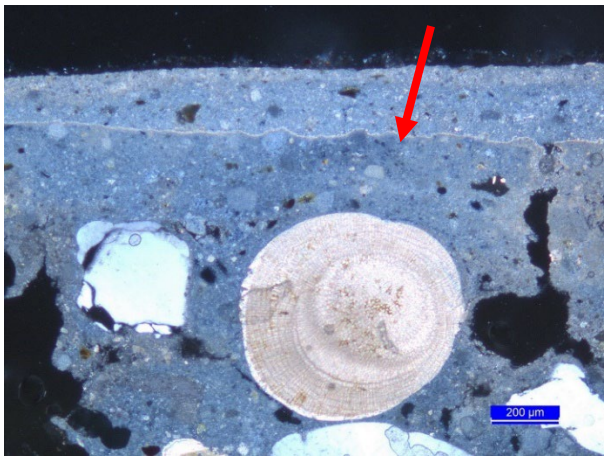


Figure 1086. View under magnification of Sample K, showing the scratch coat with coarse sand and shell fragments and a fine and thin finish layer. The arrow indicates the line between the scratch coat and finish coat.



Figure 1087. Red repair material (Sample 4A), thought to be some of the earliest repair material observed, at the officers' quarters portico.

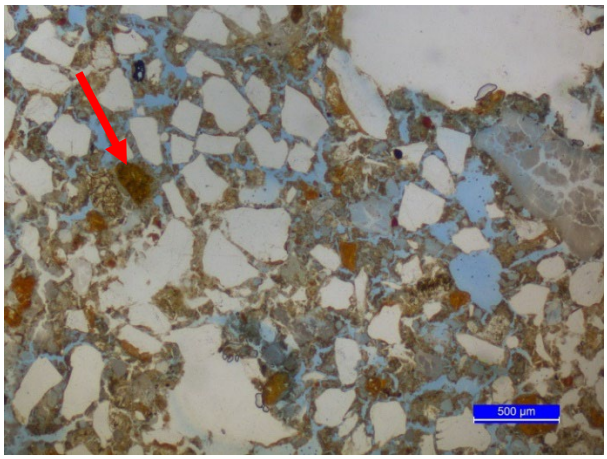


Figure 1088. View of Sample 4A under magnification. Note the red aggregate.



Figure 1089. Location at the officers' quarters where sample 6 was extracted. The material appears to be the earliest extant stucco layer at the officers' quarters.



Figure 1090. Location of Sample E following removal of the sample at the second floor of the troops' quarters.



Figure 1091. Location of Sample 10 at the first floor of the troops' quarters. Note the black layer of waterproofing applied to the stone substrate and under the stucco.

Stucco Repair Materials

Three samples of stucco repair material were extracted from the west elevation of the troops' quarters. Previously, localized stucco repairs were performed at the west elevation of the building in 2003 and in 2017. The repairs performed in 2017 are failing and the park requested petrographic study to assist in understanding conditions associated with the failure. The samples measured approximately 1-1/2 inches square and consisted of a scratch and finish coat. Typically, the finish coat measured approximately 1/8 inch deep. The depth of the scratch coat varied between each sample. The underlying substrate included clay brick and stone masonry. The locations were selected based on a review of archival photographs that showed the extent of stucco repairs performed in 2017 (Figure 1092). Cold joints and variations in the weathering of the stucco confirmed the extent of previous repairs. Two of the samples (Samples A and C) were extracted from wall areas thought to be applied as part of the 2003 repairs. Sample B was applied as part of the 2017 repairs. The following conditions were observed:

- Sample A (circa 2003) measured 5/16 inches deep and had a thin scratch coat. The stucco layers were well bonded to a stone and clay brick substrate (Figure 1093 and Figure 1094). When viewed under magnification, the stucco

was observed to have a hydrated lime paste and uniformly sized angular sand.

- Sample B (circa 2017) measured 3/4 inches deep. During extraction of the sample, the finish coat disintegrated into fine sand particles, leaving the scratch coat with remnants of the finish coat (Figure 1095 and Figure 1096). Laboratory analysis indicated that the stucco consisted of hydrated lime paste with large lumps of lime. In general, the proportion of sand to paste within the stucco mix was low and the sample exhibited widespread shrinkage cracks.
- Sample C (circa 2003) measured 13/16 inches deep and was observed to have debonding between the finish and scratch coat (Figure 1097 and Figure 1098). The individual finish and scratch coats remained intact. Petrographic analysis indicated that the sample had a hydrated lime paste with an equal proportion of sand and paste. The scratch coat exhibited fine shrinkage cracks and fissures. There was less shrinkage cracking in the finish coat.

Based on laboratory analysis, the stucco applied during the 2017 repairs (represented by Sample B) was of the same composition as the stucco applied in 2003; however, it appeared to have a low proportion of sand aggregate. A matrix with a low volume of sand has the potential for increased shrinkage cracking and lacks the dimensionally stable aggregate to accommodate the microcracks. At Sample B, widespread shrinkage cracking was observed at both the scratch coat and the finish coat. Sample C also exhibited shrinkage cracks but had a greater proportion of sand to accommodate the cracking.



Figure 1092. Image of the troops' quarters, circa 2017, showing extent of stucco repairs. Lighter white coloration of stucco denotes areas with newer stucco.



Figure 1093. Location of Sample A following extraction.

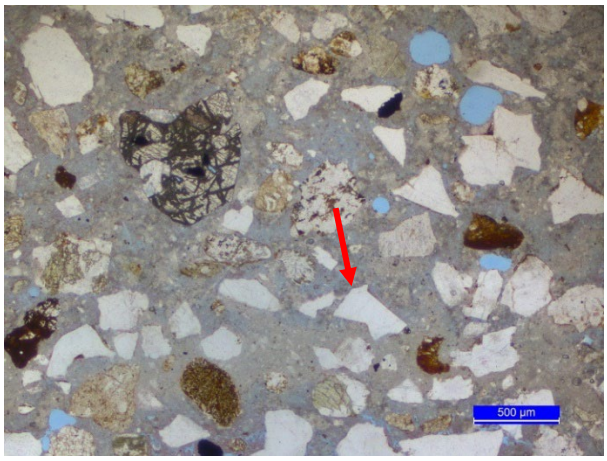


Figure 1094. Sample A viewed under magnification. Note the uniformly sized angular aggregate (red arrow).



Figure 1095. Sample B prior to preparation for laboratory analysis. Note that the base layer is intact; however, much of the finish coat has become detached.

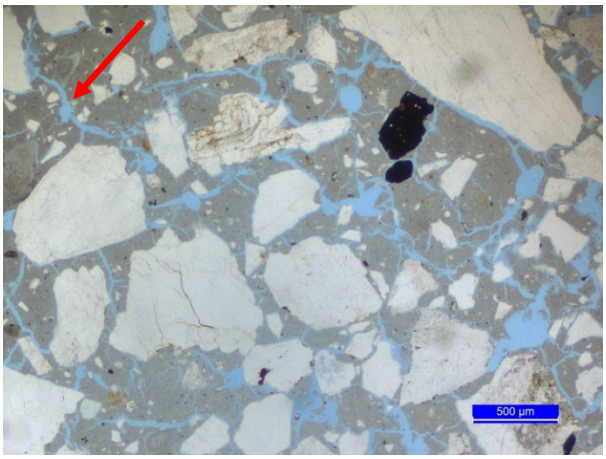


Figure 1096. Sample B viewed under magnification. Note the numerous cracks and fissures, denoted by the light blue coloration, within the sample.



Figure 1097. Location of Sample A following extraction of the sample. Note the scratches on the sample indicating where the finish coat debonded from the base layer.

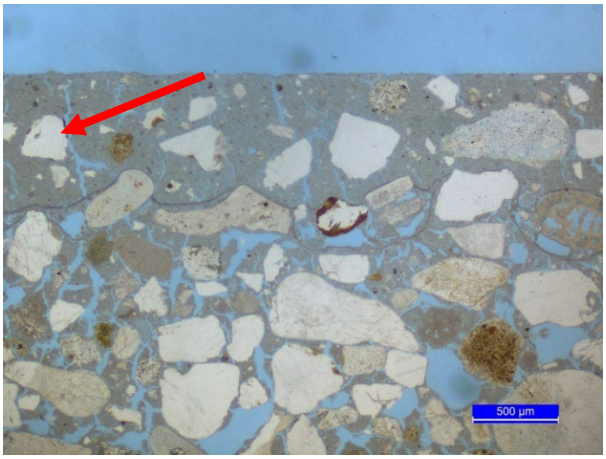


Figure 1098. Sample C viewed under magnification. Note the fine fissures in the scratch coat, denoted by the light blue coloration, and fewer cracks in the finish coat.

Surface Finishes Analysis

Approximately seventeen stucco and plaster samples from various locations throughout the fortification were extracted and reviewed to identify potential surface finishes. Finishes analysis was performed by Emily MacDonald-Korth of Longevity Art Preservation as an affiliated consultant to WJE and included samples from the Santa Teresa; El Abanico; La Princesa; and the north casemate, officers' quarters, troop's quarters, dungeon, and courtyard within the main fortification.

A detailed report of the finishes analysis is provided in Appendix D: Materials and Finishes Analysis. Below is a summary of the field observation, analysis, and findings.

Methods

In February 2023, Mike Ford of WJE removed more than thirty materials samples for potential laboratory evaluation. Samples included stucco and plaster, with historic finishes extracted from ten different structures within the fortification. Locations for sample removal were selected in coordination with park personnel. The structures at San Cristóbal have undergone many repairs and modifications over the centuries and as such, have a complicated construction history. Sample locations were selected to provide information about the earliest extant finishes for the various materials present within each building. As part of the sample extraction process, locations for sampling were reviewed under 10x magnification to identify specific locations with the most complete stratigraphy. The samples were carefully extracted using a scalpel. Prior to and after each removal, the samples and sample locations were photographed, and observations were noted. In general, the samples were very brittle and included localized area of repairs. The samples were kept intact using painter's tape and mounted to a stiff cardboard backing.

Following extraction, the samples were visually evaluated, and seventeen samples were identified for further laboratory analysis. The selected samples are intended to provide information about the materials and finishes present throughout the fortification.

In the laboratory, the samples were examined with a stereomicroscope under low power magnification (20x) to identify the areas of sample with the most complete layering structure, therefore, having the potential to give the most information during cross-sectional analysis. The selected portion of each sample was cast in resin cylinders, sanded, and polished to expose the cross section of the sample. The cross-section samples were examined and digitally photographed under reflected visible light and ultraviolet radiation (UV) at 40x to 200x, a process called optical microscopy. The evaluation provided information about paint layer stratigraphy and, based on the morphology of layers and particles and autofluorescence of the layers under varying wavelengths, characterization of the binders and coatings.

In addition to the microscopy, portions of each sample were selected for microexposure sites (very small exposure windows). Using a small stainless-steel microscalpel blade and other mechanical techniques, each paint layer was carefully scraped and cleaved away under low power magnification (20x) to reveal the layer beneath, from the uppermost paint layer to the substrate, layer by layer. The appearance of each layer and the total number of existing finish layers was compared to observations made during optical microscopy. After each microexposure was completed, each target layer was visually matched to a swatch from the Munsell Book of Color, matte edition (a color standard used in the Architectural Preservation field) using a color-corrected light source and/or daylight. Any remaining sample material that was not cast for examination or used in the microexposure process was retained for future study.

Cross-sectional optical microscopy and exposure windows are valuable complementary techniques for evaluating material finishes. Often, more layers are visible in the cross section and differences between layers can be more clearly identified. Microexposures can provide textural information

about the finishes and more accurately represent hues for color matching.

Finishes

Surface finishes were evaluated for seventeen samples from eight different general locations within the fortification. The samples represented areas that were anticipated to yield information regarding the original finishes of the building. Due to the complex construction chronology for these structures, multiple samples were extracted from some structures to compare chromochronologies and obtain a better understanding of potential original materials and finishes and to characterize subsequent repairs and finishes.

As observed in the laboratory analysis, many of the buildings had a similar stucco substrate consisting of a coarse aggregate with clumps of dark red and orange particles, likely pigment or brick fragments. At a few locations, there was evidence of a shellac present within the stucco. The toned stucco and shellac sealer indicate that, at some locations, the stucco may have been intended to be the original finish. At other locations, a lime-based paint or fresco was applied to the stucco and appeared to be well-bonded to the stucco substrate. At these locations, the paint or fresco was likely the original finish. While evident at some locations, at most of the samples there was no conclusive evidence as to whether the stucco or the earliest extant paint coating was the intended original finish.

Many of the samples exhibited shellac or tinted glaze between paint layers. In some cases, the coating may have been intended to seal the finish paint layer. However, at a few locations, a shellac may have been used to seal a base layer of paint so that a decorative finish could be applied over top.

Based on WJE observations during the field assessment and laboratory analysis performed by Longevity Art Preservation, the following is a summary of the finishes analysis, organized by building.

Santa Teresa

Sample K was removed from the interior plaster of the west guardhouse. The sample appears to represent materials original to the building. The plaster was characterized as toned and having a coarse aggregate with dark red and orange particles. The plaster was likely the intended finish for the building. The light orange/beige limewash coating and tinted glaze were likely applied at a later date.

La Princesa

Sample 19 was removed from the interior plaster walls of a storage room within the fortification. When viewed under magnification in the field, the sample exhibited a more complex chromochronology than other interior plaster walls within La Princesa.

Laboratory analysis indicated that the sample had numerous paint layers with the most recent layers being orange and blue and earlier layers being gray or beige. The earliest extant layer was a light beige lime-based paint, possibly applied as a fresco. The paint was applied directly to the plaster, which was characterized as having brown particles, generally darker in color than other plaster substrates evaluated in the study.

El Abanico

Samples M, 16, and 17 were all extracted from the exterior facade of the building. Sample M was partially debonded from the upper parapet of the building and was removed by hand. Samples 16 and 17 were removed from the lower portion of the building using hand tools and were well-bonded to the brick and stone substrate. Samples 16 and 17 are thought to be original material to the building, while Sample M may represent original but could be replacement material applied early in the history of the building.

All three samples had a toned plaster substrate characterized by a coarse aggregate and clumps of dark red, orange, and black particles with a layer of shellac possibly applied over top, indicating that the toned stucco may have been the intended original finish of the building. The earliest extent coatings at Samples 16 and 17 consisted of a two-coat lime-based paint; shades of light grey and white at Sample 16 and shades of light and dark orange at Sample 17. There was evidence of shellac

or varnish between paint layers, indicating that the upper layer may have been intended as a decorative paint layer. At Sample M, a dark yellow toned stucco or fresco was applied over the substrate, indicating that the finish is likely not original but is likely an early repair finish.

North Casemate

Sample 2 was removed from the south elevation of the north casemate. The sample represents the area with the most extensive chromochronology when viewed under magnification in the field and could include original surface finishes. The coating was very fragile and had delamination of the upper layers. The sample separated into two sections during removal.

The earliest extant finish on the sample included red and dark yellow lime-based paint or fresco. The two paint colors appeared to be of the same generation and could represent either two different one-coat treatments, with one being red and the other being dark yellow, or a decorative paint treatment, with one color applied overtop of the other. The finished were applied to a toned stucco substrate characterized by a coarse aggregate, crushed seashells, and clumps of dark red and orange particles.

Officers' Quarters

Numerous samples were taken along the east arcade of the officers' quarters. The arcade was originally an exterior facade that was enclosed and used as office spaces in the late nineteenth century. In the late twentieth century, the enclosure and interior walls were removed and the exterior arcade restored. Samples 4, 5, 6, 7, 8, 9, 14, and 15 were extracted to better understand the construction chronology of the building and identify the earliest extant finishes. During the field evaluation, all of the samples extracted, with the exception of Sample 5, were thought to potentially include finishes original to the building. Sample 5 was known to have finishes of a later vintage but was included for comparative purposes. In general, the wall finishes were very fragile and consisted of paint layers separated by localized areas with previous repairs.

Based on the laboratory analysis, it appears that Samples 5 and 14 do not include finishes original to the building. Sample 4, which appears similar to Sample 5, also does not appear to have original materials. Sample 7 appears to have original stucco material; however, it appears that original finishes either eroded or were mechanically removed prior to application of a non-original patch material. Sample 8 was removed from the south end of the arcade and may provide the most intact sample of the finishes. The sample includes twenty-nine documented finish layers on a toned stucco consisting of coarse aggregate with clumps of large red particles. The earliest extant layer is a lime-based brown paint that appears to have been applied while the stucco was wet. Assuming that the stucco is original, this would provide the earliest finish material of the samples reviewed. Samples 6 and 9 consist of paint applied on top of what appears to be original stucco. In these samples, the paint was applied directly to cured stucco, in a different process than that observed in Sample 8. While Samples 6 and 9 may also represent original finishes, they could have also been applied at a later date, especially if previous coatings had eroded or were mechanically removed, as suggested in Sample 7. The remaining Sample 15 represents a portion of the east elevation outside of the arcade. The sample appears to have an original stucco substrate with a multi-coat lime-based orange and dark yellow paint. None of the samples exhibited shellac at the stucco, indicating that a painted finish was likely intended.

Dungeon

Sample 12 was extracted from the top of the wall within the dungeon and is thought to be original material and finishes of the building. The sample consisted of a toned stucco substrate characterized by a coarse aggregate and clumps of dark red and orange particles. The earliest extant finish consisted of a light orange lime-based paint or fresco over which a light orange glaze was applied. Other layers present on the sample include light orange and beige paint and glaze.

Plaza

Sample 13 was removed from the stucco finish at the plaza ramp. The sample represents the area with the most extensive chromochronology of those locations at the plaza ramp reviewed under magnification in the field. Prior to removal, the coating was observed to be very fragile and had delamination of the upper layers.

The sample consisted of a toned stucco substrate characterized by a coarse aggregate, coarse particles of crushed brick, and clumps of dark red and orange particles. There was evidence that a shellac-based coating had been applied over top of the stucco, indicating that the toned stucco may have been the intended finish for the wall. The earliest extant surface coating consisted of a dark red lime-based paint or fresco. Numerous layers of thin stucco repairs were observed within the stratigraphy.

Troops' Quarters

Sample 11 was extracted from the interior wood flight of stairs within the troops' quarters. Portions of the railing had been replaced; however, the base rail appeared to be original. The sample was removed from a recess in the wood trim profile at the base rail that exhibited a rich chromochronology when viewed under magnification in the field.

More than thirty paint layers were identified on the sample, ranging in color from green, gray, black, and brown. The earliest extant finish appeared to be a dark brown paint.

Significance and Integrity

National Register Significance Evaluation

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.[180]

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.

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.

In addition, the Criteria for Evaluation identify the following Criteria Considerations:

> Ordinarily 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 are not considered eligible for the National Register. However, such properties *will qualify* if they are integral parts of districts that do meet the criteria or if they fall within the following categories:
>
> a. A religious property deriving primary significance from architectural or artistic distinction or historical importance; or
>
> b. A building or structure removed from its original location but which is primarily significant for architectural

180. National Park Service. "National Register of Historic Places." Accessed April 12, 2022. https://www.nps.gov/subjects/nationalregister/index.htm.

value, or which is the surviving structure most importantly associated with a historic person or event; or

c. A birthplace or grave of a historical figure of outstanding importance if there is no appropriate site or building associated with his or her productive life; or

d. A cemetery that derives its primary importance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

e. A reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

f. A property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own exceptional significance; or

g. A property achieving significance within the past 50 years if it is of exceptional importance.[181]

National Register Status

San Juan National Historic Site was authorized by the Secretary of Interior under the provisions of the 1935 Historic Sites Act, through the "Establishment Order for San Juan National Historic Site" issued on February 14, 1949.[182] The Establishment Order recognized the historic significance of the Spanish fortifications; designated the fortifications as a national historic site; and authorized the development of a cooperative agreement between the Secretary of the Interior and the Secretary of the Army to preserve the fortifications (Figure 1099).[183]

On October 15, 1966, San Juan National Historic Site, together with La Fortaleza, was administratively listed in the National Register of Historic Places under the National Historic Preservation Act. (Although La Fortaleza is not within the study area for this HSR, it is mentioned here as it relates to the National Register documentation and World Heritage Site discussed below.) Following administrative listing, several National Register nomination and documentation projects were undertaken, as described below.

National Register Nomination for San Juan Historic Zone (1972)

The National Register nomination for Zona Histórica de San Juan (San Juan Historic Zone), prepared by Luis M. Rodríguez Morales, Director, General Archives of Puerto Rico, Institute of Puerto Rican Culture and dated June 1971, was listed in the National Register on October 10, 1972 (NRIS 72001553).[184] Areas of significance are identified as Aboriginal: Historic, Architecture, Art, Commerce, Conservation, Military, Political, Religion/Philosophy, Theater, and Urban Planning. As was customary with the form used at the time of this documentation, the period of significance is broadly identified: the sixteenth, seventeenth, eighteenth, and nineteenth centuries. This nomination lists principal structures including Castillo San Felipe del Morro, Castillo San Cristóbal, the city walls, and other resources that are part of the National Historic Site.

181. *Code of Federal Regulations*, Title 36, Part 60, "The National Register Criteria for Evaluation."

182. "Establishment Order for San Juan National Historic Site," *Federal Register*, 14 Fed. 37 (February 25, 1941). Accessed October 2, 2019. https://tile.loc.gov/storage-services/service/ll/fedreg/fr014/fr014037/fr014037.pdf. Accessed October 27, 2020; Historic Sites Act of 1935, 16 USC sec. 461–467, https://www.nps.gov/ history/local-law/hsact35.htm.

183. "Establishment Order for San Juan National Historic Site," *Federal Register*, 14 Fed. 37 (February 25, 1941).

184. Luis M. Rodríguez Morales, Director, General Archives of Puerto Rico, Institute of Puerto Rican Culture, *National Register Nomination for Zona Histórica de San Juan (San Juan Historic Zone)*, dated June 1971, signed, listed in the National Register on October 10, 1972 (NRIS 72001553).

National Register Documentation for San Juan National Historic Site (1973, unsigned)

The National Register documentation for San Juan National Historic Site, prepared by F. C. Gjessing, Architect, and Loretta Schmidt, Chief Park Historian, San Juan National Historic Site, and dated June 12, 1973, is unsigned (NRIS 66000930).[185] A signed version of this nomination has not been identified by the NPS at this writing, thus the 1973 documentation is considered a draft nomination. (See further discussion of National Register status of the National Historic Site, below.) Areas of significance are identified as Aboriginal: Historic, Architecture, Engineering, and Military. As was customary with the form used at the time of this documentation, the period of significance is broadly identified: the sixteenth, seventeenth, eighteenth, nineteenth, and twentieth centuries are indicated. Specific dates of 1539–1945 are also noted as important.

The 1973 National Register nomination documentation for San Juan National Historic Site addresses the fortresses of El Morro and Castillo San Cristóbal, their outworks, the city walls, the satellite forts of El Cañuelo and San Jerónimo, and associated structures. The nomination notes that the San Juan defensive system is one of the major Caribbean fortifications of the Spanish empire and helped to protect Spanish interests in the New World.[186]

As noted in the nomination, the structures "generally retain the character and appearance of the most advanced eighteenth century defense techniques that were applied to a difficult and unusual site."[187] The resources reflect both features of earlier origin, as well as military construction characteristic of the nineteenth and twentieth centuries.

National Register Documentation for the Old San Juan Historic District (2012)

National Register documentation for the Old San Juan Historic District, prepared by Arleen Pabón-Charneco, Puerto Rico State Historic Preservation Office (SHPO) Consultant, 2012, was listed in the National Register on July 30, 2012 (NRIS 12000465).[188] This documentation addresses the urban and residential resources of Old San Juan, but also includes the military walls and resources of the National Historic Site. The National Register website indicates that the 2012 documentation is a boundary extension to the 1972 documentation (NRIS 72001553).

The 2012 National Register documentation for the historic district cites eligibility under National Register Criterion C, and Criteria Considerations A, C, D, and E. The 2012 documentation also cites two areas of significance: Architecture, and Community Planning and Development. The 2012 National Register documentation summarizes the significance of the historic district as follows:

> The Distrito Histórico del Viejo San Juan / Old San Juan Historic District is the second oldest continuously inhabited European settlement in the Western Hemisphere. Conceived as the capital of the island of Puerto Rico and known for centuries as the *ciudad del puerto Rico* (the city of the rich Port [Rich port]), it is the oldest urban core in the island and the United States of America. Listed in the National Register of Historic Places in 1972, some of its components—the Castillo de San Felipe del Morro, Castillo de San Cristóbal, circuit of defensive walls, and Palacio de Santa Catalina—are considered part of the cultural heritage of humanity.[189]

185. F. C. Gjessing, Architect, and Loretta Schmidt, Chief Park Historian, San Juan National Historic Site, *National Register Documentation for San Juan National Historic Site*, dated June 12, 1973, unsigned (NRIS 66000930).
186. Gjessing and Schmidt, Section 8.
187. Gjessing and Schmidt, Section 8.
188. Arleen Pabón-Charneco, Puerto Rico SHPO Consultant, *National Register Documentation for the Old San Juan Historic District*, 2012, listed in the National Register on July 30, 2012 (NRIS 12000465).
189. Pabón-Charneco, Puerto Rico SHPO Consultant, *National Register*

The period of significance is given as 1519–1939 (see further discussion below), with specific dates of 1519, 1625–1700, 1812, and 1898 cited as important.

National Historic Landmark documentation for the Old San Juan Historic District (2013)

National Historic Landmark documentation for the Old San Juan Historic District was also prepared by Dr. Arleen Pabón-Charneco, Puerto Rico State Historic Preservation Consultant and is dated September 24, 2012 (NRIS 13000284).[190] The National Register web site indicates that the Old San Juan Historic District was designated as a National Historic Landmark on February 27, 2013.

The 2013 National Historic Landmark documentation cites eligibility under National Register Criteria A and C, and Criteria Considerations A, C, D, and E. In addition, the 2013 documentation cites National Historic Landmark Criteria 1 and 4, and Criteria Exception 1 (which pertains to properties owned or used by a religious institution).

The documentation also indicates significance under two NHL themes—I. Peopling Places, 6. Encounters, Conflicts, and Colonization; and III. Expressing Cultural Values, 5. Architecture, Landscape Architecture, and Urban Design—and the following areas: Architecture, Community Planning and Development, and Ethnic Heritage: Hispanic. The 2013 National Historic Landmark documentation summarizes the significance of the historic district as follows:

> The Old San Juan Historic District (Distrito Histórico del Viejo San Juan) in Puerto Rico is nationally significant under NHL Criterion 1 and Criterion 4 as one of the premier colonial cities in the United States and the nation's most important and complete Spanish urban center. It is significant because of its architectural history and as a reflection of Spanish culture and colonial history. Much of the southern and western portions of what is now the continental United States were once controlled by Spain; however, Puerto Rico was located on the northern fringe of Spain's massive American empire and documented historic sites predominantly offer insight about religious and military activities and settlement on their frontier, and the relationships and conflicts between the Native Americans and the Spanish.[191]

Further, the 2013 NHL documentation notes:

> The Old San Juan Historic District is nationally significant under NHL Criterion 1 as the only extant representation of an almost four hundred year old Spanish colonial city in the United States. It is the oldest city in the United States and the second oldest continuously-inhabited European settlement in the Western Hemisphere. Old San Juan's location in the heart of the Caribbean (the first area in America to be colonized and settled by Spain) provided the Spanish with a key port from which to establish their cultural, military, and political.

The period of significance is given as 1519–1898 (see further discussion below), with specific dates of 1625–1700 and 1812 cited.

190. Arleen Pabón-Charneco, Puerto Rico SHPO Consultant, *National Historic Landmark Documentation for the Old San Juan Historic District*, September 24, 2012 (NRIS 13000284).

191. Gjessing and Schmidt, 81.

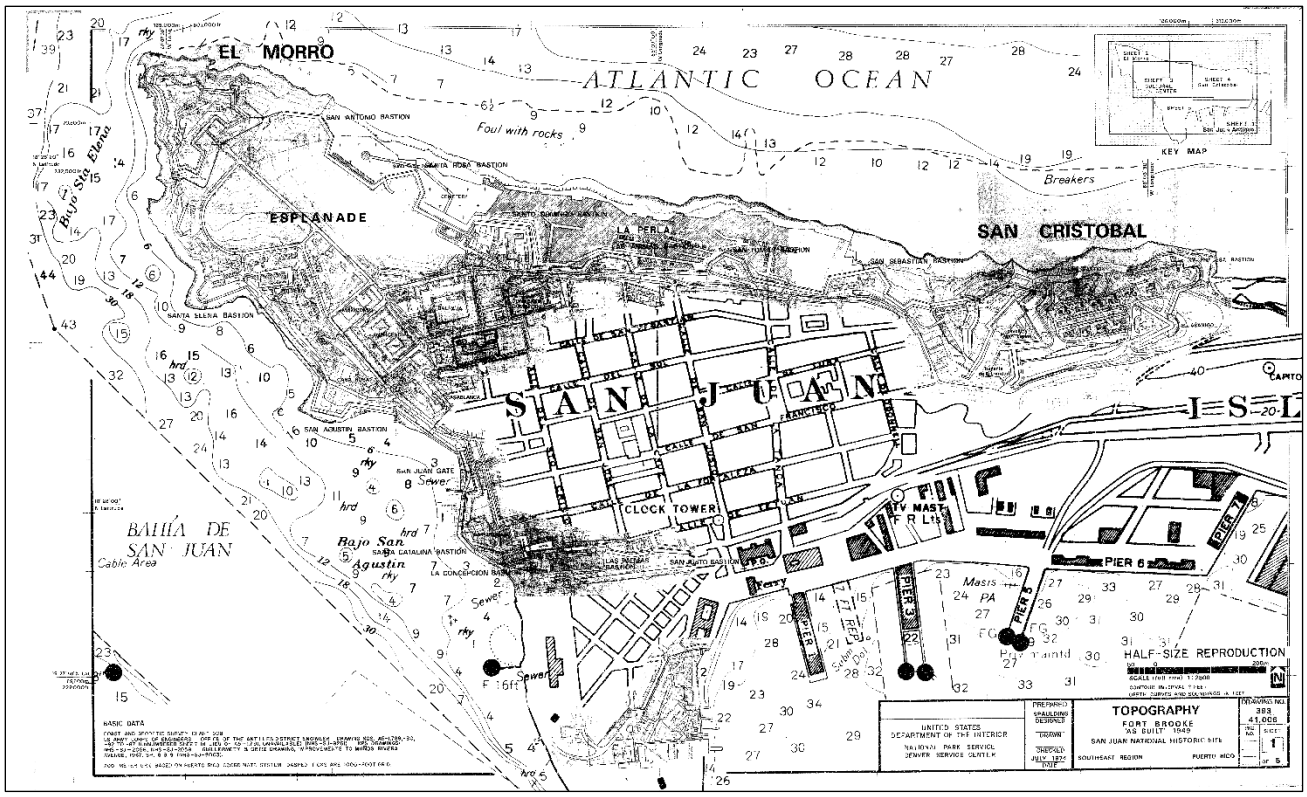


Figure 1093. Site plan of Fort Brooke as it appeared in 1949. (Source: U.S. Department of the Interior, National Park Service, Denver Service Center, "Topography: Fort Brooke 'As Built'" 1949, San Juan National Historic Site, Southeast Region, Puerto Rico," July 1974, Sheet 1 of 5)

National Register of Historic Places Additional Documentation (2022)

National Register of Historic Places additional documentation for San Juan National Historic Site was prepared by Teresa Dujnic Bulger and Paola Schiappacasse of Richard Grubb & Associates, Inc., dated June 22, 2021. The additional documentation was accepted by the National Register, March 4, 2022.[192] The additional documentation describes the 79.9-acre historic district that comprises San Juan National Historic Site as follows:

> San Juan National Historic Site is a well-preserved, complex of Spanish colonial masonry military fortifications, begun in 1539, and subject to continuous addition, reconstruction, and modernization efforts over the course of the seventeenth, eighteenth, nineteenth, and twentieth centuries. The last major construction campaign took place during the United States Army's use of the fortifications during World War II. The historic property occupies a large portion of San Juan Islet and spans the entrance to San Juan Bay to include the outpost, El Cañuelo, within its boundary. Castillo San Felipe del Morro comprises the fort of El Morro, the El Morro Esplanade, and San Antonio Guardhouse located to the east of the fort's dry moat. Castillo San Cristóbal comprises the fort of San Cristóbal, the Quarters Buildings along Norzagaray Boulevard, and the San Cristóbal Outworks which stretch out for more than 1,000 feet (305 meters) east of the fort. The Old San Juan City Walls run approximately 2.5 miles along the northern, western, and southern edges of the city of Old San Juan and comprise a discontiguous network of bastions, walls, and batteries. El Cañuelo comprises the fort of El Cañuelo (or Fortín San Juan de la

192. Teresa Dujnic Bulger and Paola Schiappacasse, Richard Grubb & Associates, Inc., *National Register of Historic Places Additional Documentation, San Juan National Historic Site, San Juan, Puerto Rico*, June 22, 2021; accepted by the National Register, March 4, 2022.

Cruz), located on the Isle de Cabras, on the west side of San Juan Bay.[193]

Within the historic district, the additional documentation identifies 18 contributing buildings, 8 contributing sites, 57 contributing structures, and 1 contributing object, for a total of 84 contributing resources; no non-contributing resources are identified.[194]

For Castillo San Cristóbal, the additional documentation identifies 11 contributing buildings, and 12 contributing structures, as follows:

- Quarters Building No. 1 *(not part of this study)*
- Quarters Building No. 2 *(not part of this study)*
- Quarters Building No. 3 *(not part of this study)*
- Quarters Building No. 4 *(not part of this study)*
- Guardhouse at Castillo San Cristóbal
- North Casements of Castillo San Cristóbal
- Troops' Quarters
- Officers' Quarters at Castillo San Cristóbal
- The Chapel
- World War II Joint Command Center *(not part of this study)*
- Main Gate at Castillo San Cristóbal
- Plaza de Armas, Castillo San Cristóbal
- South Gate at Castillo San Cristóbal
- Castillo San Cristóbal Well Houses (2)
- Cisterns (5)
- El Caballero de San Miguel
- Castillo San Cristóbal Fire Control Station A
- Castillo San Cristóbal Fire Control Station B
- North Bastion, Curtain Wall, and South Bastion
- El Espigón
- Castillo San Cristóbal Moat
- Tunnels of Castillo San Cristóbal

For the Castillo San Cristóbal Outworks, the additional documentation identifies 2 contributing sites, 1 contributing building, and 10 contributing structures, as follows:

- Castillo San Cristóbal Historic Landscape
- Castillo San Cristóbal Archeological Site Complex
- El Abanico Guardhouse
- La Trinidad Counterguard
- San Carlos Ravelin
- Santa Teresa Battery
- El Abanico
- South Gate at El Abanico
- Northeast Gate at El Abanico
- La Princesa Battery
- Gun Emplacement at Princesa Battery
- North Covered Way at Castillo San Cristóbal
- South Covered Way at Castillo San Cristóbal

The additional documentation indicates that the historic district that comprises San Juan National Historic Site is significant under National Register Criteria A, C, and D, and under the following areas of significance:

- Military History
- Maritime History
- Architecture
- Ethnic Heritage – Hispanic
- Social History
- Archeology - Historic, Non-Aboriginal[195]

In the areas of Military History and Maritime History, the additional documentation notes that San Juan National Historic Site is significant at the national level under Criterion A, "for its significance as a strategically important maritime and military base for two world powers, Spain and the United States of America," between 1539 and 1945.[196]

In the area of Architecture, the additional documentation notes that the National Historic Site is significant at the national level under Criterion C "as a significant and well-preserved

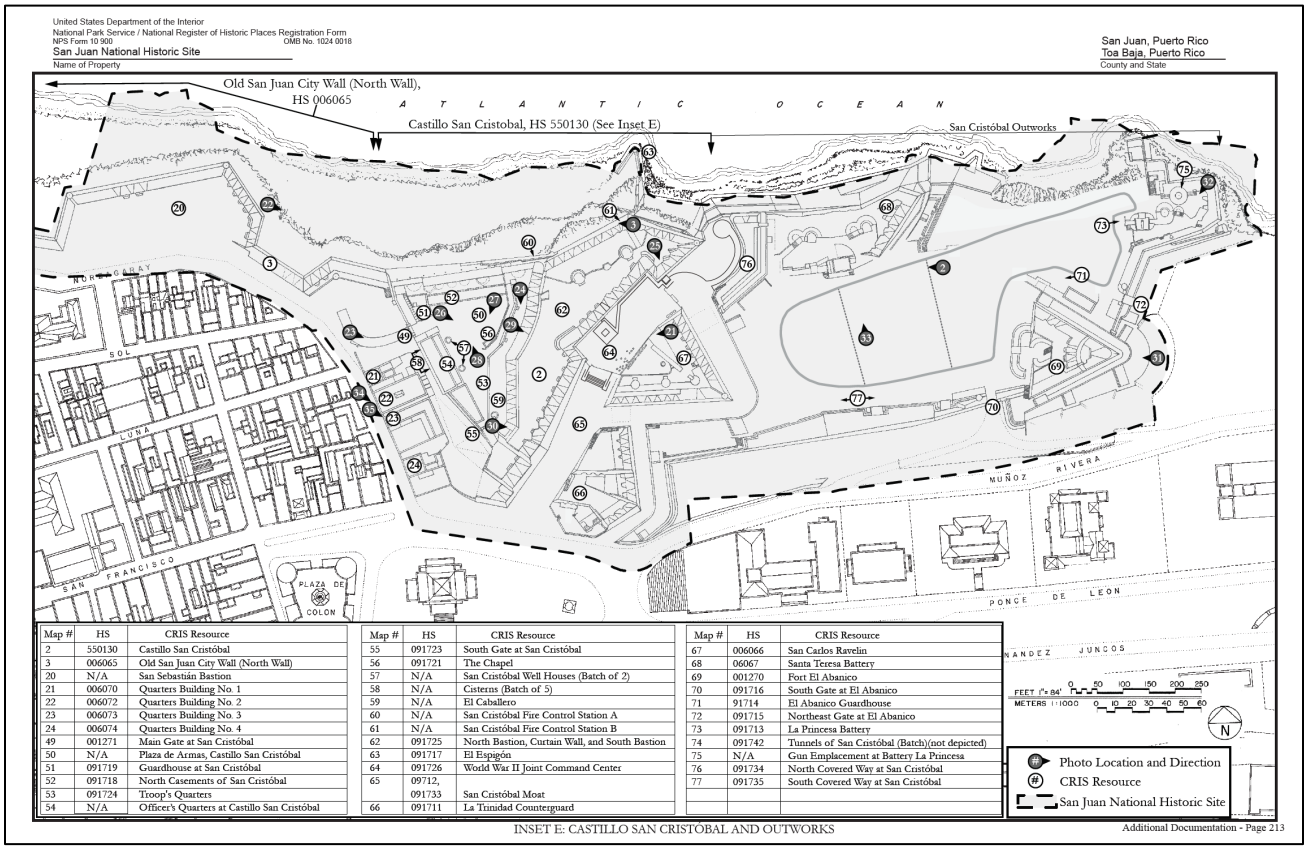
193. Bulger and Schiappacasse, 8[7]-4.
194. Bulger and Schiappacasse, 8[7]-4.
195. Bulger and Schiappacasse, 8-119.
196. Bulger and Schiappacasse, 8-120–121.

component of the system of colonial defensive architecture constructed by the Spanish Crown during the sixteenth through late nineteenth centuries and modified by the United States for its military defense system during the first half of the twentieth century."[197]

In the area of Ethnic Heritage, the additional documentation notes that the National Historic Site is significant at the state level under Criterion A, "for its association with Hispanic cultural history in Puerto Rico and its role as an unparalleled symbol of Puerto Rican identity."[198] The additional documentation also notes the National Historic Site's significance at the state level in Social History, also under Criterion A, for the National Historic Site's "association with the historic preservation movement in San Juan, which sought to protect the cultural heritage of Puerto Rico through preservation of the San Juan fortifications and other resources."[199]

Finally, in the area of Archeology - Historic, Non-Aboriginal, the additional documentation notes that the National Historic Site is significant at the national level under Criterion D in the areas of Military History, Maritime History, Ethnic Heritage, and Architecture, noting that archaeological resources at the site have both yielded and have the potential to yield information important to understanding of Spanish and American military history in Puerto Rico, as well as to the architectural development of the San Juan fortifications.[200]

The additional documentation does not indicate that the historic district is significant under any of the National Register Criteria Considerations.



Map #	HS	CRIS Resource
2	550130	Castillo San Cristóbal
3	006065	Old San Juan City Wall (North Wall)
20	N/A	San Sebastián Bastion
21	006070	Quarters Building No. 1
22	006072	Quarters Building No. 2
23	006073	Quarters Building No. 3
24	006074	Quarters Building No. 4
49	001271	Main Gate at San Cristóbal
50	N/A	Plaza de Armas, Castillo San Cristóbal
51	091719	Guardhouse at San Cristóbal
52	091718	North Casements of San Cristóbal
53	091724	Troop's Quarters
54	N/A	Officer's Quarters at Castillo San Cristóbal
55	091723	South Gate at San Cristóbal
56	091721	The Chapel
57	N/A	San Cristóbal Well Houses (Batch of 2)
58	N/A	Cisterns (Batch of 5)
59	N/A	El Caballero
60	N/A	San Cristóbal Fire Control Station A
61	N/A	San Cristóbal Fire Control Station B
62	091725	North Bastion, Curtain Wall, and South Bastion
63	091717	El Espigón
64	091726	World War II Joint Command Center
65	09712, 091733	San Cristóbal Moat
66	091711	La Trinidad Counterguard
67	006066	San Carlos Ravelin
68	06067	Santa Teresa Battery
69	001270	Fort El Abanico
70	091716	South Gate at El Abanico
71	91714	El Abanico Guardhouse
72	091715	Northeast Gate at El Abanico
73	091713	La Princesa Battery
74	091742	Tunnels of San Cristóbal (Batch)(not depicted)
75	N/A	Gun Emplacement at Battery La Princesa
76	091734	North Covered Way at San Cristóbal
77	091735	South Covered Way at San Cristóbal

Figure 1094. Map of Castillo San Cristóbal and Outworks, as illustrated in the 2022 National Register additional documentation. (Source: Bulger and Schiappacasse, *National Register of Historic Places Additional Documentation, San Juan National Historic Site*, 2022)

197. Bulger and Schiappacasse, 8-121.
198. Bulger and Schiappacasse, 8-121.
199. Bulger and Schiappacasse, 8-121.
200. Bulger and Schiappacasse, 8-121.

World Heritage Listing

San Juan National Historic Site and the earlier fortifications of La Fortaleza were inscribed in the World Heritage List in 1983 as resources of outstanding universal value. The listing notes that the fortifications:

> . . . outstandingly illustrate the adaptation to the Caribbean context of European developments in military architecture from the 16th to 20th centuries. They represent the continuity of more than four centuries of architectural, engineering, military, and political history.[201]

The World Heritage List citation for the fortifications also notes:

> These fortifications, which retain the general appearance of advanced 18th-century defense technology, clearly illustrate both a transfer of technology from Europe to America over a long period and its adaptation to the topography of a strategically significant yet difficult tropical site. Reflecting Italian Renaissance, Baroque, and French Enlightenment designs, the defenses express successive techniques and technologies in fortification construction. The varied examples of military architecture from the 16th to 20th centuries in the fortifications of San Juan are evidence of the imperial struggles that defined the development of the Americas. As one of the first as well as one of the last of the numerous seats of power in Spain's American empire, these structures are now potent symbols of the cultural ties that link the Hispanic world.[202]

The boundary for the World Heritage Site identified in the 1983 documentation was revised in an extension prepared in 2016. The letter articulating the boundary extension noted that the extension accurately reflects the boundaries of San Juan National Historic Site and was the intended basis for the 1983 nomination. Castillo San Cristóbal was included within the 1983 boundaries (Figure 1101).[203]

World Heritage Listing requires official recognition of national significance by the country in which the property is located, which can be met by National Historic Landmark designation (La Fortaleza is a designated National Historic Landmark, for example). The criterion for official recognition of national significance for inclusion in the World Heritage List can also be met by designation as a unit of the U.S. National Park System, which provides official recognition of national significance. This issue is addressed by 36 CFR section 73.7(b) of the World Heritage regulations, as follows:

> (1) The property must be nationally significant. For the purposes of this section, a property qualifies as "nationally significant" if it is:
>
> (i) A property that the Secretary of the Interior has designated as a National Historic Landmark (36 CFR part 65) or a National Natural Landmark (36 CFR part 62) under provisions of the 1935 Historic Sites Act (Public Law 74-292; 49 Stat. 666; 16 U.S.C. 461et seq.);
>
> (ii) An area the United States Congress has established as nationally significant; or
>
> (iii) An area the President has proclaimed as a National Monument under the Antiquities Act of 1906 (16 U.S.C. 433).

201. UNESCO World Heritage List. "La Fortaleza and San Juan National Historic Site in Puerto Rico." Accessed October 4, 2019. https://whc.unesco.org/en/list/266.
202. UNESCO World Heritage List, "La Fortaleza and San Juan National Historic Site in Puerto Rico."
203. Stephen A. Morris, Chief, Office of International Affairs, National Park Service, letter to Mechtild Rössler, Director, World Heritage Center, UNESCO, re: La Fortaleza and San Juan National Historic Site boundary clarification, November 6, 2015.

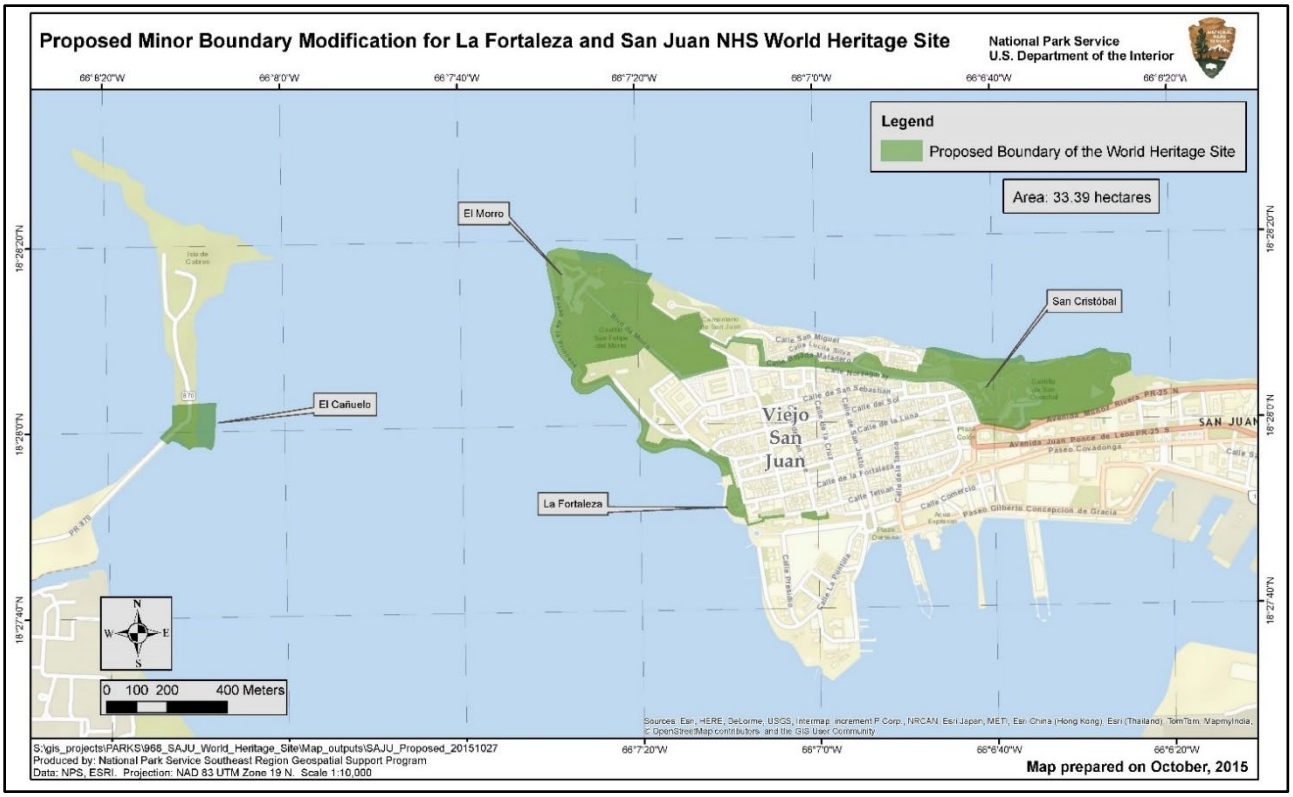


Figure 1095. Map of the 2016 boundary adjustment to La Fortaleza and San Juan National Historic Site World Heritage Site. (Source: National Park Service correspondence (2016) for Minor Boundary Modification, La Fortaleza and San Juan National Historic Site Listing World Heritage List web site, accessed August 2023, https://whc.unesco.org/en/list/266/documents/)

For San Juan National Historic Site, the official recognition of national significance is addressed both by its status as a unit of the U.S. National Park System and by its designation as a National Historic Site.[204]

Period of Significance

The 1972 National Register nomination documentation for Old San Juan, which includes the fortifications, and the 1973 nomination documentation for San Juan National Historic Site, both address the period of significance of the property as extending from the sixteenth through the nineteenth/twentieth centuries.[205] The 1973 documentation also notes as "specific dates" the period 1539–1945, suggesting a more defined period of significance than the centuries identified for "period" on the form.[206] The 2012 National Register documentation identifies the period of significance as 1519–1939, beginning with the founding of Viejo San Juan by Juan Ponce de León, and ending with "eve of World War II," characterized by the documentation's author as the end of the "Modern Period."[207] The 2013 National Historic Landmark documentation identifies the period of significance as 1519–1898, noting that the period of significance for the historic district is defined by the centuries of Spanish rule from the founding of San Juan in 1519 until annexation of Puerto Rico as a territory of the United States in 1898.[208]

204. *Federal Register*: 14 Fed. 37 (February 25, 1949); Historic Sites Act of 1935, 16 USC sec. 461–467.
205. Morales, 1972; Gjessing and Schmidt, 1973. As noted, these broad periods of significance comprising entire centuries are common in nomination documentation of the period because of the form used by the National Register at that time.
206. Gjessing and Schmidt.
207. Morales, Section 8.
208. Gjessing and Schmidt, 81.

The 1985 General Management Plan identified the "historic period" as 1539–1961, from "construction of El Morro in 1539 to transference of a major portion of the site to the Department of the Interior in 1961."[209]

The Historic Structure Report prepared for San Juan National Historic Site in 1991 identified five periods of significance for the site, as follows:

- Spanish I: circa 1539–1760, initiation of harbor defenses at El Morro, harbor walls, and city gate
- Spanish II: circa 1760–1835, period of major development at El Morro, San Cristóbal, and the north wall
- Spanish III: circa 1835–1898, modernization and rehabilitation of defensive system and outworks
- American I: circa 1898–1940, construction of the El Morro Lighthouse
- American II: circa 1940–1961, construction of the World War II harbor defense system.[210]

Similar to the General Management Plan, the 1991 Historic Structure Report identified the beginning of the period of significance as 1539, with the beginning of construction of the fortifications, and the end of the period of significance, 1961, "when the land contained within the former Fort Brooke Military Reservation was conveyed to the U.S. Department of the Interior."[211]

With respect to the cultural landscape, the Cultural Landscape Report portion of the 1991 Historic Structure Report noted two overarching periods of significance:

> The entire site history was reviewed to determine that two distinctly different types of landscape character existed, generally corresponding to the periods of Spanish and US occupation. These two periods have been classified as Period I, circa 1540–1898, and Period II, circa 1898–1961.[212]

By circa 1540, the main defensive fortifications for the city had been relocated to the morro (rocky outcrop) that rises above the eastern side of the entrance to the bay. During the period of Spanish occupation, El Morro Esplanade was developed and maintained as an integral part of the military fortifications of El Morro and San Juan, with a key role in defensive military actions and also as a training ground. The 1991 Cultural Landscape Report considers this period to be of primary significance.

The 1991 Cultural Landscape Report considers the latter period, corresponding to the U.S. Army occupation from 1898 to 1961, to be of secondary significance. The report emphasizes the development of El Morro Esplanade in the period of significance discussion, noting that the esplanade's "significant historic landscape qualifies had already been established by 1898."[213] Also, during the latter period, the U.S. Army effected a significant change in function for the esplanade, with the esplanade developed for military support activities including housing and recreation. The 1991 Cultural Landscape Report also noted that during Period I the esplanade was open and undeveloped, without large structures or trees, and offering unobstructed views from the fort to the city. During the second period, from around 1930 to 1961, the U.S. Army constructed

209. National Park Service, *Final General Management Plan and Environmental Assessment* (San Juan National Historic Site, Puerto Rico, U.S. Department of the Interior, National Park Service, December 1984, with FONSI and Statement of Findings, September 1985), 26.
210. Berkowitz et al., I, 16. Note that the 1991 report, *The Fortifications of San Juan National Historic Site: Historic Structure Report*, consists of three volumes; the Cultural Landscape Report is included as part of Volume III.
211. Berkowitz et al., I, 48–49.
212. Berkowitz et al., I, 48.
213. Berkowitz et al., III, 44–45.

roads and buildings and planted trees, creating a different landscape and more limited views from the esplanade.[214]

Regarding resources from the American period, however, the 1991 Historic Structure Report noted, "It has been determined that the American periods do not include any other resources that are known to be significant and to merit preservation."[215] The HSR identified any features reconstructed by the U.S. Army or the National Park Service as "non-historic" or "non-significant," and the remnants of Fort Brooke to be "insignificant and not worthy of preservation."[216] (The HSR later referred to World War II-era harbor defense features as "of secondary significance by comparison with the Spanish II period features"; at different points in the recommendations narrative, the HSR indicated that these features should be preserved, may be rehabilitated, or may be considered for removal.[217])

The 2022 National Register additional documentation identifies an overarching period of significance of 1539–1971.[218] The beginning date of this period is identified as when the Spanish first began construction of fortifications at the "el morro" headlands, and the end date fifty years prior to the completion of the additional documentation. Within this overarching period of significance, the additional documentation cites the following periods associated with the specific areas of significance identified for the historic district, as discussed below. (The additional documentation also notes several significant dates related to historical events, including the start and end dates for the sub-periods of significance.) The periods associated with the areas of significance are defined as follows:

- Military History, 1539–1945
- Maritime History, 1539–1945

  For Military History and Maritime History, the beginning and end dates of the period of significance are consistent with the overarching period identified in the additional documentation. The additional documentation acknowledges that the U.S. Army retained control of the fortifications until 1961, and further notes:

  > During the period of significance, the fortifications of San Juan National Historic Site played an important role in the military strategy of Spain, and later the United States, in the defense of each country's control of the island of Puerto Rico as well as the defense of each country's claim to control of the maritime traffic and commercial trade associated with the island and the Caribbean.[219]

- Architecture, 1539–1945

  For Architecture, the period of significance begins with construction of the first defensive structure on the El Morro headlands and concludes with the last architectural changes made by the U.S. Army in preparation for World War II.[220]

- Ethnic Heritage, 1539–1971

  For Ethnic Heritage, the period of significance begins in 1539, ". . . with the earliest European construction projects within San Juan National Historic Site, which set in motion centuries of cultural interactions."[221]

214. Berkowitz et al., III.
215. Berkowitz et al., I, 16.
216. Berkowitz et al., I, 16.
217. Berkowitz et al., I, 16.
218. Bulger and Schiappacasse, 8-120. The additional documentation notes that the periods associated with areas of significance of ethnic heritage and social history extend through 1971, as events associated with these areas of significance continued throughout the twentieth century.
219. Bulger and Schiappacasse, 8-120.
220. Bulger and Schiappacasse, 8-120.
221. Bulger and Schiappacasse, 8-121.

The period ends in 1971, fifty years before the date of the nomination.

- Social History, 1913–1971

  For Social History, the period of significance begins in 1913:

  > when a growing sense of Puerto Rican nationalist cultural identity and the increasing neglect of the fortifications on the part of the Army, led the territorial government of Puerto Rico to petition the United States Army for release of the fortifications to the "People of Puerto Rico." The site thereafter was subject of numerous Puerto Rican cultural preservation laws and local activism for historic preservation throughout the twentieth century."[222]

  The period ends fifty years before the date of the nomination.

  For the areas of Ethnic Heritage and Social History, the additional documentation notes that this end date was used ". . . as scholarly research is not yet available with respect to the contemporary importance of the fortifications in modern Puerto Rican ethnic heritage and social history."[223]

- Archeology - Historic, Non-Aboriginal, 1539–1945

  For Archeology - Historic, Non-Aboriginal, the period of significance begins with the earliest known historic occupation of the park at the initiation of construction of Castillo San Felipe del Morro and concludes with the end of the active use of the site by the United States military during World War II.[224]

The 2022 additional documentation encompasses the period of significance relevant to Castillo San Cristóbal as part of the larger fortifications begun in 1539, with construction of the first Spanish defensive fortifications on the El Morro headlands, through 1971, fifty years before the date of the nomination.

The 2022 documentation also notes the following significant dates:

> 1539: Construction begins at "el morro," the future site of Castillo San Felipe del Morro.
>
> 1586: Juan de Tejeda and Bautista Antonelli survey Spain's West Indies defenses.
>
> 1591: Completion of El Morro hornwork and the clifftop structure of Santa Elena Bastion.
>
> 1625: Reconstruction of hornwork at El Morro; New tower at Santa Bárbara Bastion and Mercado Bastion; construction of first wood fortifications at El Cañuelo.
>
> 1650: Completion of a two-decade campaign to complete a wall around the town of San Juan and a redoubt built at San Cristóbal Hill
>
> 1792: Completion of a 27-year modernization campaign, as recommended by Alexander O'Reilly, implemented by Chief Engineer O'Daly, and completed by engineer Juan Francisco Mestre.
>
> 1895: Spain begins to again modernize defenses at San Juan; new artillery is installed.
>
> 1897: Demolition of eastern City Walls, including Santiago Ravelin and Santiago Gate.
>
> 1898: Spanish-American War; United States bombards San Juan causing damage to forts.
>
> 1918: Coast Artillery Command build rapid-fire gun batteries to fire over parapets.
>
> 1940: Completion of a two-year WPA repair and reconstruction project.
>
> 1945: Completion of the United States building campaign to prepare for World War II.[225]

Although the initial construction of Castillo San Cristóbal is included within the period of significance developed for the 2022 additional

222. Bulger and Schiappacasse, 8-121.
223. Bulger and Schiappacasse, 8-121.
224. Bulger and Schiappacasse, 8-121.
225. Bulger and Schiappacasse, 8-119.

documentation, a period of 1634–1971 is appropriate when considering Castillo San Cristóbal as an individual resource. This period begins with original construction of Castillo San Cristóbal and ends fifty years before the date of the 2022 additional documentation for the overall historic district.

To be expanded once research and narrative for amendment has been completed.

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.[226]

The following list identifies existing character-defining features of Castillo San Cristóbal:

Overall

- Setting of the fortifications, including the relationship of the fort to the surrounding landscape, Old San Juan, and the Atlantic Ocean.
- General layout, plan, and orientation of the fortification, and the relationship between the different buildings and structures.
- Open spaces within and around fortifications, including the moat, Plaza de Armas, and the open space at the outer defenses.

Main Fortification

- Historic construction materials throughout the fortification.
- Craftsmanship and design of decorative details.
- Configuration and layout of masonry ramp and main entrance gate.
- Configuration of south gate.
- Layout, plan, and orientation of the main fortification, including the positioning of the north casemates, officers' quarters, troops' quarters, and chapel around Plaza de Armas, and the layout of the north bastion, curtain wall, and south bastion.
- Paved ramp and flat roof and rooftop battery at north casemates.
- Arcade along the south elevation of the north casemates.
- Configuration of door and window openings at the exterior and interior of the north casemates.
- Open arcade along the east elevation of the officers' quarters.
- Cornice along the top of the officers' quarters.
- Configuration of door and window openings at the exterior and interior of officers' quarters.
- Plan and configuration of troops' quarters.
- Symmetrical arrangement of doors and windows on east elevation of troops' quarters.
- Pilasters along the east elevation of the troops' quarters.
- Masonry vaults at the interior of the troops' quarters.
- Battered masonry walls of the north bastion, curtain wall, and south bastion.
- Embrasures along parapet walls of the north bastion, curtain wall, and south bastion.
- Sentry box at the north bastion.
- World War II-era concrete fire control station at the north parapet wall of the north bastion.

El Caballero de San Miguel

- Plan, configuration, and layout of El Caballero de San Miguel.

226. 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).

- Embrasures along the east parapet wall of El Caballero de San Miguel.
- World War II-era concrete fire control station at the northeast corner of El Caballero de San Miguel.

Moat

- Plan, configuration, and layout of the moat including relationship between the moat and surrounding structures including the main fortification, San Carlos Ravelin, and La Trinidad Counterguard.

San Carlos Ravelin

- Plan, configuration, and layout of San Carlos.
- Embrasures along the parapet walls of San Carlos.
- Sentry box at the east end of San Carlos.
- Concrete gun emplacements at the south parapet.
- Battered stone walls.
- Interior of casemates including vaulted ceilings.

La Trinidad Counterguard

- Plan, configuration, and layout of La Trinidad.
- Embrasures along the parapet walls of La Trinidad.
- Exterior stairs.
- Battered stone walls.
- Interior of casemates including vaulted ceilings.

Santa Teresa Battery

- Plan, configuration, and layout of Santa Teresa, including moat, masonry outwork, magazines, and gun emplacements.
- Stone and masonry walls.
- Configuration of doors and window openings.

La Princesa Battery

- Plan, configuration, and layout of La Princesa, including the curved outer walls, terreplein, moats, and scarp walls.
- Masonry walls.
- Concrete gun emplacements.

El Abanico

- Plan, configuration, and layout of El Abanico, including the relationship of El Abanico to the nearby guardhouse and gates.
- Dry moat around the perimeter of El Abanico.
- Stone masonry walls with stucco finish and brick masonry elements.
- Embrasures along the parapet walls.

World War II Joint Command Center

- *To be added once research and narrative for Volume II has been completed.*

Assessment of Integrity

Assessment of integrity is based on an evaluation of the existence and condition of the physical 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.[227]

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."[228]

Integrity of Location. Castillo San Cristóbal retains integrity of location. The location of the fortifications atop and adjacent to Castillo San Cristóbal Hill has remained unchanged since original construction.

Integrity of Design. Castillo San Cristóbal retains integrity of design. Although the landscape, buildings, and structures have been altered through additions and modifications, most of these changes occurred during the period of significance, with the fortification retaining integrity to the various sub-periods in which features were constructed. The historic plan and configuration of the fortifications remain.

Integrity of Setting. Castillo San Cristóbal retains integrity of setting. The relationship of the fortifications to the surrounding site, Old San Juan, and to the Atlantic Ocean remain intact.

Integrity of Materials and Workmanship. Castillo San Cristóbal retains integrity of materials and workmanship. Many of the alterations made to the fortification were undertaken during the period of significance and represent Spanish or U.S. military construction practices during the sub-period in which they were constructed.

Integrity of Feeling. Castillo San Cristóbal retains integrity of feeling and continues to convey its historic character. The views to the Atlantic Ocean and continued association with Old San Juan reinforce the integrity of feeling.

Integrity of Association. Castillo San Cristóbal retains integrity of association and maintains its relationship with the other features of the site that form a part of the fortifications, as well as its representation of Spanish and U.S. military history.

227. *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.
228. *National Register Bulletin: How to Apply the National Register Criteria for Evaluation*.

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Treatment and Use

Requirements for Treatment and Use

The following discussion of treatment and use for Castillo San Cristóbal at San Juan National Historic Site has been prepared based on historical research, condition assessment, and discussion with the National Park Service. The buildings and structures that comprise Castillo San Cristóbal and are part of this study are contributing features to the historic district that comprises San Juan National Historic Site and survive with sufficient integrity to convey their historic associations.

As such, treatment and use of Castillo San Cristóbal 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 interpreted for visitor use.

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), 2024
- International Existing Building Code (IEBC), 2024
- NPS Guiding Principles of Sustainable Design

The Commonwealth of Puerto Rico has adopted the 2018 IBC, with the most recent updates made in November 2020. The National Park Service is self-regulating in terms of enacting and enforcing building code standards. San Juan National Historic Site 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, NPS utilizes the series of codes developed by the International Code Council (ICC). As a result, the 2024 IBC is the model building code used by the National Park Service for design and construction. The NPS Denver Service Center also references the 2024 IEBC, with appendices, and ABAAS, with F202.5, Alterations to Qualified Historic Buildings and Facilities, relevant to Castillo San Cristóbal.

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 2024 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 *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 R306 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 R306 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.[229]

The IEBC exceptions noted above pertain to Castillo San Cristóbal as structures listed on 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*.[230]

Guiding documents include the park's *Foundation Document* (2013).

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,

229. International Code Council, Inc., International Existing Building Code 2024 (Country Club Hills, Illinois: International Code Council, 2023).
230. 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.[231]

Of the four treatment approaches, *preservation*, which involves sustaining the building or structure in its existing form, is most appropriate for Castillo San Cristóbal.

Within the overarching preservation approach for Castillo San Cristóbal, this study recommends making the repairs necessary to maintain and preserve the structures in their existing state for continued use by the park. This includes ongoing regular maintenance of the stone walls that comprise Castillo San Cristóbal, as outlined in the recommendations, as well as other repairs that will assist in the preservation of the structures.

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

Future use of Castillo San Cristóbal is anticipated to be similar to its current function— historic military structures interpreted for visitors. Any minor changes to this use should be formulated so as to not require significant alterations to the historic exterior or primary interior spaces and features. Where future modifications are considered to provide universal access and meet code requirements, these modifications should be designed to retain original historic materials, features, and character wherever possible. Where incorporation of new amenities would require significant alterations to Castillo San Cristóbal that could diminish its integrity as a historic resource, consideration should be given to limiting or avoiding these modifications.

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

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 requirements for treatment and use outlined above for Castillo San Cristóbal at San Juan National Historic Site. 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.[232]

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 Castillo San Cristóbal and the 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.

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

- 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.

Recommendations

The following specific recommendations for treatment of Castillo San Cristóbal follow the overarching treatment approach of *preservation*.

Site

- Retain the buildings and structures that comprise Castillo San Cristóbal in their current location and avoid construction of new structures that would interfere with views of historic structures.
- Continue to maintain the site around the structures through regular clearing so that the site immediately around the buildings and structures is free of trees and heavy ground vegetation.
- Remove vines and other vegetation growing on the structures. When removing vegetation, all tools, clothing, and footwear should be washed or changed between sites to avoid the potential spread of invasive species.
- Follow recommendations included in the 2015 Cultural Landscape Report for the outworks, including:
    - Removal of vegetation growth on fortification walls, particularly near La Princesa, where tree roots are damaging the historic walls.
    - Installation of visitor circulation system at outworks.
    - Relocation of masonry stockpiles to mark location of missing defense structures in the glacis of the outworks.
    - Removal of existing security fencing with barbed wire and replacement with shorter fencing that will create a more welcoming appearance while also discouraging the public from accessing unsafe areas.
    - Removal of existing stainless-steel open-frame railings that do not meet current life safety codes and replace with code-compliant railings similar to those present at the Garita del Diablo lookout.

Walls

- Regularly review walls for loose and spalled stone, parge coating, and mortar. Any loose pieces of stone, coating, or mortar that could be considered a fall hazard should be removed.
- Consideration could be given to regularly cleaning the escarpment where efflorescence and staining are present. Prior to cleaning, trial cleaning studies should be conducted to address soiling and biological growth. Cleaning should be repeated only as needed to remove heavy soiling or staining. Rinsing with clean water to remove bird droppings and other accretions can occur more frequently. Given the location of the escarpment along the coastline, cleaning may prove to be ineffective.
- Repair areas where spalls are present at La Garita del Diablo and where cracking and spalls are widespread on retaining walls. Repair materials should match the existing materials in color and composition. Prior to repair, determine the composition of extant historic coating.

  Existing, non-compatible repairs can remain, assuming they are sound and not causing damage to underlying stone or brick masonry.

  Regularly monitor existing repairs to ensure they are sound.
- Further investigation is necessary to determine how La Garita del Diablo will behave during extreme weather events that produce extreme waves. Refer to Appendix C: Structural Analysis, for further discussion.

Main Fortifications

Plaza de Armas

- Remove cracked, spalled, and otherwise failed repairs at the concrete paving at Plaza de Armas and replace with new concrete. New concrete should match existing in color, finish, texture, and composition of existing concrete, which dates to the mid-twentieth century. In areas where cracking and spalling is widespread, consideration should be given to removal and replacement of the entire concrete section.
- Consideration should be given to modifications to the concrete plaza, including partial replacement to better accommodate drainage, as water ponds at low portions of the plaza following rain. Prior to modification of the plaza, further investigation of the plaza drainage system should be conducted to determine if water is properly drained. This could include an inspection using a sewer camera.
- Remove cracked mortar at joints between concrete paving and the cistern enclosure. A sealant with backer rod for use in horizontal concrete surfaces that can withstand submersion in water should be installed at the joints. The sealant color should match adjacent concrete paving.
- Spalled, eroded, cracked, and missing stucco should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. After curing, the new stucco should be coated with a breathable surface coating to match the adjacent original surfaces. Where the stucco is missing or is removed and replaced, the underlying masonry should be repaired, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.

  To address flaking and peeling coating at the stucco on the chapel building, consideration should be given to recoating the entire chapel as part of any stucco repair work.
- The source of diagonal cracking at the west side of the chapel and vertical, horizontal, and spider cracking at the cistern enclosure should be investigated. Potential sources of cracking may include integration with adjacent ramp at the chapel and water infiltration and movement of underlying masonry at the cistern enclosure. Investigate the masonry lintel at the cistern enclosure door opening to confirm displacement and determine if the lintel is moving. Once the source(s) of cracking have been addressed, repoint open and cracked mortar joints in the wall and recoat the wall surface.
- Deterioration and distress at mortar joints between stone masonry units should be addressed using repair techniques that include the following steps:

  Unsound mortar should be removed to a depth of 2-1/2 times the width of the joint, or to sound mortar, whichever is greater. Work should be performed using handheld, non-power tools. A skilled mason can sometimes accomplish joint preparation without damaging the adjacent substrate by using a small power tool to cut along the center of the joint, followed by use of a hand tool (chisel) to remove mortar adjacent to the center cut. This process, if properly implemented, can sometimes result in less potential damage to the masonry adjacent to the joint than preparation using hand tools only, particularly for existing hard mortar adjacent to eroded or spalled stone. A trial sample is required to evaluate the skill of the mason and effectiveness of the repair.

  Joints should be repointed using appropriate mortars that match existing historic mortars. The use of hard portland cement-based mortars should be avoided. Commercially available portland cement mortars should be avoided because they can contain undisclosed additives.

Laboratory studies of existing and new mortar should continue to be undertaken to develop information for replacement mortar mixes.

Pointing work should match historic mortar joints in color, texture, joint size, profile, and tooling.

Since the repointing work may be performed over an extended period, a detailed protocol for tracking the extent of work and materials installed each year should be established. The protocol should include photographic documentation of the work before, during, and after repointing; marked-up plan and elevation drawings to indicate the extent of work; written records of mortar mixes; and physical mortar cubes prepared at the same time mortar is installed to be cured, labeled, and stored in the park archive for future comparison.

- Monitor cracked and spalled floor tile and parging at the chapel interior. Any loose pieces of marble should be removed and reset. Damaged parge coating should be removed and replaced. New parge coating should match the existing in color and composition.

Gates

- Repair cracked concrete paving at entrance ramps. Given that cracks appear at regular intervals and are perpendicular across the width of the ramps, the cracks are serving as expansion joints. Consideration should be given to installing sealant and backer rod at the existing cracks to accommodate movement. New sealant should match the color of adjacent concrete. Trial repairs should be performed to evaluate the repair, including the installation method and visual impact.
- Deterioration and distress at mortar joints between stone masonry units should be addressed using repair techniques that include the following steps:

  Unsound mortar should be removed to a depth of 2-1/2 times the width of the joint, or to sound mortar, whichever is greater. Work should be performed using handheld, non-power tools. A skilled mason can sometimes accomplish joint preparation without damaging the adjacent substrate by using a small power tool to cut along the center of the joint, followed by use of a hand tool (chisel) to remove mortar adjacent to the center cut. This process, if properly implemented, can sometimes result in less potential damage to the masonry adjacent to the joint than preparation using hand tools only, particularly for existing hard mortar adjacent to eroded or spalled stone. A trial sample is required to evaluate the skill of the mason and effectiveness of the repair.

  Joints should be repointed using appropriate mortars that match existing historic mortars. The use of hard portland cement-based mortars should be avoided. Commercially available portland cement mortars should be avoided because they can contain undisclosed additives.

  Laboratory studies of existing and new mortars should continue to be undertaken to develop information for replacement mortar mixes.

  Pointing work should match historic mortar joints in color, texture, joint size, profile, and tooling.

  Since the repointing work may be performed over an extended period, a detailed protocol for tracking the extent of work and materials installed each year should be established. The protocol should include photographic documentation of the work before, during, and after repointing; marked-up plan and elevation drawings to indicate the extent of work; written records of mortar mixes; and physical mortar cubes prepared at the same time mortar is installed to be cured, labeled, and stored in the park archive for future comparison.
- Stone units with shallow erosion do not require repair unless horizontal surfaces exist that allow water to pond on the surface of the stone unit. If this condition is present, consideration should be given to retooling the face of the stone units to ensure water can

properly drain off the face. Tool marks should match the existing finish of the stones.

- Repair stone units with large spalls or cracks that may present a safety hazard if not addressed, or that may collect water, which contributes to ongoing or accelerated deterioration. Where stone repair is considered, various options are available. For severely eroded or cracked stone units where much of the original material is already lost, consideration can be given to replacement in kind with an entirely new sandstone unit. Replacement units should be photographically documented before, during, and after the work, and drawings should be annotated to show the location of the units. The new unit should be permanently embossed or engraved on a concealed surface with a notation such as "NPS, 2024." For stones with localized damage, dutchman units can be installed that replace a portion of the original unit with compatible sandstone, cut square and installed to re-create the original profile.

  Where cracked or loose cementitious repairs are present at the cheek wall along the main gate ramp, the patches should be removed. Consideration should be given to installing replacement stone units, as described above, if much of the original material is lost. If only localized damage is present, dutchman units can be installed, as described above.

- Spalled, eroded, cracked, and missing stucco should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. After curing, the new stucco should be coated with a breathable surface coating to match the adjacent original surfaces. Where the stucco is missing or is removed and replaced, the underlying masonry should be repaired, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.

- Peeling paint and corrosion at iron and steel elements should be removed and repaired as follows:

  The existing surface coating and rust scale should be removed to bare metal using abrasive blasting in preparation for a new coating system. (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 removal of paint, 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, followed by abrasive blasting to prepare the surface to receive the new coating system. The steel or iron surfaces should be pressure-washed to remove chloride contamination.

  Where previously coated, exposed metal surfaces, such as anchors, should be prepared and coated with a high-performance coating system, including a zinc-rich primer. 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.

  If stainless-steel hardware is coated to match historic finishes, proper preparation of the surface is needed.

  Adjacent masonry should be protected prior to any work on steel and iron elements in situ.

North Casemates

- The source of cracking at the underside of the concrete roof slab should be investigated. Given the presence of moisture staining and efflorescence around the cracks, water

infiltration through the roof above may be contributing to the cracks.

- The shallow pitting of the concrete floor finish at the arcade of the north casemates does not appear to present a tripping hazard. As a result, no repair is recommended at this time. However, the condition of the floor should be monitored, and repairs should be undertaken in the future, if the pitting worsens and presents a life safety hazard.
- Consideration should be given to modifications to the concrete floor in the arcade where ponding water was noted. The ponding water occurs where the mid-century concrete paving intersects with what appears to be historic paving. Potential repairs could include replacement of the concrete floor paving where ponding is occurring to better align with adjacent pavement.
- Spalled, eroded, cracked, and missing stucco at the casemate walls should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. After curing, the new stucco should be coated with a breathable surface coating to match the adjacent original surfaces. Where the stucco is missing or is removed and replaced, the underlying masonry should be repaired, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Embedded steel at the stucco or plaster walls should be repaired as follows:

  The existing surface coating and rust scale should be removed to bare steel using abrasive blasting in preparation for a new coating system. (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 removal of paint, 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, followed by abrasive blasting to prepare the surface to receive the new coating system. The steel surfaces should be pressure-washed to remove chloride contamination.

  Where previously coated, exposed metal surfaces, such as anchors, should be prepared and coated with a high-performance coating system including a zinc-rich primer. 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.

  If stainless-steel hardware is coated to match historic finishes, proper preparation of the surface is needed.
- Consideration could be given to installation of new parge coating over exposed brick masonry at west ramp stairs on the north casemates. Prior to installation of the parge coating, any cracked or loose mortar at joints between brick units should be repaired. New parge coating should match existing in color, texture, finish, and composition.
- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.
- Spalled and eroded brick masonry should be removed and replaced at locations where much of the original material is already lost, including sills and at the parapet at the roof level. New bricks should match the existing in size and color. In locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed using appropriate mortars that

match existing historic mortars in conjunction with any brick replacement.

- Cracked and spalled wall plaster should be removed and replaced with new plaster compatible with the existing substrate and matching the historic plaster in composition and texture. In locations where there are signs of water infiltration at the damaged plaster, further investigation is needed prior to the completion of plaster repairs to identify the source of the infiltration. Following the completion of plaster repairs, these areas should be repainted to match the existing wall finish.
- Split, checked, and deteriorated wood at windows shutters and sills should be replaced if significant amounts of the existing material are lost. If the area of deterioration is localized, a wood dutchman unit can be installed rather than replacing the entire element. New wood should match the existing in size and species.
- Investigate the existing drainage system to determine if it is working as intended. This could include the use of a sewer camera. As indicated by investigation, consider partial replacement of the storm drain system including exposed and corroded drainpipes.
- Clean brick masonry where affected by biological growth and efflorescence. Prior to cleaning, conduct trial cleaning studies to address soiling and biological growth on masonry. Cleaning treatments fall into three general categories: water-based, chemical, and mechanical methods. Water-based methods include pressurized water spray, heated water or steam treatments, and misting. Chemical methods involve the use of products ranging from non-ionic detergents to acidic or alkaline cleaners, as well as biocidal treatments, in a variety of gels, liquids, pastes, and poultices. Mechanical cleaning methods include very low pressure (less than 75 psi) micro-abrasive systems and specialized laser-based cleaning equipment; these techniques are likely not appropriate for the masonry at Castillo San Cristóbal.

The selection of a removal method should be based on successful trials and should follow the Secretary of the Interior's Standards for the Treatment of Historic Properties, which state 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.

Low-pressure water washing can be effective, at no greater than 100 to 200 pounds per square inch (psi), or less as indicated by trial samples. Any cleaning method using water should occur only when the temperature will remain above 50 degrees Fahrenheit for at least 72 hours after cleaning.

If chemicals are used, test samples should be performed and carefully evaluated to avoid over-cleaning. Chemical cleaners should be selected by an expert in the type and condition of the masonry material to be cleaned. Cleaners containing strong acids or which are highly alkaline can damage historic materials and should be avoided. Some chemical cleaners may also result in the staining of porous masonry in the near term and long term.

Biological staining can be removed using an approved masonry cleaner/biocide containing a quaternary ammonium compound, if shown by trials to be appropriate for the masonry at the north casemates. This type of cleaner helps to discourage the recurrence of organic growth on the masonry surface.

Appropriate water pressure, nozzle, distance, and fan tip should be used based on cleaning trials and conservator's microscopic examination of trial samples and uncleaned masonry. Only stainless-steel nozzles with fan tip spray, typically 40 degrees, should be used, held a minimum of 12 to 18 inches from the surface being cleaned. Prewetting and thorough rinsing are necessary in any cleaning process involving water or chemical cleaning. Finally, it should be understood that some soiling may remain; the masonry should not be expected to appear new after cleaning.

Cleaning should be repeated only as needed to remove heavy soiling or staining. Rinsing with low-pressure clean water to remove bird droppings and other accretions can occur more frequently. A treatment record should be maintained of cleaning work, including date of cleaning, materials used, notation of any change in condition since the previous cleaning, and field notes with photographs.

Troops' Quarters

- Spalled, eroded, cracked, and missing stucco at the walls of the troops' quarters should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. After curing, the new stucco should be coated with a breathable surface coating to match the adjacent original surfaces. Where the stucco is missing or removed and replaced, the underlying masonry should be repaired, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.

  At areas repaired in 2017, where the distress is most pronounced, further investigation is needed to determine if water infiltration is causing the distress at the stucco. Potential investigation could include water infiltration testing and inspection openings to better understand what may be causing the ongoing distress. This investigation should be completed before any repairs to the exterior of the building, including the underlying masonry, are undertaken. Prior to repairs, consideration could be given to installing mock-up repairs to determine if the repairs will be more durable than the previous work.

- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.

- Spalled and eroded brick masonry should be replaced at locations where much of the original material is already lost, including sills and at the parapet at the roof level. New bricks should match the existing in size and color. In locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed using appropriate mortars that match existing historic mortars in conjunction with any brick replacement.

- Pintle hinges should be replaced where severe or full section loss was observed. New stainless-steel hinges should match existing in size and style.

- Deteriorated clear finish on wood windows at the south facade of the second-floor addition should be stripped; the wood prepared and treated with a biocide; and refinished with a protective clear surface coating.

- Consideration should be given to the replacement of deteriorated portions of wood handrails. New wood should match the existing in profile and species. In conjunction with any wood repair work, repaint handrails to match existing.

- Investigate potential causes of water infiltration at interior of troops' quarters that appear to be cause of efflorescence, discoloration, moisture staining, and bubbling paint. Sources of water infiltration should be determined before proceeding with any plaster repairs. Once water infiltration has been addressed, cracked and spalled wall plaster should be removed and replaced with new plaster compatible with the existing substrate and matching the historic plaster in composition and texture. Following the completion of plaster repairs, these areas should be repainted to match the existing wall finish.

- In areas where plaster damage was noted but no signs of water infiltration were observed, cracked and spalled wall plaster should be removed and replaced with new plaster compatible with the existing substrate and matching the historic plaster in composition and texture. Following the completion of

plaster repairs, these areas should be repainted to match the existing wall finish.

- Embedded steel at the stucco or plaster walls should be repaired as follows:

  The existing surface coating and rust scale should be removed to bare steel using abrasive blasting in preparation for a new coating system. (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 removal of paint, 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, followed by abrasive blasting to prepare the surface to receive the new coating system.

  The steel surfaces should be pressure-washed to remove chloride contamination.

  Where previously coated, exposed metal surfaces, such as anchors, should be prepared and coated with a high-performance coating system, including a zinc-rich primer. 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.

- Concrete repair mixes should be developed to match the color, finish, and texture of the original concrete. Form and pour techniques should be used for repairs rather than trowel-applied patches. 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 to retain as much sound concrete beyond the spalled area as possible. The sawcut may align with edges of the formboard profile where present and as appropriate to the repair location.

  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.

  Repair concrete matching the original concrete color, finish, and texture (as discussed above), should be placed and consolidated. The concrete repair should be wet cured.

Officers' Quarters

- Spalled, eroded, cracked, and missing stucco at the walls of the officers' quarters should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. After curing, the new stucco should be coated with a breathable surface coating to match the adjacent original surfaces. Where the stucco is missing or removed and replaced, the underlying masonry should be repaired, including replacing deteriorated masonry units in kind and repointing open or friable

mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.

At areas where signs of water infiltration are present, further investigation is needed to determine if water infiltration is causing the distress at the stucco. This should be completed before any repairs to the exterior of the building are undertaken.

Further investigation is needed at the south end of the officers' quarters to understand the reason for and extent of cracking and to develop appropriate repairs.

- Remove and reinstall the displaced window frame at the women's restroom at the south addition of the officers' quarters. Any deteriorated wood should be replaced if significant amounts of the existing material are lost. New wood should match the existing in size and species.
- Split, checked, and deteriorated wood at windows, shutters and doors should be replaced if significant amounts of the existing material are lost. If the area of deterioration is localized, a wood dutchman unit can be installed rather than replacing the entire element. New wood should match the existing in size and species.
- Deteriorated clear finish on wood window at the south facade of the second-floor addition should be stripped; the wood prepared and treated with a biocide; and refinished with a protective clear surface coating.
- Pintle hinges where full section loss was observed should be replaced. New hinges should match existing in size and style.
- Consideration could be given to the installation of new parge coating where existing coating is cracked at parapet walls. Prior to installation of parge coating, any cracked or loose mortar at joints between brick units should be repaired. New parge coating should match the existing in color, texture, finish, and composition.
- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.
- Any vegetation, including small, rooted plants and other growth at mortar joints should be removed. When removing vegetation, all tools, clothing, and footwear should be washed or changed between sites to avoid the potential spread of invasive species. Any damage to the mortar joints in these areas should be addressed, as follows:

  Unsound mortar should be removed to a depth of 2-1/2 times the width of the joint, or to sound mortar, whichever is greater. Work should be performed using handheld, non-power tools. A skilled mason can sometimes accomplish joint preparation without damaging the adjacent substrate by using a small power tool to cut along the center of the joint, followed by use of a hand tool (chisel) to remove mortar adjacent to the center cut. This process, if properly implemented, can sometimes result in less potential damage to the masonry adjacent to the joint than preparation using hand tools only, particularly for existing hard mortar adjacent to eroded or spalled stone. A trial sample is required to evaluate the skill of the mason and effectiveness of the repair.

  Joints should be repointed using appropriate mortars that match existing historic mortars. The use of hard portland cement-based mortars should be avoided. Commercially available portland cement mortars should be avoided because they can contain undisclosed additives.

  Laboratory studies of existing and new mortars should continue to be undertaken to develop information for replacement mortar mixes.

  Pointing work should match historic mortar joints in color, texture, joint size, profile, and tooling.

  Since the repointing work may be performed over an extended period, a detailed protocol for tracking the extent of work and materials installed each year should be established. The protocol should include photographic

documentation of the work before, during, and after repointing; marked plan and elevation drawings to indicate the extent of work; written records of mortar mixes; and physical mortar cubes prepared at the same time mortar is installed, to be cured, labeled, and stored in the park archive for future comparison.

- Investigate potential causes of water infiltration at interior of officers' quarters that appear to be cause of efflorescence, discoloration, moisture staining, cracked plaster, bubbling paint, and cracked and deteriorated concrete. Sources of water infiltration should be determined before proceeding with any plaster repairs.

  Once water infiltration has been addressed, cracked and spalled wall plaster should be removed and replaced with new plaster compatible with the existing substrate and matching the historic plaster in composition and texture. Following the completion of plaster repairs, these areas should be repainted to match the existing wall finish.

- In areas where plaster damage was noted but no signs of water infiltration were observed, cracked and spalled wall plaster should be removed and replaced with new plaster compatible with the existing substrate and matching the historic plaster in composition and texture. Following the completion of plaster repairs, these areas should be repainted to match the existing wall finish.

- Concrete repair mixes should be developed to match the color, finish, and texture of the original concrete. Form and pour techniques should be used for repairs rather than trowel-applied patches. 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 to retain as much sound concrete beyond the spalled area as possible. The sawcut may align with edges of the formboard profile where present and as appropriate to the repair location.

  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.

  Repair concrete matching the original concrete color, finish, and texture (as discussed above), should be placed and consolidated. The concrete repair should be wet cured.

  Interior concrete repairs should not be undertaken until investigation of ongoing water infiltration has been completed and the source of the water has been remedied.

- Where quarry tiles are cracked and chipped resulting in a majority of the tiles being damaged or missing, new tiles should be installed. The new tiles should match the existing.

  In locations where the quarry tile is missing and has been replaced with parge coating, consideration could be given to replacing damaged parge coating with new quarry tile to match existing tile.

- Develop a conservation plan to preserve and maintain historic painted tile at the center casemate of the officers' quarters.

North Bastion, South Bastion, and Curtain Wall

- Review close-up the exterior walls of the north and south bastions and curtain wall and remove any loose stucco.
- Deterioration and distress at mortar joints between stone and brick masonry units at the exterior walls should be addressed using repair techniques that include the following steps:

  Unsound mortar should be removed to a depth of 2-1/2 times the width of the joint, or to sound mortar, whichever is greater. Work should be performed using handheld, non-power tools. A skilled mason can sometimes accomplish joint preparation without damaging the adjacent substrate by using a small power tool to cut along the center of the joint, followed by use of a hand tool (chisel) to remove mortar adjacent to the center cut. This process, if properly implemented, can sometimes result in less potential damage to the masonry adjacent to the joint than preparation using hand tools only, particularly for existing hard mortar adjacent to eroded or spalled stone. A trial sample is required to evaluate the skill of the mason and effectiveness of the repair.

  Joints should be repointed using appropriate mortars that match existing historic mortars. The use of hard portland cement-based mortars should be avoided. Commercially available portland cement mortars should be avoided because they can contain unnecessary and undisclosed additives and fillers.

  Laboratory studies of existing and new mortars should continue to be undertaken to develop information for replacement mortar mixes.

  Pointing work should match historic mortar joints in color, texture, joint size, profile, and tooling.

  Since the repointing work may be performed over an extended period, a detailed protocol for tracking the extent of work and materials installed each year should be established. The protocol should include photographic documentation of the work before, during, and after repointing; marked plan and elevation drawings to indicate the extent of work; written records of mortar mixes; and physical mortar cubes prepared at the same time mortar is installed to be cured, labeled, and stored in the park archive for future comparison.
- Repair stone units with large spalls or cracks that may present a safety hazard if not addressed, or that may collect water, which contributes to ongoing or accelerated deterioration. Where stone repair is considered, various options are available. For severely eroded or cracked stone units where much of the original material is already lost, consideration can be given to replacement in kind with an entirely new sandstone unit. Replacement units should be photographically documented before, during, and after the work, and drawings should be annotated to show the location of the units. The new unit should be permanently embossed or engraved on a concealed surface with a notation such as "NPS, 2024." For stones with localized damage, dutchman units can be installed that replace a portion of the original unit with compatible sandstone, cut square and installed to re-create the original profile.

  Where cracked or loose cementitious repairs are present, the patches should be removed. Consideration should be given to installing replacement stone units, as described above, if much of the original material is lost. If only localized damage is present, dutchman units can be installed, as described above.
- Any previous cementitious patches that are sound and intact can remain in place. Damaged patches should be removed with repairs made to the underlying stone and mortar joints as described above.
- Spalled, eroded, cracked, and missing stucco at interior or covered walls of the north and south bastions, including at tunnels, should be removed and replaced with stucco matching the surface texture and general composition of

the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.

At areas where signs of water infiltration are present, further investigation is needed to determine if water infiltration is causing the distress at the stucco. This should be completed before any repairs to the exterior of the building are undertaken.

Investigate possible sources of water infiltration at walls of the tunnel that leads to the north bastion.

- Concrete repair mixes should be developed to match the color, finish, and texture of the original concrete. Form and pour techniques should be used for repairs rather than trowel-applied patches. 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 to retain as much sound concrete beyond the spalled area as possible. The sawcut may align with edges of the formboard profile where present and as appropriate to the repair location.

  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.

  Repair concrete matching the original concrete color, finish, and texture (as discussed above), should be placed and consolidated. The concrete repair should be wet cured.

  Interior concrete repairs should not be undertaken until investigation of ongoing water infiltration has been completed and the source of the water has been remedied.

- Regularly inspect drainage paths and remove any debris or sedimentation that is present.
- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.
- Develop a conservation plan to preserve historic graffiti that is visible on the curtain wall and south bastion embrasure walls.
- Further structural analysis of the north bastion garita structure is recommended to accurately assess the applied stresses on the masonry from design wind loads. Refer to Appendix C: Structural Analysis, for further discussion.

Tunnels

- At areas where signs of water infiltration are present, further investigation is needed to determine if water infiltration is causing the distress.
- Once water infiltration has been addressed, cracked and spalled wall plaster should be removed and replaced with new plaster compatible with the existing substrate and

matching the historic plaster in composition and texture.

- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.
- Evaluate stone rubble at the top of the south dungeon wall by sounding to ensure stone is not loose or at risk of falling.
- Develop a conservation plan to preserve historic graffiti that is visible along the east wall of the dungeon.
- Monitor the cracks in the dungeon to determine if there is any active movement. If determined there is no active movement, repair the cracks with mortar that is compatible with the historic mortar.
- Embedded steel at walls should be repaired as follows:

  The existing surface coating and rust scale should be removed to bare steel using abrasive blasting in preparation for a new coating system. (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 removal of paint, 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, followed by abrasive blasting to prepare the surface to receive the new coating system.

  The steel surfaces should be pressure-washed to remove chloride contamination.

  Where previously coated, exposed metal surfaces, such as anchors, should be prepared and coated with a high-performance coating system, including a zinc-rich primer. 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.

El Caballero de San Miguel

- Review close-up the exterior walls of El Caballero and remove any loose stucco.
- Deterioration and distress at mortar joints between stone and brick masonry units at the exterior walls should be addressed using repair techniques that include the following steps:

  Unsound mortar should be removed to a depth of 2-1/2 times the width of the joint, or to sound mortar, whichever is greater. Work should be performed using handheld, non-power tools. A skilled mason can sometimes accomplish joint preparation without damaging the adjacent substrate by using a small power tool to cut along the center of the joint, followed by use of a hand tool (chisel) to remove mortar adjacent to the center cut. This process, if properly implemented, can sometimes result in less potential damage to the masonry adjacent to the joint than preparation using hand tools only, particularly for existing hard mortar adjacent to eroded or spalled stone. A trial sample is required to evaluate the skill of the mason and effectiveness of the repair.

  Joints should be repointed using appropriate mortars that match existing historic mortars. The use of hard portland cement-based mortars should be avoided. Commercially available portland cement mortars should be avoided because they can contain unnecessary and undisclosed additives and fillers.

  Laboratory studies of existing and new mortars should continue to be undertaken to develop information for replacement mortar mixes.

  Pointing work should match historic mortar joints in color, texture, joint size, profile, and tooling.

Since the repointing work may be performed over an extended period, a detailed protocol for tracking the extent of work and materials installed each year should be established. The protocol should include photographic documentation of the work before, during, and after repointing; marked plan and elevation drawings to indicate the extent of work; written records of mortar mixes; and physical mortar cubes prepared at the same time mortar is installed to be cured, labeled, and stored in the park archive for future comparison.

- Repair stone units with large spalls or cracks that may present a safety hazard if not addressed, or that may collect water, which contributes to ongoing or accelerated deterioration. Where stone repair is considered, various options are available. For severely eroded or cracked stone units where much of the original material is already lost, consideration can be given to replacement in kind with an entirely new sandstone unit. Replacement units should be photographically documented before, during, and after the work, and drawings should be annotated to show the location of the units. The new unit should be permanently embossed or engraved on a concealed surface with a notation such as "NPS, 2024." For stones with localized damage, dutchman units can be installed that replace a portion of the original unit with compatible sandstone, cut square and installed to re-create the original profile.

  Where cracked or loose cementitious repairs are present, the patches should be removed. Consideration should be given to installing replacement stone units, as described above, if much of the original material is lost. If only localized damage is present, dutchman units can be installed, as described above.

- Spalled and eroded brick masonry should be replaced at locations where much of the original material is already lost, including sills and at the parapet at the roof level. New bricks should match the existing in size and color. In locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed using appropriate mortars that match existing historic mortars in conjunction with any brick replacement.

- Cracked stucco at the ramp walls of the should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.

San Carlos Ravelin

- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.

- Deterioration and distress at mortar joints between stone and brick masonry units at the exterior walls should be addressed using repair techniques that include the following steps:

  Unsound mortar should be removed to a depth of 2-1/2 times the width of the joint, or to sound mortar, whichever is greater. Work should be performed using handheld, non-power tools. A skilled mason can sometimes accomplish joint preparation without damaging the adjacent substrate by using a small power tool to cut along the center of the joint, followed by use of a hand tool (chisel) to remove mortar adjacent to the center cut. This process, if properly implemented, can sometimes result in less potential damage to the masonry adjacent to the joint than preparation using hand tools only, particularly for existing hard mortar adjacent to eroded or spalled stone. A trial sample is required to evaluate the skill of the mason and effectiveness of the repair.

Joints should be repointed using appropriate mortars that match existing historic mortars. The use of hard portland cement-based mortars should be avoided. Commercially available portland cement mortars should be avoided because they can contain unnecessary and undisclosed additives and fillers.

Laboratory studies of existing and new mortars should continue to be undertaken to develop information for replacement mortar mixes.

Pointing work should match historic mortar joints in color, texture, joint size, profile, and tooling.

Since the repointing work may be performed over an extended period, a detailed protocol for tracking the extent of work and materials installed each year should be established. The protocol should include photographic documentation of the work before, during, and after repointing; marked plan and elevation drawings to indicate the extent of work; written records of mortar mixes; and physical mortar cubes prepared at the same time mortar is installed to be cured, labeled, and stored in the park archive for future comparison.

- Any vegetation and other growth at mortar joints should be removed. When removing vegetation, all tools, clothing, and footwear should be washed or changed between sites to avoid the potential spread of invasive species. Any damage to the mortar joints in these areas should be addressed, as described above.
- Repair stone units with large spalls or cracks that may present a safety hazard if not addressed, or that may collect water, which contributes to ongoing or accelerated deterioration. Where stone repair is considered, various options are available. For severely eroded or cracked stone units where much of the original material is already lost, consideration can be given to replacement in kind with an entirely new sandstone unit. Replacement units should be photographically documented before, during, and after the work, and drawings should be annotated to show the location of the units. The new unit should be permanently embossed or engraved on a concealed surface with a notation such as "NPS, 2024." For stones with localized damage, dutchman units can be installed that replace a portion of the original unit with compatible sandstone, cut square and installed to re-create the original profile.

  Where cracked or loose cementitious repairs are present, the patches should be removed. Consideration should be given to installing replacement stone units, as described above, if much of the original material is lost. If only localized damage is present, dutchman units can be installed, as described above.
- Spalled and eroded brick masonry should be replaced at locations where much of the original material is already lost. New bricks should match the existing in size and color. In locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed using appropriate mortars that match existing historic mortars in conjunction with any brick replacement.
- Cracked and eroded stucco along the north parapet should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied.

  Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Cracked and spalled wall plaster should be removed and replaced with new plaster compatible with the existing substrate and matching the historic plaster in composition and texture. Following the completion of plaster repairs, these areas should be repainted to match the existing wall finish.

- Concrete repair mixes should be developed to match the color, finish, and texture of the original concrete. Form and pour techniques should be used for repairs rather than trowel-applied patches. 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 to retain as much sound concrete beyond the spalled area as possible. The sawcut may align with edges of the formboard profile where present and as appropriate to the repair location.

  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.

  Repair concrete matching the original concrete color, finish, and texture (as discussed above), should be placed and consolidated. The concrete repair should be wet cured.

La Trinidad Counterguard

- Review close-up the exterior walls of La Trinidad Counterguard focusing on spalls in rubble wall and stucco finish and remove any loose pieces.
- Cracked, spalled, and eroded stucco should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Portland cement patches at areas where deterioration of the stone wall is present should be removed. Following removal, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Spalled and eroded brick masonry should be replaced at locations where much of the original material is already lost, including at the merlon ends of the middle battery. New bricks should match the existing in size and color. In locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed using appropriate mortars that match existing historic mortars in conjunction with any brick replacement.
- Repair stone units with large spalls or cracks that may present a safety hazard if not addressed, or that may collect water, which contributes to ongoing or accelerated deterioration. Where stone repair is considered, various options are available. For severely eroded or cracked stone units where much of the original material is already lost, consideration can be given to replacement in kind with an entirely new sandstone unit. Replacement units should be photographically documented before, during, and after the work, and drawings should be annotated to show the location of the units. The new unit

should be permanently embossed or engraved on a concealed surface with a notation such as "NPS, 2024." For stones with localized damage, dutchman units can be installed that replace a portion of the original unit with compatible sandstone, cut square and installed to re-create the original profile.

Where cracked or loose cementitious repairs are present, the patches should be removed. Consideration should be given to installing replacement stone units, as described above, if much of the original material is lost. If only localized damage is present, dutchman units can be installed, as described above.

In locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed using appropriate mortars that match existing historic mortars in conjunction with any stone repair or replacement.

- Any vegetation and other growth at mortar joints should be removed. When removing vegetation, all tools, clothing, and footwear should be washed or changed between sites to avoid the potential spread of invasive species. Any damage to the mortar joints in these areas should be addressed, as described above.
- Overgrown vegetation at the esplanades, including the middle battery, should be addressed.

Santa Teresa Battery

Guardhouse

- Cracked, spalled, and eroded stucco at the exterior of the guardhouse should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Any vegetation and other growth at cracks should be regularly removed.
- Any loose plaster spalls should be removed at the interior of the guardhouse. Where the underlying masonry is visible, make repairs as needed, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.

Latrine

- Cracked, spalled, and eroded stucco at the exterior of the latrine should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.

Bunkers and Gun Emplacements

- Any vegetation and other growth at cracks or joints should be regularly removed. When removing vegetation, all tools, clothing, and footwear should be washed or changed between sites to avoid the potential spread of invasive species. Any associated damaged mortar joints should be repaired following removal of vegetation.
- Spalled and eroded brick masonry should be replaced at locations where much of the original material is already lost. New bricks should match the existing in size and color. In locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed

using appropriate mortars that match existing historic mortars in conjunction with any brick replacement.

- Cracked, spalled, and eroded stucco at the exterior of the bunkers should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Any loose plaster spalls should be removed at the interior of the bunkers. Where the underlying masonry is visible, make repairs as needed, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.

Battery

- Any vegetation and other growth at cracks or joints should be regularly removed. When removing vegetation, all tools, clothing, and footwear should be washed or changed between sites to avoid the potential spread of invasive species. Any associated damaged mortar joints should be repaired following removal of vegetation.
- Spalled and eroded brick masonry should be replaced at locations where much of the original material is already lost. New bricks should match the existing in size and color. In locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed using appropriate mortars that match existing historic mortars in conjunction with any brick replacement.
- Cracked, spalled, and eroded stucco at the exterior of the battery should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Repair stone units with large spalls or cracks that may present a safety hazard if not addressed, or that may collect water, which contributes to ongoing or accelerated deterioration. Where stone repair is considered, various options are available. For severely eroded or cracked stone units where much of the original material is already lost, consideration can be given to replacement in kind with an entirely new sandstone unit. Replacement units should be photographically documented before, during, and after the work, and drawings should be annotated to show the location of the units. The new unit should be permanently embossed or engraved on a concealed surface with a notation such as "NPS, 2024." For stones with localized damage, dutchman units can be installed that replace a portion of the original unit with compatible sandstone, cut square and installed to re-create the original profile.

  In locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed using appropriate mortars that match existing historic mortars in conjunction with any stone repair or replacement.

Traverse

- Spalled and eroded brick masonry should be replaced at locations where much of the original material is already lost. New bricks should match the existing in size and color. In

locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed using appropriate mortars that match existing historic mortars in conjunction with any brick replacement.

- Cracked, spalled, and eroded stucco at the traverse should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Monitor the easternmost flight of brick masonry stairs at the west perimeter of the moat to see if there is active movement. If movement is not active, repair the mortar joint between the displaced step and the upper step.

Covered Way

- Cracked, spalled, and eroded stucco at the traverse should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Any vegetation and other growth at cracks or joints should be regularly removed. When removing vegetation, all tools, clothing, and footwear should be washed or changed between sites to avoid the potential spread of invasive species. Any associated damaged mortar joints should be repaired following removal of vegetation.

Tunnels

- Any loose plaster spalls should be removed at the interior of the tunnels. Where the underlying masonry is visible, make repairs as needed, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.
- The earthen fill and stone obstruction at the south end of Tunnel 7 is not of concern. Regularly monitor the location for any signs of movement.

La Princesa

North and East Perimeter Walls

- Cracked, spalled, and eroded stucco at the perimeter walls should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.

Troop Powder Rooms

- Cracked, spalled, and eroded stucco at the exterior of the troop powder rooms should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar.

Consideration should be given to using compatible salvaged brick from the site, if available.

Excavated Parapet

- Cracked, spalled, and eroded stucco at the excavated parapet should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Any vegetation and other growth at cracks or joints should be regularly removed. When removing vegetation, all tools, clothing, and footwear should be washed or changed between sites to avoid the potential spread of invasive species. Any associated damaged mortar joints should be repaired following removal of vegetation.

North Covered Way

- Review condition of the north covered way and adjacent dry moat (areas were inaccessible for review as part of this study). Assuming that construction of these areas is similar to that observed in accessible areas of the fortifications, the following recommendations apply to this area as well. Treatments should be confirmed following assessment when this area is accessible.
- Cracked, spalled, and eroded stucco at the north covered way and adjacent dry moat should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.

World War II Gun Emplacement

- Concrete repair mixes should be developed to match the color, finish, and texture of the original concrete. Form and pour techniques should be used for repairs rather than trowel-applied patches. 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 to retain as much sound concrete beyond the spalled area as possible. The sawcut may align with edges of the formboard profile where present and as appropriate to the repair location.

  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.

  Repair concrete matching the original concrete color, finish, and texture (as discussed above), should be placed and consolidated. The concrete repair should be wet cured.

- Embedded steel should be repaired as follows:

  The existing surface coating and rust scale should be removed to bare steel using abrasive blasting in preparation for a new coating system. (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 removal of paint, 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, followed by abrasive blasting to prepare the surface to receive the new coating system.

  The steel surfaces should be pressure-washed to remove chloride contamination.

  Where previously coated, exposed metal surfaces, such as anchors, should be prepared and coated with a high-performance coating system, including a zinc-rich primer. 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.

- Monitor the east side of the concrete cog track where undermining was observed. Further investigation is required to determine the cause of this condition.

Moat

- Cracked, spalled, and eroded stucco at the La Princesa moat should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.

- Replace heavily weathered CMU at the south moat near the outlet with new CMU to match existing.

- Corroded steel should be repaired as follows:

  The existing surface coating and rust scale should be removed to bare steel using abrasive blasting in preparation for a new coating system. (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 removal of paint, 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, followed by abrasive blasting to prepare the surface to receive the new coating system.

  The steel surfaces should be pressure-washed to remove chloride contamination.

  Where previously coated, exposed metal surfaces, such as anchors, should be prepared and coated with a high-performance coating system, including a zinc-rich primer. 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.

- Develop a conservation plan to preserve historic graffiti that is visible on the west wall of the stair corridor.

Latrine

- Cracked, spalled, and eroded stucco at the latrine should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Cracked brick masonry should be replaced at locations where much of the original material is already lost. New bricks should match the existing in size and color.

1897 Bombproof Structure and Gun Emplacement

- Cracked, spalled, and eroded stucco at the bombproof and the perimeter wall of the gun emplacement should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Any vegetation and other growth at cracks or joints should be regularly removed. When removing vegetation, all tools, clothing, and footwear should be washed or changed between sites to avoid the potential spread of invasive species. Any associated damaged mortar joints should be repaired following removal of vegetation.
- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.

Powder Magazine

- Cracked, spalled, and eroded stucco at the powder magazine should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Corroded steel should be repaired as follows:

  The existing surface coating and rust scale should be removed to bare steel using abrasive blasting in preparation for a new coating system. (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 removal of paint, 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, followed by abrasive blasting to prepare the surface to receive the new coating system.

  The steel surfaces should be pressure-washed to remove chloride contamination.

  Where previously coated, exposed metal surfaces, such as anchors, should 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.

- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.
- Investigate potential causes of water infiltration at interior of the powder magazine that appears to be cause of efflorescence. Sources of water infiltration should be determined before proceeding with any repairs. Once water infiltration has been addressed, cracked and spalled wall plaster should be removed and replaced with new plaster compatible with the existing substrate and matching the historic plaster in composition and texture.

Gate and Sentry Box

- Repair stone units where significant erosion was noted and where stone units are missing at the stone pier. Where stone repair is considered, various options are available. For severely eroded or cracked stone units where much of the original material is already lost, consideration can be given to replacement in kind with an entirely new sandstone unit. Replacement units should be photographically documented before, during, and after the work, and drawings should be annotated to show the location of the units. The new unit should be permanently embossed or engraved on a concealed surface with a notation such as "NPS, 2024." For stones with localized damage, dutchman units can be installed that replace a portion of the original unit with compatible sandstone, cut square and installed to re-create the original profile.

  In locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed using appropriate mortars that match existing historic mortars in conjunction with any stone repair or replacement.

  Reset displaced stone at base of stone pier in conjunction with replacement of missing stone units.
- Deterioration and distress at mortar joints between stone masonry units should be addressed using repair techniques that include the following steps:

  Unsound mortar should be removed to a depth of 2-1/2 times the width of the joint, or to sound mortar, whichever is greater. Work should be performed using handheld, non-power tools. A skilled mason can sometimes accomplish joint preparation without damaging the adjacent substrate by using a small power tool to cut along the center of the joint, followed by use of a hand tool (chisel) to remove mortar adjacent to the center cut. This process, if properly implemented, can sometimes result in less potential damage to the masonry adjacent to the joint than preparation using hand tools only, particularly for existing hard mortar adjacent to eroded or spalled stone. A trial sample is required to evaluate the skill of the mason and effectiveness of the repair.

  Joints should be repointed using appropriate mortars that match existing historic mortars. The use of hard portland cement-based mortars should be avoided. Commercially available portland cement mortars should be avoided because they can contain unnecessary and undisclosed additives and fillers.

  Laboratory studies of existing and new mortars should continue to be undertaken to develop information for replacement mortar mixes.

  Pointing work should match historic mortar joints in color, texture, joint size, profile, and tooling.

  Since the repointing work may be performed over an extended period, a detailed protocol for tracking the extent of work and materials installed each year should be established. The protocol should include photographic documentation of the work before, during, and after repointing; marked plan and elevation drawings to indicate the extent of work; written records of mortar mixes; and physical mortar cubes prepared at the same time mortar is installed to be cured, labeled, and stored in the park archive for future comparison.

- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.
- Investigate the condition of the brick foundation under the piers where bricks were found to be deteriorated and spalled. Deteriorated brick masonry should be replaced at locations where much of the original material is already lost. New bricks should match the existing in size and color.
- Cracked, spalled, and eroded stucco at the sentry box and pier caps should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.

El Abanico

- Cracked, spalled, and eroded stucco at the exterior of El Abanico should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Portland cement patches at areas where deterioration of the stone wall is present should be removed. Following removal, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Any vegetation and other growth at cracks or joints should be regularly removed. When removing vegetation, all tools, clothing, and footwear should be washed or changed between sites to avoid the potential spread of invasive species. Any associated damaged mortar joints should be repaired following removal of vegetation.
- Develop a conservation plan to preserve historic graffiti that is visible throughout El Abanico. The graffiti has been inscribed on the stucco layer, and the origin dates vary.
- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.
- Eroded brick masonry should be replaced at locations where much of the original material is already lost. New bricks should match the existing in size and color.

Guardhouse

- Cracked, spalled, and eroded stucco at the exterior of the guardhouse should be removed and replaced with stucco matching the surface texture and general composition of the existing stucco. The use of a bonding agent should be considered when new stucco is applied. Where the stucco is missing or removed and replaced, repair the underlying masonry, including replacing deteriorated masonry units in kind and repointing open or friable mortar joints with new mortar. Consideration should be given to using compatible salvaged brick from the site, if available.
- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.
- Investigate potential causes of water infiltration at the interior of the guardhouse.

Gate and Sentry Box

- Repair stone units with large spalls or cracks that may present a safety hazard if not addressed, or that may collect water, which contributes to ongoing or accelerated deterioration, and install new units where stone units are missing at the stone pier. Where stone repair is considered, various options are available. For severely eroded or cracked stone units where much of the original material is already lost, consideration can be given to replacement in kind with an entirely new sandstone unit. Replacement units should be photographically documented before, during, and after the work, and drawings should be annotated to show the location of the units. The new unit should be permanently embossed or engraved on a concealed surface with a notation such as "NPS, 2024." For stones with localized damage, dutchman units can be installed that replace a portion of the original unit with compatible sandstone, cut square and installed to re-create the original profile.

  In locations where adjacent mortar joints remain intact, it is likely the joints could contain portland cement-based mortar. If so, the mortar should be removed and repointed using appropriate mortars that match existing historic mortars in conjunction with any stone repair or replacement.

  Reset displaced stone at base of stone pier in conjunction with replacement of missing stone units.

- Deterioration and distress at mortar joints between stone masonry units should be addressed using repair techniques that include the following steps:

  Unsound mortar should be removed to a depth of 2-1/2 times the width of the joint, or to sound mortar, whichever is greater. Work should be performed using handheld, non-power tools. A skilled mason can sometimes accomplish joint preparation without damaging the adjacent substrate by using a small power tool to cut along the center of the joint, followed by use of a hand tool (chisel) to remove mortar adjacent to the center cut. This process, if properly implemented, can sometimes result in less potential damage to the masonry adjacent to the joint than preparation using hand tools only, particularly for existing hard mortar adjacent to eroded or spalled stone. A trial sample is required to evaluate the skill of the mason and effectiveness of the repair.

  Joints should be repointed using appropriate mortars that match existing historic mortars. The use of hard portland cement-based mortars should be avoided. Commercially available portland cement mortars should be avoided because they can contain unnecessary and undisclosed additives and fillers.

  Laboratory studies of existing and new mortars should continue to be undertaken to develop information for replacement mortar mixes.

  Pointing work should match historic mortar joints in color, texture, joint size, profile, and tooling.

  Since the repointing work may be performed over an extended period, a detailed protocol for tracking the extent of work and materials installed each year should be established. The protocol should include photographic documentation of the work before, during, and after repointing; marked plan and elevation drawings to indicate the extent of work; written records of mortar mixes; and physical mortar cubes prepared at the same time mortar is installed to be cured, labeled, and stored in the park archive for future comparison.

- Soiling and organic growth should be treated with a mild detergent or biocide. Cleaning trials should be performed at localized areas prior to cleaning larger areas.

- Cracked brick masonry should be replaced at locations where much of the original material is already lost. New brick should match the existing in size and color.

- Consideration should be given to installing sealant at the large open joint between the concrete apron and the bottom of the wing wall.

Miscellaneous Recommendations

Mock-ups

- Prior to undertaking any recommended repairs, mock-ups should be performed to evaluate work processes and to serve as a standard for the overall work.

Water Infiltration and Drainage Investigation

- Investigations to determine the sources of water infiltration at structures throughout Castillo San Cristóbal should be undertaken. Additionally, a review of the existing drainage infrastructure, particularly at the main portion of the fortification, should be undertaken to determine if any issues related to drainage are contributing to ongoing water infiltration. Investigation could include use of a sewer camera to determine if any blockages are present in the drainage system. Any further investigation should be completed before repairs are made at locations of suspected water infiltration.

Graffiti Mitigation

- Approaches that can be considered to mitigate the effects of modern graffiti include cleaning to remove the markings, application of a sacrificial surface treatment to make removal of future graffiti that may occur easier, and application of a film-forming coating to conceal existing graffiti that cannot be sufficiently removed by cleaning.

  The selection of a cleaning method to remove graffiti must take into consideration both the type of graffiti to be removed and the nature and condition of the substrate. For removal of painted graffiti, the sooner a cleaning product can be applied, the more likely it is to be successful. As with other treatments, the graffiti 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.

- Due to the bond between the graffiti and the substrate, microabrasive methods are often unsuccessful in removing graffiti without affecting the underlying surface. Also, in the removal of isolated graffiti, even when used at very low pressures, microabrasive cleaning may etch a shadow of the graffiti image into the substrate. Chemical cleaning methods include a wide range of products (paint strippers or coating removers) that can be used to address graffiti. As with other chemical cleaners, the products selected must not result in damage to the substrate material and should not be hazardous to workers or the environment. If chemicals are used, test samples should be performed and carefully evaluated to avoid over-cleaning. Poultices are generally effective in removing graffiti and can be applied to specific locations and remain active in place for several hours, thus helping to dissolve and draw out the stain. Water methods alone have generally not been effective in removing most painted graffiti, as water lacks the ability to dissolve most common graffiti coatings.

- Overpainting—covering the graffiti with paint instead of removing it—may be appropriate for substrates that were painted historically. However, this treatment is not an appropriate means to address graffiti on any surfaces where the substrate was not originally painted.

- Various clear film-forming protective coatings (also known as sacrificial or barrier coatings) have been developed to protect the underlying substrate from the graffiti application. These coatings facilitate the removal of the graffiti. In accordance with the Secretary of the Interior's Standards for the Treatment of Historic Properties, treatments applied to historic buildings should be reversible. Long-lasting film-forming clear protective coatings may not be reversible and typically affect the appearance and reflectivity of the surfaces to which they are applied. Therefore, these

protective coatings are not recommended. Sacrificial clear protective coatings, on the other-hand, are water-based and, if additional graffiti occurs, are removed as part of the graffiti cleaning process. The coating is then reapplied after each graffiti removal event.

- Prompt removal of graffiti will improve the effectiveness of removal efforts and may also tend to discourage repetition of this vandalism.

The addition of lights to discourage vandalism is not recommended as they can be intrusive and may draw attention to resources at periods when park staff is not present. Additionally, lighting that is adequate enough to discourage vandalism would conflict with the NPS Sustainable Outdoor Lighting Principles.

Recommendations for Further Research and Investigation

1. Conduct further research on the people who contributed to construction of the fortifications. Puerto Rican and Spanish archives may detail the character of skilled work involving masons, blacksmiths, carpenters, and other trades. Further research is also recommended to determine the role forced laborers played in the construction of the fortifications.
2. Perform research to better understand the existing drainage infrastructure and how water moves through various structures, particularly at the main fortifications.
3. Develop conservation plan to preserve historic graffiti that is present throughout Castillo San Cristóbal and to preserve and maintain historic painted tile at the center casemate of the officers' quarters.
4. Investigate how Garita del Diablo will behave during extreme weather events that produce extreme waves. A wave analysis could be completed for the offshore and shoreline conditions at La Garita del Diablo to provide further information regarding wave impact on the structure.
5. At areas of the troops' quarters exterior walls repaired in 2017, where the distress is most pronounced, further investigation is needed to determine if water infiltration is causing the observed distress at the stucco. Potential investigation could include water infiltration testing and inspection openings to better understand the cause(s) of the ongoing distress.
6. Investigate potential source and extent of cracking at the south end of the officers' quarters and develop appropriate repairs.
7. Monitor the cracks in the dungeon to determine if there is any active movement. If determined there is no active movement, repair the cracks with mortar that is compatible with the historic mortar.
8. Evaluate stone rubble at the top of the south dungeon wall by sounding to ensure stone is not loose or at risk of falling.
9. Monitor cracked and spalled floor tile and parging at the chapel interior. Any loose pieces of marble should be removed and reset.
10. Monitor the easternmost brick masonry stair at the west perimeter of the moat to see if there is active movement.
11. Regularly monitor the earthen fill and stone obstruction at the south end of Tunnel 7 for any signs of movement.

Resilience to Natural Hazards

Puerto Rico is part of the Greater Antilles, a group of islands that extend across the north side of the Caribbean Sea. Puerto Rico is the easternmost island in the archipelago. The Greater Antilles, along with the Lesser Antilles to the south and east, indicate the edge of the subduction zone between the North American and Caribbean tectonic plates. Puerto Rico is positioned with the North Atlantic Ocean to the north and the Caribbean Sea to the south. Because of its physical and geophysical location, the island has historically been affected by earthquakes, tsunamis, and hurricanes.

San Juan National Historic Site is located at the west end of the Island of San Juan, a small island connected to the main island of Puerto Rico by bridges and causeways. It is situated on a bedrock foundation along the North Atlantic coastline and is approximately 100 feet above mean sea level. The Bay of San Juan separates the Island of San Juan from the main island.

The first recorded earthquake in Puerto Rico occurred in the 1520s. The event reportedly resulted in severe damage to Ponce de Leon's home. Other major earthquakes occurred in 1717, 1787, and 1867. The 1787 earthquake resulted in severe damage to El Morro and Castillo San Cristóbal, among other large and prominent structures. While there have been many smaller seismic events, the last major earthquake in Puerto Rico occurred in October 1918. This earthquake was measured at a magnitude of 7.5 on the Richter scale and was accompanied by a tsunami that claimed many lives. Tsunamis, associated with earthquakes elsewhere along the archipelago, were also reported in May 1922 and August 1946.[233]

Earthquakes will continue to be a natural hazard to which San Juan National Historic Site is vulnerable. As tectonic plates continue to shift and realign, they will produce shocks and earthquakes. FEMA has identified Puerto Rico as having a seismic design category of D, indicating that the area could experience very strong shaking due to earthquakes. The results could potentially include considerable damage to ordinary substantial buildings and extensive damage to poorly built structures.[234] During the 1918 earthquake, many rubble masonry structures were destroyed. Those rubble masonry buildings that remained standing were mostly government buildings constructed of higher-quality materials and with engineered designs.

Hurricanes occur frequently in the Caribbean region and are often accompanied by storm surges, winds, rainfall, tornados, and flooding. Some of the most devastating hurricanes in Puerto Rico include the San Ciriaco hurricane in August 1899, which produced 23 inches of rain in a twenty-four-hour period and claimed 2,184 victims and $35 million in damage. In September 1928, the San Felipe II hurricane had recorded winds of 200 miles an hour and claimed 300 lives with an economic impact of over $50 million. On September 18, 1989, Hurricane Hugo struck Puerto Rico and was responsible for twelve deaths and $1 billion in damages.[235] On September 21, 1998, Hurricane Georges made landfall on Puerto Rico and over a two-day period produced 30 inches of rainfall and caused $2 billion in damage. Hurricane María, the most recent and destructive hurricane in Puerto Rico's history, reached the island on September 20, 2017, as a Category 4 hurricane. It resulted in loss of power for much of the island for almost a year, temporary loss of potable water, the deaths of 2,975 people, and $90 billion in damages; to date the island has not yet fully recovered.[236]

233. Risa Palm and Michael E. Hodgson, "Natural Hazards in Puerto Rico," *Geographical Review* 83, no.3 (1993): 280–289.
234. Federal Emergency Management Agency Earthquake Hazard Maps, accessed March 2024, https://www.fema.gov/earthquake-hazard-maps.
235. Federal Emergency Management Agency Earthquake Hazard Maps, accessed March 2024, https://www.fema.gov/earthquake-hazard-maps.
236. Ibid.

Increasingly frequent strong storms and heavy rainfall have been noted for several years in the Caribbean and southeastern United States. Over the last thirty years, Puerto Rico has experienced three of its most destructive recorded hurricanes, claiming the lives of thousands of people, totaling billions of dollars in damage, and devastating local communities. In addition to the initial impact of an earthquake or hurricane, natural hazards resulting from these hazards, such as landslides and flooding, cause damage and distress.

In planning for these storms, historic sites and parks similarly require identification of the resources anticipated to be threatened—both buildings and landscapes—and planning for protection as well as mitigation in the face of increased storms.

As loss of historic resource integrity may occur, suddenly or slowly, from conditions related to natural hazards, documentation is a proactive measure to mitigate anticipated loss or diminishment, or to plan for the impacts associated with natural hazards. This Historic Structures Report, including the historical narrative, condition assessment, and recommendations, together with photographs and measured drawings, as well as data from laser scanning conducted for this study in support of drawing development, is an important part of the documentation process.

As part of future efforts to build on and update the documentation provided in this HSR, the National Park Service should consider such approaches as monitoring weather-related deterioration, updating emergency and disaster planning to address resiliency to natural hazards, and strategic planning for mitigation of the effects of natural hazards on park resources. The latter may include special protection, documentation, and interpretation measures to address resources that are especially vulnerable to damage or loss due to extreme weather-related conditions.

In addition to threats to the cultural and natural resources, natural hazards will affect visitation patterns. If not already underway, a study of the impacts of natural hazards on the park and visitation patterns would be beneficial.

Efforts conducted for the San Juan National Historic Site will benefit from coordination with other planning and documentation projects to address effects and 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 natural hazards should be anticipated and considered in planning for protection and maintenance of the site and its resources.

Other natural hazards to which the San Juan National Historic Site is vulnerable include rising sea level change, wave erosion, and flooding. It is projected that the sea level in the area will rise as much as 0.64 meters by the end of the twenty-first century.[237] The rise in sea level will impact many of the coastal features of San Juan National Historic Site, including the fortress walls, and will likely accelerate their deterioration.

237. Maria A. Caffrey, Rebecca L. Beavers, and Cat Hawkins Hoffman, *Sea Level Rise and Storm Surge Projections for the National Park Service, Natural Resource Report Series NPS/NRSS/NRR—2018/1648* (Fort Collins, Colorado: U.S. Department of the Interior, National Park Service, Natural Resources Stewardship and Science, May 2018). The study is the first to analyze information from the United Nations Intergovernmental Panel on Climate Change (IPCC) and National Oceanic and Atmospheric Administration (NOAA) models. This research is the first to analyze IPCC and NOAA projections of sea level and storm surge under climate variability for U.S. national parks.

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Glossary

Banquette (also firing step): A raised walkway, sometimes stepped, located behind the fortification parapet constructed to enable troops to fire their weapons over the wall.

Bastion (also baluarte, bulwark): A forward projecting work or structure extending from the main walls of a defensive enclosure designed to expand the lookout views and firing angles of a fortification and thus defend the adjacent perimeter together with the area in front of the ramparts.

Batter: The inclination of the face of a wall inward from the vertical to enhance structural stability.

Bombproof: A building or structure associated with a fortification designed to withstand the impact of cannon balls or shells.

Bombproof magazine: A bombproof structure designed to store ammunition.

Casemate: Chamber inside a scarp wall that can include batteries for seacoast defense.

Cavalier: A work within a fort's enceinte raised 10 to 12 feet higher than the rest of the works, and often used within a bastion or at its gorge.

Coping: The top course, usually sloping, of a masonry or brick wall.

Counterscarp: The outer wall of a ditch in a fortification built opposite the scarp, or inner wall of the ditch.

Counterfort: A buttress built against or integral with a wall, but on the back or thrust-receiving side.

Covered way: A corridor running along the top of a counterscarp and protected by an embankment whose outer slope forms the glacis.

Curtain wall: The main wall of a defensive work, which often extends between two bastions.

Embrasure (also battlement): An opening or cut in the parapet used to fire artillery without exposing the gun crew; normally wider at the front than at the rear.

En Barbette: Guns emplaced on a fixed, raised platform in such a way that they can fire over a parapet rather than through an embrasure.

Enceinte: The body or mass of a fort, inside the ditch.

Esplanade: A long, open, level area.

Fortification: A military structure designed for the defense of territories in warfare or to establish rule in a region during peacetime. The design of fortifications follows military engineering principles related to artillery fire and establishing obstacles and a field of fire that limit the ability of an attacking enemy to overrun the structure.

Glacis: A gently graded landform that slopes away from a fortification that establishes an open field and masks the scarp of the fort from direct fire, while also providing a clear field of fire for the defenders.

Gorge: The side or sides of the fort away from the water, where land defense is the primary concern.

Gun emplacements: A structure designed to mount an artillery piece.

Hormigón: Concrete poured cementitious material.

Knee wall: A short wall that may be used to support another structural element.

Mampostería: Rubble masonry or roughly coursed stone and rubble masonry using lime mortar.

Merlon: The solid part of a parapet as it extends between two embrasures.

Outworks: A section of a fortification or system of defense which is in front of the main part.

Parapet: The earthen or masonry construction atop the wall or a bastion or curtain wall that rises above the terreplein and provides soldiers within the fortification with protection against direct fire.

Parging: A thin coat of mortar or concrete added to the surface of a wall to protect or repair its surface from moisture or the effects of air voids or to convey a relatively smooth appearance.

Paseo: A plaza or walkway for strolling.

Portal: A protected gate or opening in a fortification wall system.

Rampart: A thick wall of earth or masonry forming the main defense of a fortification, usually broad-topped and reinforced from the rear with the terreplein.

Redoubt: A temporary or supplementary fortification, square or polygonal, that does not have flanking walls.

Render: A coating of sand, lime (or cement) and water that is applied to masonry walls as a protective finish.

Revelin: A detached triangular or V-shaped outerwork constructed beyond the main curtain wall of a fortification, with two faces that form a salient angle. Revelins protect the bastions and curtain wall behind them from direct enemy artillery fire.

Runnel: A narrow channel in the ground that can be used to direct the flow of stormwater.

Salient angle: An outward projection of a bastion or other projecting work.

Sallyport: An entrance or access point to enter or exit a fortification. Sallyports are often associated with moats, and bridges that can be raised to defend against enemy entry.

Scarp: The outer slope or wall of a fortification.

Scupper: A hole at the base of a parapet wall that allows water to drain out of the structure.

Sentry box (garita): A structure providing shelter for a standing sentry.

Tenaille: Low, detached outworks, generally placed in the ditch, usually between bastions.

Terreplein: A level space where a battery of guns is mounted.

Traverse: A rampart or platform that is built perpendicular to a wall and provides protection against flanking fire.

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Appendix A: Measured Drawings

Sheet Index

Sheet 1. First Floor Plan

Sheet 2 Roof Level Plan

Sheet 3 Chapel Elevations and Plans

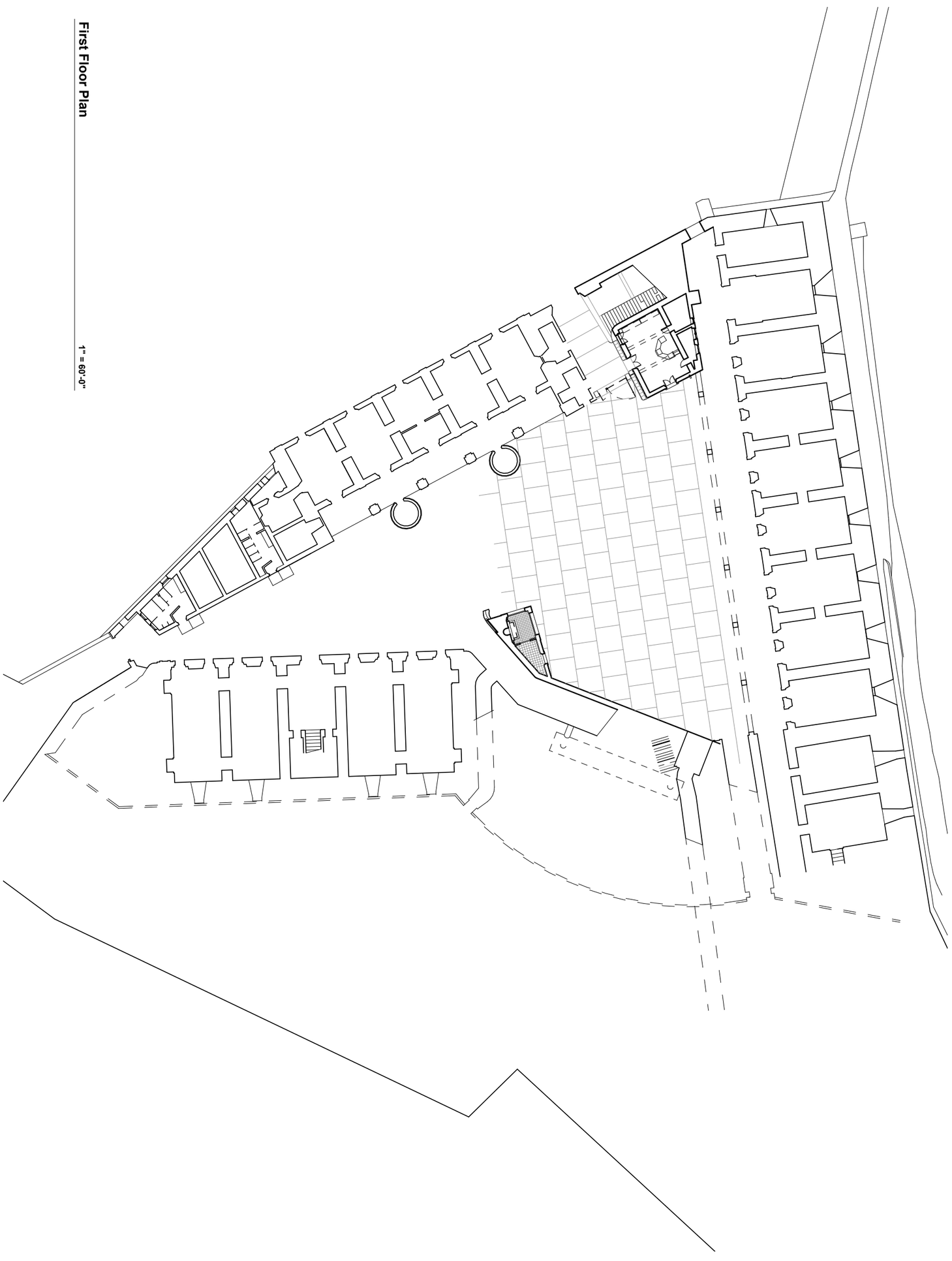
Sheet 4 Officers' Quarters Plans and Elevations

Sheet 5 North Casemates Plans and Elevations

Sheet 6 Troops' Quarters Plans and West Elevation

First Floor Plan

1" = 60'-0"

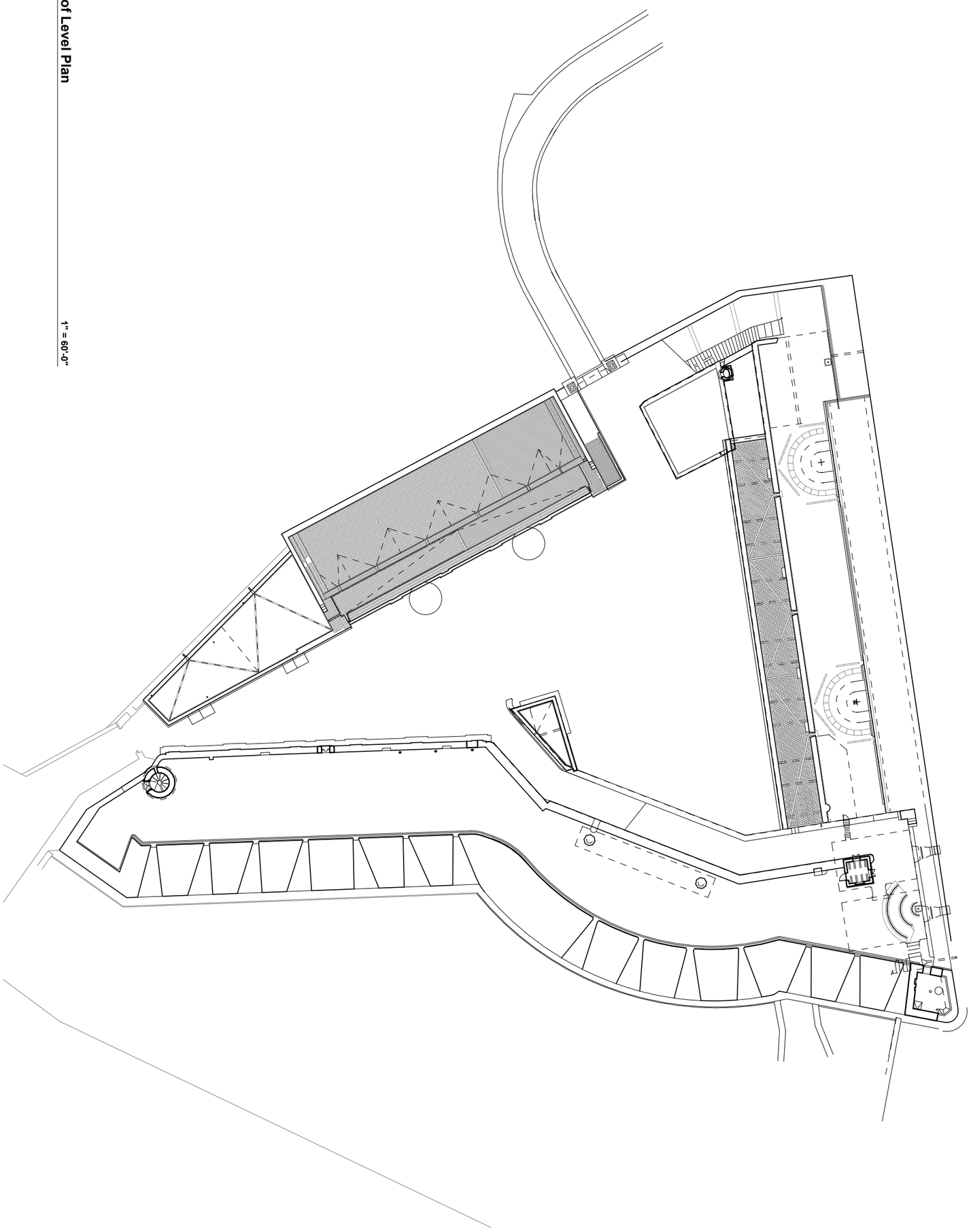


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NATIONAL PARK SERVICE U.S. DEPARTMENT OF THE INTERIOR SOUTHEAST REGIONAL OFFICE	SAN JUAN	**CASTILLO SAN CRISTÓBAL** SAN JUAN NATIONAL HISTORIC SITE	PUERTO RICO	HISTORIC STRUCTURE REPORT	SHEET **1**

Roof Level Plan

1" = 60'-0"



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CHAPEL WEST ELEVATION 1/8" = 1'-0"

CHAPEL NORTH ELEVATION 1/8" = 1'-0"

CHAPEL SOUTH ELEVATION 1/8" = 1'-0"

CHAPEL ROOF PLAN 1/8" = 1'-0"

CHAPEL FLOOR PLAN 1/8" = 1'-0"

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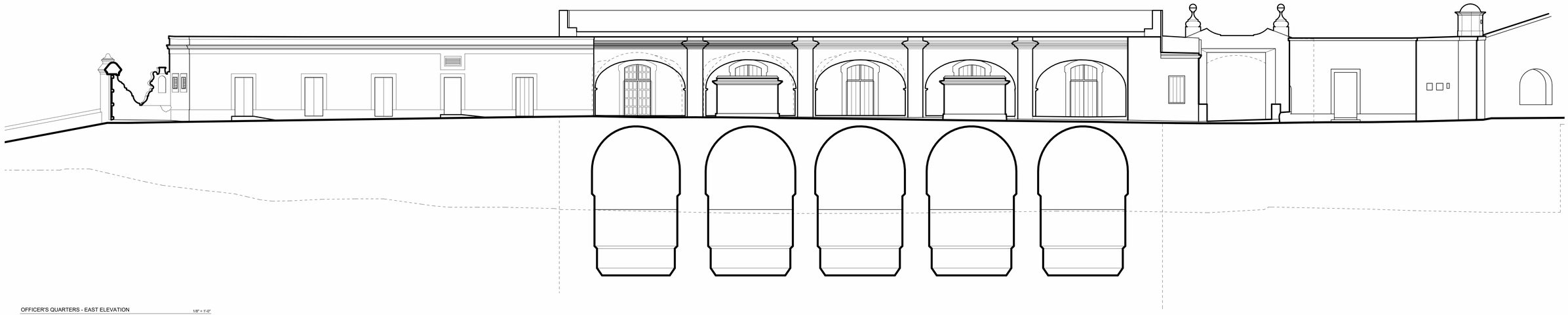
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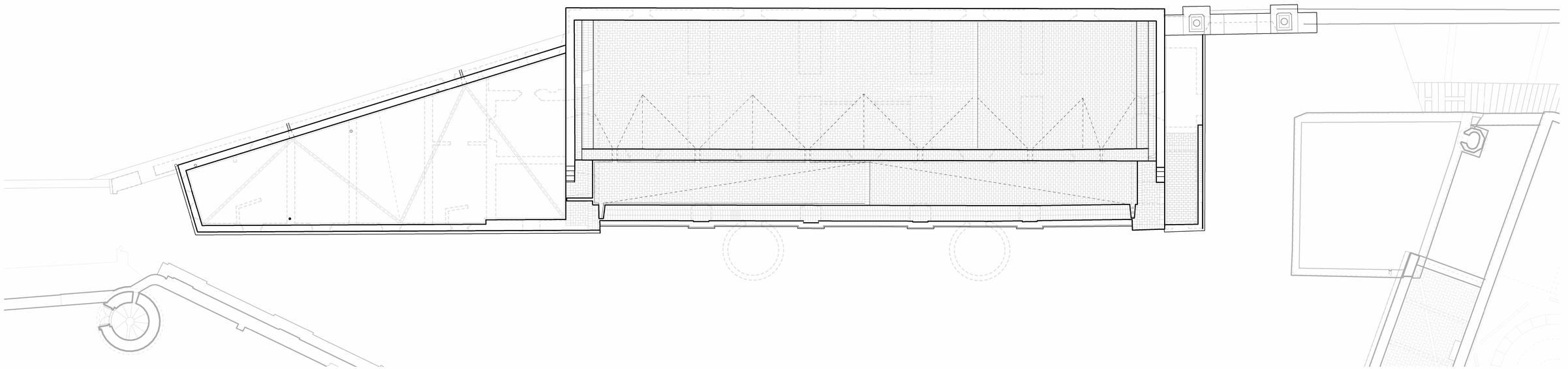
CASTILLO SAN CRISTÓBAL
SAN JUAN NATIONAL HISTORIC SITE
PUERTO RICO

HISTORIC STRUCTURE REPORT

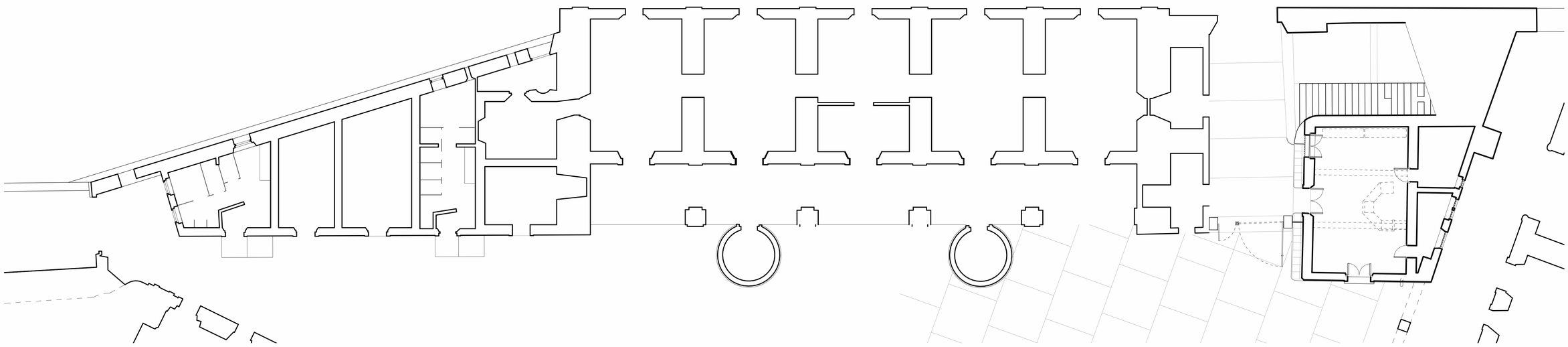
SHEET 3



OFFICER'S QUARTERS - EAST ELEVATION 1/8" = 1'-0"



OFFICER'S QUARTERS - ROOF PLAN 1/8" = 1'-0"



OFFICER'S QUARTERS - FLOOR PLAN 1/8" = 1'-0"

SHEET 4

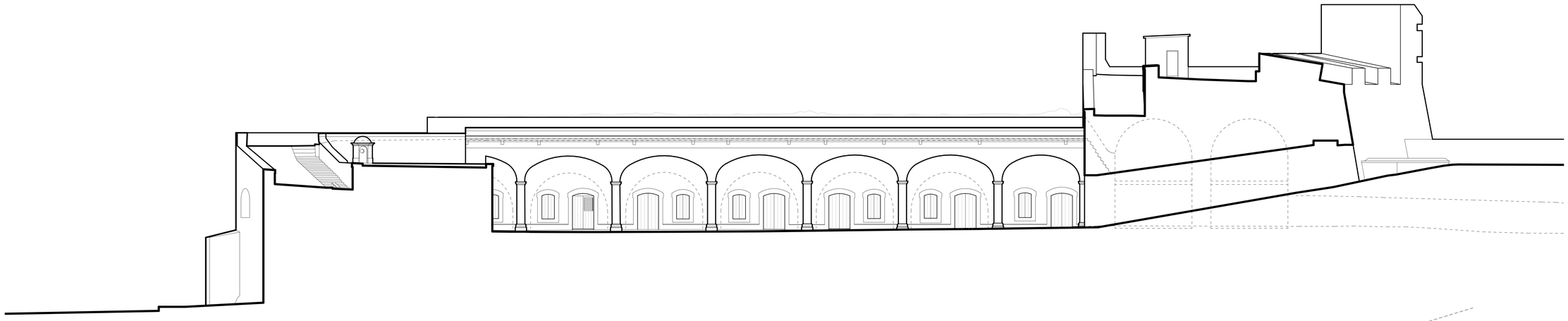
HISTORIC STRUCTURE REPORT

CASTILLO SAN CRISTÓBAL
SAN JUAN NATIONAL HISTORIC SITE
PUERTO RICO

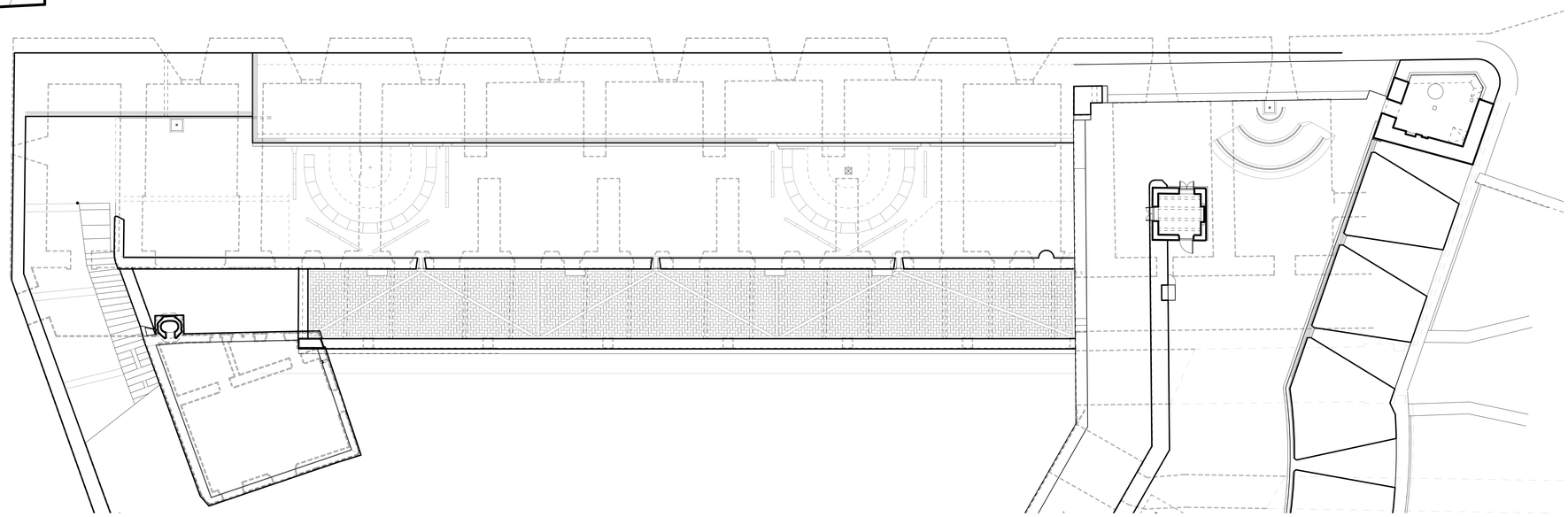
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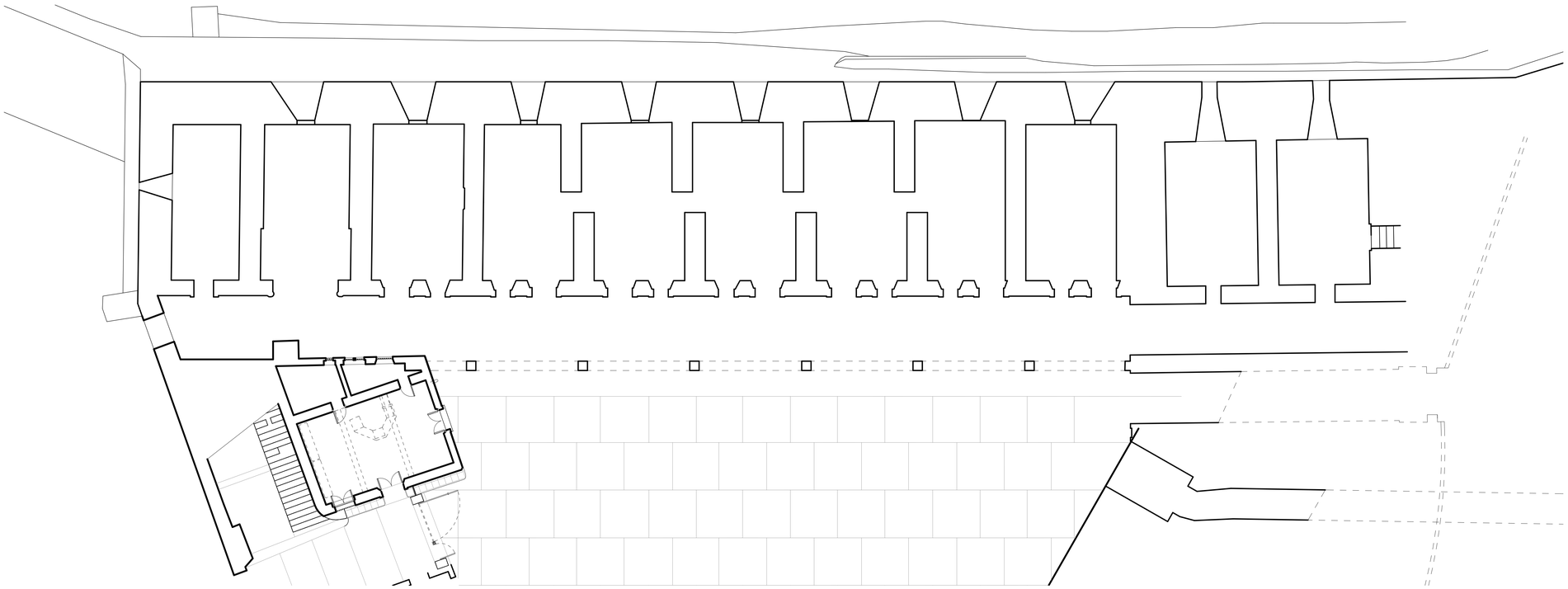
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NORTH CASEMATES - SOUTH ELEVATION 3/32" = 1' - 0"



NORTH CASEMATES - ROOF PLAN 3/32" = 1' - 0"



NORTH CASEMATES - FLOOR PLAN 3/32" = 1' - 0"

SHEET 5

HISTORIC STRUCTURE REPORT

CASTILLO SAN CRISTÓBAL

SAN JUAN NATIONAL HISTORIC SITE

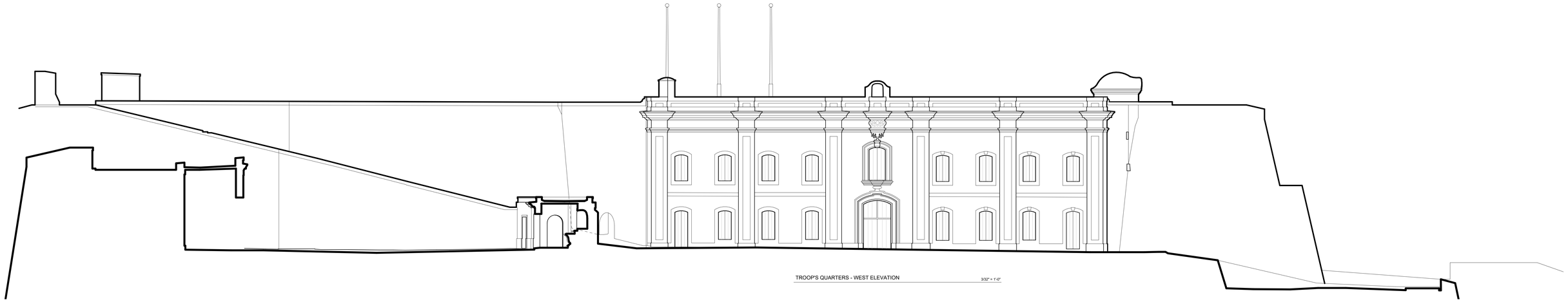
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SAN JUAN

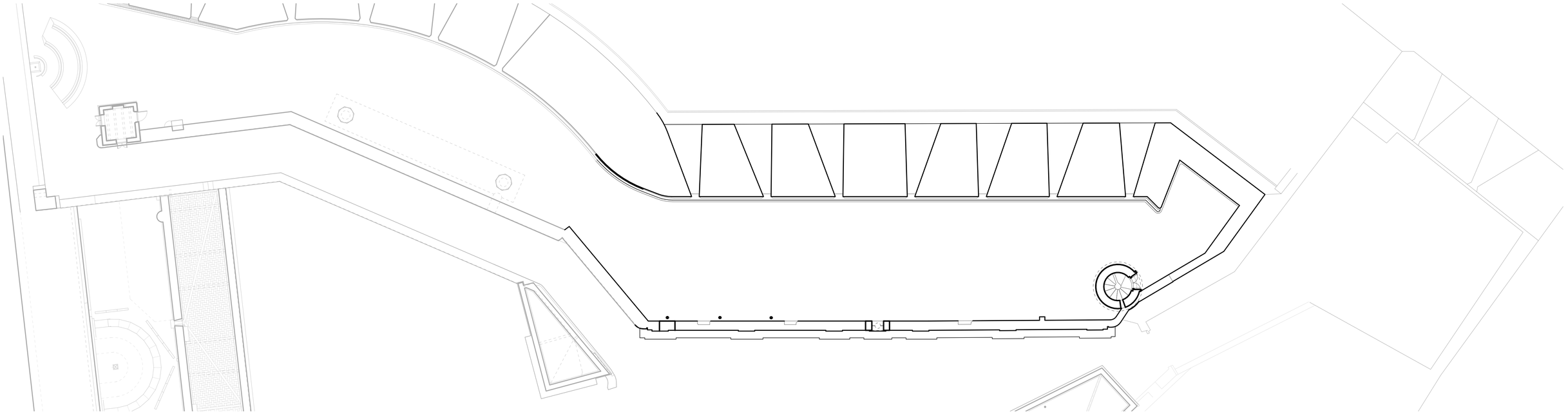
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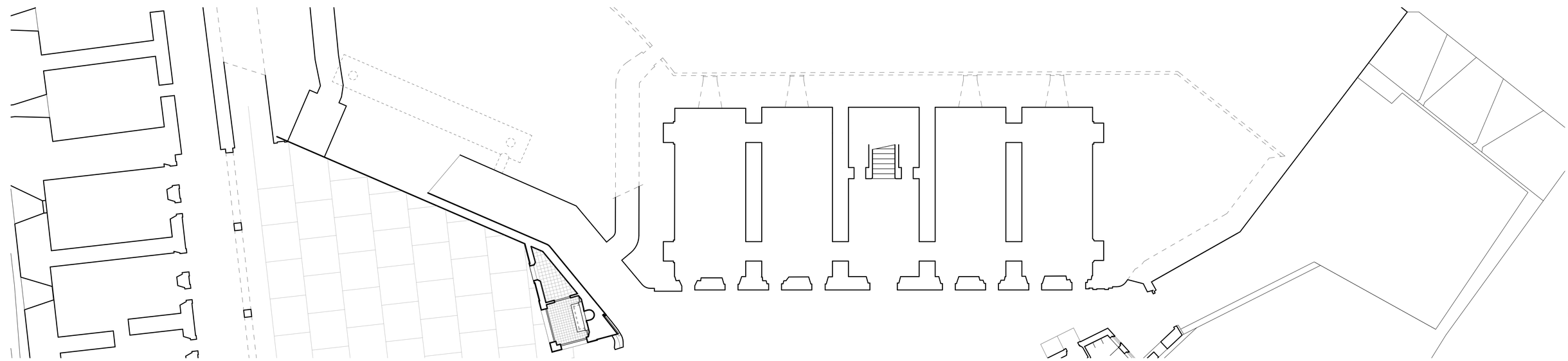
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TROOP'S QUARTERS - WEST ELEVATION 3/32" = 1'-0"



TROOP'S QUARTERS - ROOF PLAN 3/32" = 1'-0"



TROOP'S QUARTERS - GROUND FLOOR PLAN 3/32" = 1'-0"

SHEET 6

HISTORIC STRUCTURE REPORT

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PUERTO RICO

SAN JUAN

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Appendix B: Historic American Buildings Survey (HABS) Drawings

Castillo de San Cristóbal, Boulevard Norzagaray, San Juan, San Juan Municipio, PR. 1940. Historic American Buildings Survey, HABS PR-47.

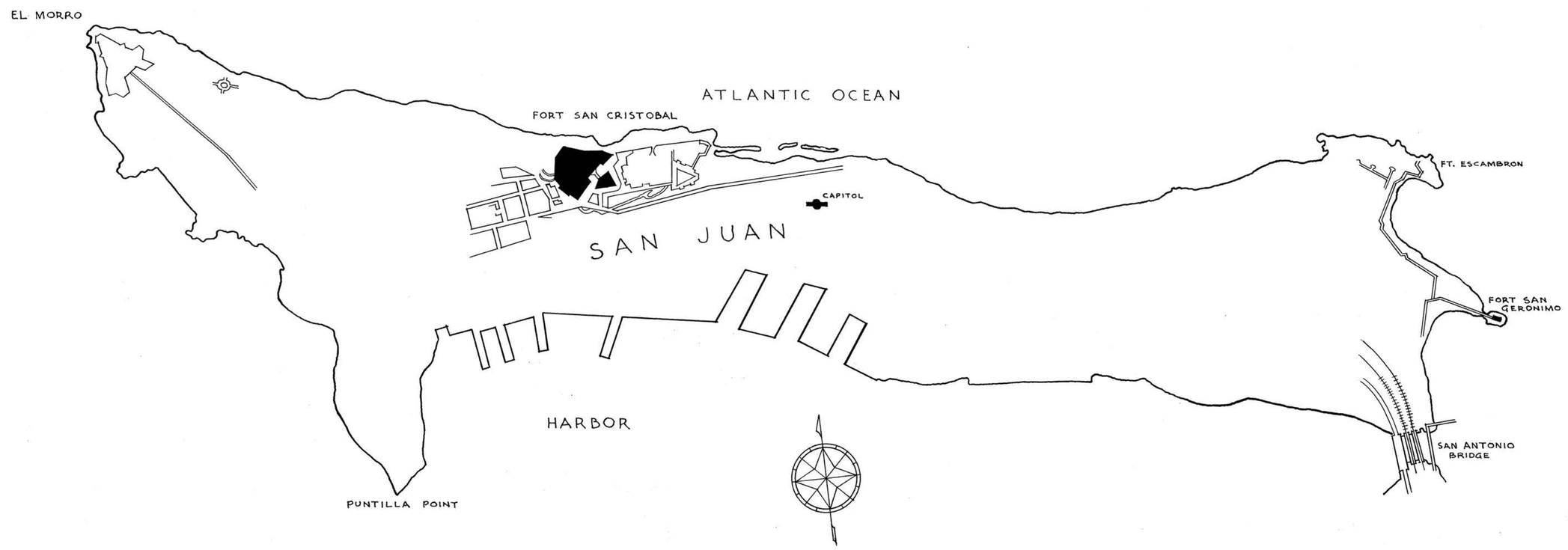
Sheet Index

Cover Location Plan, Fort San Cristóbal

Sheet 1 Birds Eye View, Fort San Cristóbal

FORT SAN CRISTOBAL

SAN JUAN, PUERTO RICO



LOCATION PLAN

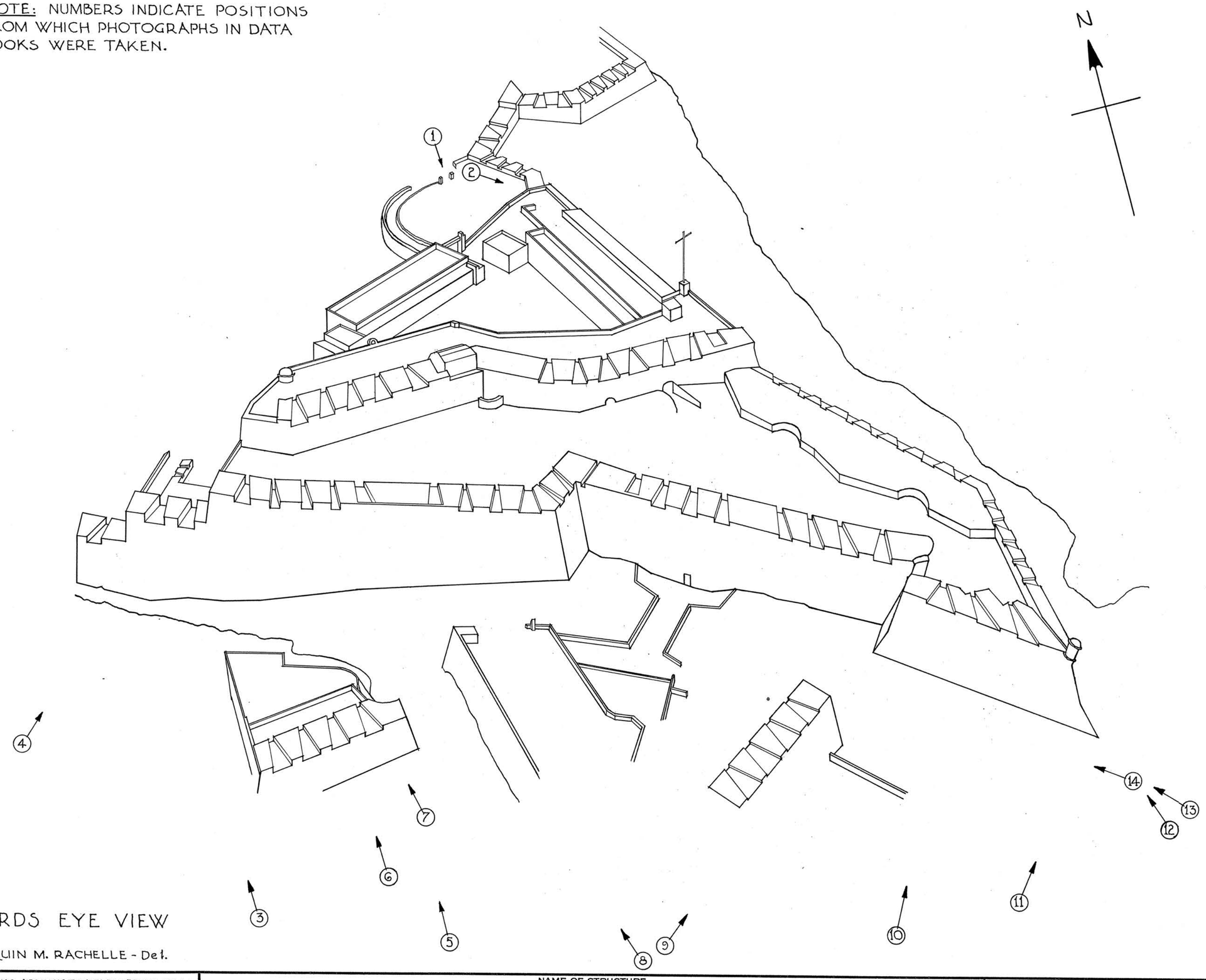
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ERECTED 1631 – 1783

HISTORIC AMERICAN BUILDINGS SURVEY U. S. DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE BRANCH OF PLANS AND DESIGN	MEASURED: DRAWN: JANUARY 1940 MEASUREMENTS CHECKED:	DRAWINGS APPROVED: Celestino Perez Jr. (W), DISTRICT OFFICER. DRAWINGS APPROVED: L. C. Wirt, CHIEF ARCHITECT. ACCEPTED FOR LIBRARY OF CONGRESS:	·DISTRICT·OF·PUERTO·RICO· ·FIELD·PARTY· ·THOMAS T. WATERMAN· ·HISTORIC·AMERICAN·BLDGS.·SURVEY· ·WASHINGTON, D.C.·	SURVEY NO. P.R-47 1 SHEET	INDEX NO. P.R. 7-SAJU 5.

19

NOTE: NUMBERS INDICATE POSITIONS FROM WHICH PHOTOGRAPHS IN DATA BOOKS WERE TAKEN.



BIRDS EYE VIEW

TARQUIN M. RACHELLE - Del.

1940 PUBLIC WORKS ADMINISTRATION PROGRAM
FEDERAL PROJECT – 498-A
UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN

NAME OF STRUCTURE

FORT SAN CRISTOBAL

SAN JUAN, PUERTO RICO

SURVEY NO. P.R. 47

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 1 OF 1 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

Castillo de San Cristóbal Entrance Gate, San Juan, PR. 1965. Historic American Buildings Survey, HABS PR-56.

Sheet Index

Sheet 1 Map of Old San Juan and Site Plan, San Cristóbal

Sheet 2 Plan of Gate

Sheet 3 Front Elevation

Sheet 4 Rear Elevation

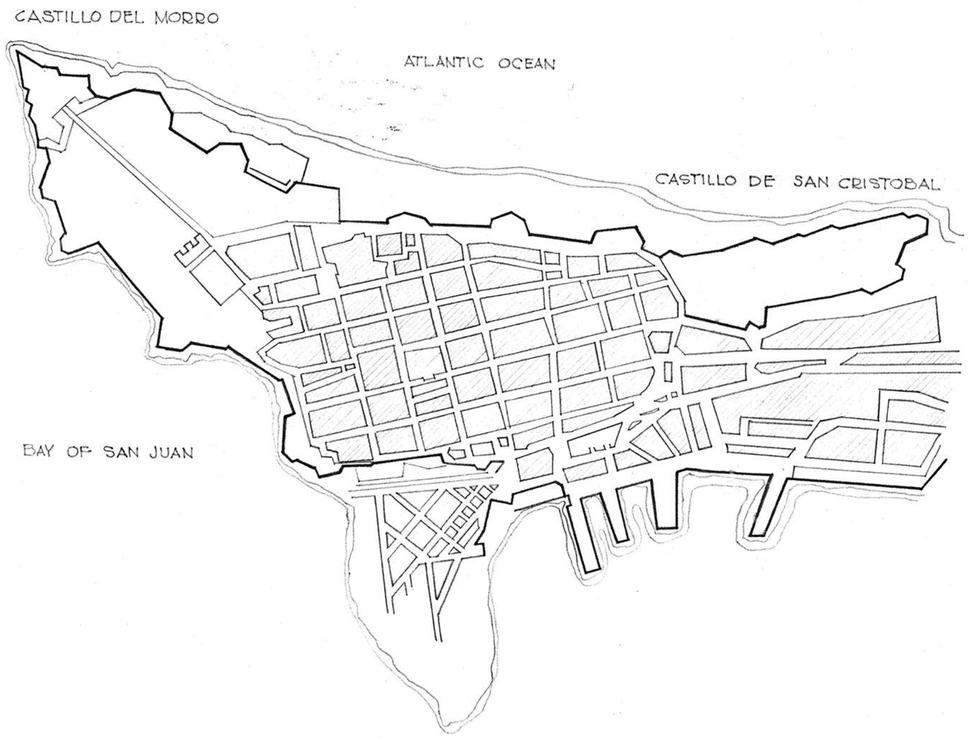
Sheet 5 Cornice Detail and Section A-A

TRIM LINE

CASTILLO DE SAN CRISTOBAL ENTRANCE GATE

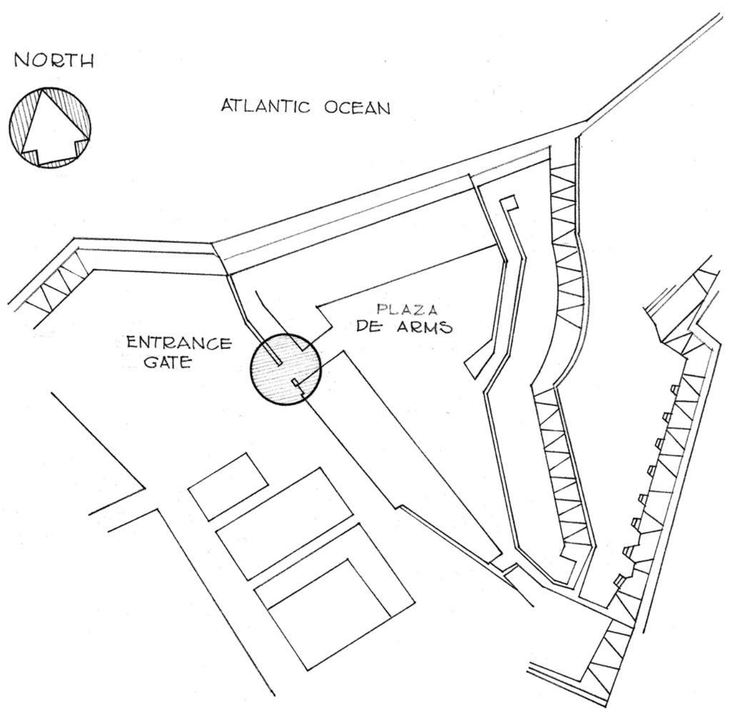
THE SANDSTONE ENTRANCE GATE WAS BUILT BETWEEN 1775 AND 1783. IT WAS DESIGNED BY ENGINEER THOMAS O'DALEY. THERE IS NO INFORMATION ABOUT THE WOODEN DOORS OF THE GATE UNTIL THE 1860'S. THE TOP PART OF THE STONE GATE WAS REFINED IN THE NINETEENTH CENTURY

THESE DRAWINGS WERE PREPARED UNDER THE DIRECTION OF PAUL E. ROBINSON IN THE SAN JUAN FIELD OFFICE AT THE SAN JUAN NATIONAL HISTORIC SITE, IN APRIL OF 1965.



MAP OF OLD SAN JUAN

0 100 200 400 800 1200 FEET



SITE PLAN - SAN CRISTOBAL

0 50 100 200 300 FEET

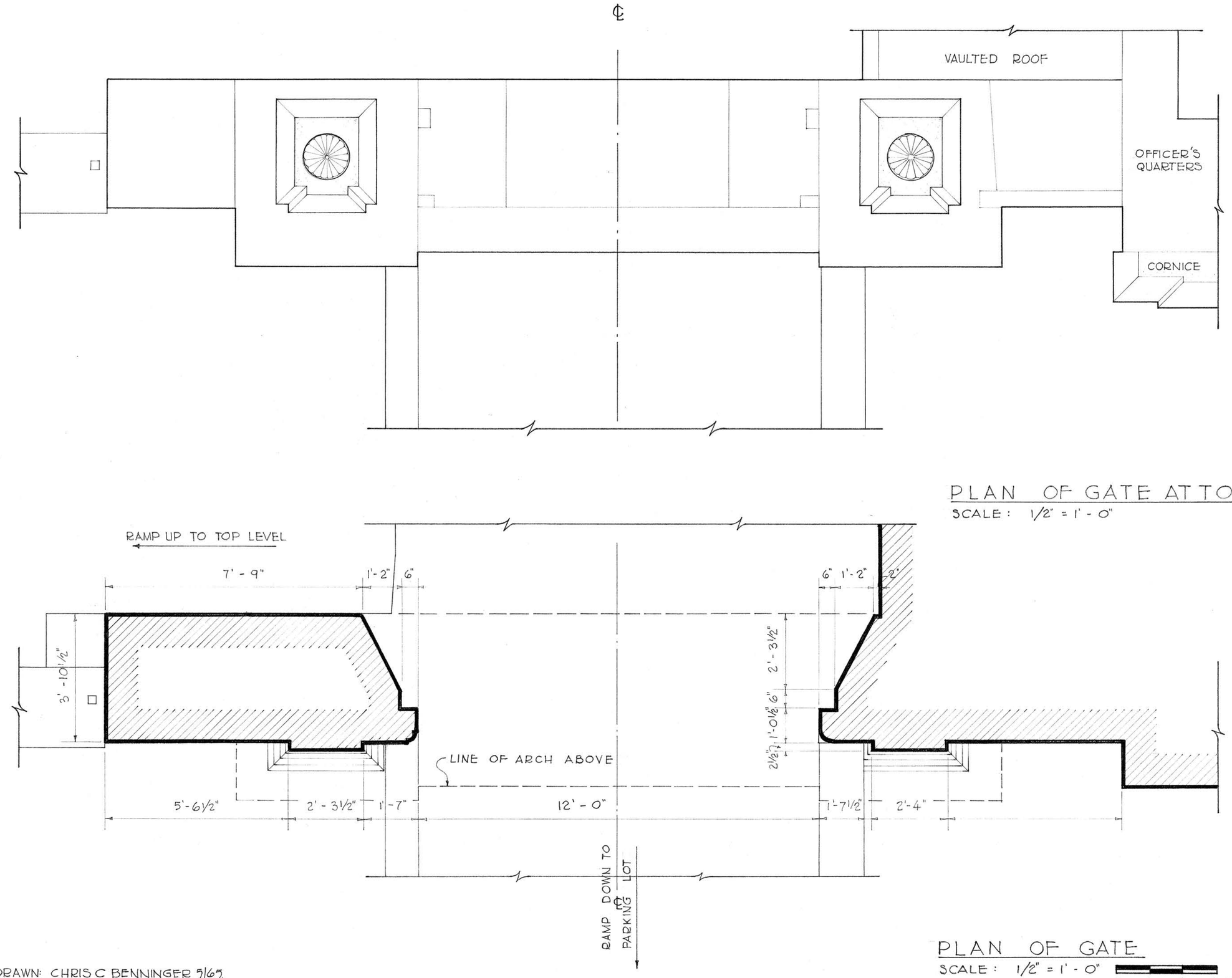
SAN JUAN PUERTO RICO

REDRAWN: CHRIS C BENNINGER 5/65
DRAWN BY: PAUL E ROBINSON 4164

SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF THE NATIONAL PARK SERVICE, UNITED STATES DEPARTMENT OF THE INTERIOR	NAME AND LOCATION OF STRUCTURE ENTRANCE GATE, CASTILLO DE SAN CRISTOBAL SAN JUAN PUERTO RICO	SURVEY NO. PR-56	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 1 OF 5 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

NOTE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.

TRIM LINE



PLAN OF GATE AT TOP

SCALE: 1/2" = 1' - 0"

PLAN OF GATE

SCALE: 1/2" = 1' - 0"

0 1 2 3 FEET

REDRAWN: CHRIS C BENNINGER 9/69

DRAWN BY: PAUL E ROBINSON 4/64

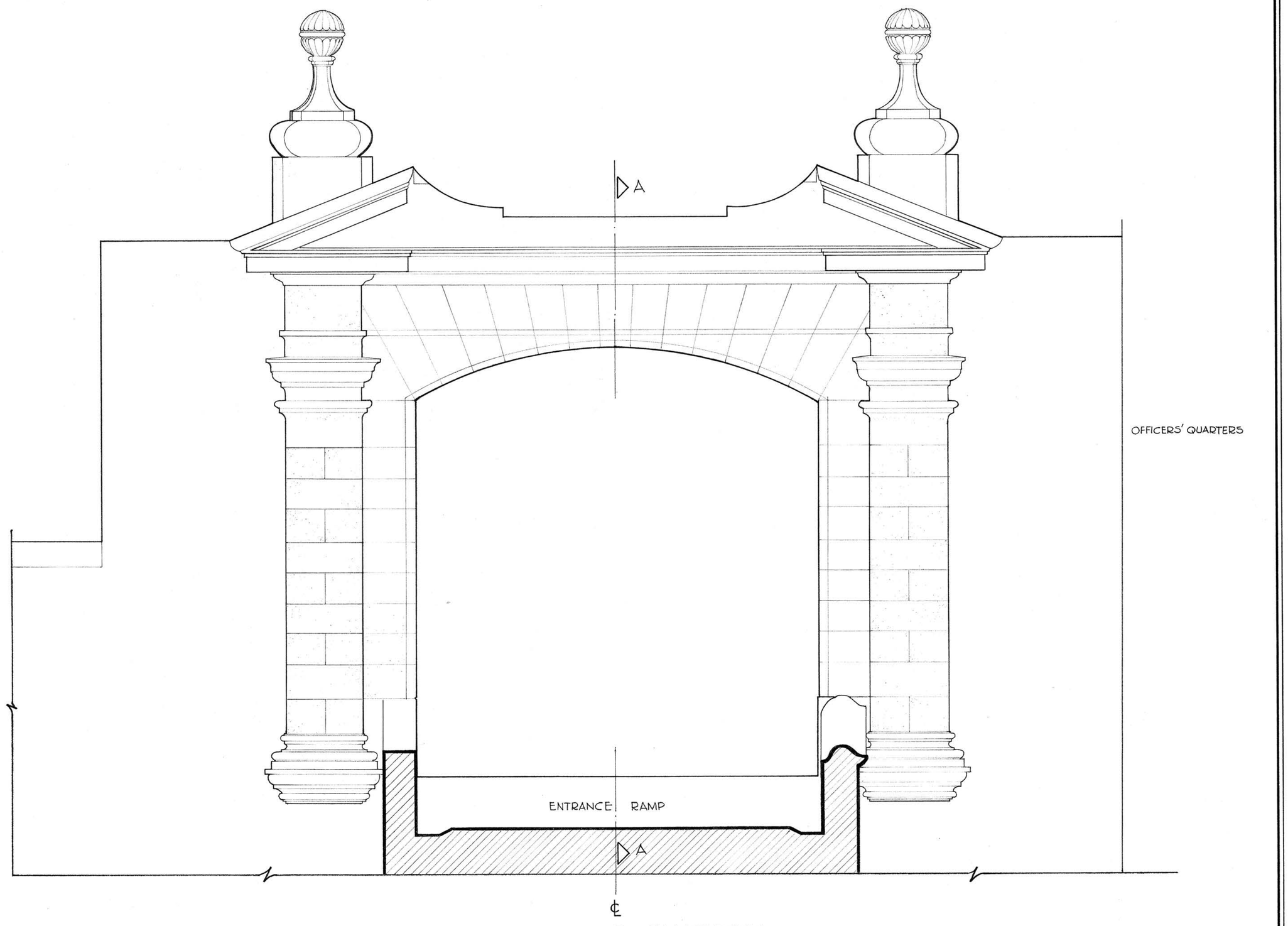
SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF THE NATIONAL PARK SERVICE, UNITED STATES DEPARTMENT OF THE INTERIOR	NAME AND LOCATION OF STRUCTURE ENTRANCE GATE, CASTILLO DE SAN CRISTOBAL SAN JUAN PUERTO RICO	SURVEY NO. PR-516	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 2 OF 5 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

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TRIM LINE

TRIM LINE



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FRONT ELEVATION

SCALE: 1/2" = 1'-0" 0 1 2 3 FEET

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DRAWN BY: PAUL E. ROBINSON 4/64

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF THE NATIONAL PARK SERVICE,
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE
ENTRANCE GATE, CASTILLO DE SAN CRISTOBAL
SAN JUAN PUERTO RICO

SURVEY NO. PR-86

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 3 OF 5 SHEETS

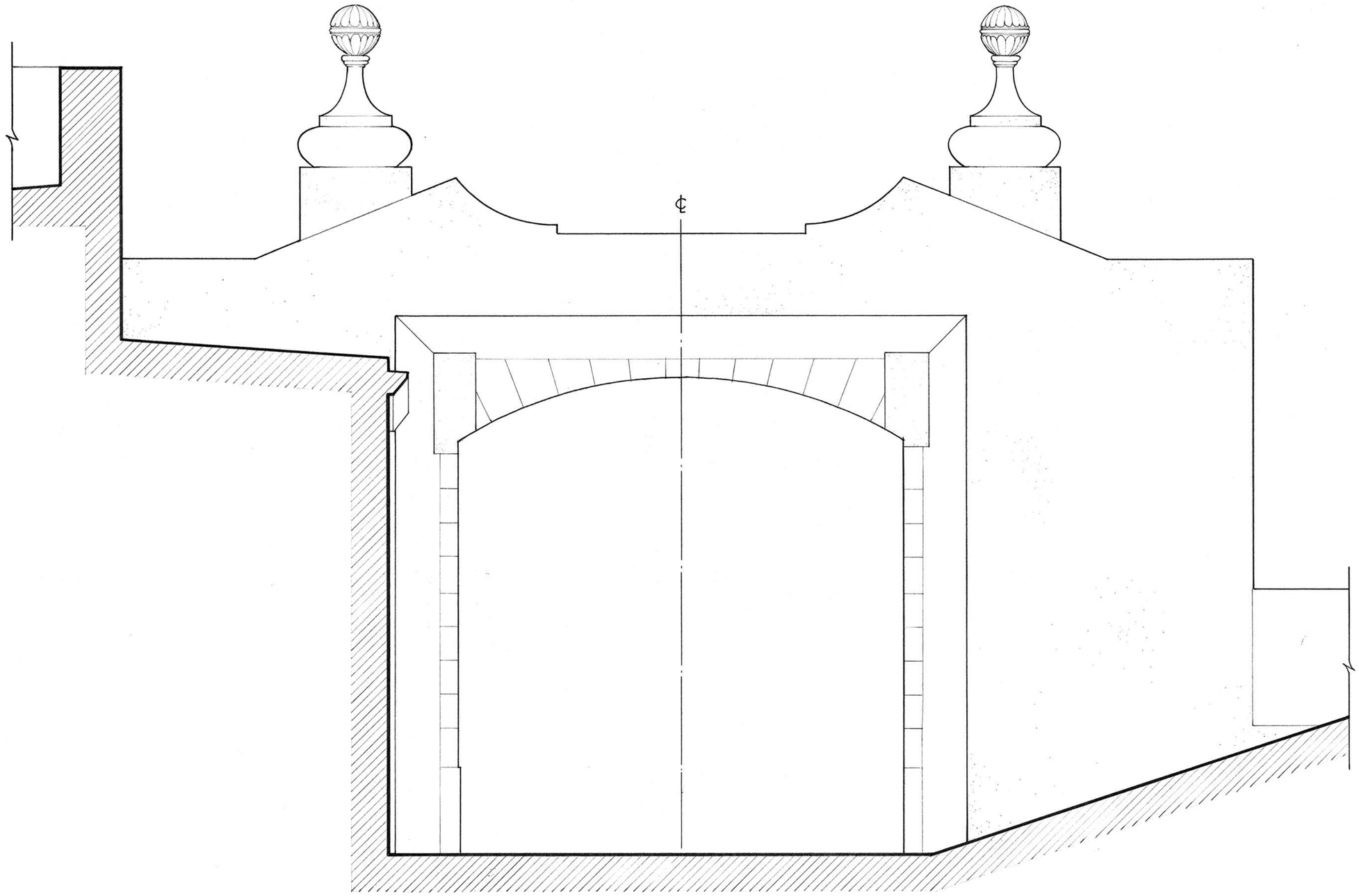
LIBRARY OF CONGRESS INDEX NUMBER

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TRIM LINE

P. B. P. CO. 16-8559

TRIM LINE



REAR ELEVATION

SCALE: 1/2" = 1'-0"

0 1 2 3 FEET

RE DRAWN: CHRIS C BENNINGER 5/65
DRAWN BY: PAUL E. ROBINSON 4/64

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF THE NATIONAL PARK SERVICE,
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE
ENTRANCE GATE, CASTILLO DE SAN CRISTOBAL
SAN JUAN PUERTO RICO

SURVEY NO. PR-56

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 4 OF 5 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

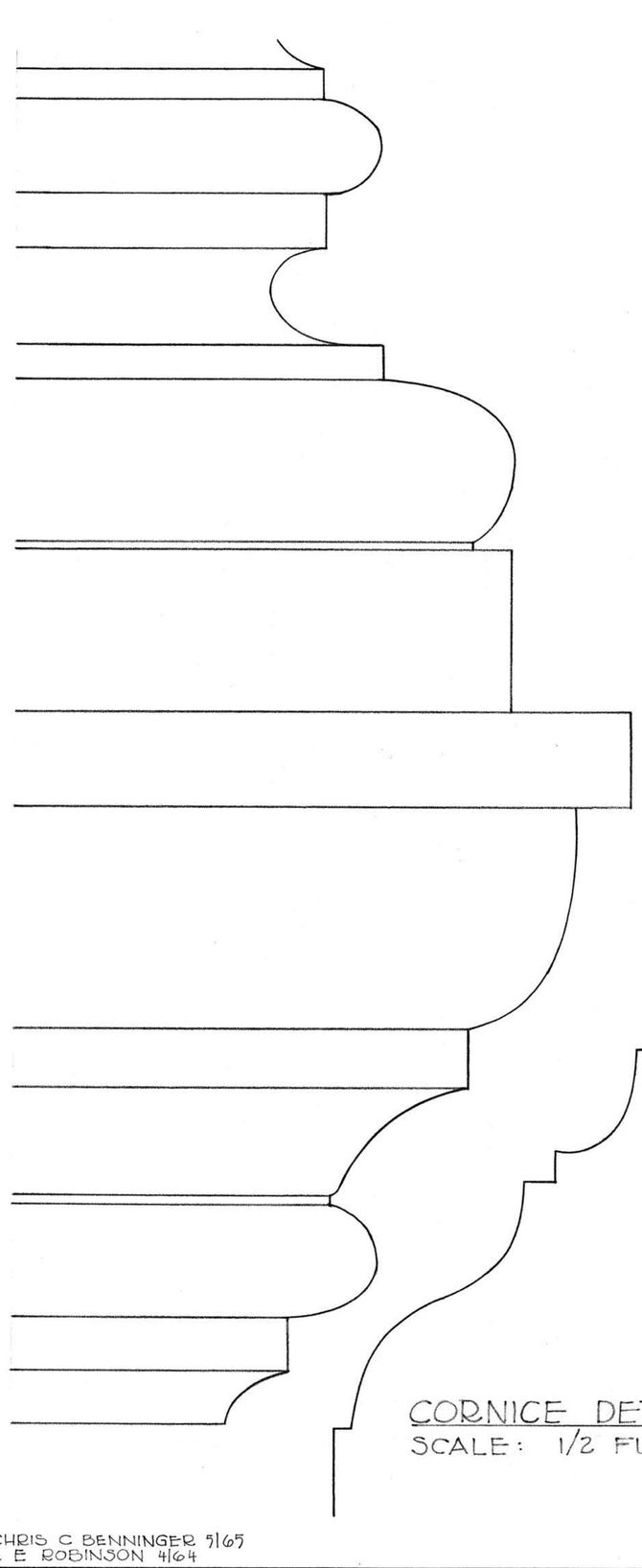
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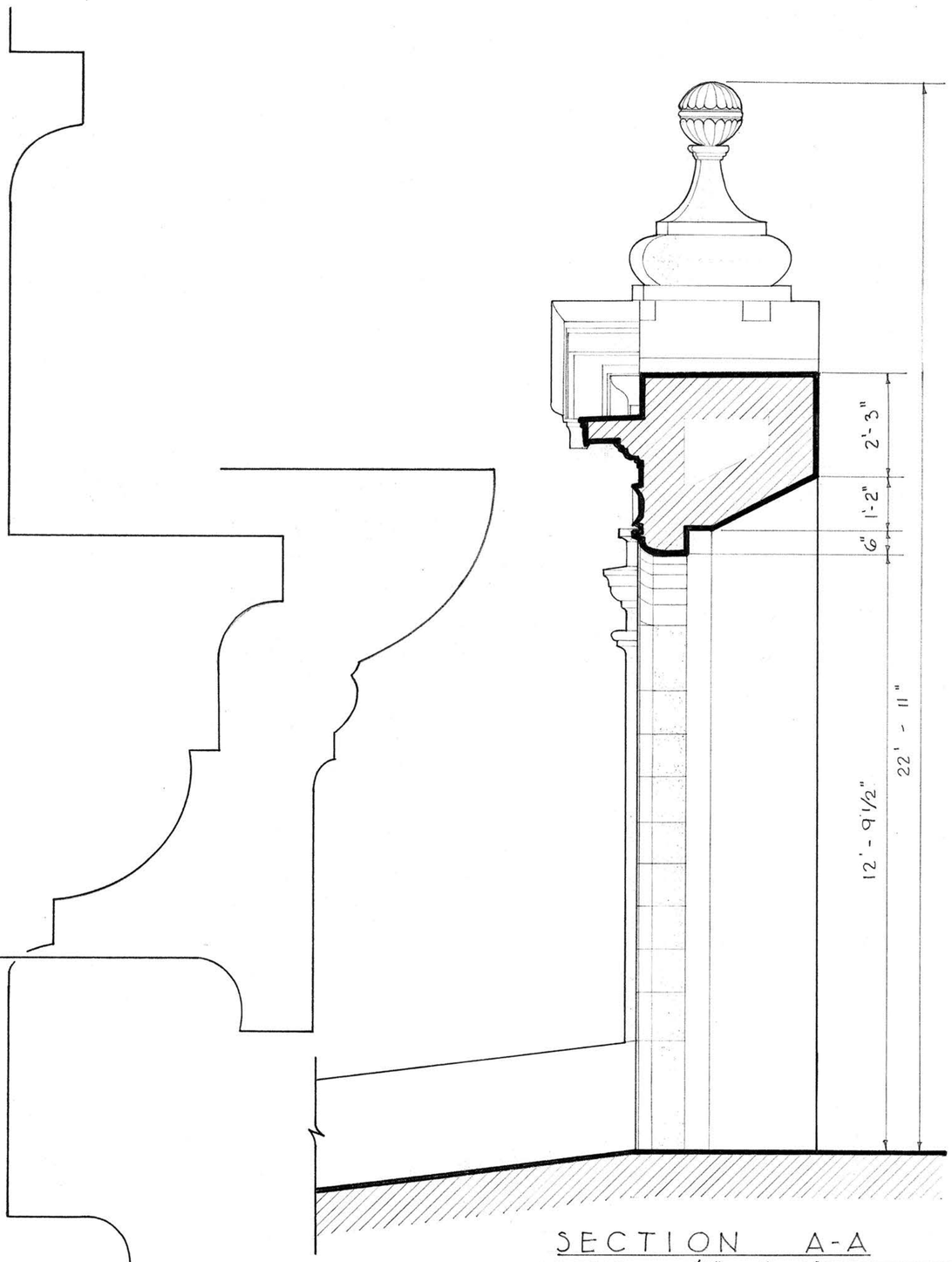
P. B. P. CO. 16-5559

5

TRIM LINE



CORNICE DETAIL
SCALE: 1/2 FULL SCALE



SECTION A-A
SCALE : 1/2" = 1'-0"
0 1 2 3 FEET

REDRAWN: CHRIS C BENNINGER 5/65
DRAWN BY: PAUL E ROBINSON 4/64

SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF THE NATIONAL PARK SERVICE, UNITED STATES DEPARTMENT OF THE INTERIOR	NAME AND LOCATION OF STRUCTURE ENTRANCE GATE, CASTILLO DE SAN CRISTOBAL SAN JUAN PUERTO RICO	SURVEY NO. PR-56	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 5 OF 5 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

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Castillo de San Cristóbal South Gate, San Juan, PR. 1963. Historic American Buildings Survey, HABS PR-57.

Sheet Index

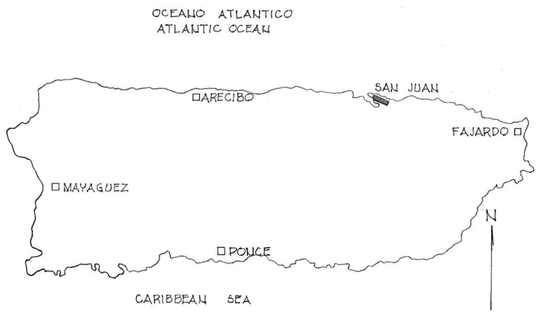
Sheet 1 Map of Puerto Rico, map of Old San Juan, and Site Plan, San Cristóbal

Sheet 2 Plan

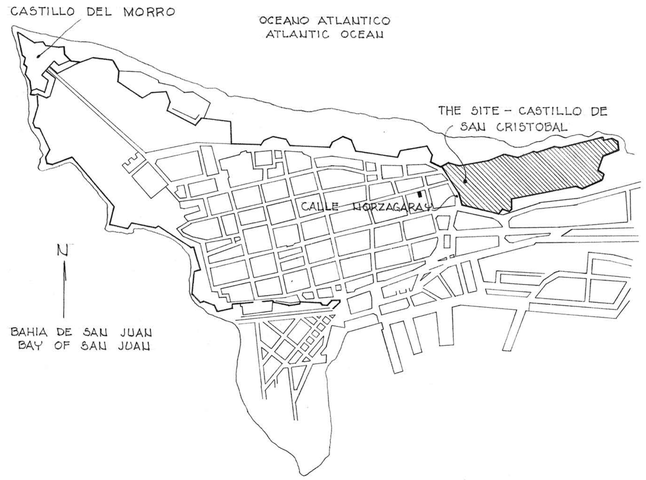
Sheet 3 West Elevation and South Elevation

CASTILLO DE SAN CRISTOBAL

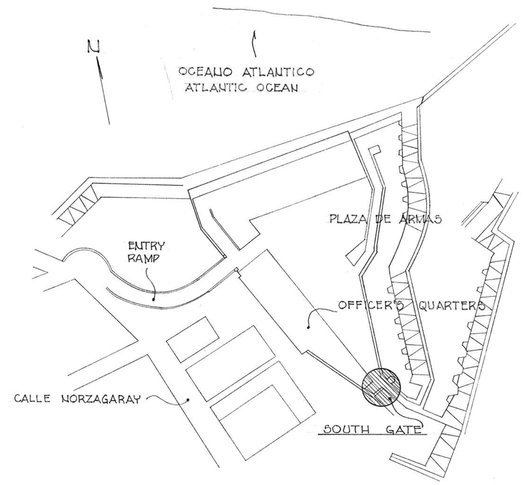
SOUTH GATE



MAP OF PUERTO RICO



MAP OF OLD SAN JUAN



SITE PLAN - SAN CRISTOBAL

SAN JUAN PUERTO RICO

THIS STRUCTURE, ALTHOUGH EXTENSIVELY MODIFIED BY SUBSIQUENT CONSTRUCTION, RETAINS MOST OF ITS ORIGINAL CHARACTERISTICS. OF SPECIAL INTEREST ARE FRAGMENTS OF EARLY STUCCO FINISH, DECORATIVE COPING, AND AN ORNATE SURROUND OF AN ARCHED OPENING.

E. B. CLIVER DEL.

SUPERVISING ARCHITECT — HENRY JUDD, HISTORIC STRUCTURES
PROJECT SUPERVISOR — E. C. GIESSING, ARCHITECT
ASST. PROJECT SUPERVISOR — R. REEVES, ARCHITECT
DELINEATORS — L. D. ALTHOUSE, STU. ASST. ARCH. (U. OF FLA.)
E. B. CLIVER, STU. ASST. ARCH. (CARNEGIE TECH)

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE, E. O. D. C.

NAME OF STRUCTURE:
SOUTH GATE — CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO. PR-57

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 1 OF 3 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

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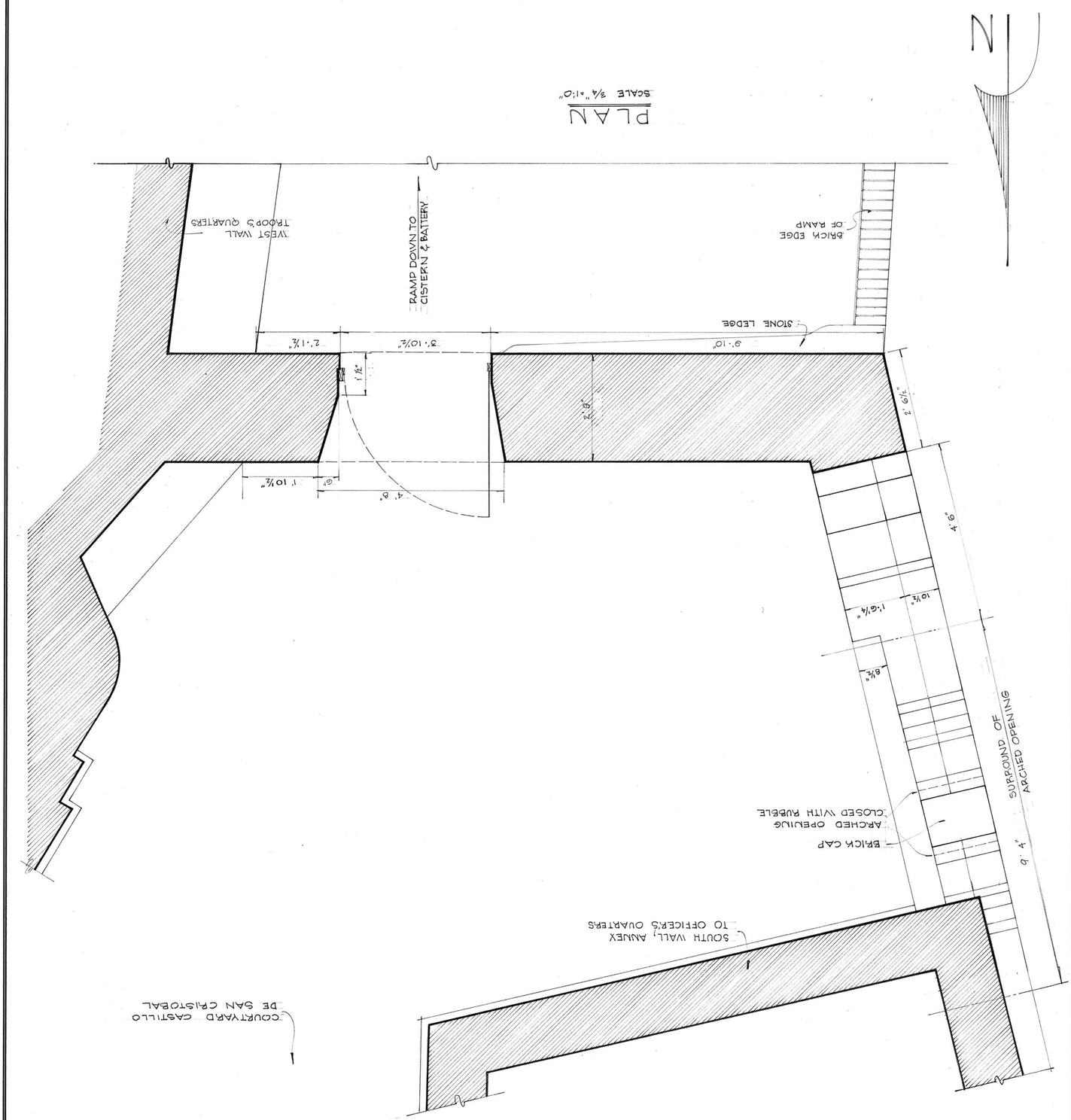
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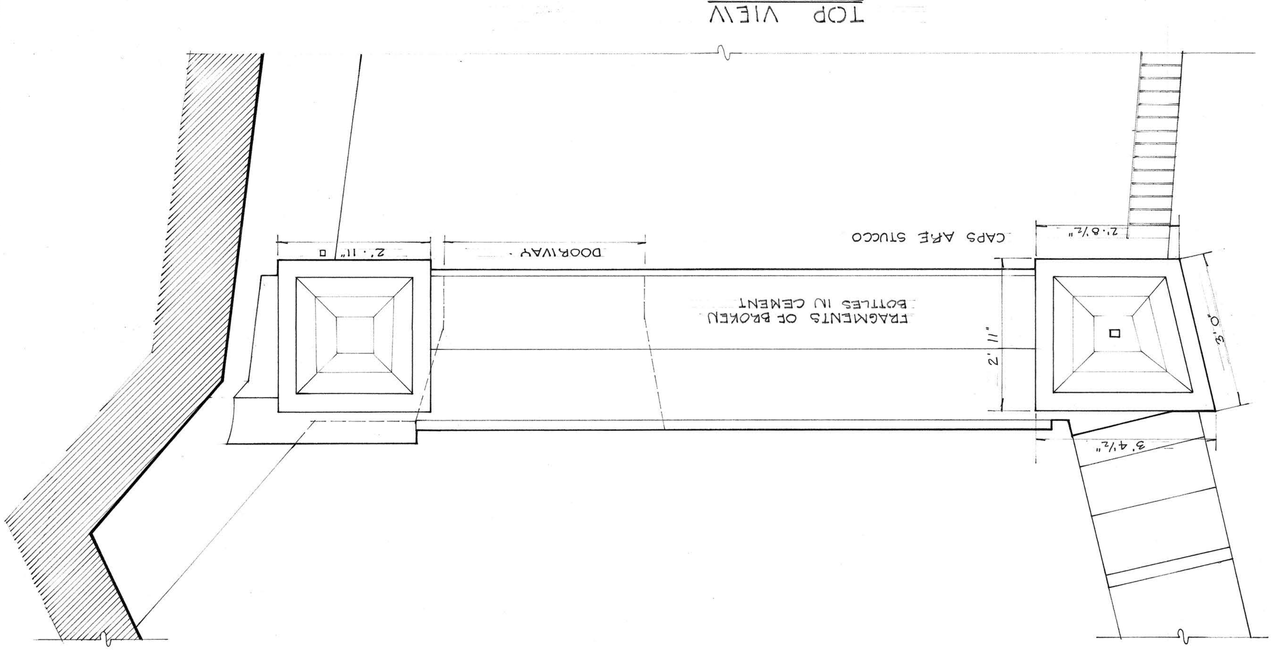
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HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 2 OF 2 SHEETS

SURVEY NO. PR-57

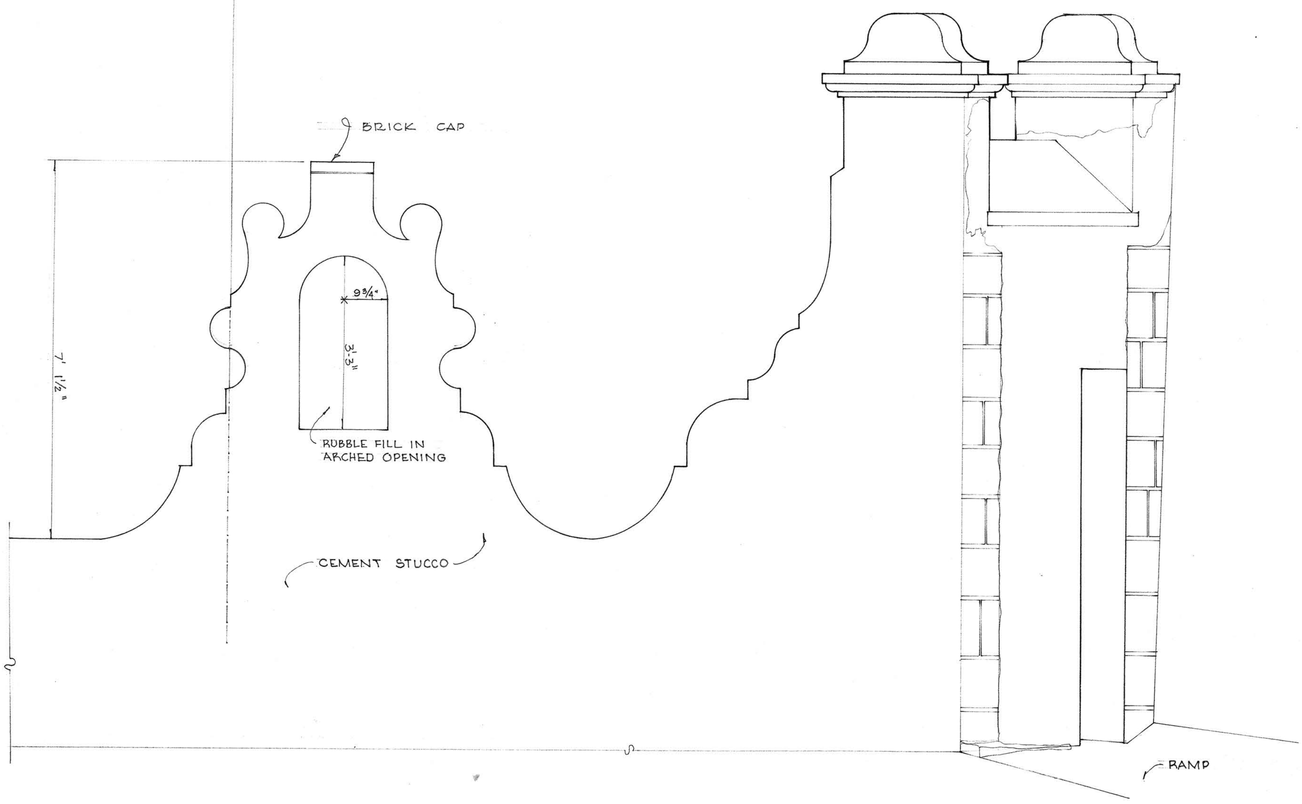
NAME OF STRUCTURE
SOUTH GATE CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO



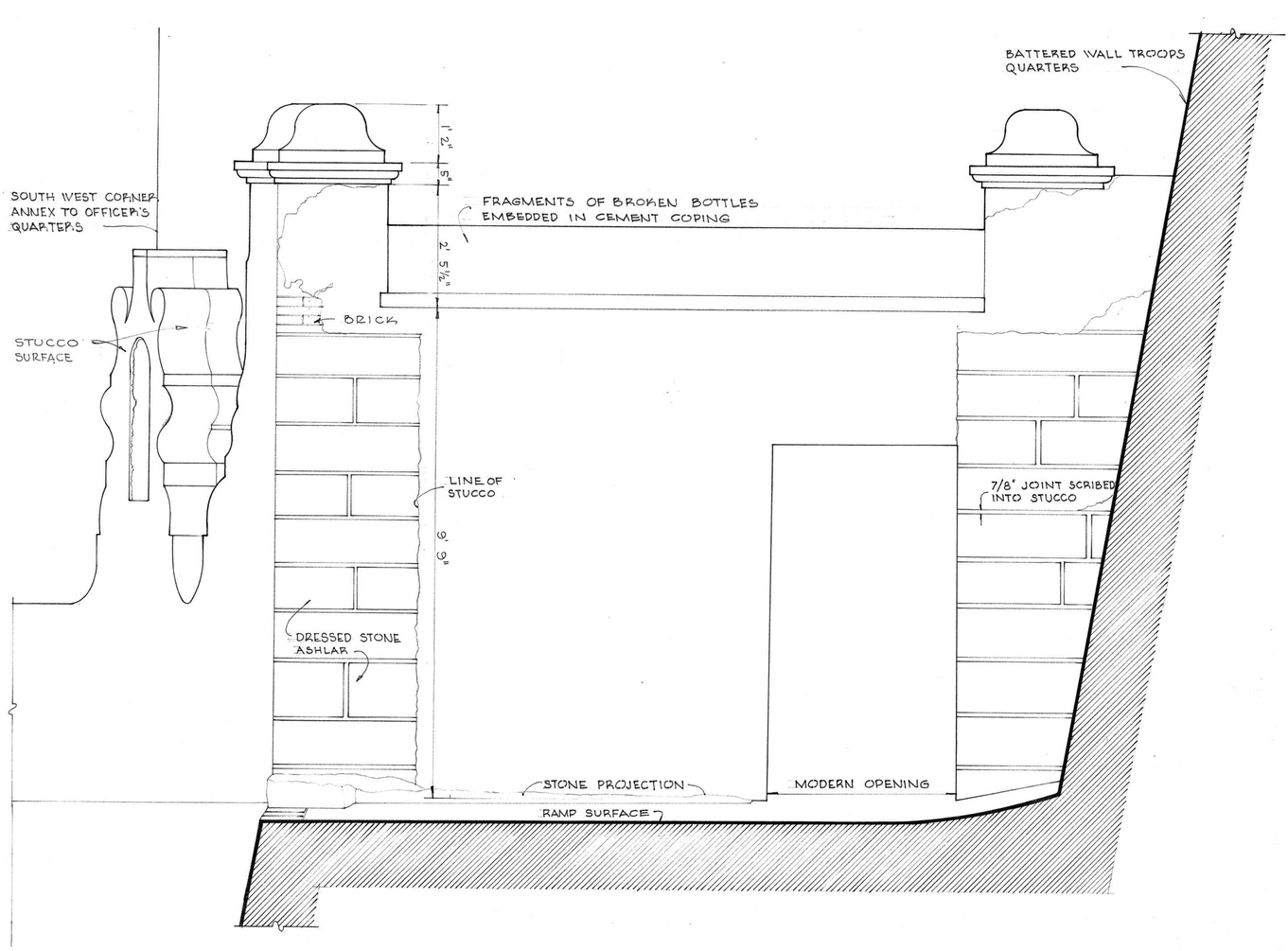


N. P. ANTHONY: DEL.

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE: E. O. D., C.



WEST ELEVATION
SCALE ¾" = 1'-0"



SOUTH ELEVATION
SCALE ¾" = 1'-0"

N. P. AUTHORITY DEL.

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE, E.O.D.C.

NAME OF STRUCTURE
SOUTH GATE
CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO.
PR-57

AMERICAN SURVEY
HISTORIC BUILDINGS
SHEET 3 OF 3 SHEETS

DRAWN BY
INDEX
CHECKED BY

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Santa Teresa Battery, San Juan, PR. 1986. Historic American Buildings Survey, HABS PR-91.

Sheet Index

Sheet 1 Location Map and West Bunker and Gun Emplacement Section/Elevation

Sheet 2 Site Plan

Sheet 3 Floor Plan – East Portion

Sheet 4 Floor Plan – West Portion

Sheet 5 North Elevation, Section B-B, Section C-C, and Section D-D

Sheet 6 Section/South Elevation – East Portion and Section F-F – East Portion

Sheet 7 Section/South Elevation – West Portion, Section F-F – West Portion

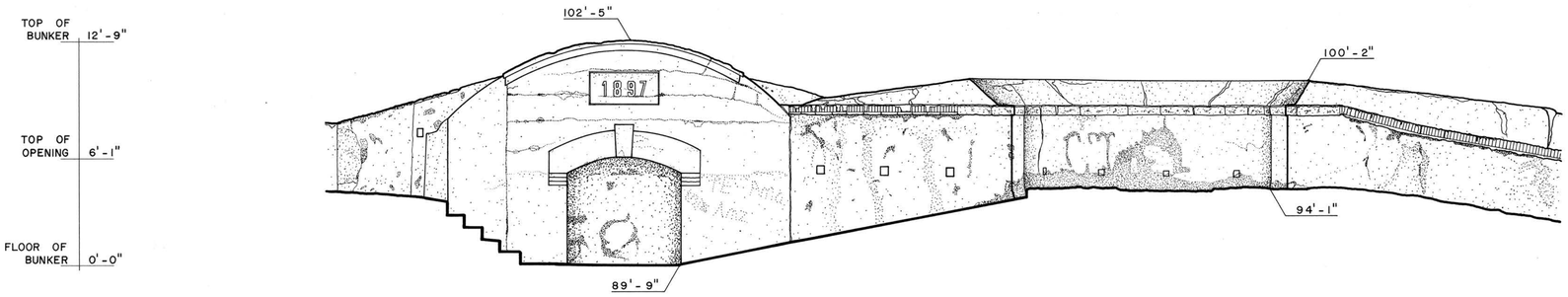
Sheet 8 Section G-G/Traverse West Elevation, Section H-H/Battery East Elevation, and Section J-J

Sheet 9 Section K-K and Section L-L

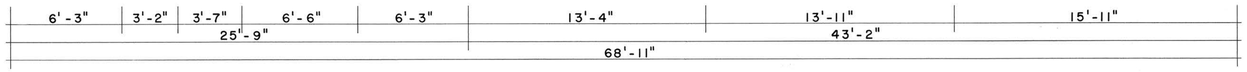
Sheet 10 Guardhouse Floor Plan and Section/South Elevation M-M

TRIM LINE

SANTA TERESA BATTERY



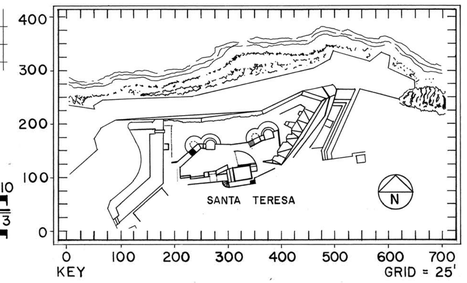
NOTE:
SPOT ELEVATIONS ARE IN RELATION TO THE SEA LEVEL



WEST BUNKER AND GUN EMPLACEMENT — SECTION/ELEVATION

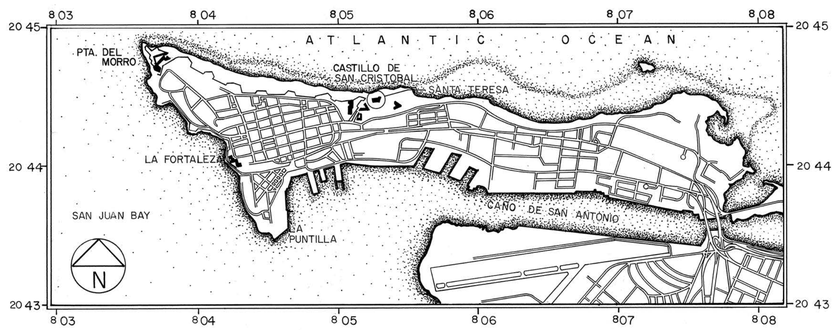
FEET 1/4"= 1'-0" 0 1 2 3 4 5 10

METERS 1:48 0 1 2 3



IN 1631, GOVERNOR ENRIQUE ENRIQUEZ DE SOTOMAYOR BEGAN TO ENCLOSE THE CITY OF SAN JUAN AND STRENGTHEN ITS DEFENSES BY BUILDING THE CASTILLO DE SAN CRISTOBAL. IN 1765, A COMPLETE REDESIGNING AND REBUILDING OF SAN CRISTOBAL WAS UNDERTAKEN BY MILITARY ENGINEERS TOMAS O'DALY AND JUAN FRANSISCO MESTRES. MOST OF THE MODIFICATIONS, INCLUDING THE GUN EMPLACEMENT KNOWN AS THE SANTA TERESA BATTERY, WERE COMPLETED BY 1783. THE DEFENSES OF PUERTO RICO WERE TURNED OVER TO THE U.S. ARMY IN 1898. THE DEFENSES SURROUNDING SAN JUAN, INCLUDING SAN CRISTOBAL, BECAME THE SAN JUAN NATIONAL HISTORIC SITE IN 1949.

THE FIELD RECORDING PROJECT WAS UNDERTAKEN BY THE HABS/HAER DIVISION, ROBERT J. KAPSCH, CHIEF, AND WAS INITIATED AND DIRECTED BY KENNETH L. ANDERSON, AIA, CHIEF OF THE HISTORIC AMERICAN BUILDINGS SURVEY (HABS), IN CONJUNCTION WITH BENJAMIN NISTAL-MORET, ARCHITECTURAL CONSERVATOR, SOUTHEAST REGION'S CULTURAL RESOURCES PRESERVATION CENTER, AND WITH W.P. CRAWFORD, SUPERINTENDANT, SAN JUAN NATIONAL HISTORIC SITE. THE 1986 MEASURED DRAWINGS WERE PRODUCED IN THE HABS SAN JUAN, PUERTO RICO FIELD OFFICE BY PROJECT SUPERVISOR JOSE M. MARTINEZ-CANINO (ARCHITECT, HABS WASHINGTON D.C. OFFICE), ARCHITECTURAL FOREMAN ERIC FRASER NIEMY (CARLETON UNIVERSITY, CANADA - U.S. ICOMOS), AND ARCHITECTURAL TECHNICIANS ORLANDO BADILLO (UNIVERSIDAD DE PUERTO RICO), TERRY BAILY (NORTH DAKOTA STATE UNIVERSITY), MICHAEL P. BEARY (UNIVERSITY COLLEGE OF DUBLIN, IRELAND - U.S./ICOMOS), AND JORGE L. SEIN (CITY COLLEGE OF NEW YORK).



TAKEN FROM: USGS SAN JUAN, P.R. QUADRANGLE 1969 (PHOTOREVISED 1982)
USGS BAYAMON, P.R. QUADRANGLE 1969 (PHOTOREVISED 1982)

UTM 19.805257.2044486

LOCATION MAP

FEET 1"=1667' 0 1000 3000 5000

METERS 1:20000 0 1 KM 2 KM

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HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 1 OF 11 SHEETS

SURVEY NO. PR-91

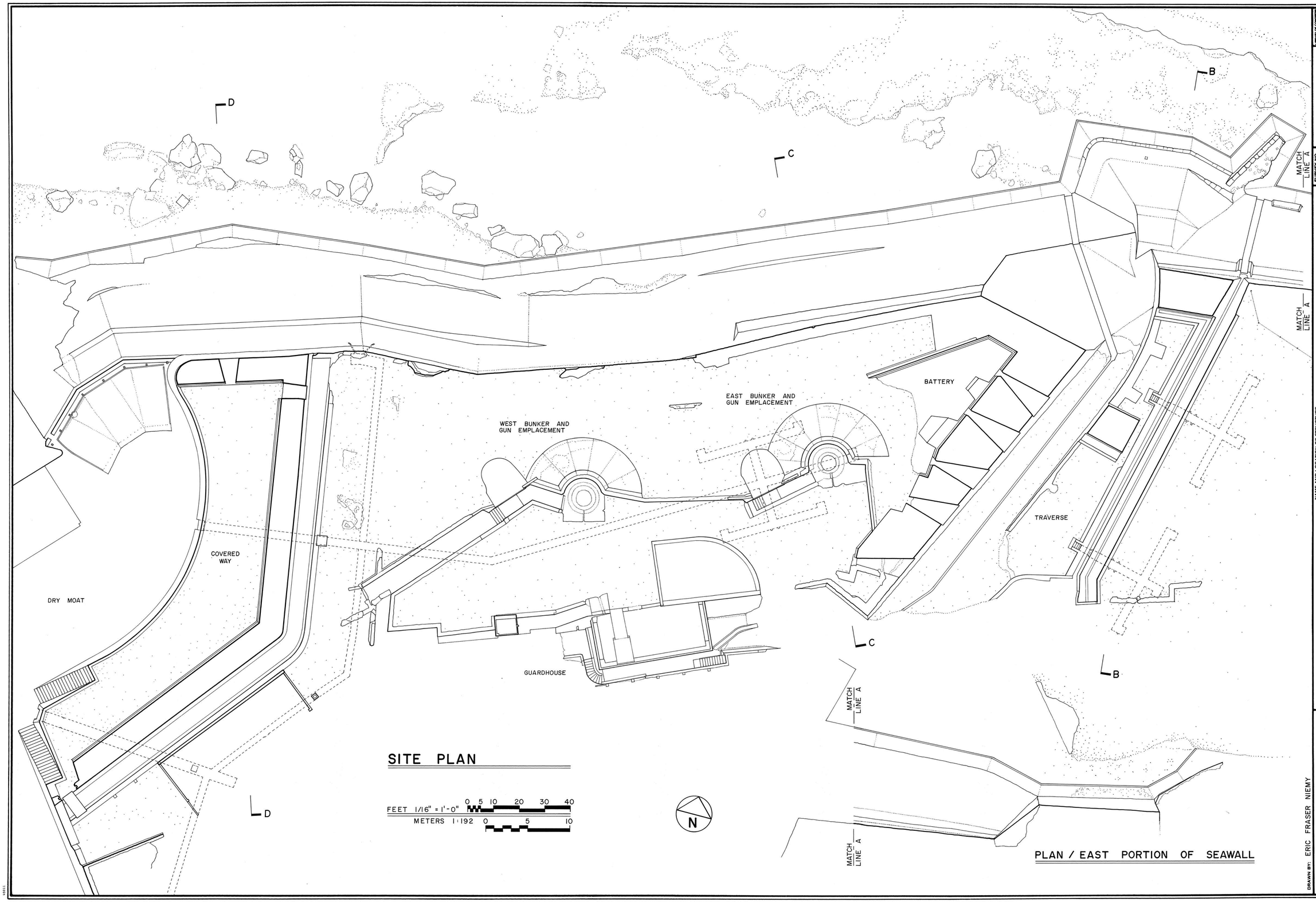
NAME AND LOCATION OF STRUCTURE
SANTA TERESA BATTERY
CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

DRAWN BY: MICHAEL P. BEARY
SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1986
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

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TRIM LINE

TRIM LINE



SITE PLAN

PLAN / EAST PORTION OF SEAWALL

NAME AND LOCATION OF STRUCTURE
SANTA TERESA BATTERY
CASTILLO DE SAN CRISTOBAL OLD SAN JUAN PUERTO RICO
SAN JUAN NATIONAL HISTORIC SITE SAN JUAN NATIONAL HISTORIC SITE

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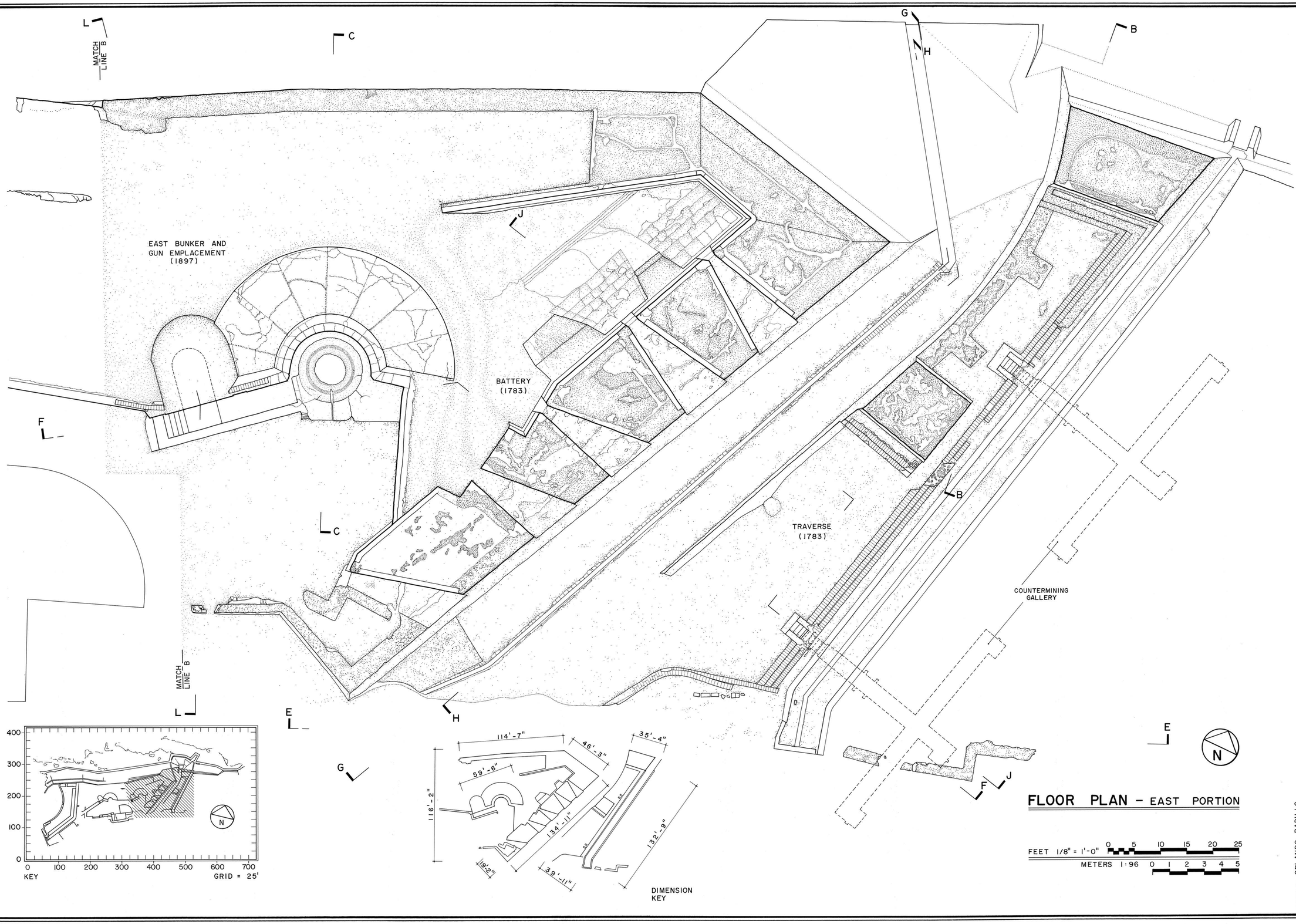
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 2 OF 11 SHEETS

DRAWN BY: ERIC FRASER NIEMY
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TRIM LINE

TRIM LINE



FLOOR PLAN – EAST PORTION

FEET 1/8" = 1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5

NAME AND LOCATION OF STRUCTURE

SANTA TERESA BATTERY

SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE

DRAWN BY: ORLANDO BADILLO

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1986

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UNITED STATES DEPARTMENT OF THE INTERIOR

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HISTORIC AMERICAN BUILDINGS SURVEY SHEET 3 OF 11 SHEETS

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V1511

TRIM LINE

TRIM LINE

D

K

MATCH LINE B

WEST BUNKER (1897)

COVERED WAY (1770)

WEST GUN EMPLACEMENT (1897)

F

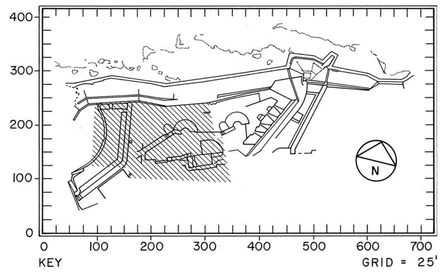
D

F

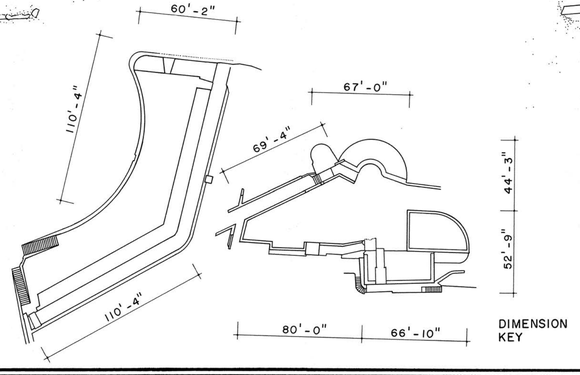
GUARDHOUSE (1897)

E

N



E



MATCH LINE B

K

FLOOR PLAN – WEST PORTION

FEET 1/8" = 1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5

DRAWN BY: JORGE L. SEIN AND ERIC F. NIEMY, INKED BY ERIC F. NIEMY

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1986

NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE

SANTA TERESA BATTERY

SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

CASTILLO DE SAN CRISTOBAL

SURVEY NO. PR-91

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 4 OF 11 SHEETS

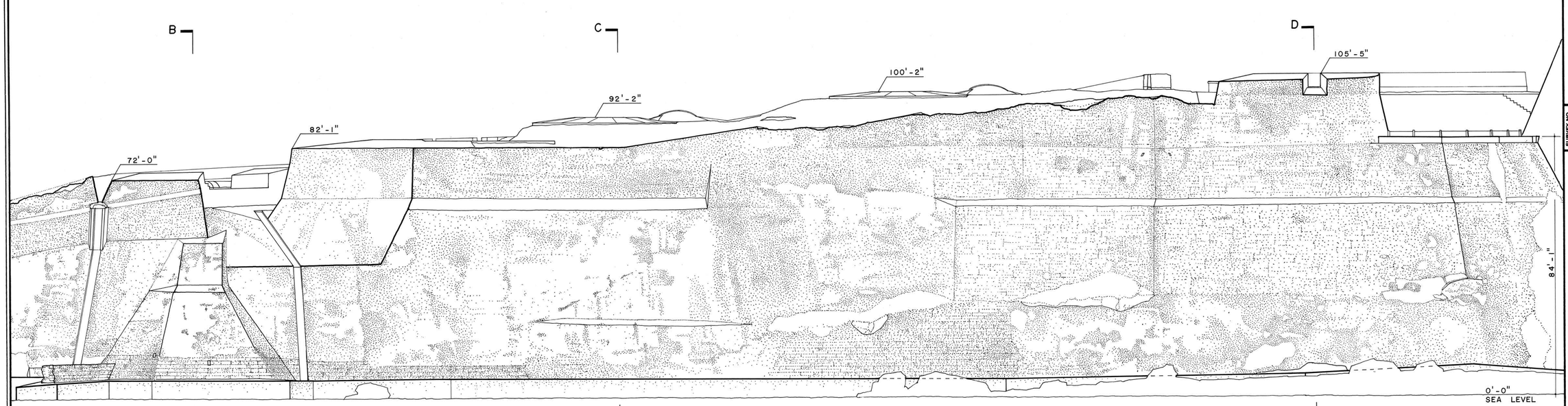
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19511

TRIM LINE

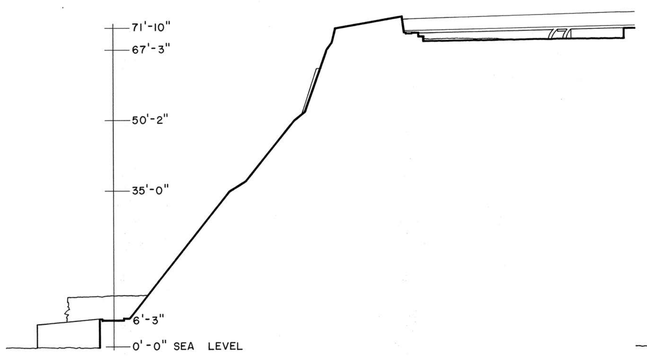
TRIM LINE



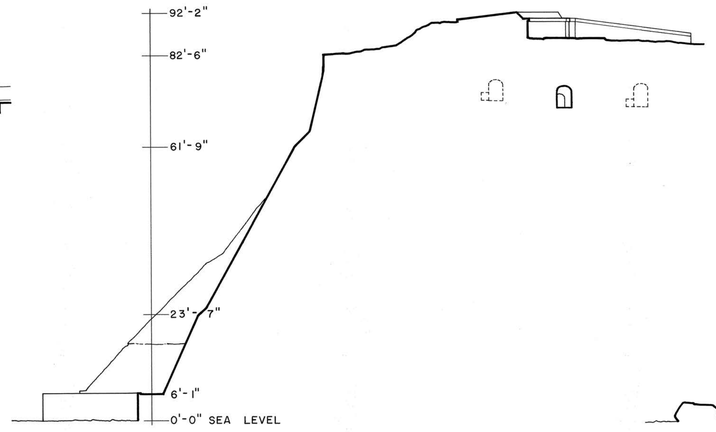
NORTH ELEVATION A-A / SEAWALL

FEET 1/16" = 1'-0" 0 5 10 20 30 40

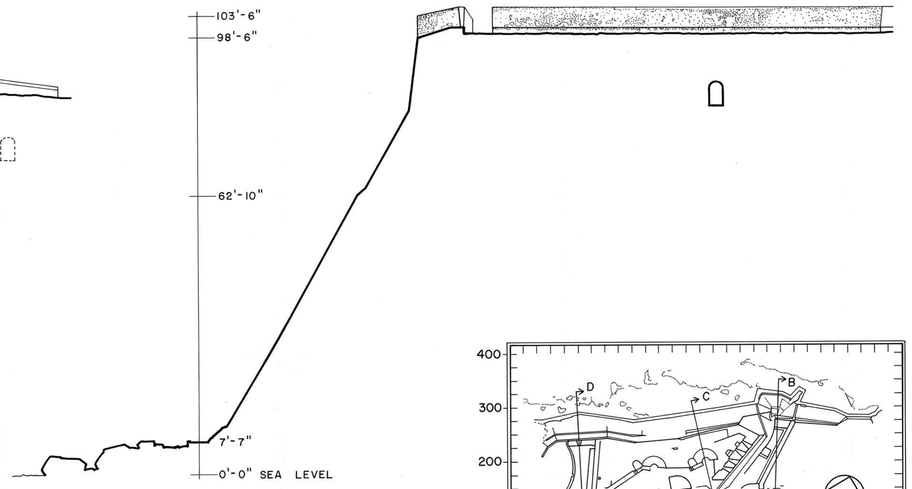
METERS 1:192 0 5 10



SECTION B-B



SECTION C-C



SECTION D-D

LIBRARY OF CONGRESS HABS NUMBER

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 5 OF 11 SHEETS

SURVEY NO. PR-91

PUERTO RICO

NAME AND LOCATION OF STRUCTURE

SANTA TERESA BATTERY

OLD SAN JUAN

SAN JUAN NATIONAL HISTORIC SITE

CASTILLO DE SAN CRISTOBAL

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1986

DRAWN BY: ERIC FRASER NIEMY

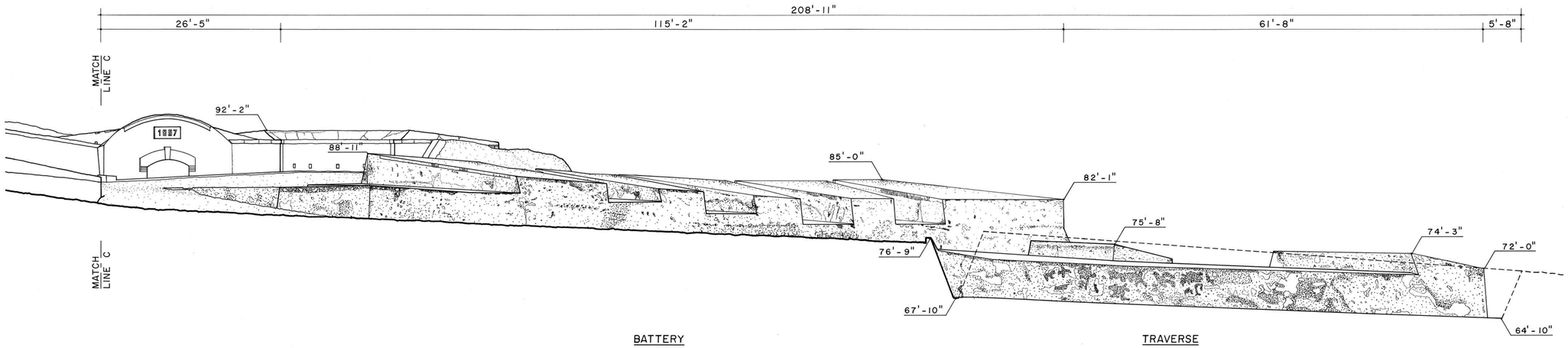
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V3511

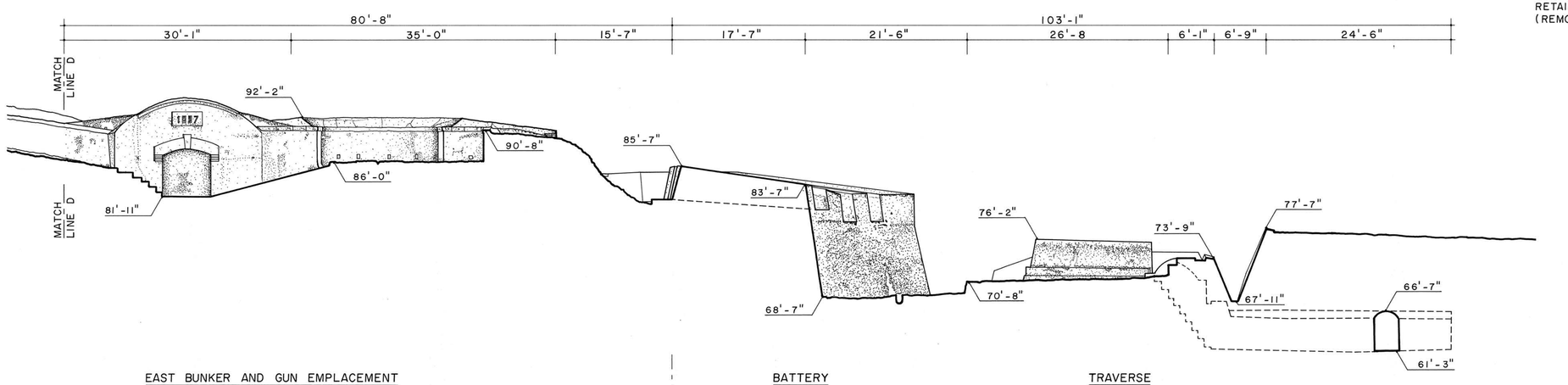
TRIM LINE

TRIM LINE



SECTION / SOUTH ELEVATION E-E – EAST PORTION

NOTE:
DASHED LINE INDICATES THE CONFIGURATION OF THE EAST RETAINING WALL OF DITCH. (REMOVED FOR CLARITY)



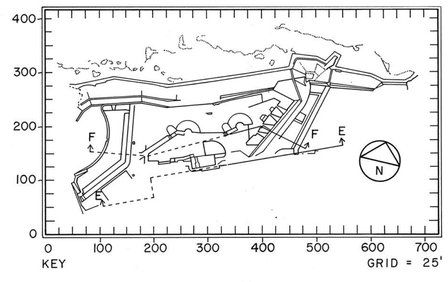
SECTION F-F – EAST PORTION

FEET 1/8" = 1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5

NOTE:
HORIZONTAL DIMENSIONS ARE COMPARATIVE UNITS SINCE ELEMENTS MAY BE SHOWN FORESHORTENED.

NOTE:
SPOT ELEVATIONS ARE IN RELATION TO THE SEA LEVEL.



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HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 6 OF 11 SHEETS

SURVEY NO. PR-91

PUERTO RICO

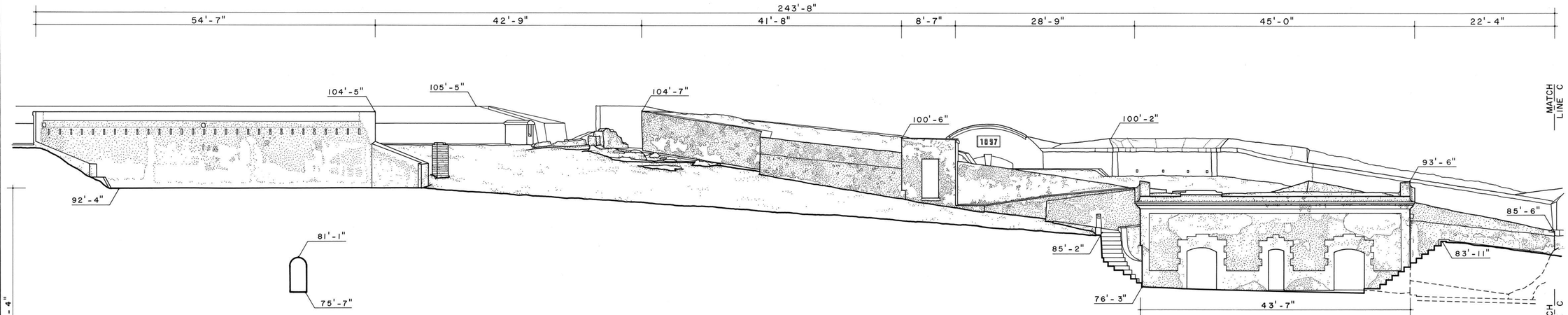
NAME AND LOCATION OF STRUCTURE
SANTA TERESA BATTERY
CASTILLO DE SAN CRISTOBAL OLD SAN JUAN
SAN JUAN NATIONAL HISTORIC SITE

DRAWN BY: MICHAEL P. BEARY
SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1986
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

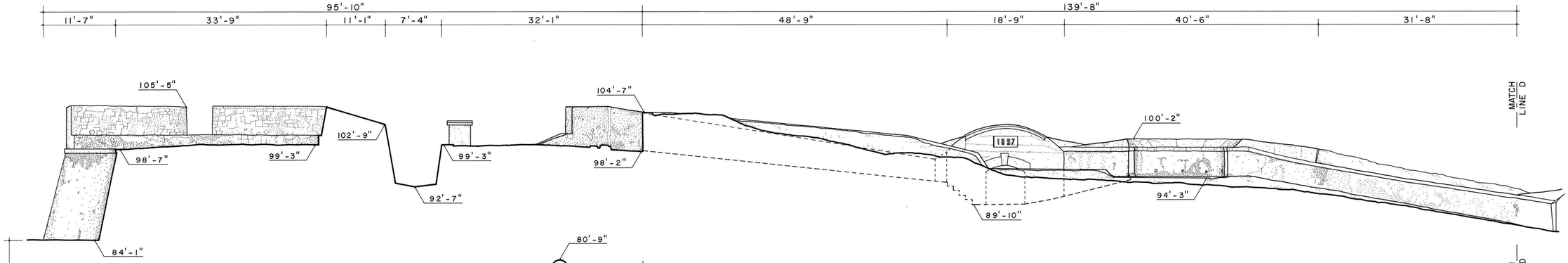
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TRIM LINE

TRIM LINE



SECTION / SOUTH ELEVATION E - E – WEST PORTION



COVERED WAY

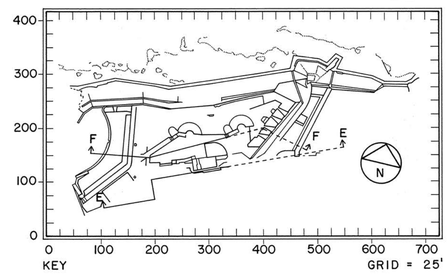
SHIFT IN ANGLE OF VIEW ON SECTION

WEST BUNKER AND GUN EMPLACEMENT

SECTION F - F – WEST PORTION

FEET 1/8" = 1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5



NOTE:
HORIZONTAL DIMENSIONS ARE COMPARATIVE UNITS SINCE ELEMENTS MAY BE SHOWN FORESHORTENED.

NOTE:
SPOT ELEVATIONS ARE IN RELATION TO THE SEA LEVEL.

NAME AND LOCATION OF STRUCTURE
SANTA TERESA BATTERY
HISTORIC SITE OLD SAN JUAN PUERTO RICO
CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE

SURVEY NO. PR-91

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 7 OF 11 SHEETS

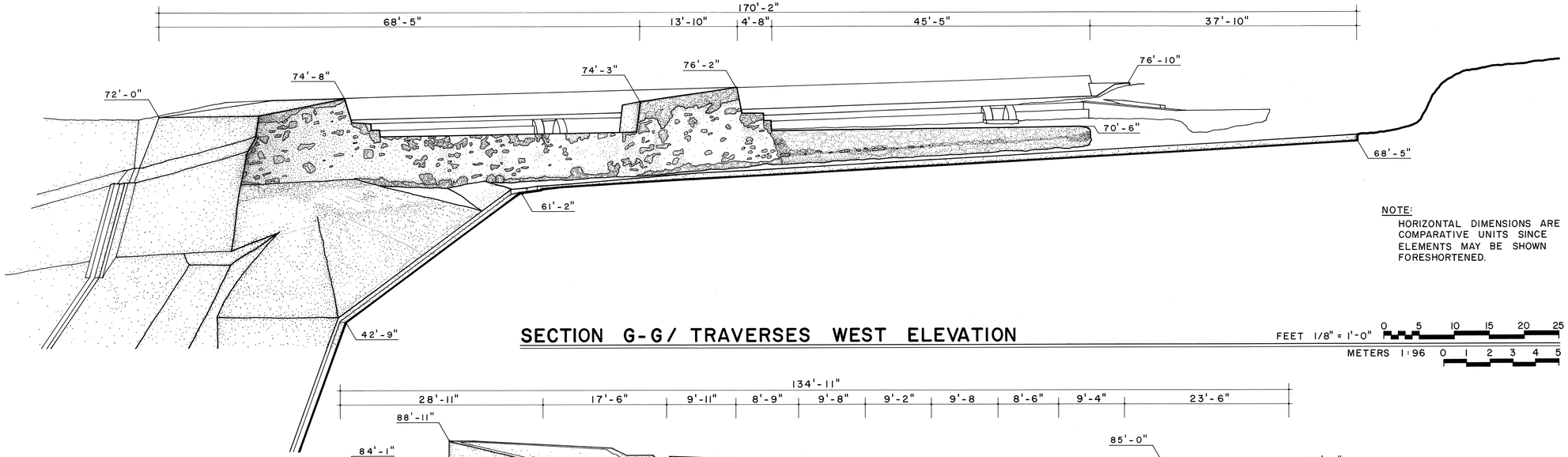
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DRAWN BY: JOSE M. MARTINEZ - CANINO
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TRIM LINE

TRIM LINE



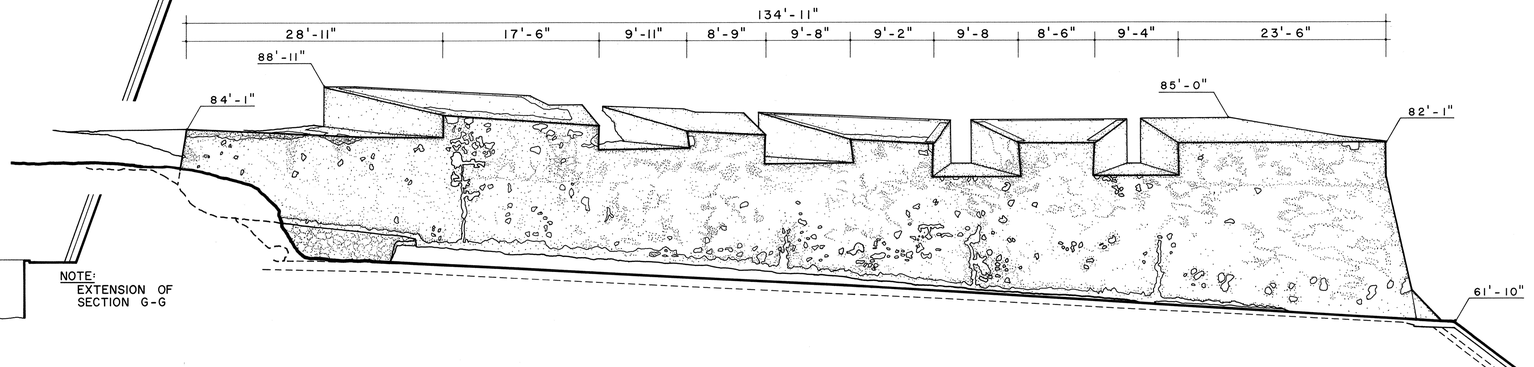
SECTION G-G / TRAVERSES WEST ELEVATION

NOTE:
HORIZONTAL DIMENSIONS ARE COMPARATIVE UNITS SINCE ELEMENTS MAY BE SHOWN FORESHORTENED.

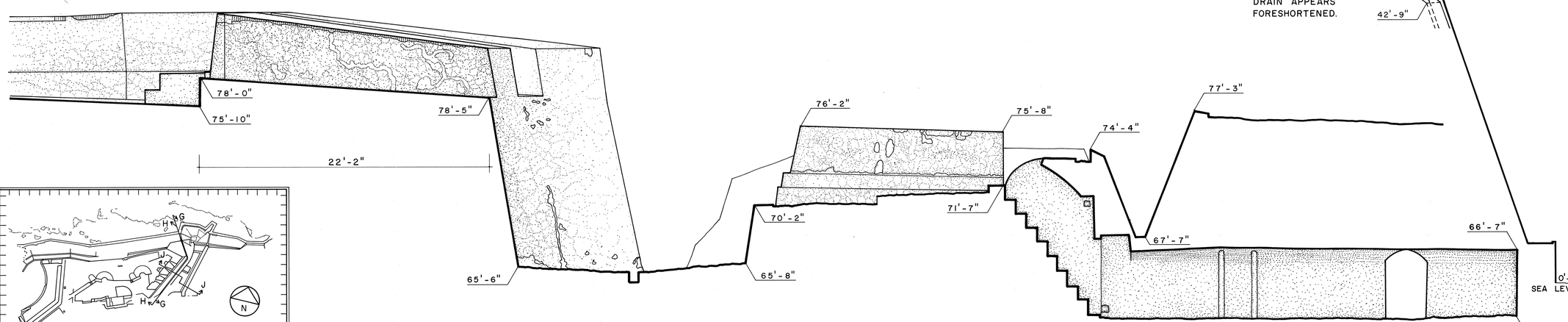
FEET 1/8" = 1'-0" 0 5 10 15 20 25
METERS 1:96 0 1 2 3 4 5

72'-0"

NOTE:
SPOT ELEVATIONS ARE IN RELATION TO THE SEA LEVEL.



SECTION H-H / BATTERY EAST ELEVATION



SECTION J-J

FEET 1/4" = 1'-0" 0 1 2 3 4 5 10
METERS 1:48 0 1 2 3

2'-2" | 17'-4" | 8" | 19'-3" | 7'-4" | 21'-9" | 3'-2" | 6'-11"

19931

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HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 8 OF 11 SHEETS

SURVEY NO. PR-91

PUERTO RICO

NAME AND LOCATION OF STRUCTURE
SANTA TERESA BATTERY
OLD SAN JUAN
SAN JUAN NATIONAL HISTORIC SITE
CASTILLO DE SAN CRISTOBAL

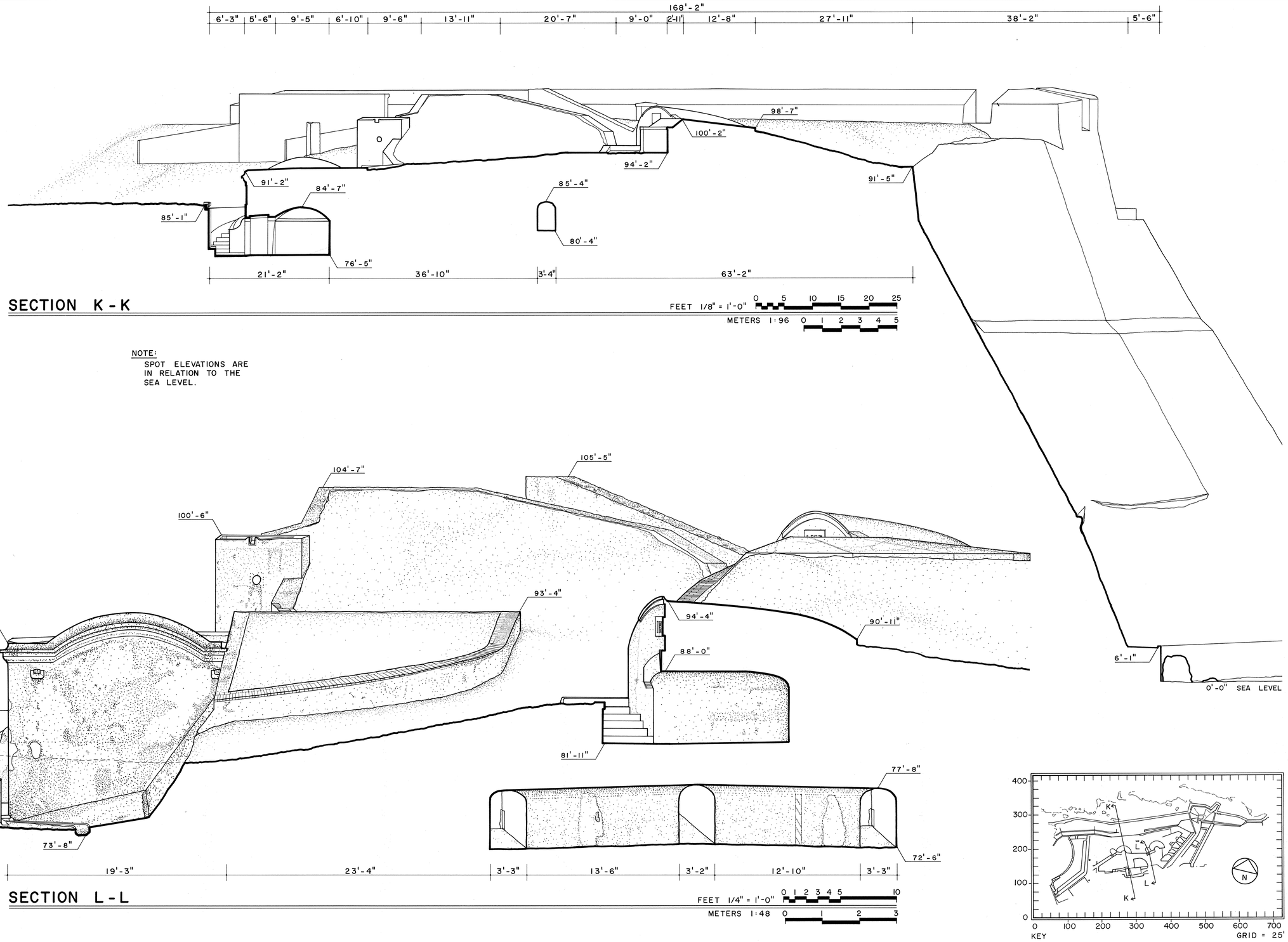
DRAWN BY: T. L. BAILEY

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1986
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

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TRIM LINE

TRIM LINE



SECTION K - K

FEET 1/8" = 1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5

NOTE:
SPOT ELEVATIONS ARE IN RELATION TO THE SEA LEVEL.

SECTION L - L

FEET 1/4" = 1'-0" 0 1 2 3 4 5 10

METERS 1:48 0 1 2 3

NAME AND LOCATION OF STRUCTURE
SANTA TERESA BATTERY
CASTILLO DE SAN CRISTOBAL OLD SAN JUAN PUERTO RICO
SAN JUAN NATIONAL HISTORIC SITE

SURVEY NO. PR-91

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 9 OF 11 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

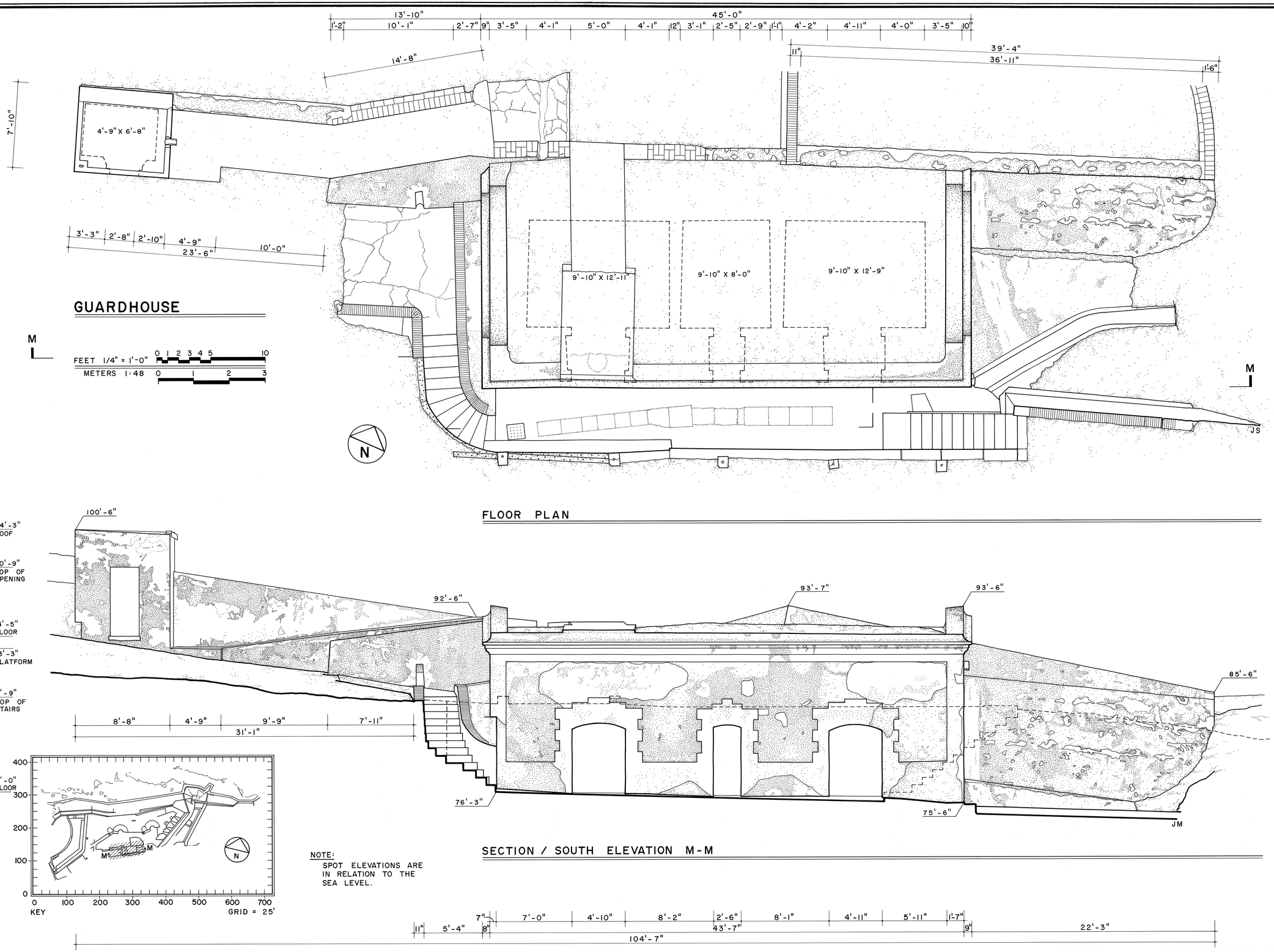
DRAWN BY: MICHAEL P. BEARY
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1991

TRIM LINE

TRIM LINE



NAME AND LOCATION OF STRUCTURE
SANTA TERESA BATTERY
SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

DRAWN BY: JORGE L. SEIN AND JOSE M. MARTINEZ-CANINO, INKED BY JOSE M. MARTINEZ-CANINO

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1986
NATIONAL PARK SERVICE
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CASTILLO DE SAN CRISTOBAL
SAN JUAN NATIONAL HISTORIC SITE

SURVEY NO. PR-91

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 10 OF 11 SHEETS

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TRIM LINE

Revellín San Carlos, San Juan, PR. 1985. Historic American Buildings Survey, HABS PR-93.

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Sheet 4 Site Plan

Sheet 5 Floor Plan – South Rampart

Sheet 6 Floor Plan – North Rampart & Place D' Armes

Sheet 7 South Elevation A (Face) and West Elevation B (South Flank)

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Sheet 9 Section E-E and Section F-F

Sheet 10 Section/Elevation G, Enlarged Elevation H, and Detail – Finial

Sheet 11 South Terreplein Floor Plan

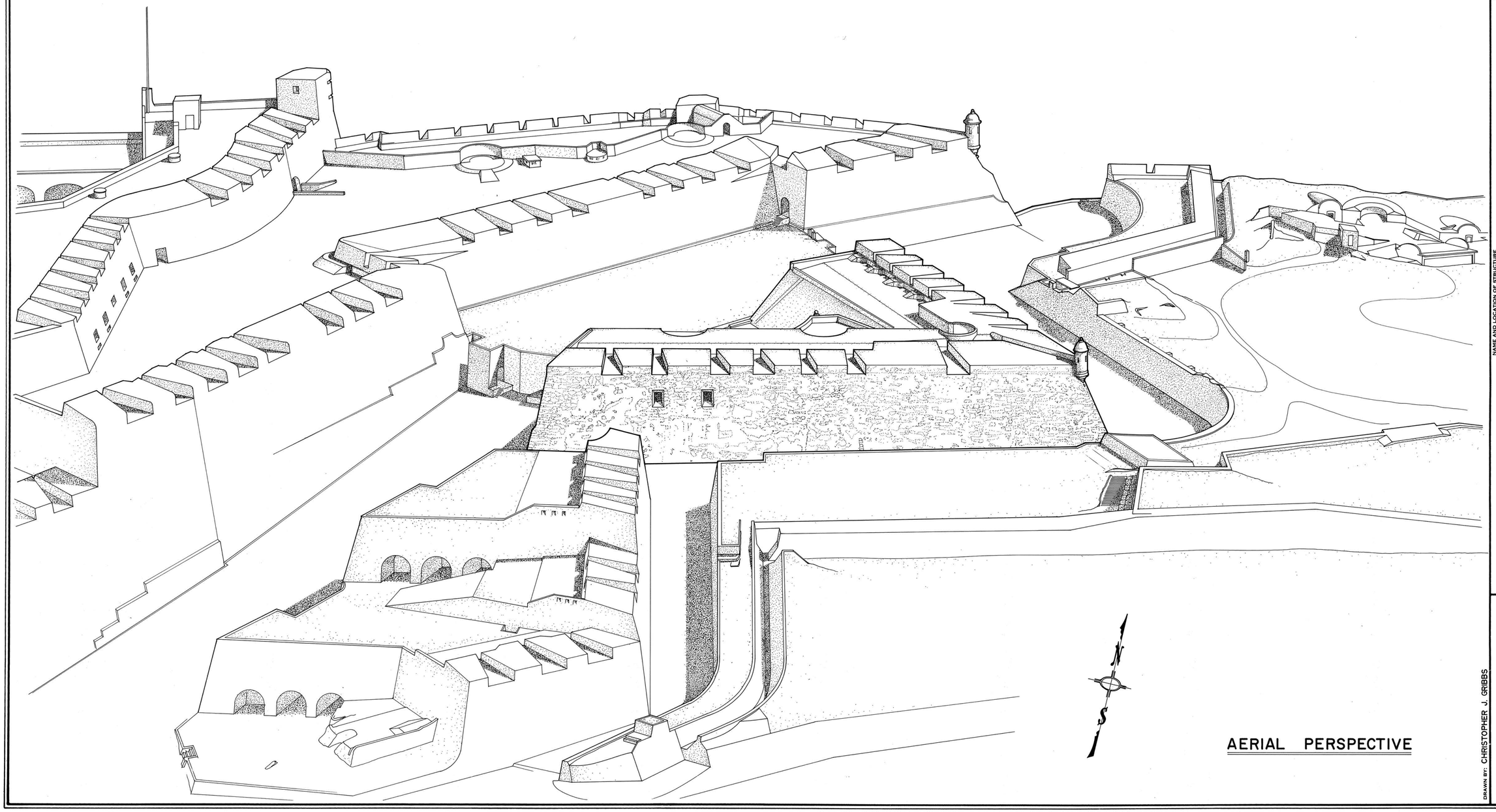
Sheet 12 North Terreplein Floor Plan

Sheet 13 Casements [sic] Section/Elevation M, Section/Elevation N, Section/Elevation P and Floor Plan

Sheet 14 Sentry Box Floor Plan, Roof Plan, Section G-G, Section/Entry Elevation R, Sentinel Point Elevation, North Elevation, and Half-Scale Cornice Detail

TRIM LINE

REVELLÍN SAN CARLOS



AERIAL PERSPECTIVE

DRAWN BY: CHRISTOPHER J. GRIBBS
SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1985
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE
SAN CARLOS RAVELIN
CASTILLO DE SAN CRISTOBAL OLD SAN JUAN
SAN JUAN NATIONAL HISTORIC SITE PUERTO RICO

SURVEY NO. PR-93

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 1 OF 14 SHEETS

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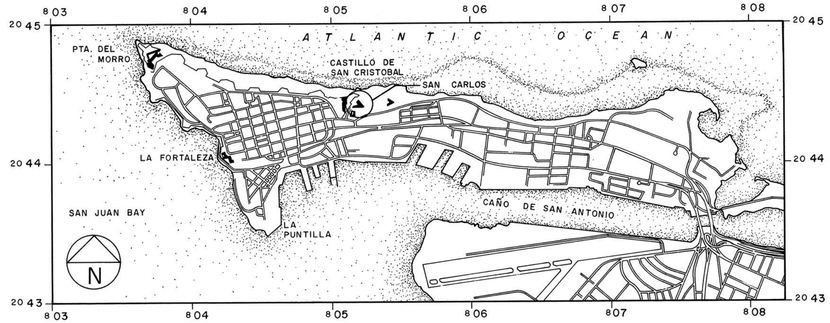
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SAN CARLOS RAVELIN

REVELLIN SAN CARLOS

SAN CARLOS RAVELIN WAS BUILT BETWEEN 1765 AND 1773 AS PART OF THE LANDWARD DEFENSIVE ENSEMBLE OF SAN JUAN, PUERTO RICO. ITS DESIGN EVOLVED INTO A NON-CLASSICAL CONFIGURATION IN ORDER TO STRENGHTEN THE EXISTING ADJACENT SEVENTEENTH CENTURY WALL. THE NORTH RAMPART OF SAN CARLOS WAS ORIENTED SO AS TO FLANK A HILL WHICH PERMITTED A COVERED APPROACH TO THE WALLS OF THE CITY. THE SOUTH RAMPART TRANSFORMED AN EXISTING RIDGE INTO A FORTIFIED POSITION DOMINATING THE APPROACHES TO THE CITY GATE. SAN CARLOS, ALONG WITH THE OTHER NEW RAMPARTS, SUBMITTED ANY ATTACKER TO FLANK AND ENFILADE FIRE ALONG THE APPROACHES HE COULD TAKE (SEE FIGURES 1, 2 AND 3). THE TWO RAMPARTS OF SAN CARLOS FULFILLED SPECIFIC ROLES WITHIN A DEFENSIVE HIERARCHY BASED ON AN EXPECTED OFFENSIVE APPROACH ALONG THE NORTHERLY SHORELINE HEIGHTS (SEE FIGURES 1, 3 AND 4). THE NORTH RAMPART WAS MADE SHORTER THAN THE SOUTH, WITH BOTH IT AND ITS COUNTERMOAT COUNTERMINED. THIS RAMPART WAS OTHERWISE SOLID WHILE THE SOUTH HAD THREE CASEMATES HOUSING TROOPS AND SUPPLIES. THESE ELEMENTS, ALONG WITH A CISTERN THAT APPEARS FOR THE FIRST TIME IN THE PLAN OF 1773 AND A SET OF BARRICADES WITHIN THE COUNTERMOATS, INDICATE THE SUPERPOSITIONING OF INFANTRY AND ARTILLERY POSITIONS (SEE FIGURES 3 AND 4). THE STAIR THAT APPEARS IN THE 1769 CONSTRUCTION REPORT WOULD HAVE LEAD FROM THE PLACE DE ARMES TO THE SOUTH TERREPLEIN. IT, WITH THE TRAVERSE WHICH PROTECTED DEFENDERS ON THE SOUTH ESPLANADE FROM RICOCHET COMING FROM THE NORTH, WERE INTENDED AS A MEANS OF RETREAT SHOULD THE NORTH RAMPART AND RAMP BE DESTROYED (SEE FIGURE 3).

EL REVELLIN SAN CARLOS FUE CONSTRUIDO ENTRE 1765 Y 1773 COMO PARTE DEL CONJUNTO DEFENSIVO DEL FRENTE DE TIERRA DE SAN JUAN DE PUERTO RICO. TOMO UNA CONFORMACION NO CLASICA PARA REFORZAR LA MURALLA DEL SIGLO DIECISIETE YA EXISTENTE EN ESE LUGAR. EL TERRAPLEN DEL NORTE DE SAN CARLOS FUE ORIENTADO PARA FLANQUEAR UNA COLINA QUE PERMITIA ACCESO CUBIERTO HASTA LAS MURALLAS DE LA CIUDAD. EL TERRAPLEN DEL SUR TRANSFORMO UNA CRESTA EN POSICION FORTIFICADA QUE DOMINABA LAS INMEDIACIONES DE LA PUERTA DE LA CIUDAD. SAN CARLOS, ASI COMO LAS OTRAS NUEVAS MURALLAS, SOMETIAN A CUALQUIER ATACANTE A FUEGO DE FLANCO Y ENFILADO EN LOS APROCHES QUE PODRIA TOMAR (VER FIGURAS 1, 2 Y 3). LOS DOS TERRAPLENES DE SAN CARLOS CUMPLIAN PAPELES ESPECIFICOS DENTRO DE UNA JERARQUIA DEFENSIVA BASADA EN UNA ESPERADA OFENSIVA A TRAVES DE LAS ALTURAS DE LA COSTA NORTE (VER FIGURAS 1, 3 Y 4). EL TERRAPLEN DEL NORTE FUE CONSTRUIDO MAS CORTO QUE EL DEL SUR, CONTRAMINADO ASI COMO SU CONTRAFOSO. AUN ASI, ESTE TERRAPLEN ERA SOLIDO MIENTRAS QUE EL DEL SUR INCLUIA TRES CASAMATAS PARA TROPA Y PERTRECHOS. ESTOS ELEMENTOS, ASI COMO LA CISTERNA QUE APARECE POR PRIMERA VEZ EN EL PLANO DE 1773 Y EL PAR DE BARRICADAS DENTRO DEL CONTRAFOSO INDICAN UNA SUPERPOSICION DE INFANTERIA Y ARTILLERIA (VER FIGURAS 3 Y 4). LA ESCALERA QUE APARECE EN EL INFORME DE 1769 HUBIERA SALIDO DESDE LA PLAZOLETA DE ARMAS HASTA EL TERRAPLEN DEL SUR. ESTA, CON EL TRAVES QUE PROTEGIA A LOS DEFENSORES SOBRE LA EXPLANADA AL SUR CONTRA EL TIRO DE REBOTE VINIENDO DESDE EL NORTE, FUERON PENSADOS COMO UN CAMINO DE RETIRADA EN EL CASO DE SER INUTILIZADOS EL TERRAPLEN DEL NORTE Y LA RAMPA (VER FIGURA 3).



TAKEN FROM: USGS SAN JUAN, P.R. QUADRANGLE 1969 (PHOTOREVISED 1982)
USGS BAYAMON, P.R. QUADRANGLE 1969 (PHOTOREVISED 1982)

UTM 19.805195.2044420.

LOCATION MAP

FEET 1" = 1667' 0 1000 3000 5000

METERS 1:20000 0 1 KM 2 KM

THE BATTERY BUILT IN 1896 SHIFTED THE ORIENTATION AND RANGE TOWARDS THE MORE DISTANT HILLS AND OCEAN WHILE EMPHASIZING AGAIN THE AUTONOMY OF THE SOUTH RAMPART. IN SAN CARLOS THE SOUTH RAMPART WAS MODIFIED IN ORDER TO HOUSE THREE GUNS. A CRANE WAS INSTALLED FOR RAISING

LA BATERIA CONSTRUIDA EN 1896 CAMBIO LA ORIENTACION Y ALCANCE HACIA LAS COLINAS Y AL OCEANO MAS DISTANTES, ENFATIZANDO ASI DE NUEVO LA AUTONOMIA DEL TERRAPLEN DEL SUR. EN SAN CARLOS, EL TERRAPLEN DEL SUR FUE MODIFICADO PARA ACOMODAR TRES CAÑONES. UNA GRUA FUE

FIG. 1. CONDITIONS IN 1765
ESTADO EN 1765

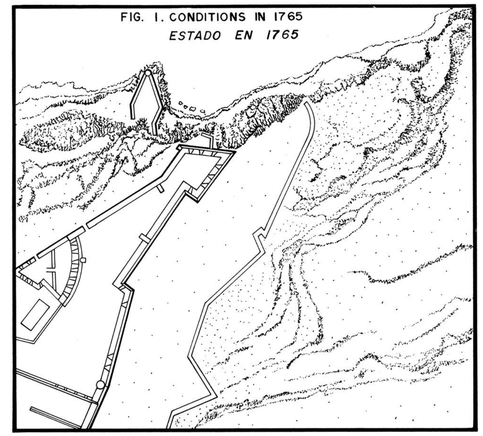


FIG. 2. 1765 PROJECT
PROYECTO 1765

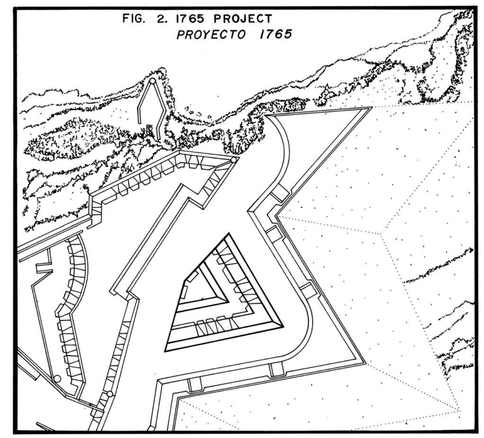
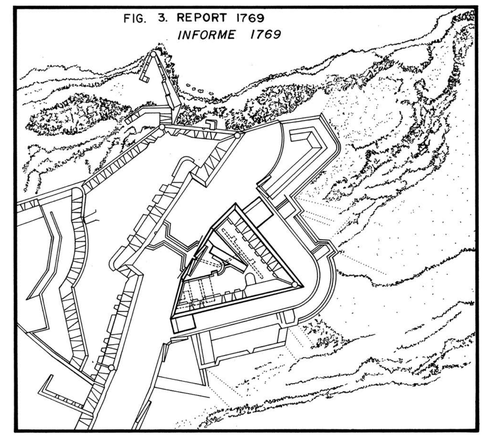


FIG. 3. REPORT 1769
INFORME 1769



HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 2 OF 14 SHEETS

SURVEY NO. PR-93

NAME AND LOCATION OF STRUCTURE
SAN CARLOS RAVELIN
OLD SAN JUAN PUERTO RICO

CASTILLO DE SAN CRISTOBAL
SAN JUAN NATIONAL HISTORIC SITE

DRAWN BY: JUAN BLANCO
SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1985
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

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TRIM LINE

TRIM LINE

AMMUNITION AND GUNS MAKING A CUT IN THE PARAPET OVER THE PLACE DE ARMES FOR THIS PURPOSE NEAR THE SPOT WHERE THE STAIR PROJECTED IN 1769 WOULD HAVE REACHED THE SOUTH TERREPLEIN (SEE FIGURES 3 AND 5).

INSTALADA PARA LEVANTAR MUNICIONES Y PERTRECHOS HACIENDOSE UN CORTE EN EL PARAPETO SOBRE LA PLAZOLETA CON ESTE PROPOSITO CERCA DEL LUGAR DONDE LA ESCALERA PROPUESTA EN 1769 HUBIERA ALCANZADO EL TERRAPLEN DEL SUR (VER FIGURAS 3 Y 5).

IN THE 1930'S THE UPPER PORTION OF THE SENTRY BOX DESTROYED IN 1896 WAS REBUILT AND THE EARTHFILL COVERING THE EIGHTEENTH CENTURY EMBRASURES REMOVED AND REPLACED WITH CONCRETE. DURING WORLD WAR II A BUNKER WAS BUILT IN THE MOAT BETWEEN SAN CARLOS AND SAN CRISTOBAL. AS A RESULT, THE CAPONIER – OR COVERED WAY WITHIN A MOAT – BUILT IN THE EIGHTEENTH CENTURY IN ORDER TO CONNECT THESE TWO STRUCTURES WAS DESTROYED. AT THAT TIME THE BARRICADES WITHIN THE COUNTERMOATS WERE COVERED OVER WITH ASPHALT IN ORDER TO CREATE A ROAD (SEE FIGURES 4 AND 6).

DURANTE LOS AÑOS TREINTA, LA PARTE SUPERIOR DE LA GARITA DESTRUIDA EN 1896 FUE REEMPLAZADA POR UNA DE BLOQUE DE CEMENTO Y LA TIERRA CUBRIENDO LAS TRONERAS DEL SIGLO DIECIOCHO FUE REMOVIDA Y REEMPLAZADA CON CONCRETO. DURANTE LA SEGUNDA GUERRA MUNDIAL SE CONSTRUYO UN "BUNKER" DENTRO DEL FOSO ENTRE SAN CARLOS Y SAN CRISTOBAL. COMO RESULTADO, LA CAPONERA – CAMINO CUBIERTO DENTRO DE UN FOSO – CONSTRUIDA EN EL SIGLO DIECIOCHO PARA CONECTAR ESTAS DOS ESTRUCTURAS, FUE DESTRUIDA. FUE ENTONCES CUANDO LAS BARRICADAS DENTRO DEL CONTRAFOSO FUERON CUBIERTAS CON ASFALTO CREANDOSE ASI UNA CARRETERA (VER FIGURAS 4 Y 6).

THE 1985 HABS SUMMER DOCUMENTATION OF SAN CARLOS RAVELIN IS THE SECOND PHASE OF THE SAN JUAN NATIONAL HISTORIC SITE RECORDING PROJECT INITIATED IN 1984. THE FIELD RECORDING PROJECT WAS UNDERTAKEN BY THE WASHINGTON D.C. OFFICE OF THE HISTORIC AMERICAN BUILDINGS SURVEY (HABS) IN COOPERATION WITH THE SOUTHEAST REGION'S CULTURAL RESOURCES PRESERVATION CENTER AND CO-SPONSORED BY THE SAN JUAN NATIONAL HISTORIC SITE, THE AMERICAN INSTITUTE OF ARCHITECTS COLLEGE OF FELLOWS AND THE U.S./INTERNATIONAL COUNCIL ON MONUMENTS AND SITES – U.S./ICOMOS.

LA DOCUMENTACION DE HABS *EN EL VERANO DE 1985 DEL REVELLIN SAN CARLOS ES LA SEGUNDA FASE DEL PROYECTO DE DOCUMENTACION DEL* SAN JUAN NATIONAL HISTORIC SITE *INICIADO EN 1984. EL PROYECTO DE DOCUMENTACION DE CAMPO FUE EMPRENDIDO POR LA OFICINA EN WASHINGTON D.C. DEL* HISTORIC AMERICAN BUILDINGS SURVEY (HABS) *EN COOPERACION CON EL* SOUTHEAST PRESERVATION CENTER *DE LA OFICINA DE RECURSOS CULTURALES DE LA REGION DEL SURESTE, Y COPATRONIZADO POR EL* SAN JUAN NATIONAL HISTORIC SITE, *EL* AMERICAN INSTITUTE OF ARCHITECTS COLLEGE OF FELLOWS, *Y EL* U.S./INTERNATIONAL COUNCIL ON MONUMENTS AND SITES – U.S./ICOMOS.

THE FIELD RECORDING PROJECT WAS UNDERTAKEN BY THE HABS/HAER DIVISION, ROBERT J. KAPSCH, CHIEF, AND WAS INITIATED AND DIRECTED BY KENNETH L. ANDERSON, PRINCIPAL ARCHITECT, HABS, IN CONJUNCTION WITH BENJAMIN NISTAL-MORET, ARCHITECTURE CONSERVATOR, SOUTHEAST PRESERVATION CENTER, AND WITH LUIS GARCIA-CURBELO, SUPERINTENDENT, SAN JUAN NATIONAL HISTORIC SITE. THE 1985 MEASURED DRAWINGS WERE PRODUCED IN THE HABS SAN JUAN, PUERTO RICO FIELD OFFICE BY PROJECT SUPERVISOR CHRISTOPHER J. GRIBBS (UNIVERSITY OF DETROIT), AND ARCHITECTURAL FOREMAN JUAN BLANCO (UNIVERSITY OF CALIFORNIA, BERKELEY), AND ARCHITECTURAL TECHNICIAN ERIC F. NIEMY (CARLETON UNIVERSITY – U.S./ICOMOS).

EL PROYECTO DE DOCUMENTACION DE CAMPO FUE EMPRENDIDO POR LA DIVISION HABS/HAER, *ROBERT J. KAPSCH, JEFE, Y FUE INICIADO Y DIRIGIDO POR KENNETH L. ANDERSON, ARQUITECTO PRINCIPAL,* HABS, *EN ASOCIACION CON BENJAMIN NISTAL MORET, ARQUITECTO CONSERVADOR,* SOUTHEAST PRESERVATION CENTER, *Y CON LUIS GARCIA CURBELO, SUPERINTENDENTE,* SAN JUAN NATIONAL HISTORIC SITE. *LOS DIBUJOS MEDIDOS DE 1985 FUERON PRODUCIDOS EN LA OFICINA DE CAMPO DE* HABS *EN SAN JUAN, PUERTO RICO POR EL SUPERVISOR DEL PROYECTO, CHRISTOPHER J. GRIBBS* (UNIVERSITY OF DETROIT), *Y EL CAPATAZ ARQUITECTONICO JUAN BLANCO* (UNIVERSITY OF CALIFORNIA, BERKELEY), *Y EL TECNICO ARQUITECTONICO ERIC F. NIEMY* (CARLETON UNISITY – U.S./ICOMOS).

FIG. 4. CONDITIONS IN 1783
ESTADO EN 1783

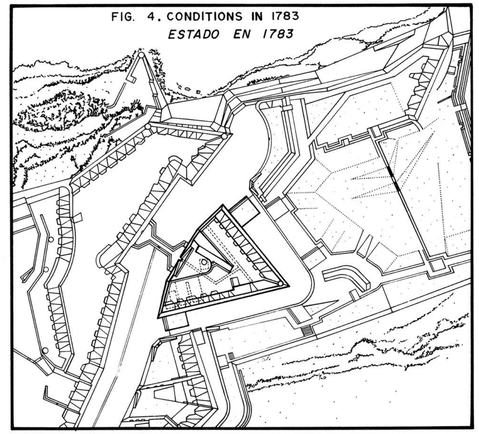


FIG. 5. CONDITIONS IN 1896
ESTADO EN 1896

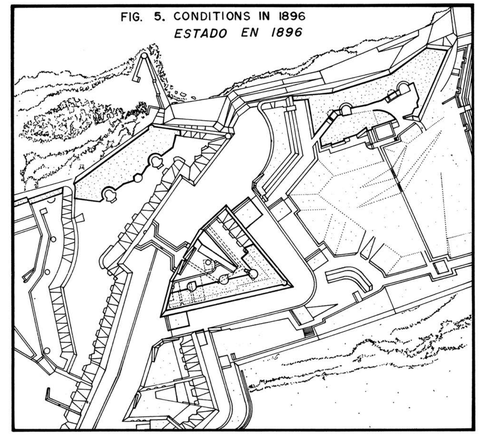
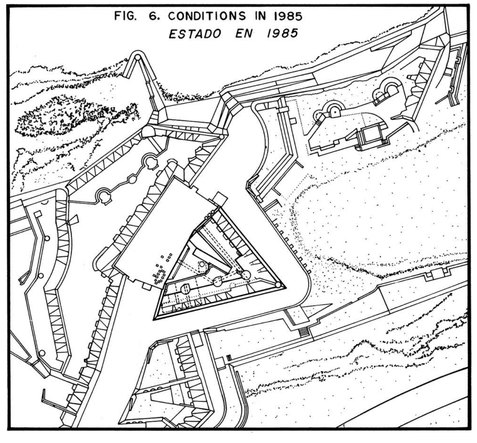


FIG. 6. CONDITIONS IN 1985
ESTADO EN 1985



HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 3 OF 14 SHEETS

SURVEY NO. PR-93

NAME AND LOCATION OF STRUCTURE
SAN CARLOS RAVELIN
OLD SAN JUAN PUERTO RICO
CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE

SAN JUAN NATIONAL HISTORIC SITE PROJECT – 1985
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

DRAWN BY: JUAN BLANCO

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TRIM LINE

TRIM LINE

SITE PLAN

FEET 1/16"=1'-0" 0 5 10 20 30 40

METERS 1:192 0 5 10

DRAWN BY: ERIC FRASER NIEMY

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1985

NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE

SAN CARLOS RAVELIN

CASTILLO DE SAN CRISTOBAL — OLD SAN JUAN — SAN JUAN NATIONAL HISTORIC SITE — PUERTO RICO

SURVEY NO.
PR-93

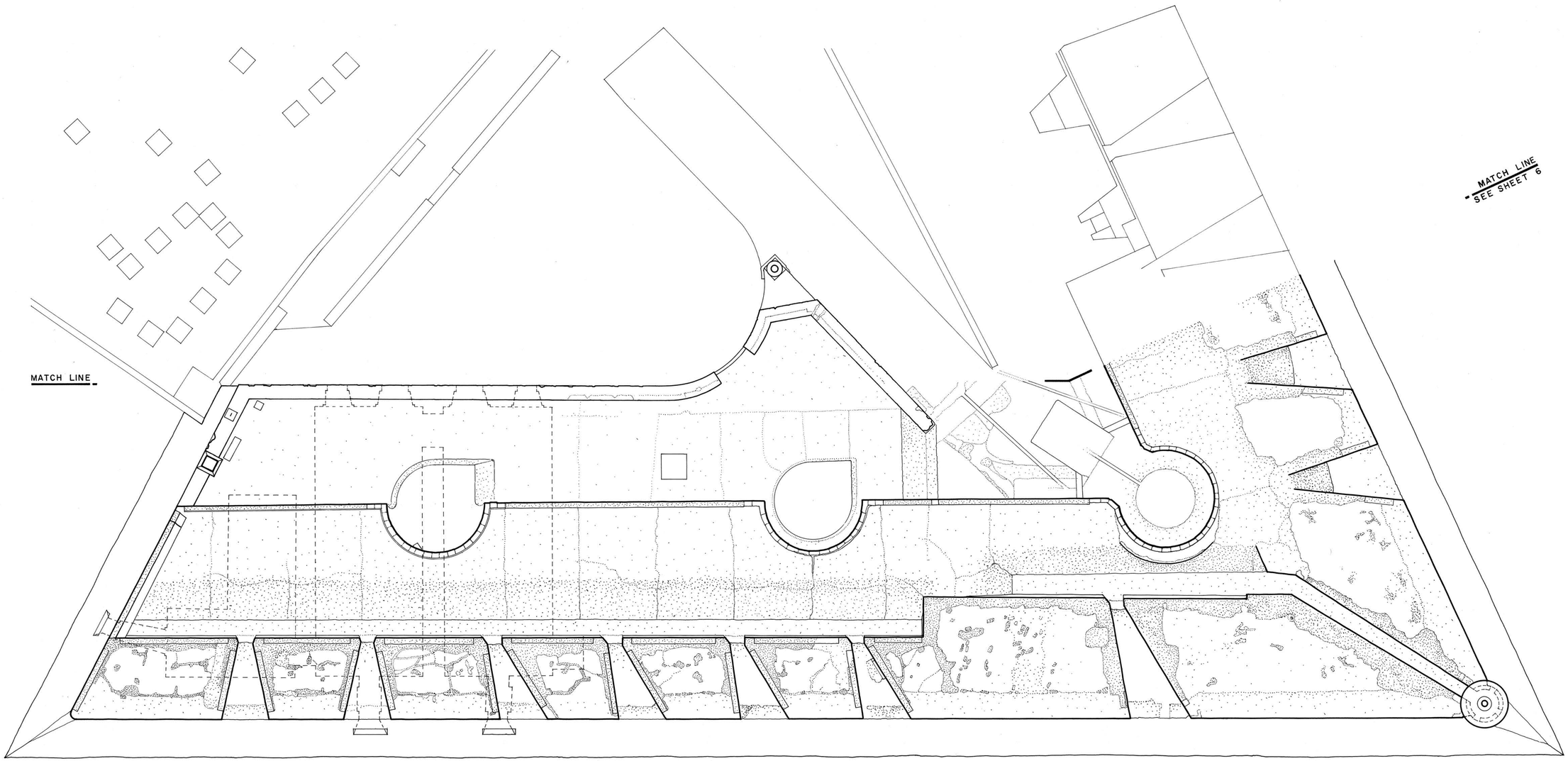
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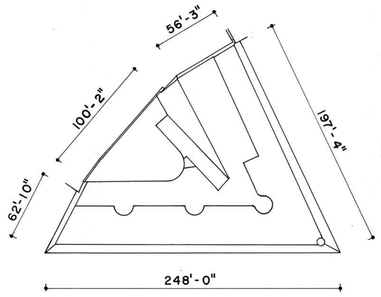
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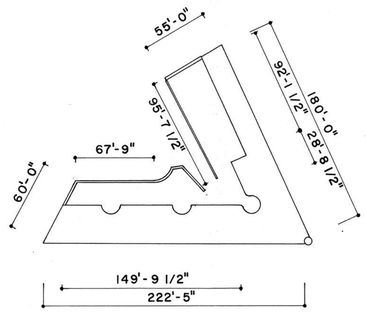
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TRIM LINE





BASE LEVEL

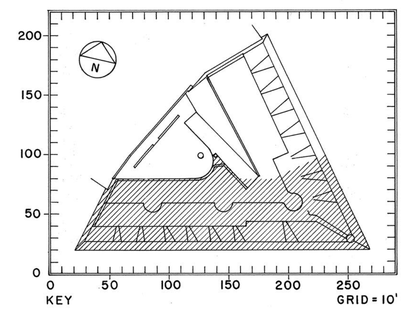


UPPER LEVEL

FLOOR PLAN - SOUTH RAMPART

FEET 1/8" = 1'-0" 0 5 10 15 20 25

METERS 1 : 96 0 1 2 3 4 5



NAME AND LOCATION OF STRUCTURE

SAN CARLOS RAVELIN

CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

SURVEY NO. PR-93

HISTORIC AMERICAN BUILDINGS SURVEY SHEET 5 OF 14 SHEETS

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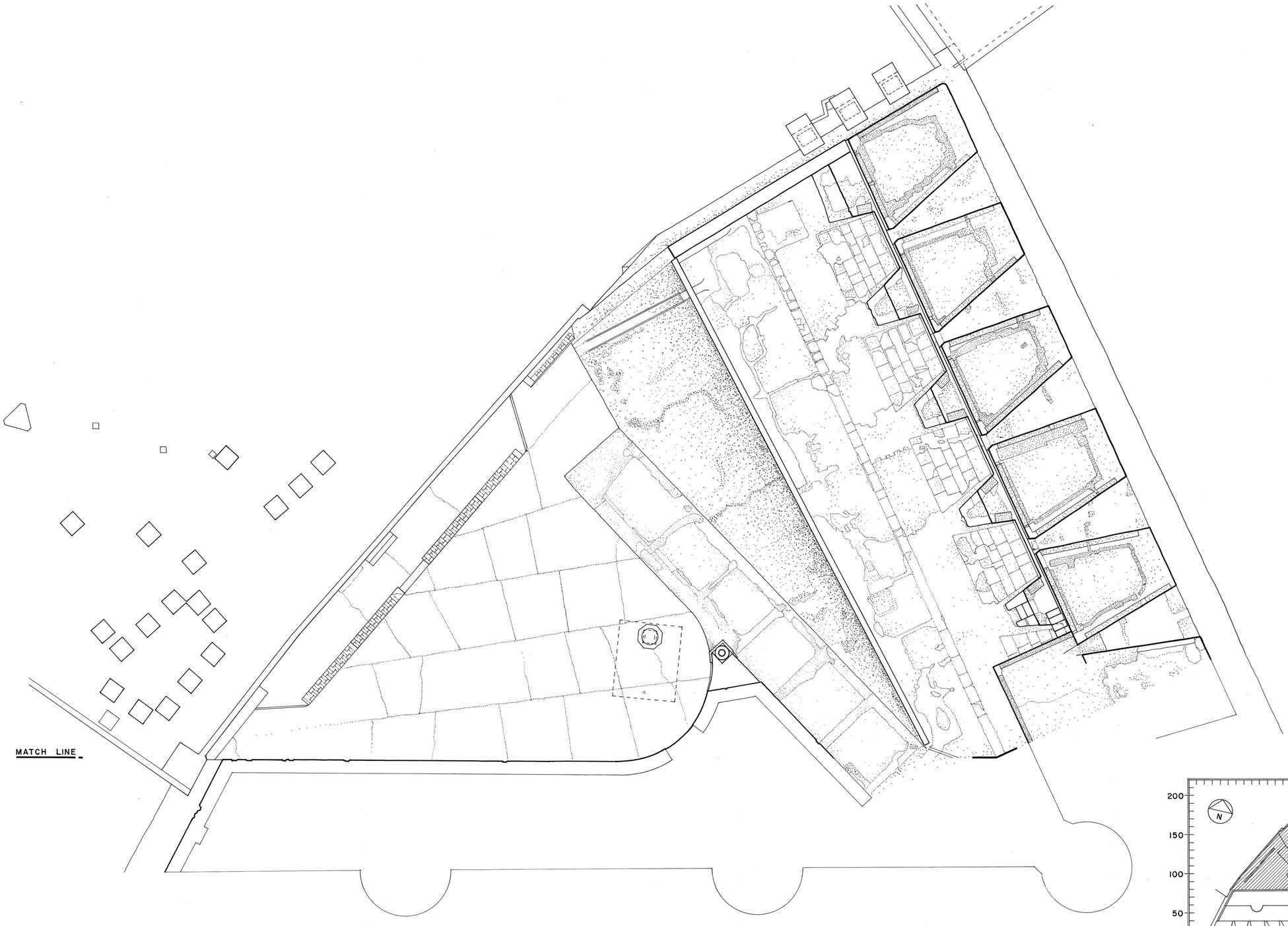
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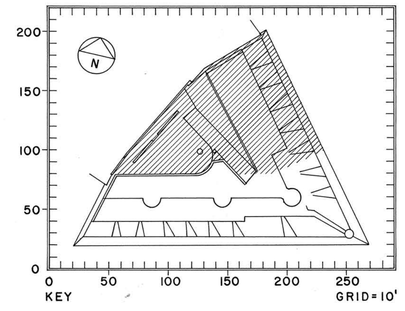
TRIM LINE

TRIM LINE



FLOOR PLAN - NORTH RAMPART & PLACE D'ARMES

FEET 1/8"= 1'-0" 0 5 10 15 20 25
METERS 1:96 0 1 2 3 4 5



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UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE
SAN CARLOS RAVELIN
CASTILLO DE SAN CRISTOBAL OLD SAN JUAN PUERTO RICO
SAN JUAN NATIONAL HISTORIC SITE

SURVEY NO. PR-93

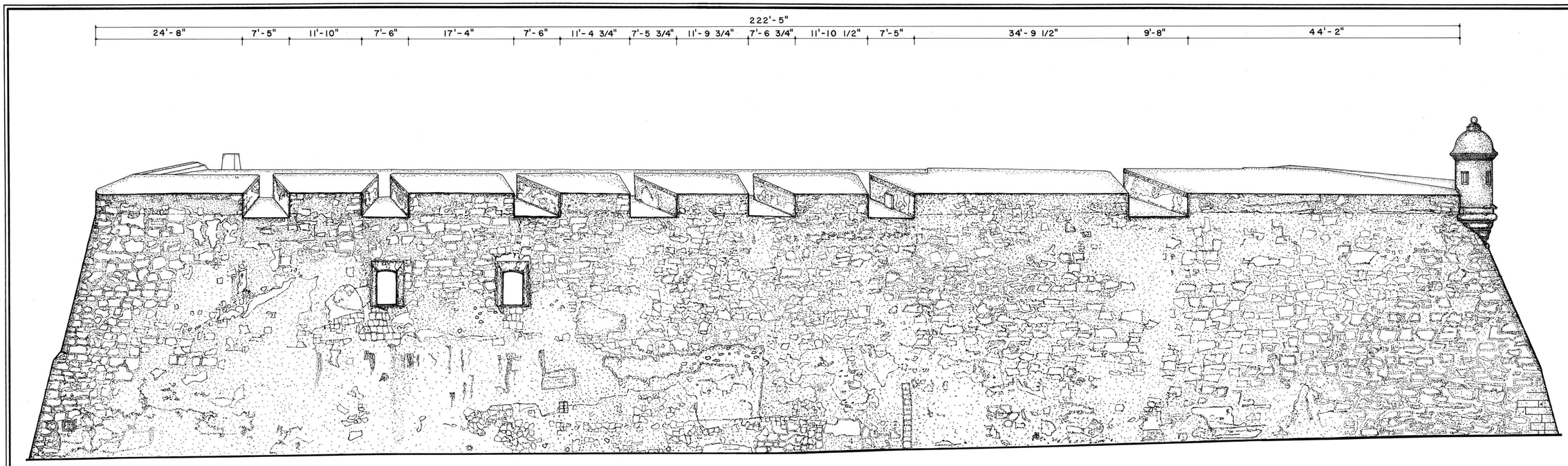
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 6 OF 14 SHEETS

LIBRARY OF CONGRESS
HABS NUMBER

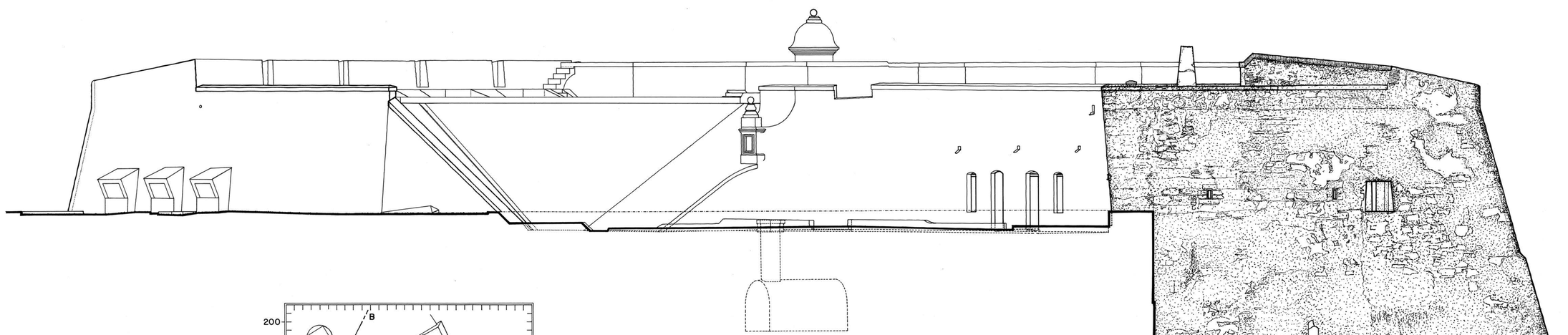
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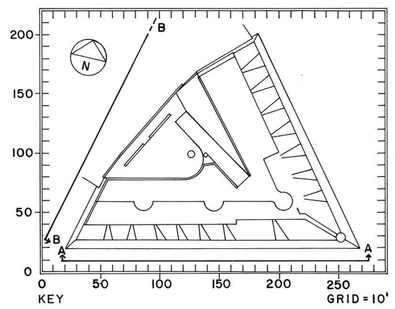
TRIM LINE

TRIM LINE



SOUTH ELEVATION A (FACE)





WEST ELEVATION B (SOUTH FLANK)

BUILDING ELEVATIONS

FEET 1/8"= 1'-0" 0 5 10 15 20 25
METERS 1:96 0 1 2 3 4 5

LIBRARY OF CONGRESS INDEX NUMBER

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 7 OF 14 SHEETS

SURVEY NO.
PR-93

NAME AND LOCATION OF STRUCTURE
SAN CARLOS RAVELIN
SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

CASTILLO DE SAN CRISTOBAL

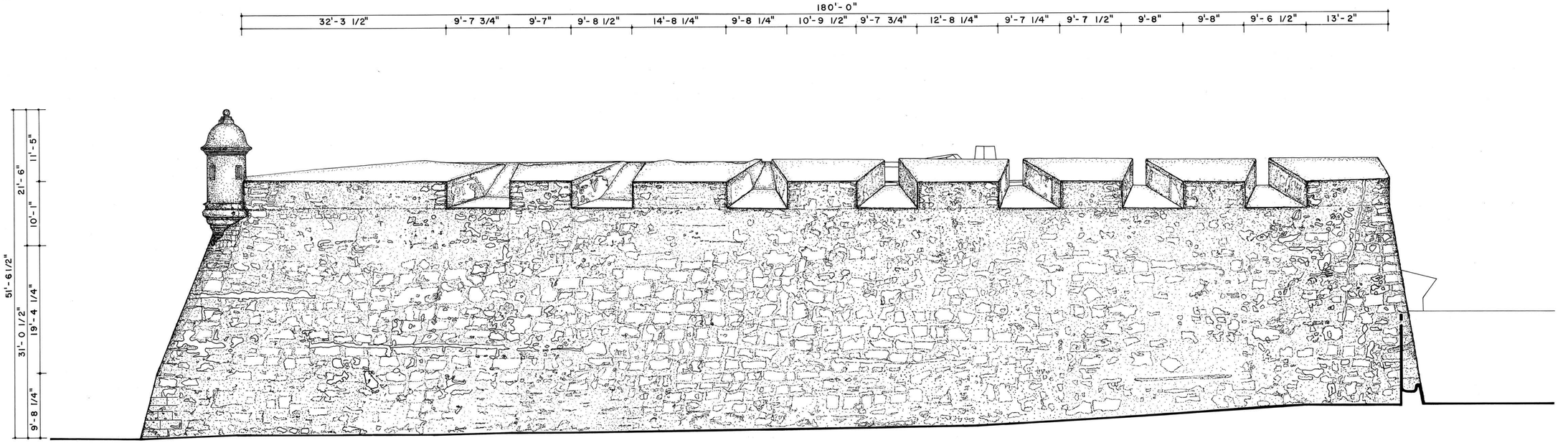
DRAWN BY: JUAN BLANCO

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1985
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

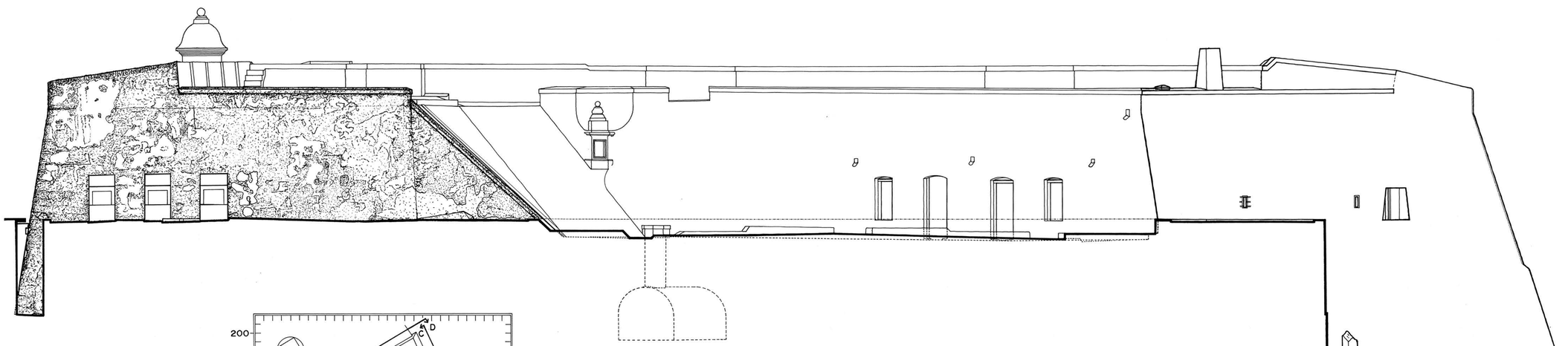
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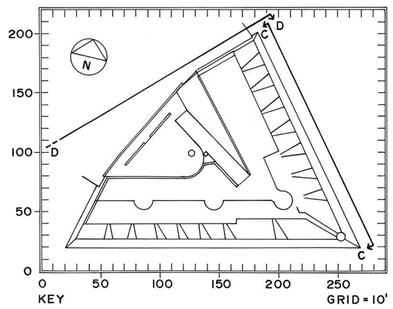
TRIM LINE

TRIM LINE



NORTH ELEVATION C (FACE)





WEST ELEVATION D (NORTH FLANK)

BUILDING ELEVATIONS

FEET 1/8"= 1'-0" 0 5 10 15 20 25
METERS 1:96 0 1 2 3 4 5

NAME AND LOCATION OF STRUCTURE
SAN CARLOS RAVELIN
SAN JUAN NATIONAL HISTORIC SITE — OLD SAN JUAN — PUERTO RICO

CASTILLO DE SAN CRISTOBAL

SURVEY NO. PR-93

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 8 OF 14 SHEETS

INDEX NUMBER

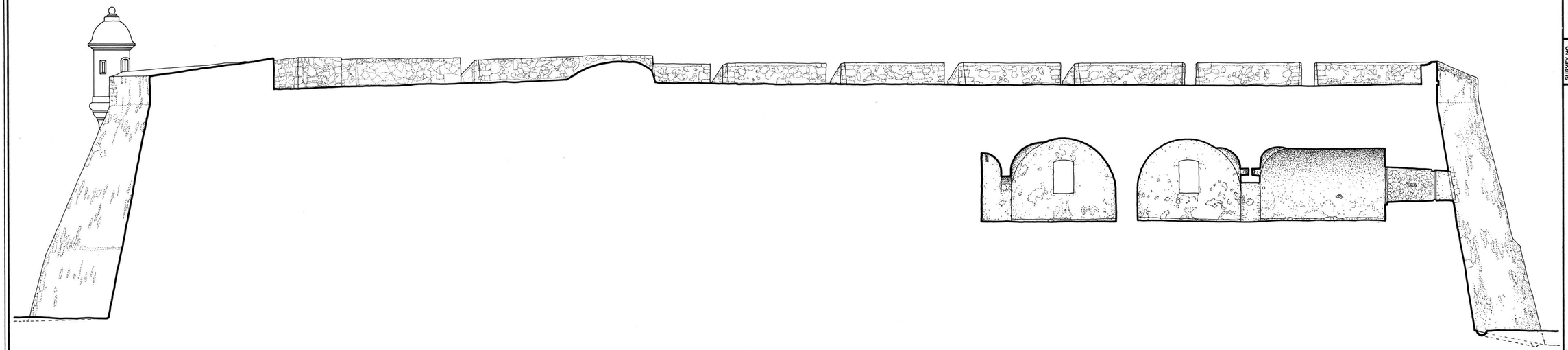
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SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1985
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

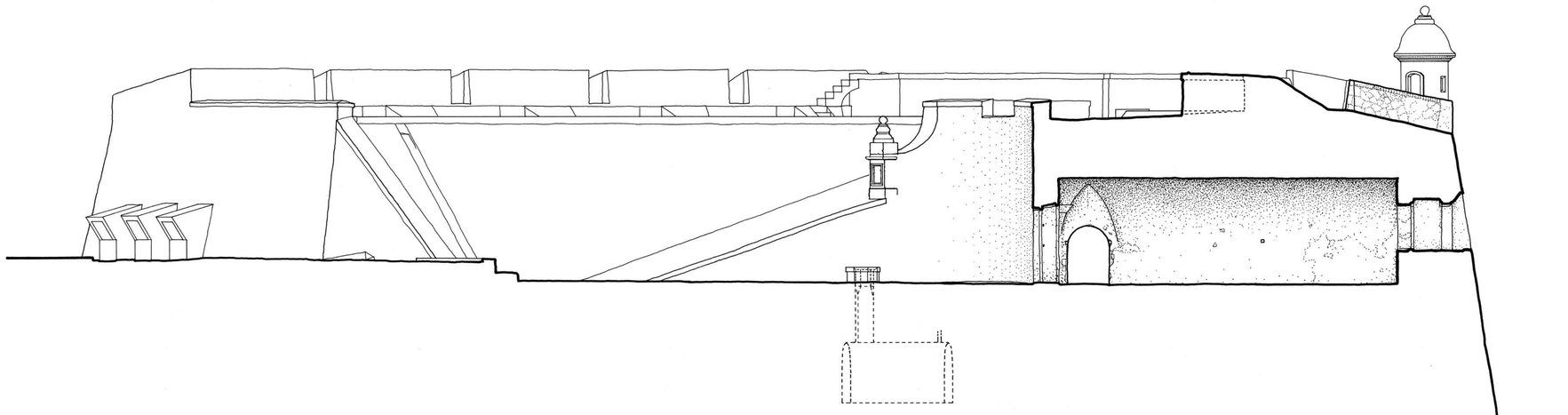
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TRIM LINE



SECTION E-E

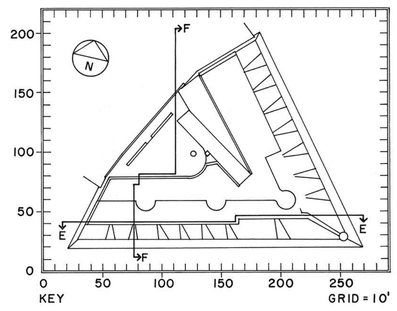


SECTION F-F

BUILDING SECTIONS

FEET 1/8"= 1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5



NAME AND LOCATION OF STRUCTURE

SAN CARLOS RAVELIN

SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

CASTILLO DE SAN CRISTOBAL

SURVEY NO. PR-93

HISTORIC AMERICAN BUILDINGS SURVEY SHEET 9 OF 14 SHEETS

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DRAWN BY: CHRISTOPHER J. GRIBBS

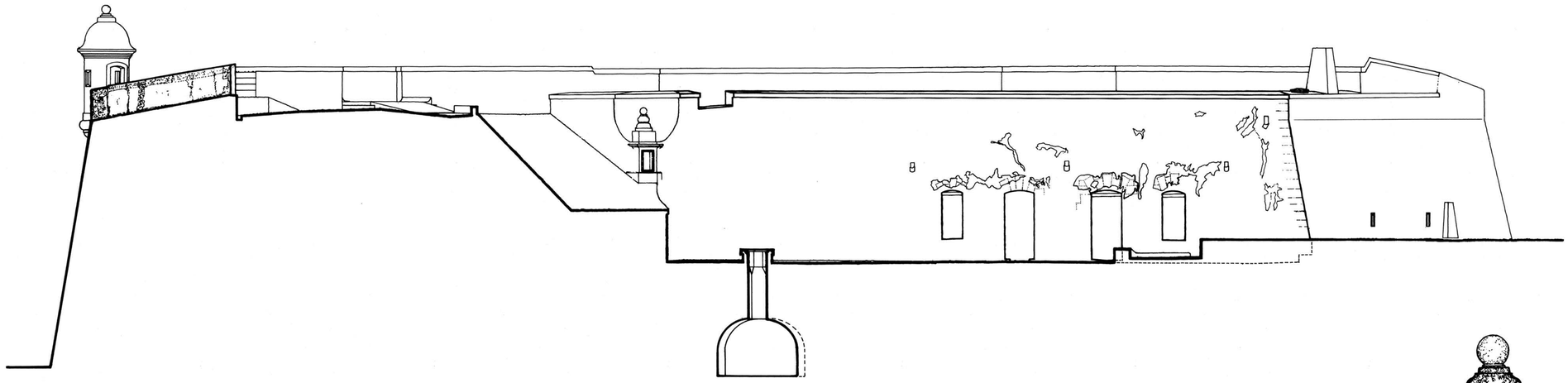
SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1985

NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

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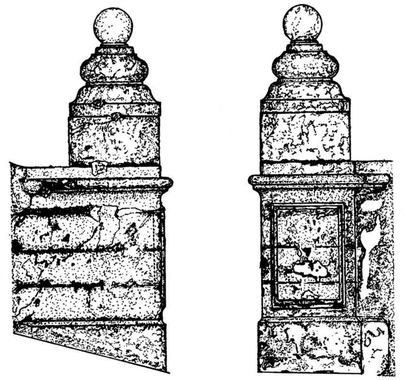
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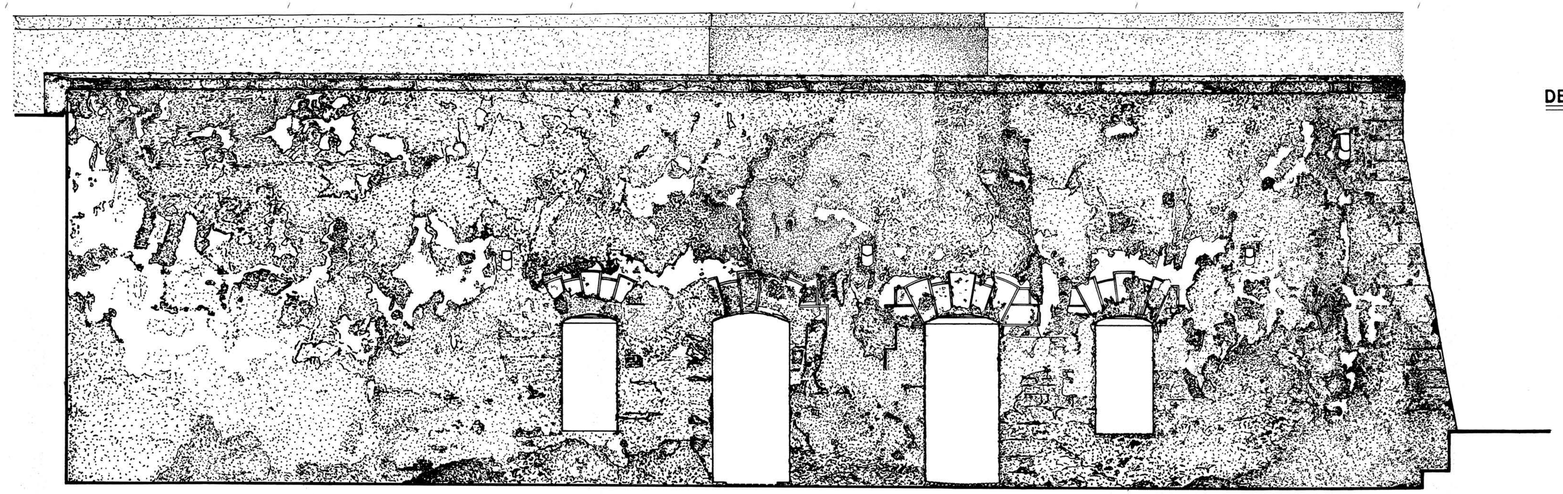
SECTION / ELEVATION G

FEET 1/8"= 1'-0" 0 5 10 15 20 25
METERS 1:96 0 1 2 3 4 5



DETAIL - FINIAL

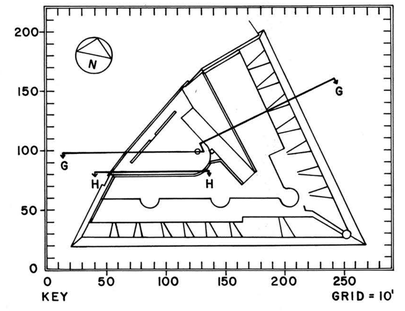
FEET 1/2"= 1'-0" 0 1 2 3 4 5
CENTIMETERS 1:24 0 50 100



ENLARGED ELEVATION H

FEET 1/4"= 1'-0" 0 1 2 3 4 5 10
METERS 1:48 0 2 3

PLACE D'ARMES



NAME AND LOCATION OF STRUCTURE
SAN CARLOS RAVELIN
SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE

SURVEY NO. PR-93

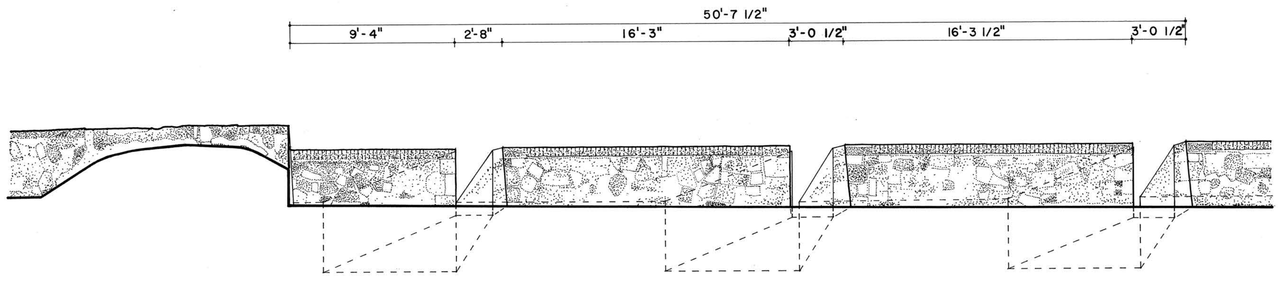
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 10 OF 14 SHEETS

DRAWN BY: JUAN BLANCO

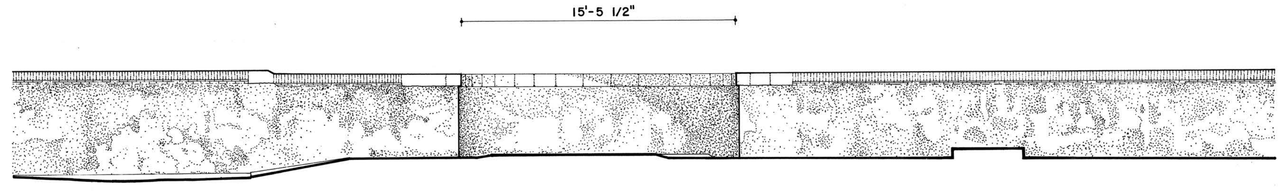
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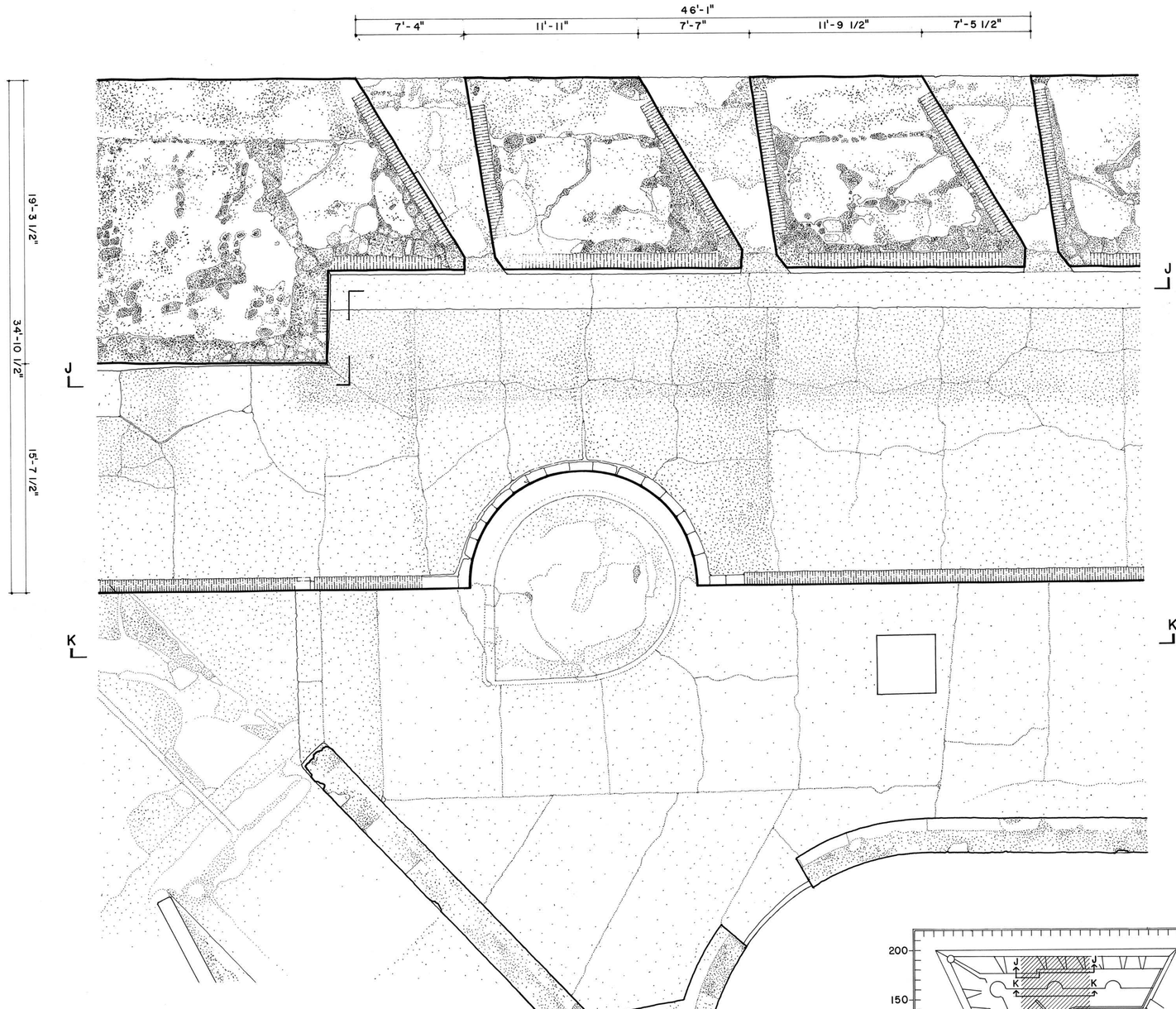
TRIM LINE



SECTION / ELEVATION J



SECTION / ELEVATION K

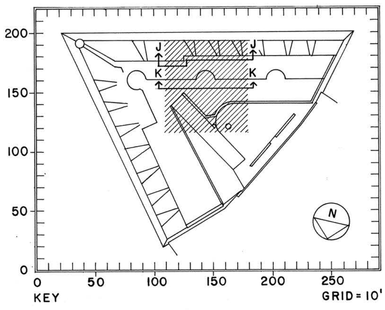


SOUTH TERREPLEIN

FLOOR PLAN

FEET 1/4"= 1'-0" 0 1 2 3 4 5 10

METERS 1:48 0 1 2 3



DRAWN BY: ERIC FRASER NIEMY

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1985
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE
SAN CARLOS RAVELIN
CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

SURVEY NO. PR-93

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 11 OF 14 SHEETS

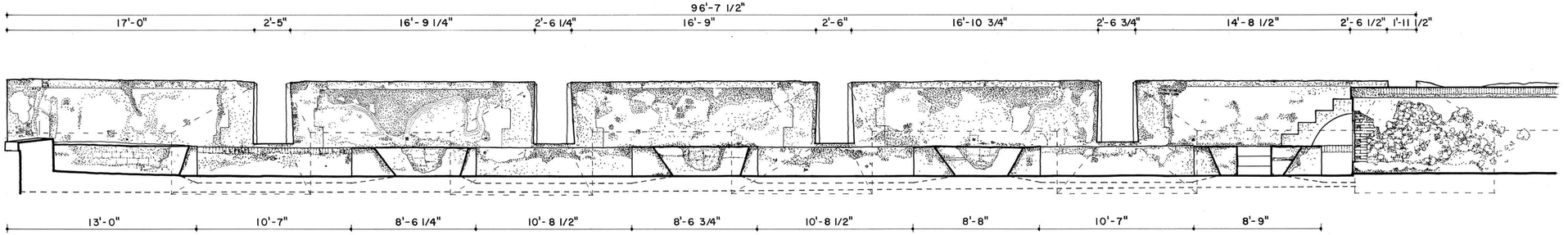
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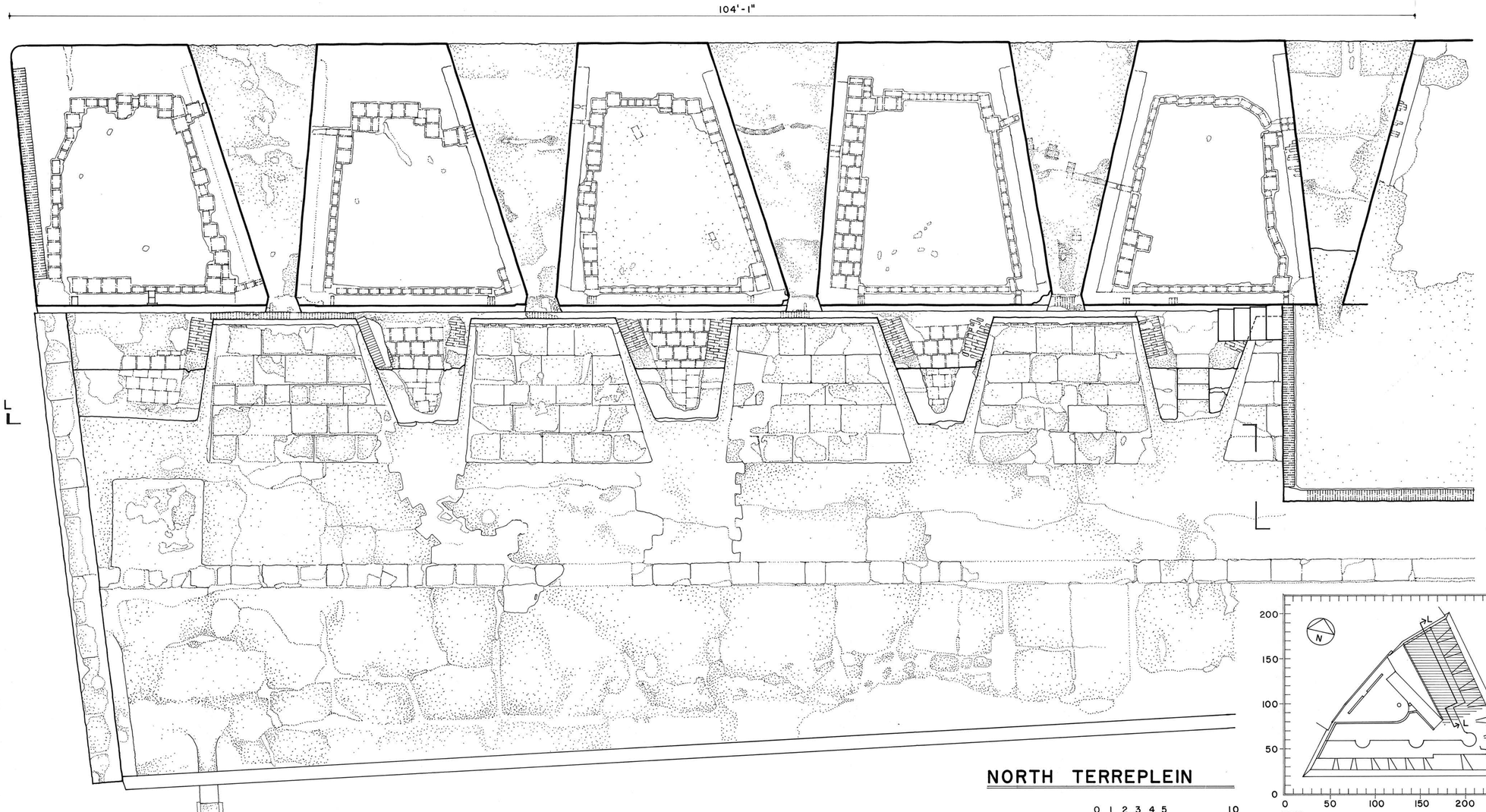
TRIM LINE

TRIM LINE

TRIM LINE



SECTION / ELEVATION L



FLOOR PLAN

NORTH TERREPLEIN

FEET 1/4" = 1'-0" 0 1 2 3 4 5 10

METERS 1:48 0 1 2 3

DRAWN BY: ERIC FRASER NIEMY

SAN JUAN NATIONAL HISTORIC SITE PROJECT – 1985

NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE

SAN CARLOS RAVELIN

CASTILLO DE SAN CRISTOBAL OLD SAN JUAN SAN JUAN NATIONAL HISTORIC SITE PUERTO RICO

SURVEY NO. PR-93

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 12 OF 14 SHEETS

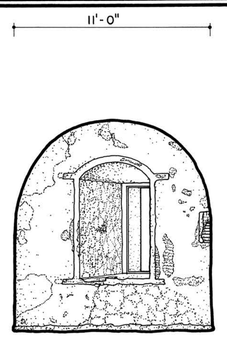
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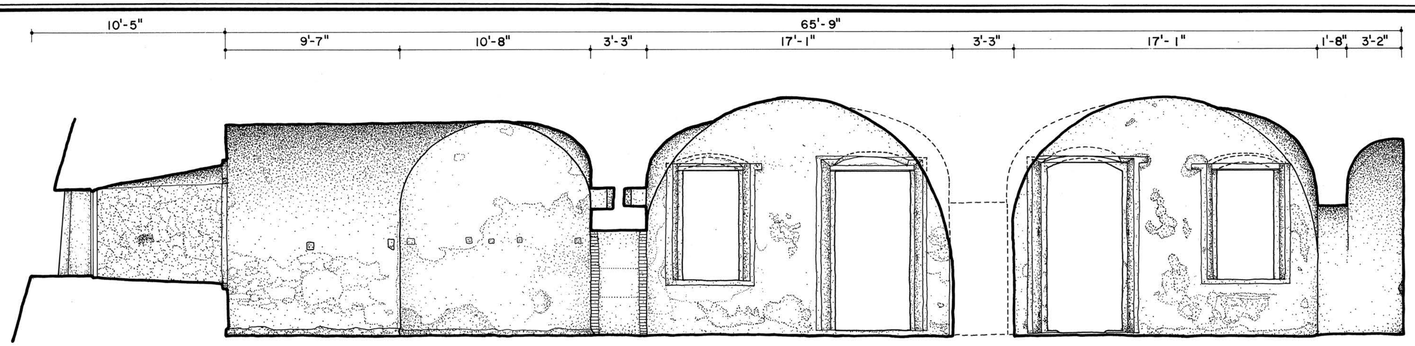
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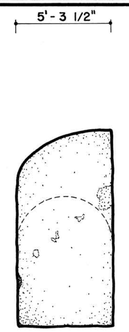
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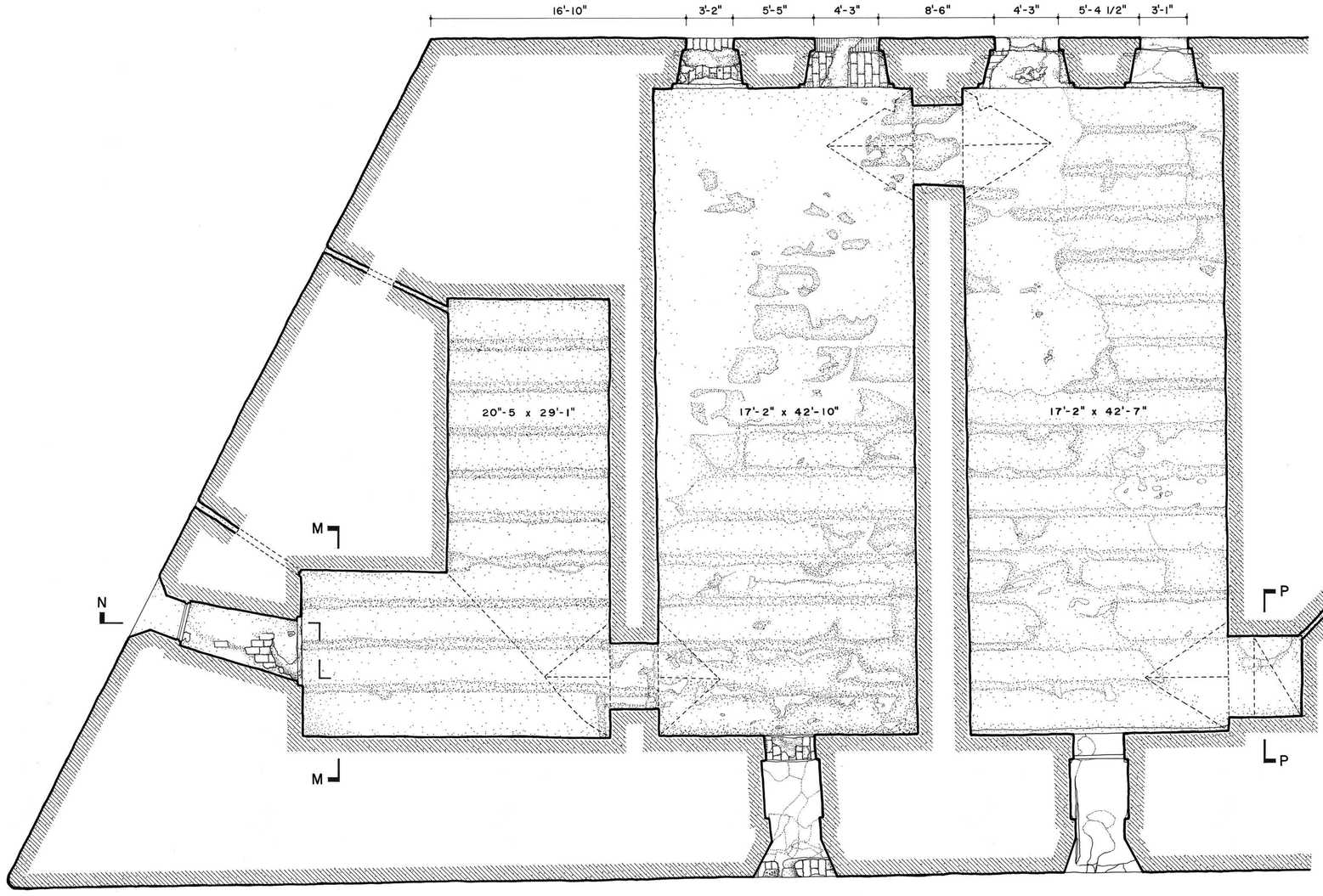
SECTION / ELEVATION M



SECTION / ELEVATION N

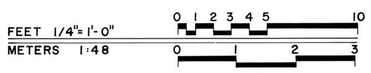


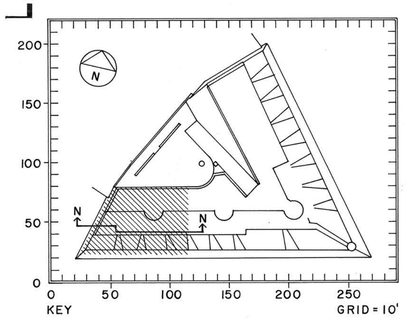
SECTION / ELEVATION P



FLOOR PLAN

CASEMENTS





DRAWN BY: CHRISTOPHER J. GRIBBS

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1985

NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE

SAN CARLOS RAVELIN

CASTILLO DE SAN CRISTOBAL OLD SAN JUAN SAN JUAN NATIONAL HISTORIC SITE PUERTO RICO

SURVEY NO. PR-93

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 13 OF 14 SHEETS

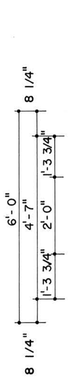
LIBRARY OF CONGRESS HIGH POWERS

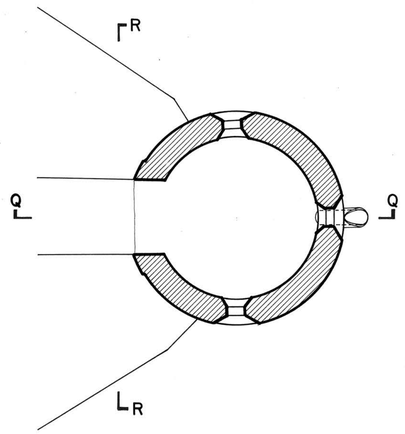
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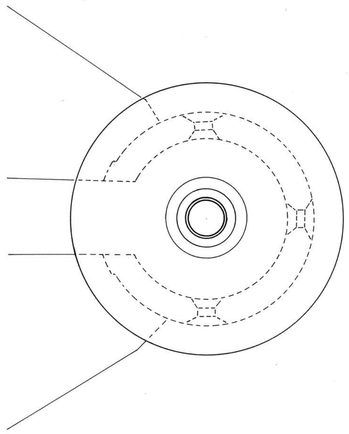
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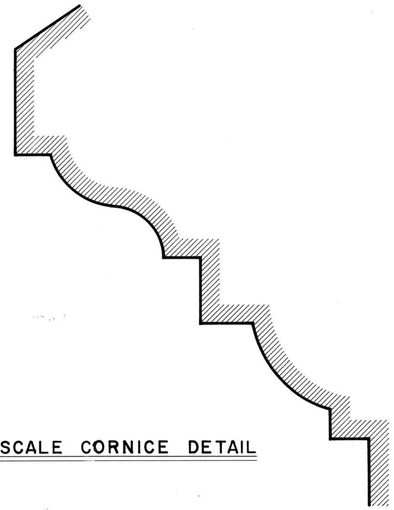




FLOOR PLAN



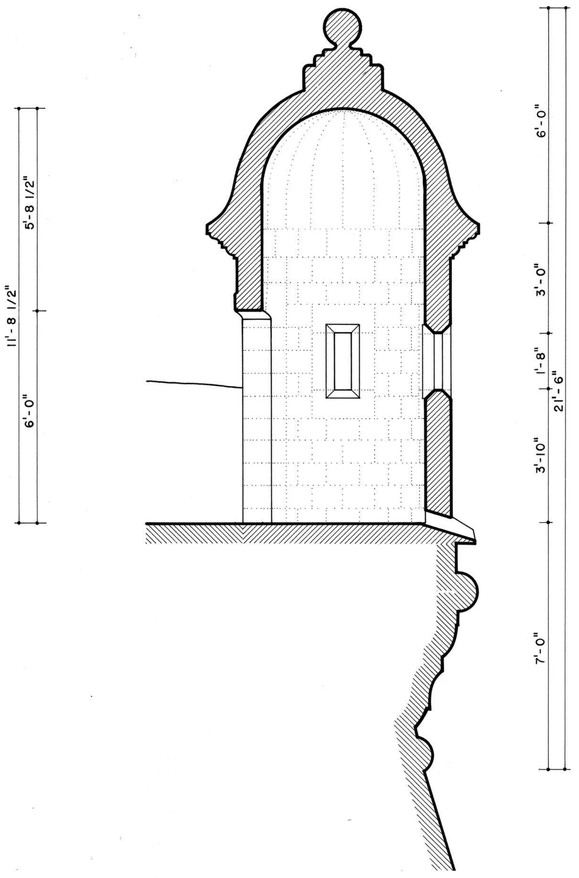
ROOF PLAN



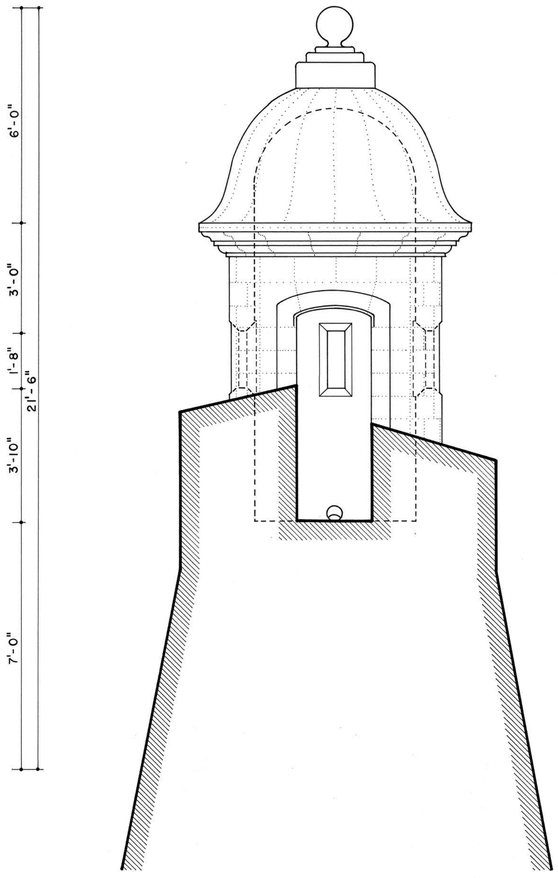
HALF - SCALE CORNICE DETAIL

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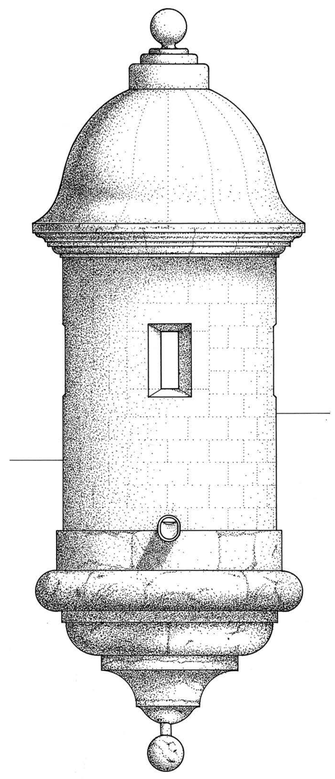
CENTIMETERS 1:24 0 50 100



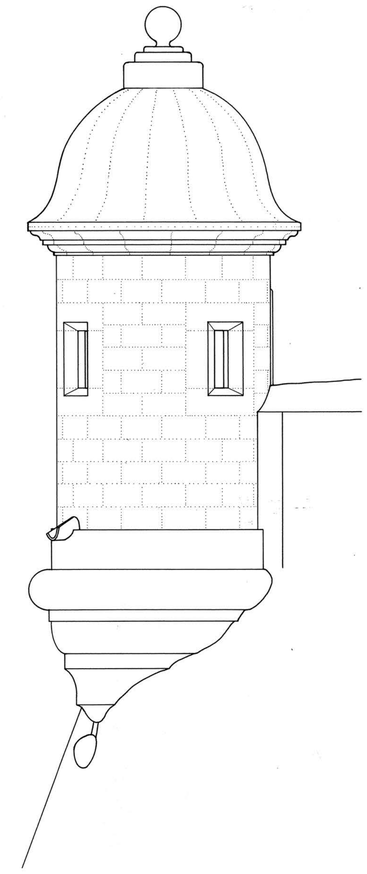
SECTION Q - Q



SECTION / ENTRY ELEVATION R



SENTINEL POINT ELEVATION



NORTH ELEVATION

NAME AND LOCATION OF STRUCTURE

SAN CARLOS RAVELIN

CASTILLO DE SAN CRISTOBAL — OLD SAN JUAN — SAN JUAN NATIONAL HISTORIC SITE — PUERTO RICO

DRAWN BY: CHRISTOPHER J. GRIBBS

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1985

NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

SURVEY NO. PR-93

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 14 OF 14 SHEETS

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Fuerte El Albanico, San Juan, PR. 1963. Historic American Buildings Survey, HABS PR-94.

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Sheet 2 Plan of Fort & Outerworks

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Sheet 4 Plan at Parade, Troop-Powder Room Rooms, and Mining Galleries, and Section through Tunnel & a Recess for Demolition

Sheet 5 Sections through Troop-Powder Rooms & Mining Galleries

Sheet 6 Section A, Section B, Section C, Section D, Profile 1 – Great Moat & Covered Way in Outworks, Profile 2 – Gun embrasure, Cross-Moat, & Ravelin Slope, Profile 3 – Moat at Southwest Corner, and Profile 4 – West Moat at Parade

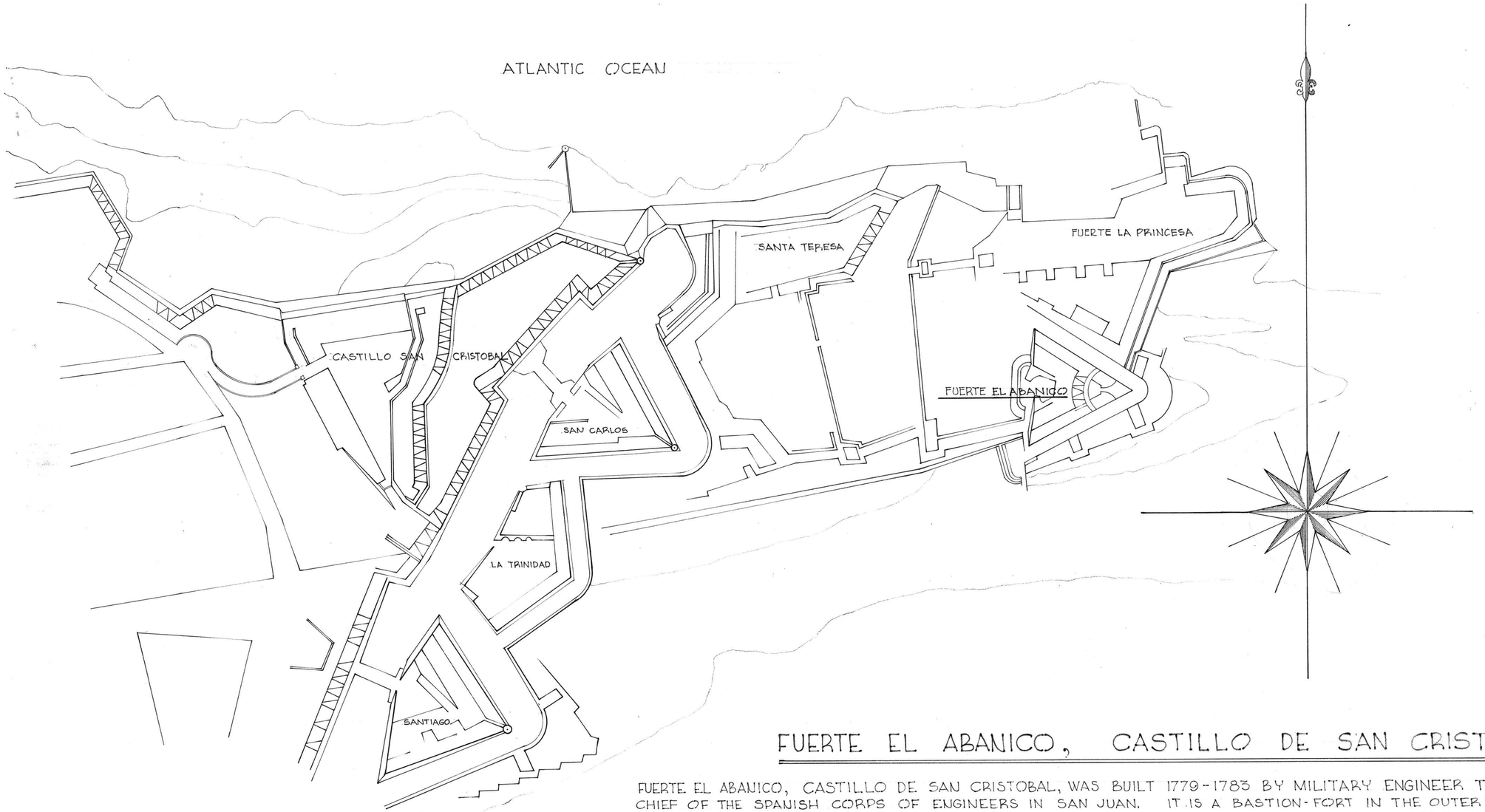
Sheet 7 Detail – West Elevation

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Sheet 9 Detail Plan: Entrance Covered Way and Lower Covered Way

Sheet 10 Detail Plan: Parade & Entrance Covered Way

Sheet 11 Bridge Between Parade & Entrance: Covered Way, Detail Elevation: Southwest Corner, and Decorative Coping at Top of North Ramp



LOCATION PLAN
SCALE NONE
MAP REFERENCE: MAP PREPARED FOR CAPTAIN H. F. HODGES, U.S. CORPS OF ENGINEERS, MARCH 1899 (NHS SJ 9794) (DRAWING NOT COMPLETE.)

FUERTE EL ABANICO, CASTILLO DE SAN CRISTOBAL

FUERTE EL ABANICO, CASTILLO DE SAN CRISTOBAL, WAS BUILT 1779-1783 BY MILITARY ENGINEER THOMAS O'DALY, CHIEF OF THE SPANISH CORPS OF ENGINEERS IN SAN JUAN. IT IS A BASTION-FORT IN THE OUTER WORKS OF CASTILLO SAN CRISTOBAL, A FAN-SHAPED DESIGN DETERMINED BY THREE GUN EMPLACEMENTS FOR CROSS-FIRE. THROUGH AN EMBRASURE IN THE PARAPET OF THE RAVELIN TO COVER THE EASTERN APPROACH OF THE FORT. OF SPECIAL INTEREST IS A SYSTEM OF MINING GALLERIES UNDER THE TERREPLEINE. THIS STRUCTURE APPEARS TO HAVE BEEN ONLY SLIGHTLY MODIFIED BY 19th-20th CENTURY REVISIONS AND REMAINS AN INTACT EXAMPLE OF THE FORTIFICATIONS ERECTED BY SPAIN TO PROTECT ITS HOLDINGS IN THE NEW WORLD.

THIS PROJECT WAS FINANCED FROM FUNDS OF THE "MISSION 66" PROGRAM OF THE NATIONAL PARK SERVICE, MEASURED AND DRAWN DURING THE SUMMER OF 1963 UNDER THE DIRECTION OF HENRY JUDD, SUPERVISING ARCHITECT, HISTORIC STRUCTURES; FREDERIK C. GJESSING, ARCHITECT; F. BLAIR REEVES, ARCHITECT; AND STUDENT ASSISTANT ARCHITECTS: N. PAUL ANTHONY, U. OF FLORIDA; FERNANDO BATLLE, U. OF MICHIGAN; E. BLAIN CLIVER, CARNEGIE INSTITUTE OF TECHNOLOGY.

N. PAUL ANTHONY: DEL.

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE : E.O.D.C.

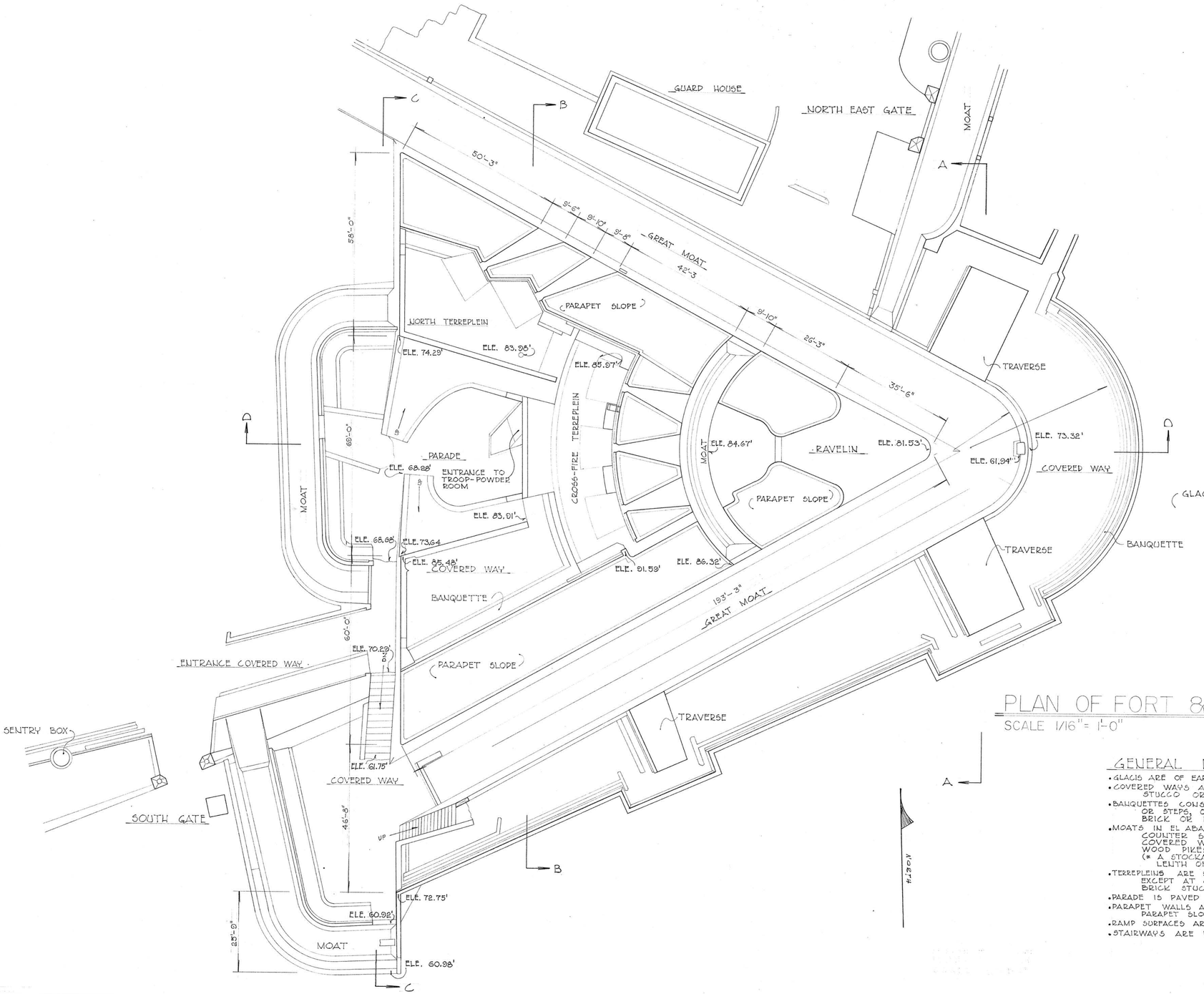
NAME OF STRUCTURE
FUERTE EL ABANICO
CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO.
PR-94

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 1 OF 11 SHEETS

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BM - IL 3
ELE. 77.517'

NOTE:
BM IL 3 LOCATED FROM MAP DRAWN FOR, OFFICE OF THE ANTILLES DISTRICT ENGINEER U.S. ARMY, DRAWING NO. AD - 1.786 JUNE 1947.
ALL ELEVATIONS FROM MEAN SEA LEVEL

PLAN OF FORT & OUTERWORKS

SCALE 1/16" = 1'-0"

GENERAL DESCRIPTION:

- GLACIS ARE OF EARTH AND GROUND COVER.
- COVERED WAYS ARE SURFACED WITH STUCCO OR EARTH.
- BANQUETTES CONSIST OF ONE OR TWO CURBS OR STEPS, ORIGINALLY COVERED WITH BRICK OR LIME STUCCO.
- MOATS IN EL ABANICO ARE DRY* SCARP AND COUNTER SCARP WALL ARE MASONRY COVERED WITH YELLOW-OCHER STUCCO. WOOD PIKES PROJECTED FROM THE SCARP WALL. (* A STOCKADE OF WOOD POLES RAN THE LENTH OF THE GREAT MOAT.)
- TERREPLEINS ARE SURFACED WITH LIME STUCCO OVER EARTH, EXCEPT AT GUN EMPLACEMENTS WHERE A BRICK STUCCO COVERED STONE.
- PARADE IS PAVED WITH STUCCO OVER EARTH FILL.
- PARAPET WALLS ARE MASONRY COVERED WITH STUCCO, PARAPET SLOPES ARE STUCCO OVER FILL.
- RAMP SURFACES ARE EARTH AND/OR STUCCO.
- STAIRWAYS ARE BRICK OR STONE.

0 2 4 6 8 10 15 50

SCALE 1/16"=1'-0"

E. B. CLIVER: DEL.:

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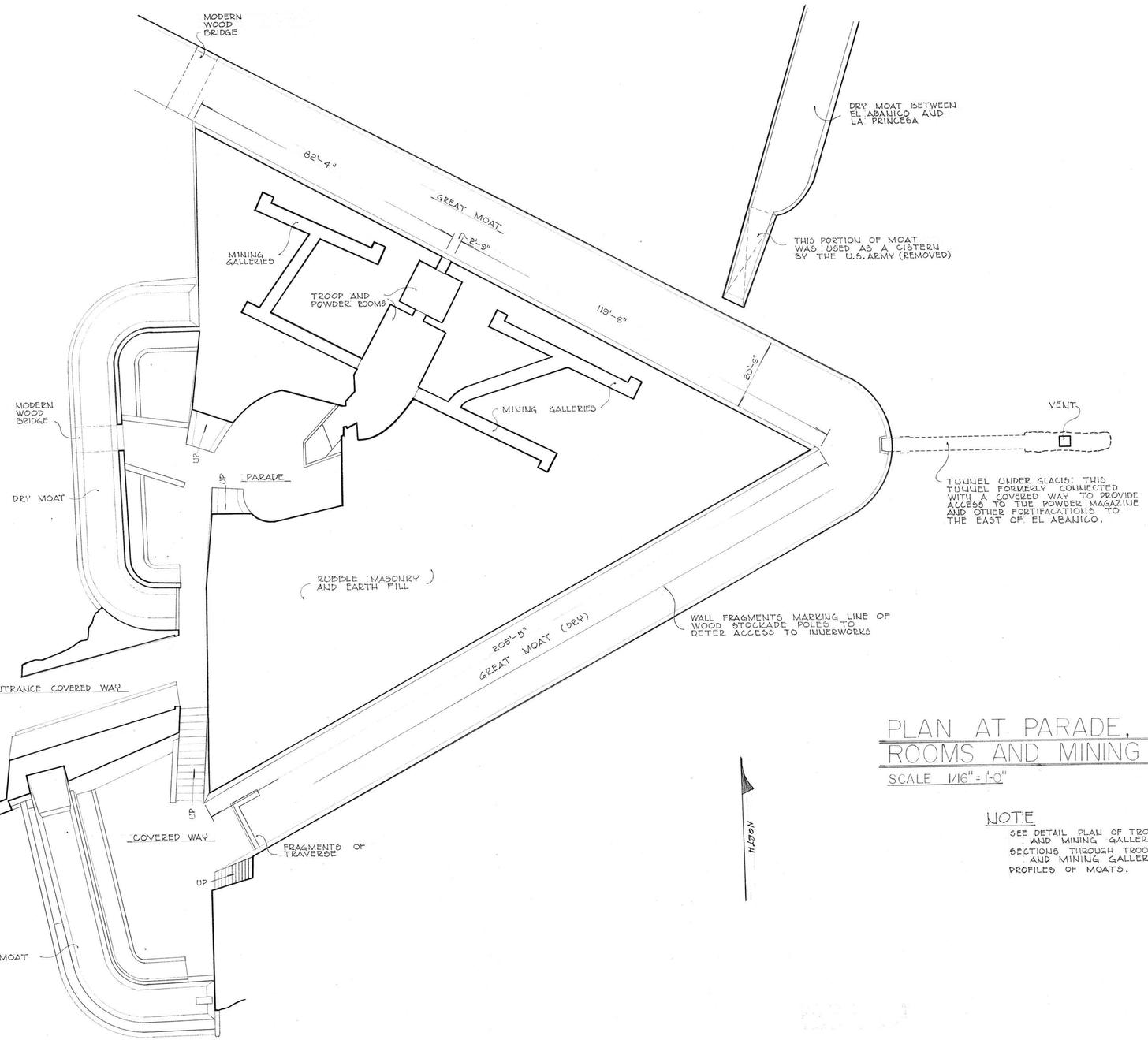
NAME OF STRUCTURE
FUERTE EL ABANICO — CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO.
PR-94

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 2 OF 11 SHEETS

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PLAN AT PARADE, TROOP-POWDER ROOMS AND MINING GALLERIES

SCALE 1/16" = 1'-0"

NOTE

SEE DETAIL PLAN OF TROOP-POWDER ROOMS AND MINING GALLERIES. SHEET 4
SECTIONS THROUGH TROOP-POWDER ROOMS AND MINING GALLERIES. SHEET 5
PROFILES OF MOATS. SHEET 6

0 4 8 10 15 30
SCALE 1/16" = 1'-0"

E.B. CLIVER : DEL.

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FUERTE EL ABANICO

NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO. PR-94

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 3 OF 11 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

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SURFACE OF SCARP

38'-6"

NICHE TO RECEIVE BARRICADE

25'-11"

NOTE:
- ROOMS A + B ARE TRADITIONALLY REFERED TO AS TROOP-POWDER ROOMS
- ALL IRON GATES, DOORS AND GRILL ARE MODERN.
- VENTS IN MINING GALLERIES EXTEND TO TERREPLEIN.

E

5'-8"

HINGED IRON BAR GRILL

ROOM B
FLOOR: EARTH & CEMENT
WALLS: STUCCO
CEILING: STUCCO VAULT

12'-9"

14'-0"

2'-10"

2'-5"

WOOD DOOR FRAME

18'-0"

ROOM A
FLOOR: 4" CONC. SLAB
WALLS: STUCCO
CEILING: STUCCO. ELLIPTICAL VAULT

38'-6"

F

37'-3"

VENT

2'-9"

IRON GATE

5' 4½"

RAMPS UP

STEEL PLATE DOOR

CURB

RAMPS DN.

RAMP UP TO TERREPLEIN

PARADE

E

46'-6"

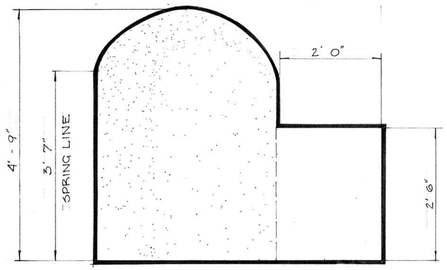
24'-0"

F

VENT

44'-6"

RECESS FOR EXPLOSIVES (SEE DETAIL)



SECTION THRU TUNNEL & A RECESS FOR DEMOLITION
SCALE 3/4" = 1' 0"

PLAN OF TROOP-POWDER ROOM AND MINING GALLERIES

SCALE 1/4" = 1' 0"

0 1 2 3 4 5 10 FT
SCALE 1/4" = 1'-0"

0 6" 1 2 3 4 6 FT
SCALE 3/4" = 1'-0"

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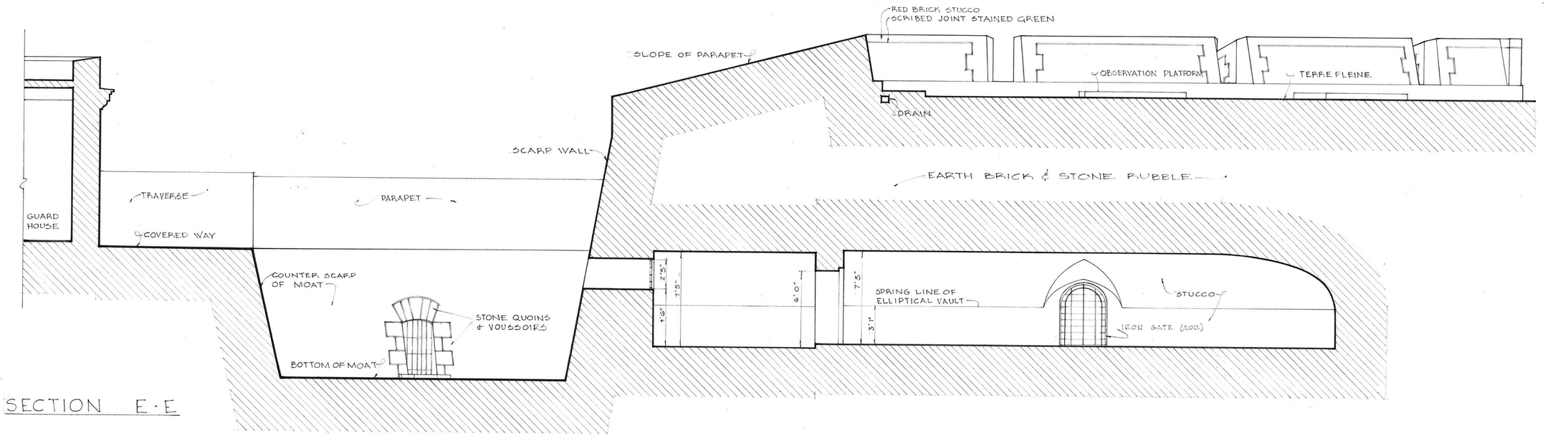
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SAN JUAN, PUERTO RICO

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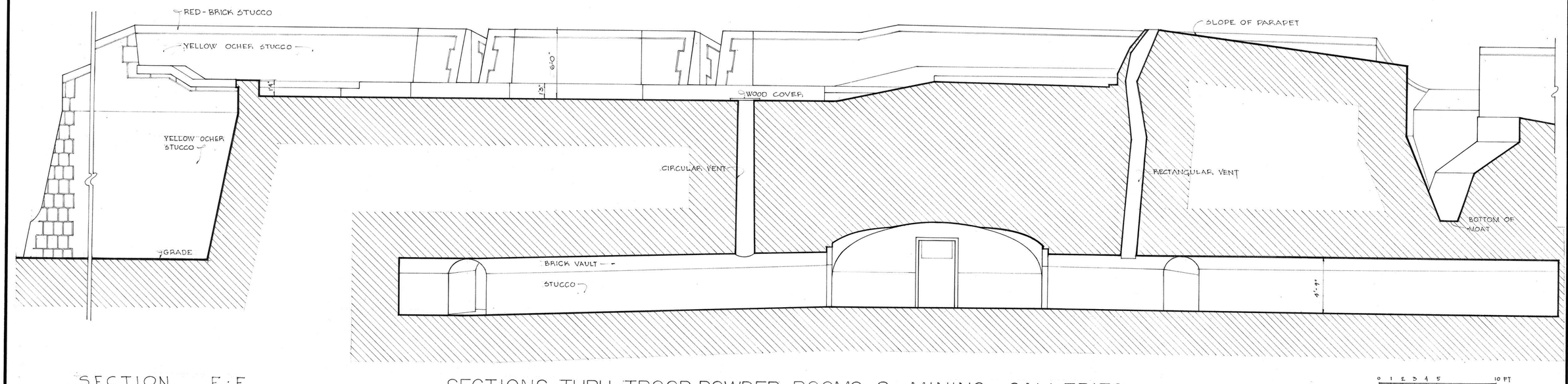
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 4 OF 11 SHEETS

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SECTION E·E



SECTION F·F

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SECTIONS THRU TROOP-POWDER ROOMS & MINING GALLERIES

0 1 2 3 4 5 10 FT

SCALE 1/4"·1'0"

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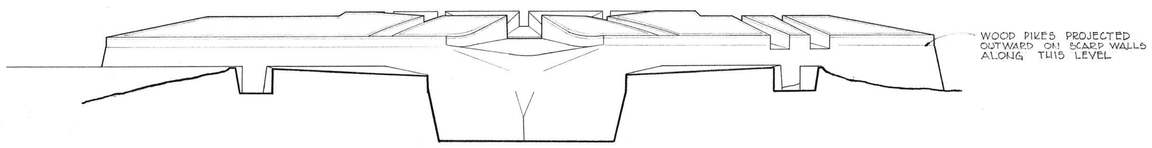
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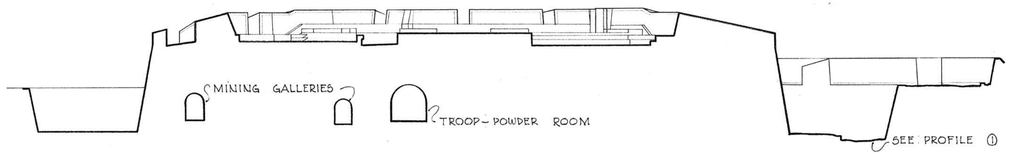
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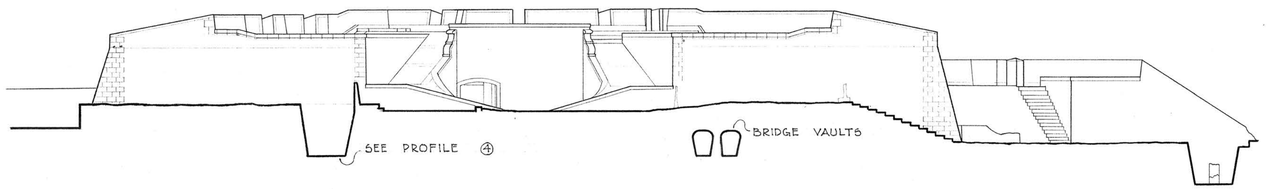
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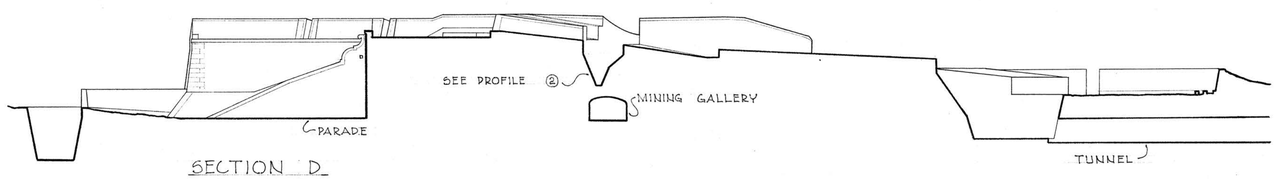
SECTION A
SCALE 1/16" = 1'-0"



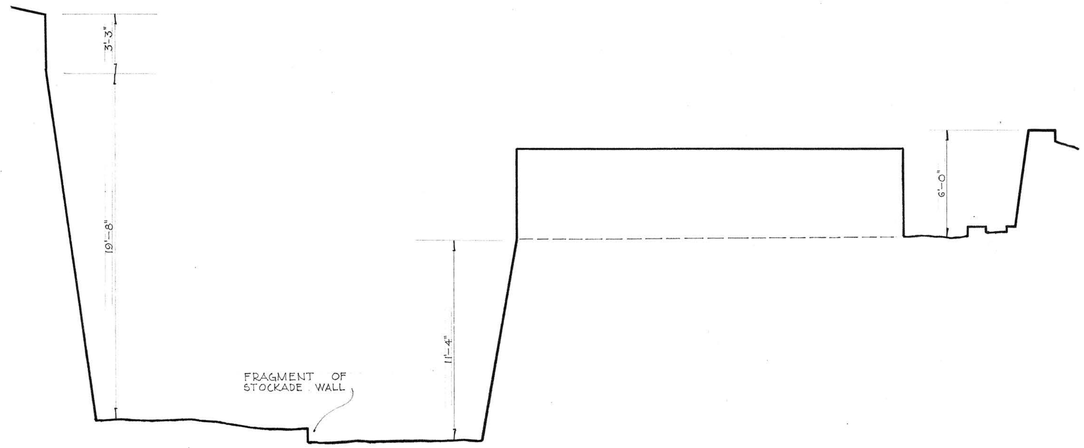
SECTION B
SCALE 1/16" = 1'-0"



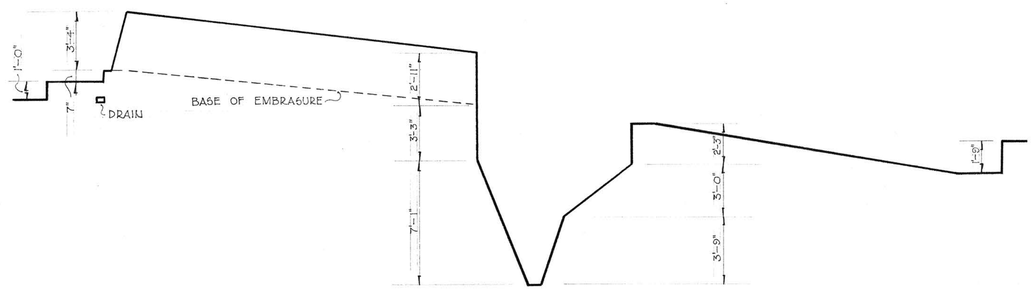
SECTION C
SCALE 1/16" = 1'-0"



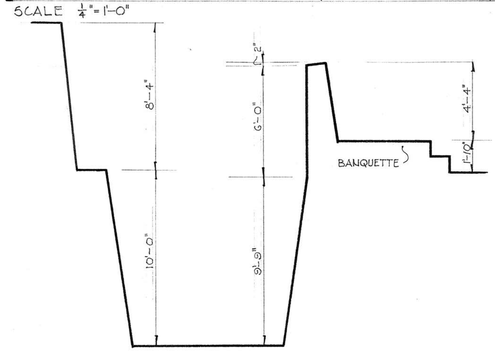
SECTION D
SCALE 1/16" = 1'-0"



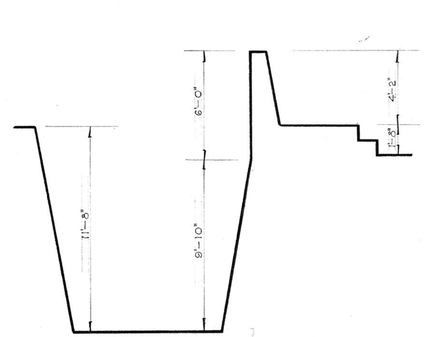
PROFILE ① — GREAT MOAT & COVERED WAY IN OUTWORKS
SCALE 1/4" = 1'-0"



PROFILE ② — GUN EMBRASURE, CROSS-MOAT & RAVELIN SLOPE
SCALE 1/4" = 1'-0"



PROFILE ③ — MOAT @ SOUTHWEST CORNER
SCALE 1/4" = 1'-0"



PROFILE ④ — WEST MOAT @ PARADE
SCALE 1/4" = 1'-0"

0 1 2 3 4 5 10
SCALE 1/4" = 1'-0"

0 2 4 6 8 10 15 30
SCALE 1/16" = 1'-0"

E.B. CLIVER: DEL.

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FUERTE EL ABANICO

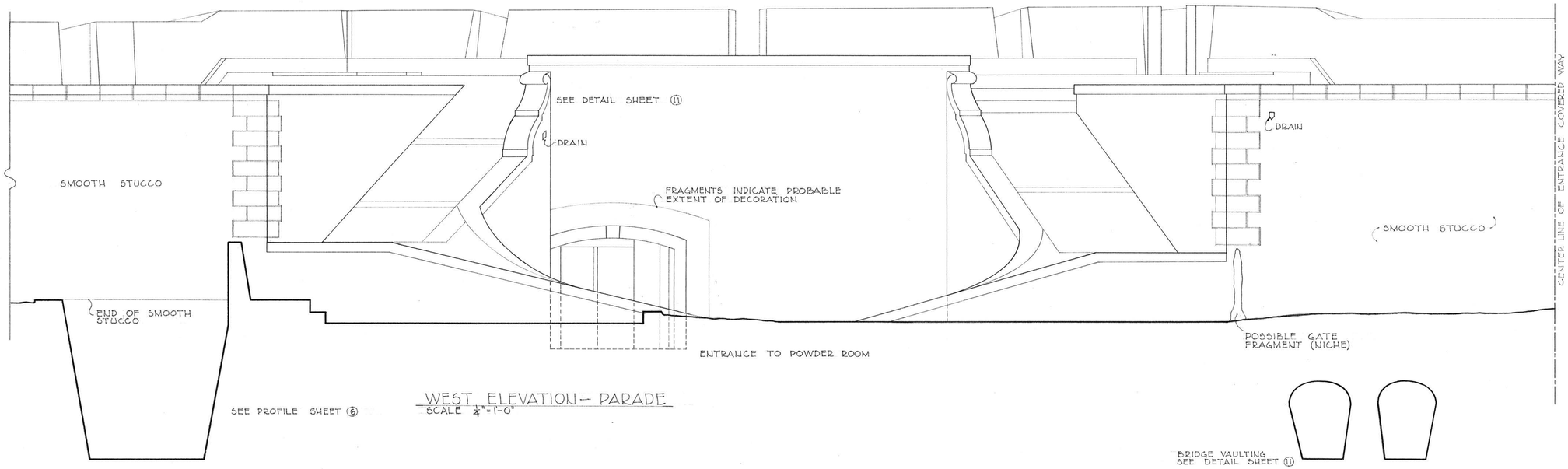
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CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO.
PR-94

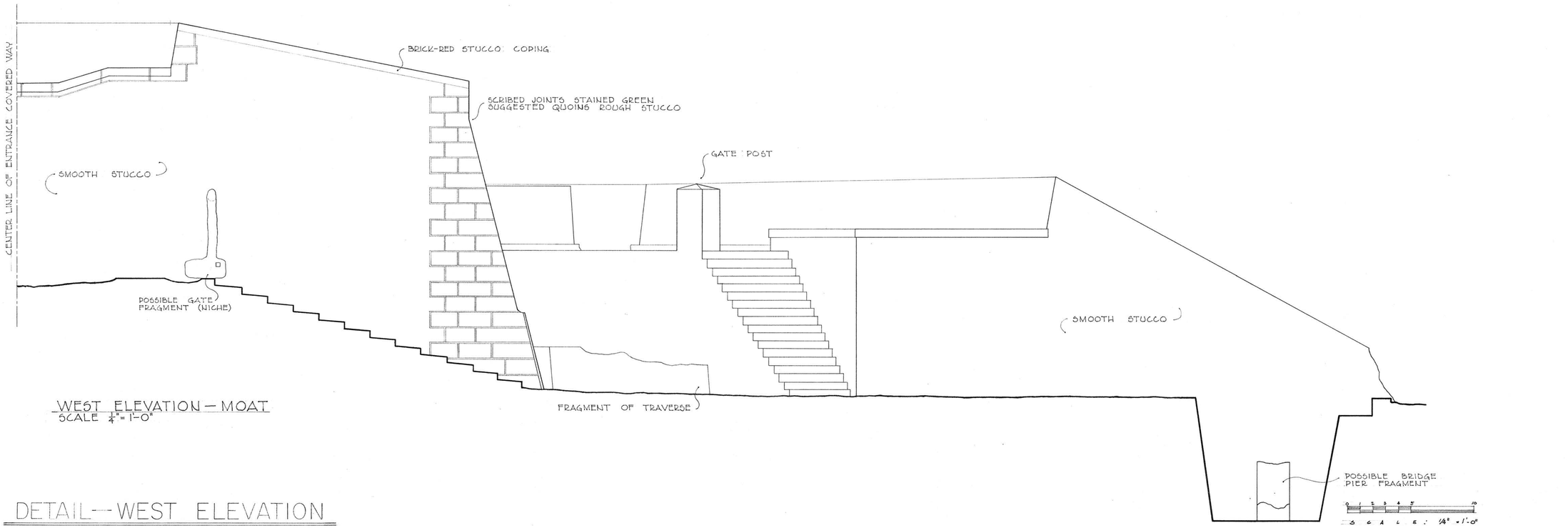
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 6 OF 11 SHEETS

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WEST ELEVATION — PARADE
SCALE 1/4" = 1'-0"



WEST ELEVATION — MOAT
SCALE 1/4" = 1'-0"

DETAIL — WEST ELEVATION

E. B. CLIVER: DEL.

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SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE : E. D. D. C.

FUERTE EL ABANICO

NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO.
PR-94

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 7 OF 11 SHEETS

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RAMP DOWN TO NORTH TERREPLEINE

RAMP DOWN TO PARADE

STACK FOR VENT TO MINING GALLERIES

STUCCO COPING

FRAGMENTS INDICATE THAT GUN EMPLACEMENTS ARE STONE COVERED WITH STUCCO

OBSERVATION PLATFORM

STUCCO OVER CORNER STONES

SLOPE OF PARAPET

DRAIN

DRAIN

SLOPE OF PARAPET

R 5'3"

R 4'5"

R 4'3"

11' 10"

TRENCH CUT INTO TOP OF RAVELIN # 1 (MODERN)

R 5'0"

R 4'0"

CENTER OF CURVATURES (ACCUMULATIVE DIMENSIONS)

3 END TO END BULLHEADER BRICK COURSES

R 3'9"

R 4'5"

WHITE STUCCO

R 4'0"
R 3'0"

FRAGMENTS OF CONC.

BRICK STUCCO OVER BULL HEADERS

GUTTER

DRAIN

MODERN WOOD BRIDGE

STUCCO OVER FILL

RAMP DOWN TO PARADE

3 RISERS AT 11" EACH DOWN TO SOUTH COVERED WAY

DRAIN

COVERED WAY

8'9"

BRICK STUCCO OVER BRICK TREADS

BRICK STUCCO

GUTTER

DRAIN

NOTE:
- ALL EDGES OF PARAPET, CURBS, ETC. ARE BEVELED
- LIME STUCCO IS YELLOW-OCHER.
- BRICK STUCCO IS RED

BEVELED TOP OF SCARP WALL.
WALL OF MOAT IS STUCCO, YELLOW-OCHER.

NORTH

DETAIL PLAN TERREPLEIN & RAVELIN

SCALE 1/4" = 1'-0"

0 1 2 3 4 5 10 FT.

N. PAUL ANTHONY, DEL.

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UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE : E.O.D.C.

NAME OF STRUCTURE
FUERTE EL ABANICO — CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO.
PR-94

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 8 OF 11 SHEETS

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DETAIL PLAN: ENTRANCE COVERED WAY AND LOWER COVERED WAY

SCALE 1/16" = 1'-0"

NOTE:
ADJACENT DETAIL PLAN OF PARADE AND COVERED WAY — ENTRANCE SHEET 10

SLOPE OF PARAPET

CEMENT

PATTERN OF BRICK TREAD

UP TO PARADE LEVEL

8'-2"

FACE BRICK & FRAGMENTS OF STUCCO

CENTER LINE OF ENTRANCE COVERED WAY

47'-6"

BANQUETTE

STUCCO

COVERED WAY

4'-9"

1'-7"

12'-6"

FRAGMENT OF TRAVERSE

SEE DETAIL SHEET 11

2'-4"

MODERN WOOD STAIRS OVER STONE ORIGINAL

UP TO COVERED WAY IN OUTER WORKS

COVERED WAY OUTER WORKS

SLOPED COPING

STUCCO

STONE

BANQUETTE

EARTH GLACIS

NORTH

MASONRY

11'-8"

7'-4"

STONE

8'-8"

1'-9"

2'-4"

FRAGMENT

15"

BRICK STUCCO OVER BRICK STEPS

FRAGMENTS OF STUCCO OVER EARTH FILL

BANQUETTE

4'-6" 1'-9" 12"

BRICK COPING

DRAIN

10'-7"

11'-9"

24'-10"

25'-7"

24'-9"

23'-1"

STUCCO

DRY MOAT

SCALE: 1/4" = 1'-0"

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UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE : E. O. C. C.

NAME OF STRUCTURE
FUERTE EL ABANICO — CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO. PR-94

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 9 OF 11 SHEETS

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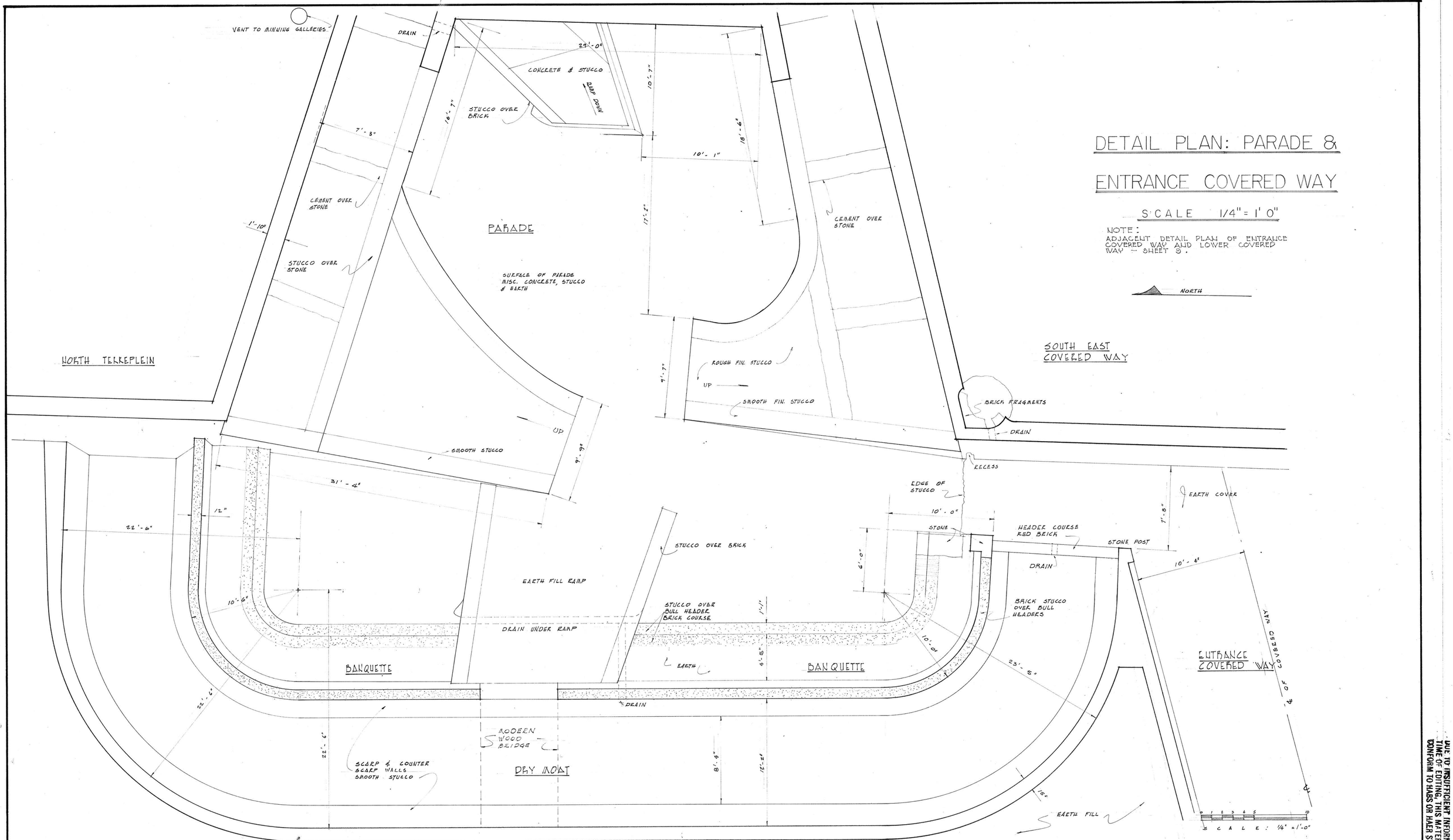
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DETAIL PLAN: PARADE & ENTRANCE COVERED WAY

SCALE 1/4" = 1' 0"

NOTE:
ADJACENT DETAIL PLAN OF ENTRANCE COVERED WAY AND LOWER COVERED WAY — SHEET 9.

NORTH

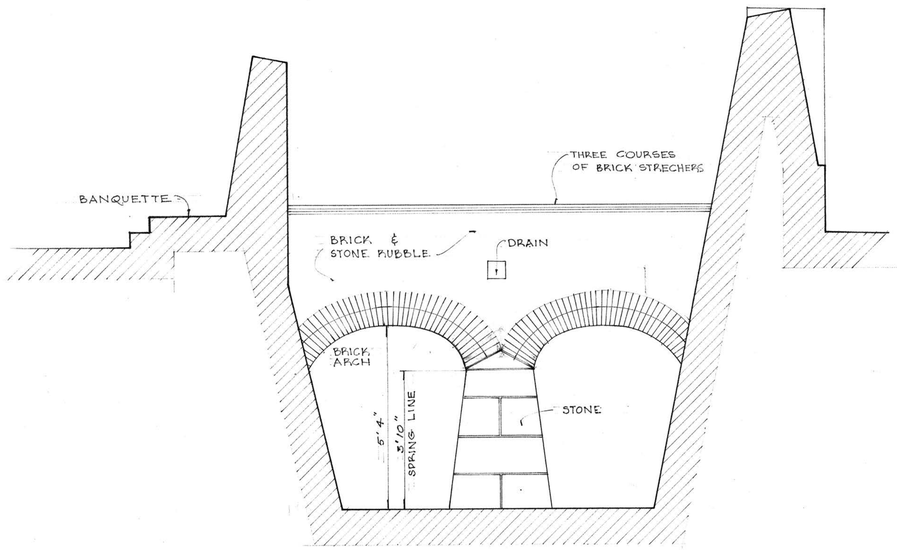


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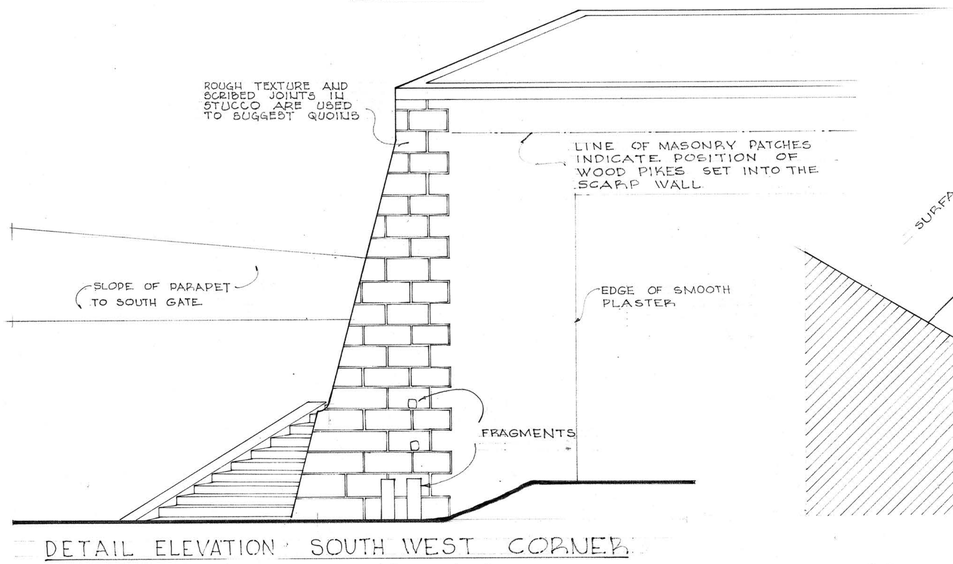
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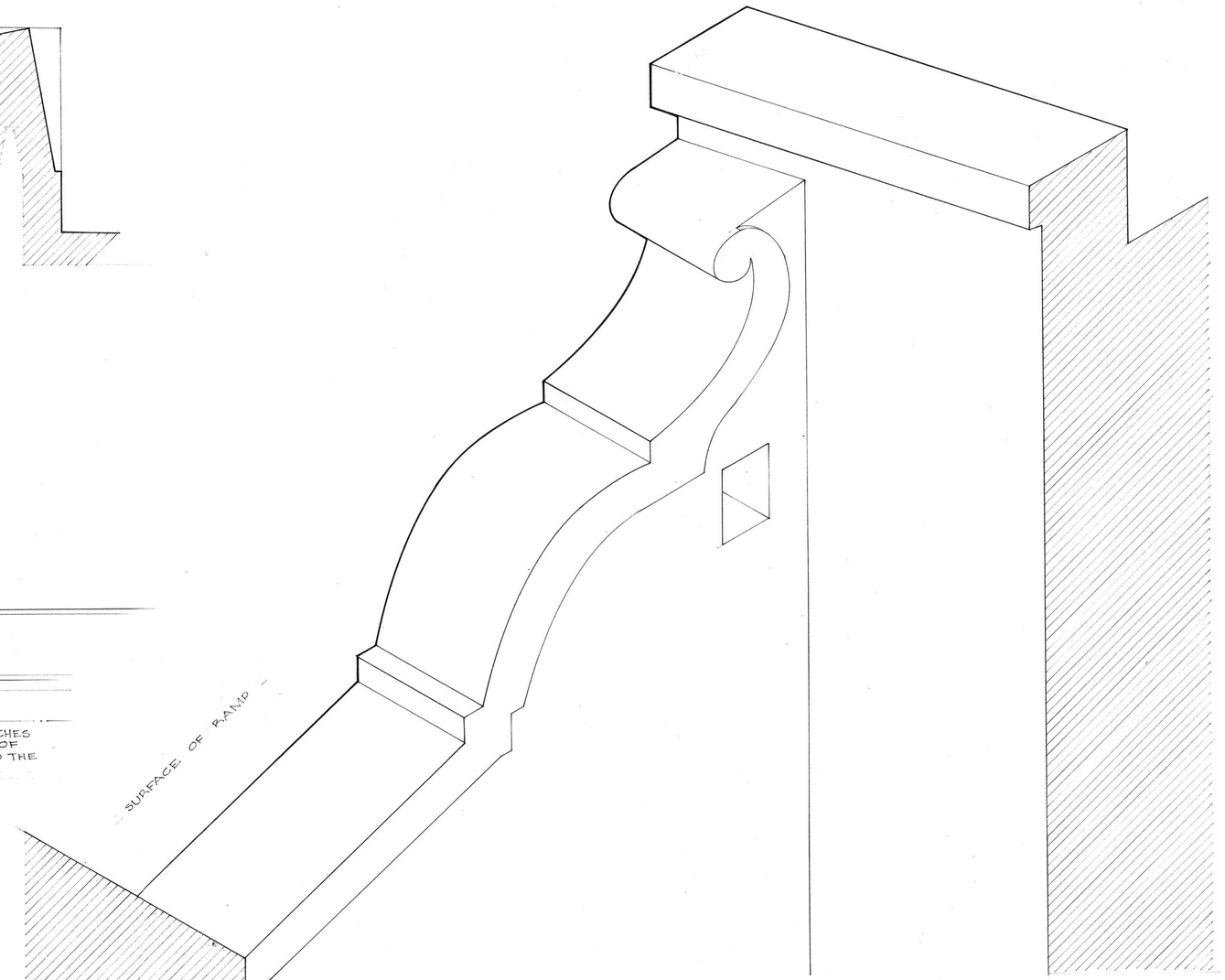
BRIDGE BETWEEN PARADE & ENTRANCE COVERED WAY

SCALE 1/2" = 1'-0"



DETAIL ELEVATION SOUTH WEST CORNER

SCALE 1/4" = 1'-0"



DECORATIVE COPING AT TOP OF NORTH RAMP

SCALE = 1" = 1'0"

(ISOMETRIC)

0 1 2 3 4 5 10FT
SCALE 1/4" = 1'0"

-6" 0" 1' 2' 3FT.
SCALE = 1/2" = 1' 0"

0 1 2 3 6" 1 2 3 FT
SCALE = 1" = 1' 0"

N. P ANTHONY : DEL.

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SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE : E. P. D. C.

NAME OF STRUCTURE
FUERTE EL ABANICO
CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO.
PR-94

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 11 OF 11 SHEETS

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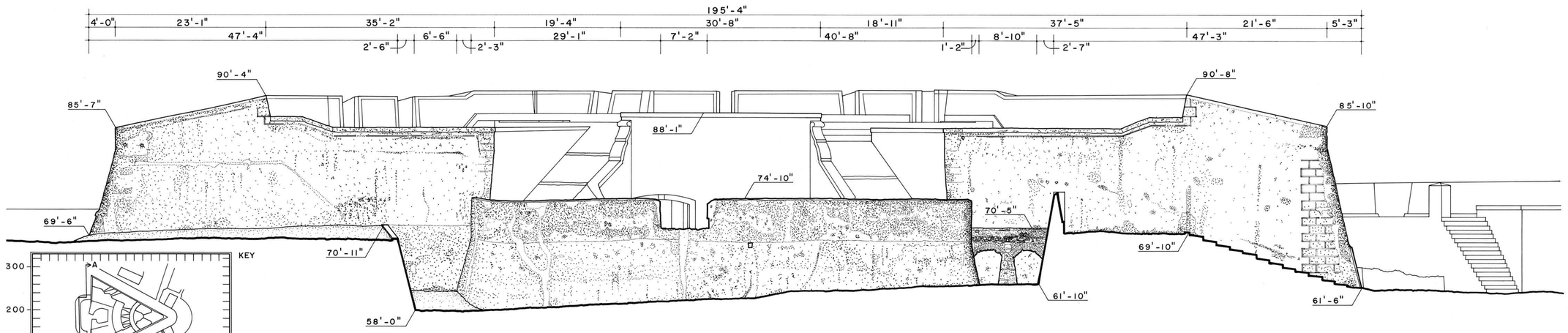
Sheet Index

Sheet 1 West Elevation A-A and Location Map

Sheet 2 Southeast Elevation B-B and Northeast Elevation C-C

TRIM LINE

FUERTE EL ABANICO

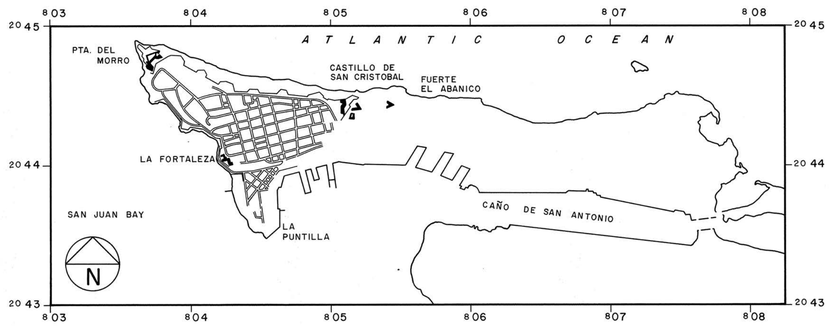


WEST ELEVATION A-A

NOTE:
SPOT ELEVATIONS ARE IN RELATION TO THE SEA LEVEL.

FEET 1/8" = 1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5



TAKEN FROM: USGS SAN JUAN, P.R. QUADRANGLE 1969 (PHOTOREVISED 1982) UTM 19.
USGS BAYAMON, P.R. QUADRANGLE 1969 (PHOTOREVISED 1982)

LOCATION MAP

FEET 1" = 1667' 0 1000 3000 5000

METERS 1:20000 0 1 KM 2 KM

V911

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 1 OF 2 SHEETS

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PR-94

NAME AND LOCATION OF STRUCTURE
FUERTE EL ABANICO
HISTORIC SITE
OLD SAN JUAN PUERTO RICO

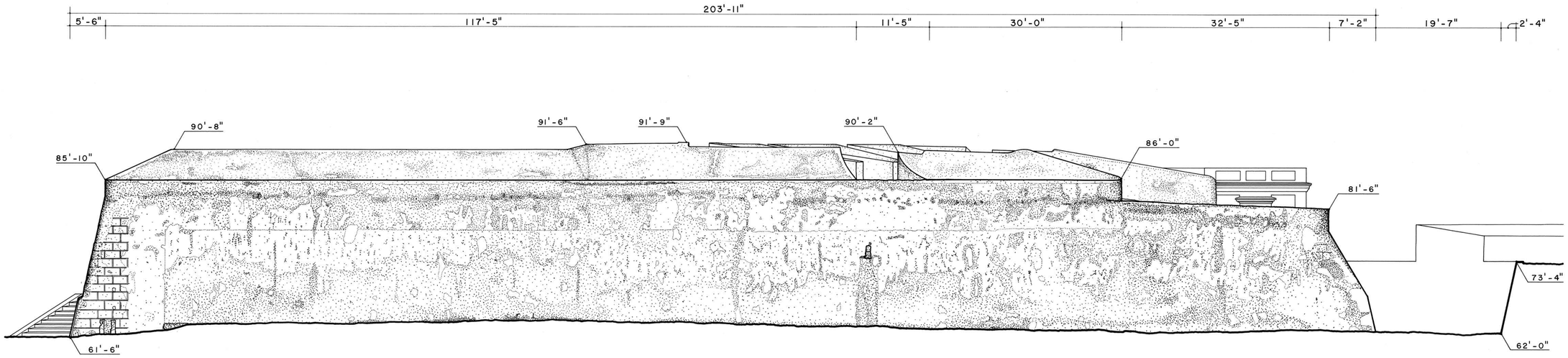
ADDENDUM TO
CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE

DRAWN BY: MICHAEL P. BEARY
SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1986
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

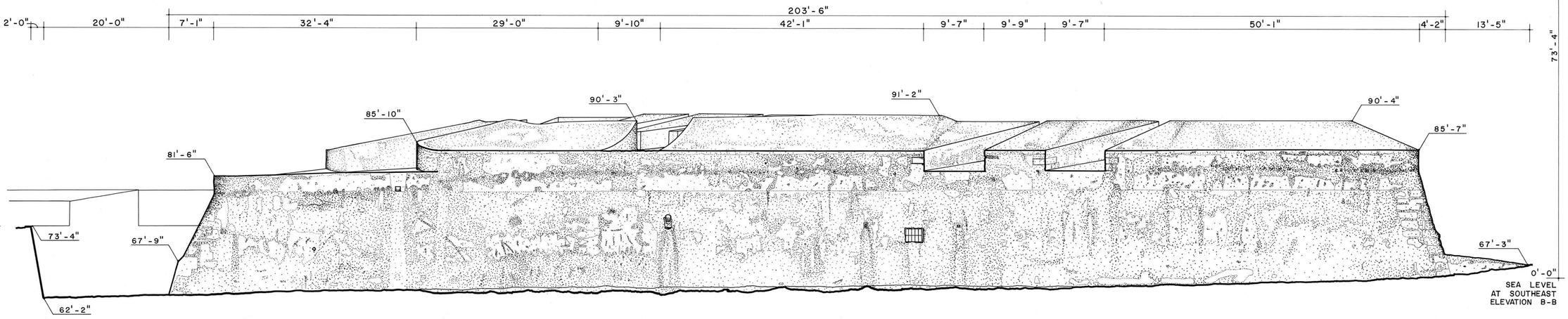
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TRIM LINE

TRIM LINE



SOUTHEAST ELEVATION B-B

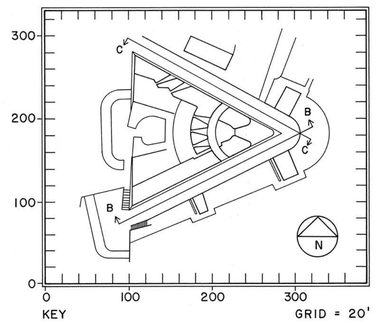


NORTHEAST ELEVATION C-C

FEET 1/8" = 1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5

NOTE:
SPOT ELEVATIONS ARE IN RELATION TO THE SEA LEVEL.



NAME AND LOCATION OF STRUCTURE
FUERTE EL ABANICO
ADDENDUM TO
CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE

OLD SAN JUAN PUERTO RICO

DRAWN BY: MICHAEL P. BEARY
SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1986
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

SURVEY NO. PR-94

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 2 OF 2 SHEETS

LIBRARY OF CONGRESS HABS NUMBER

IF REPRODUCED, PLEASE CREDIT: HISTORIC AMERICAN BUILDINGS SURVEY, NATIONAL PARK SERVICE, NAME OF DELINEATOR, DATE OF THE DRAWING

19511

TRIM LINE

South Gate, Fuerte El Albanico, San Juan, PR. 1963. Historic American Buildings Survey, HABS PR-94-B.

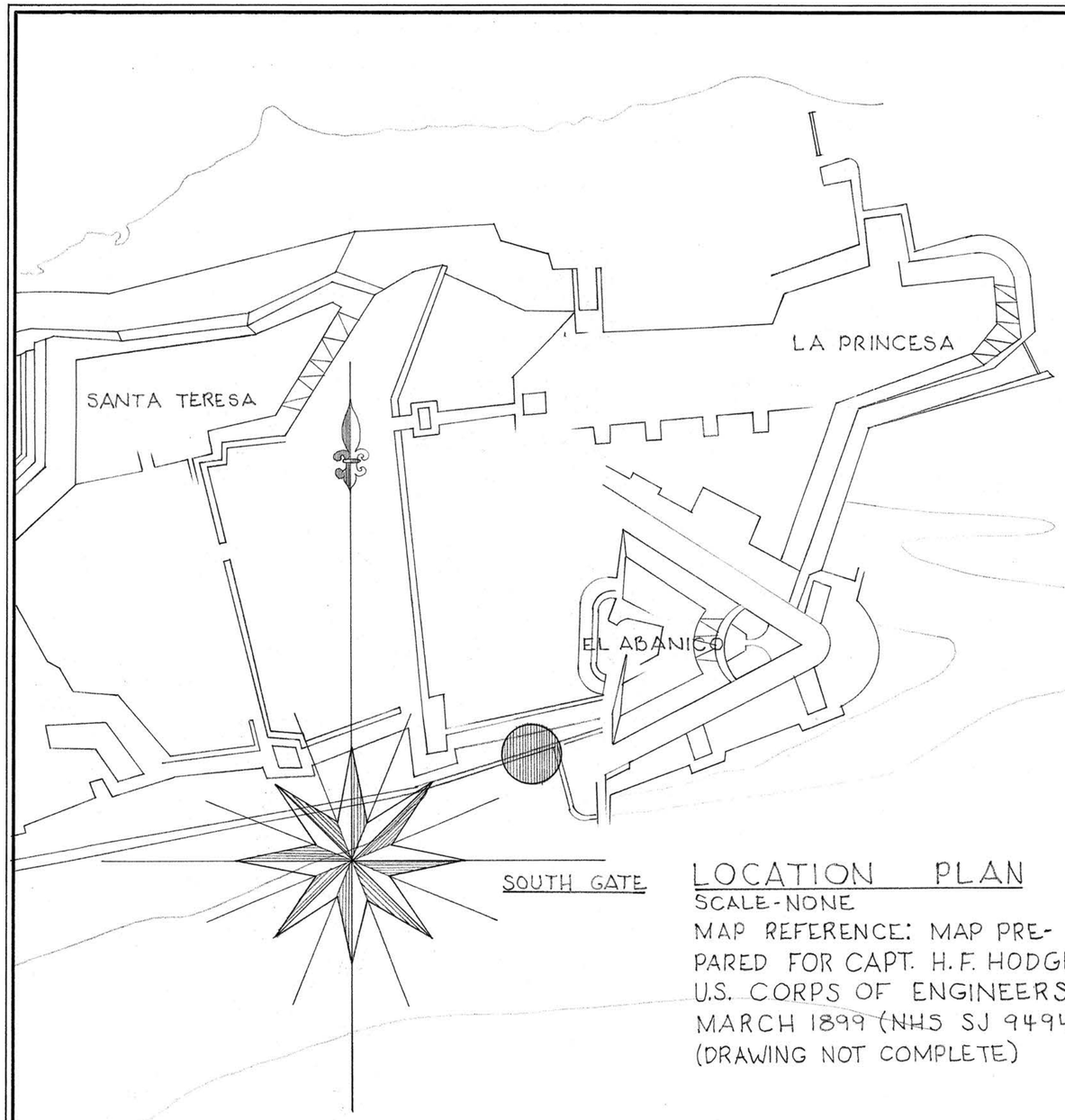
Sheet Index

Sheet 1 Location Plan and Site Plan

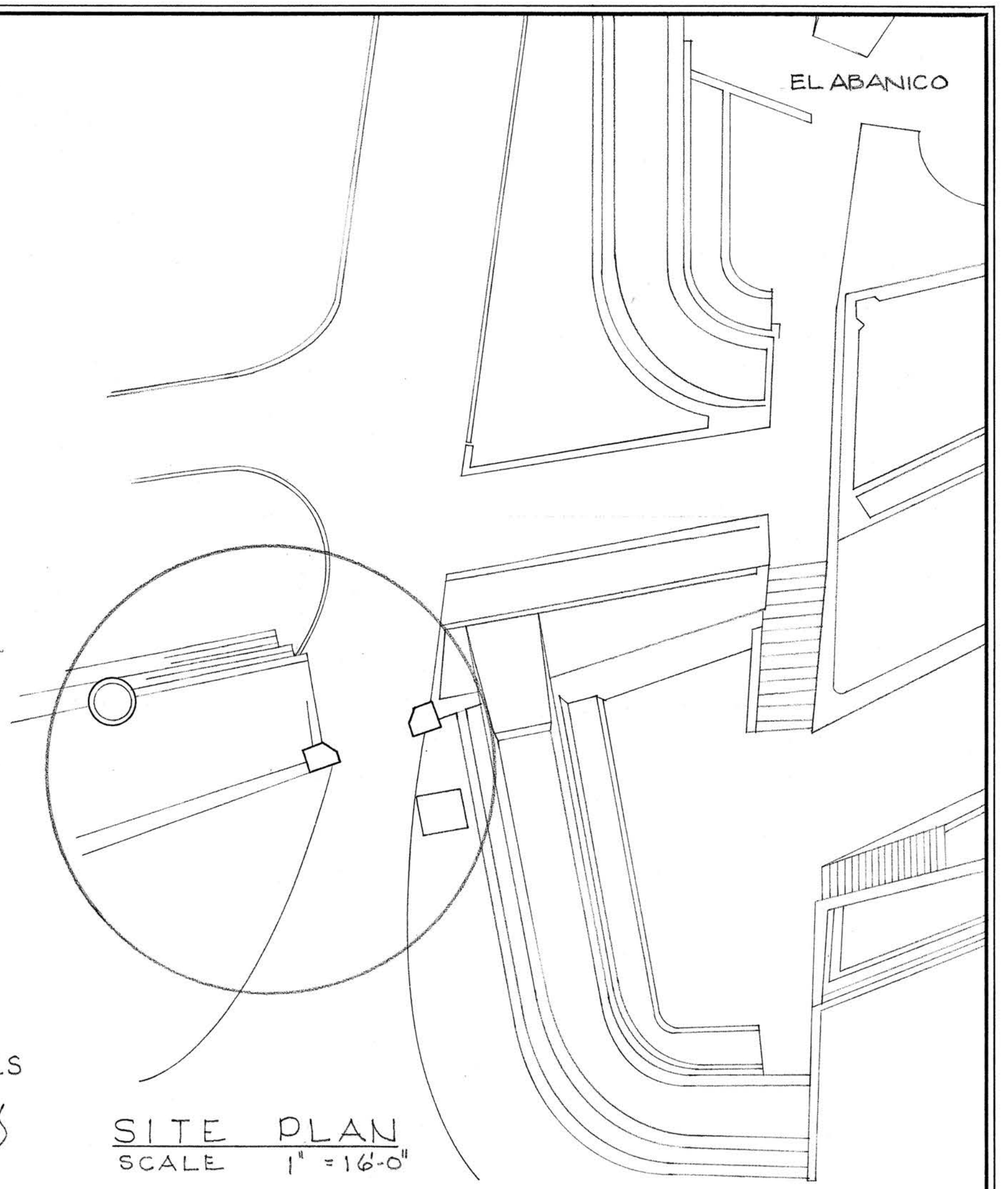
Sheet 2 Plan of South Gate and Sentry Box and Section A-A

Sheet 3 South Elevation and One Eight Size Section of Gate Post Caps

TRIM LINE



LOCATION PLAN
SCALE-NONE
MAP REFERENCE: MAP PREPARED FOR CAPT. H.F. HODGES U.S. CORPS OF ENGINEERS, MARCH 1899 (NHS SJ 9494) (DRAWING NOT COMPLETE)



SITE PLAN
SCALE 1" = 16'-0"

SOUTH GATE FUERTE EL ABANICO CASTILLO DE SAN CRISTOBAL

THIS STRUCTURE, SET INTO THE PARAPET WALL BETWEEN FUERTE EL ABANICO AND SAN CARLOS BASTION OF THE CASTILLO DE SAN CRISTOBAL, PROVIDES ACCESS TO EL ABANICO, LA PRINCESA, AND U.S. ARMY HOUSING. IT WAS BUILT BEFORE THE SPANISH-AMERICAN WAR AND IS TYPICAL 19th CENTURY MILITARY ARCHITECTURE.

THIS PROJECT WAS FINANCED FROM FUNDS OF "MISSION 66" PROGRAM OF THE NATIONAL PARK SERVICE; MEASURED AND DRAWN DURING THE SUMMER OF 1963 UNDER THE DIRECTION OF HENRY JUDD, SUPERVISING ARCHITECT, HISTORIC STRUCTURES; FREDERIK C. GJESSING, ARCHITECT; F. BLAIR REEVES, ARCHITECT; AND STUDENT ASSISTANT ARCHITECTS: N. PAUL ANTHONY, UNIV. OF FLORIDA; FERNANDO BATLLÉ, UNIV. OF MICHIGAN; E. BLAINE CLIVER, CARNEGIE INSTITUTE OF TECHNOLOGY.

DRAWN BY: N.P. ANTHONY
REDRAWN BY D.L. JAHNCKE JR.

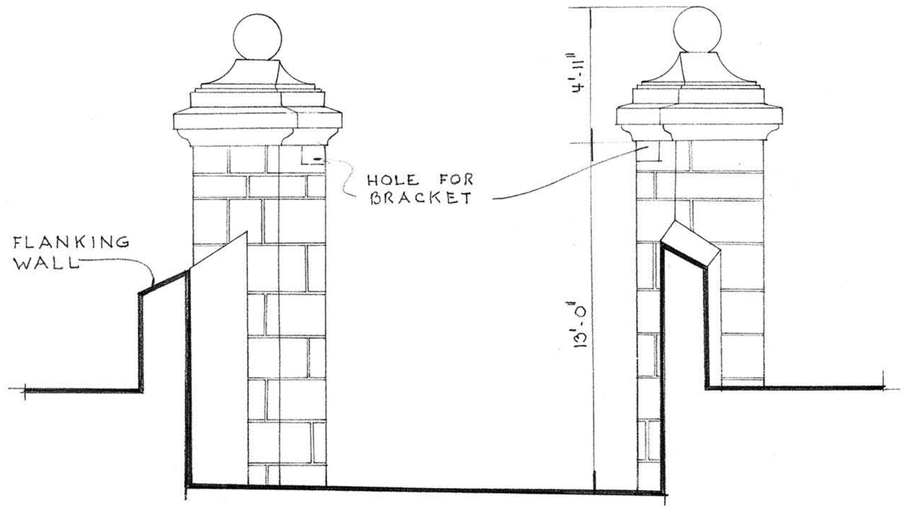
SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF THE NATIONAL PARK SERVICE, UNITED STATES DEPARTMENT OF THE INTERIOR	NAME AND LOCATION OF STRUCTURE SOUTH GATE, FUERTE EL ABANICO, CASTILLO DE SAN CRISTOBAL SAN JUAN, PUERTO RICO	SURVEY NO. PR-94-B	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 1 OF 3 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT

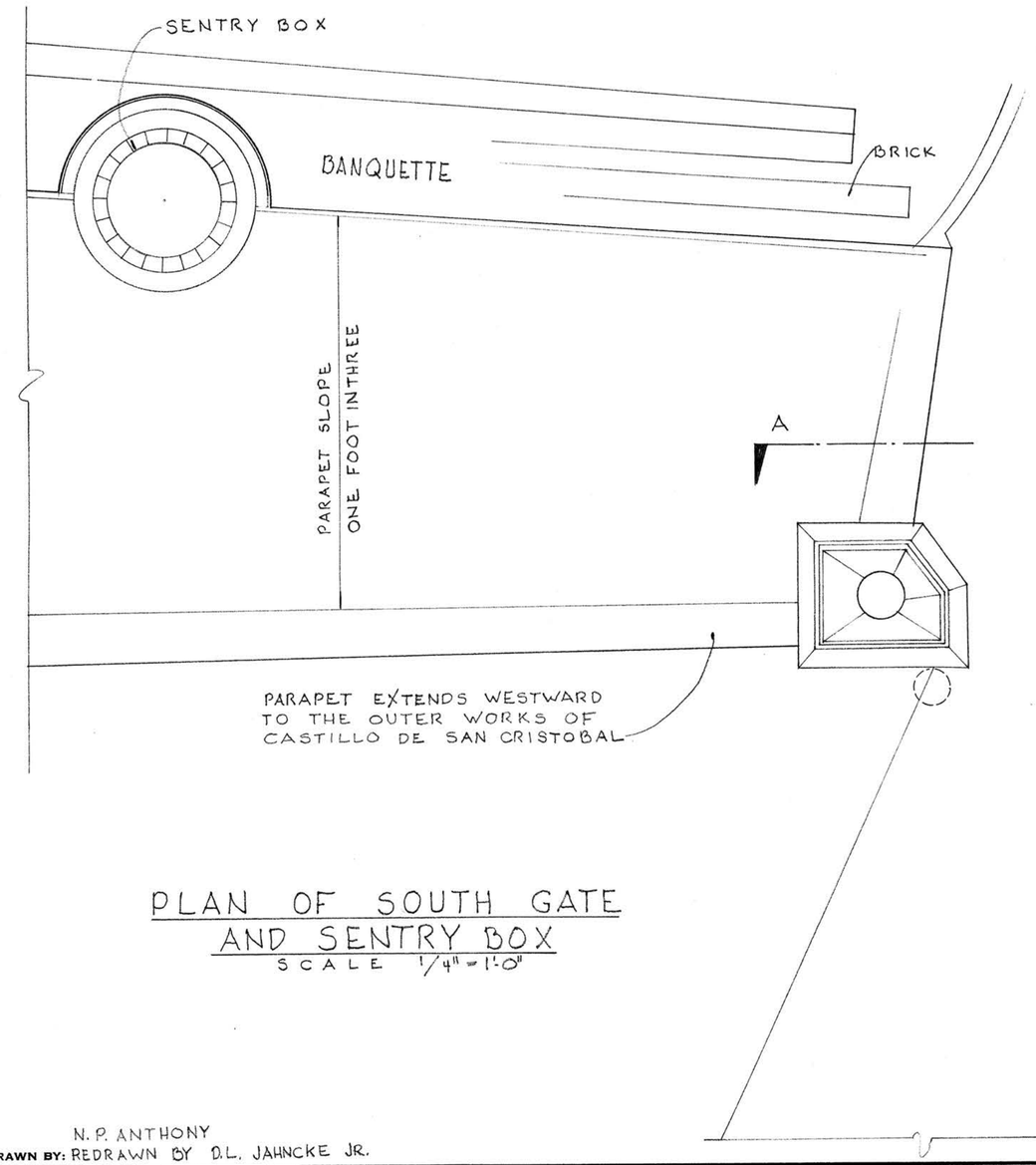
P. B. P. CO. 16-5559

TRIM LINE

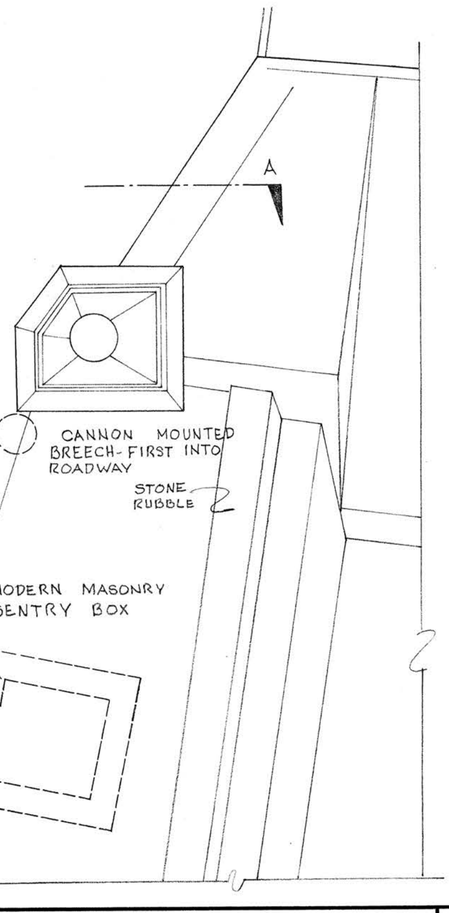
TRIM LINE



SECTION A-A'
SCALE 1/4" = 1'-0"



PLAN OF SOUTH GATE AND SENTRY BOX
SCALE 1/4" = 1'-0"



N. P. ANTHONY
DRAWN BY: REDRAWN BY D.L. JAHNCKE JR.

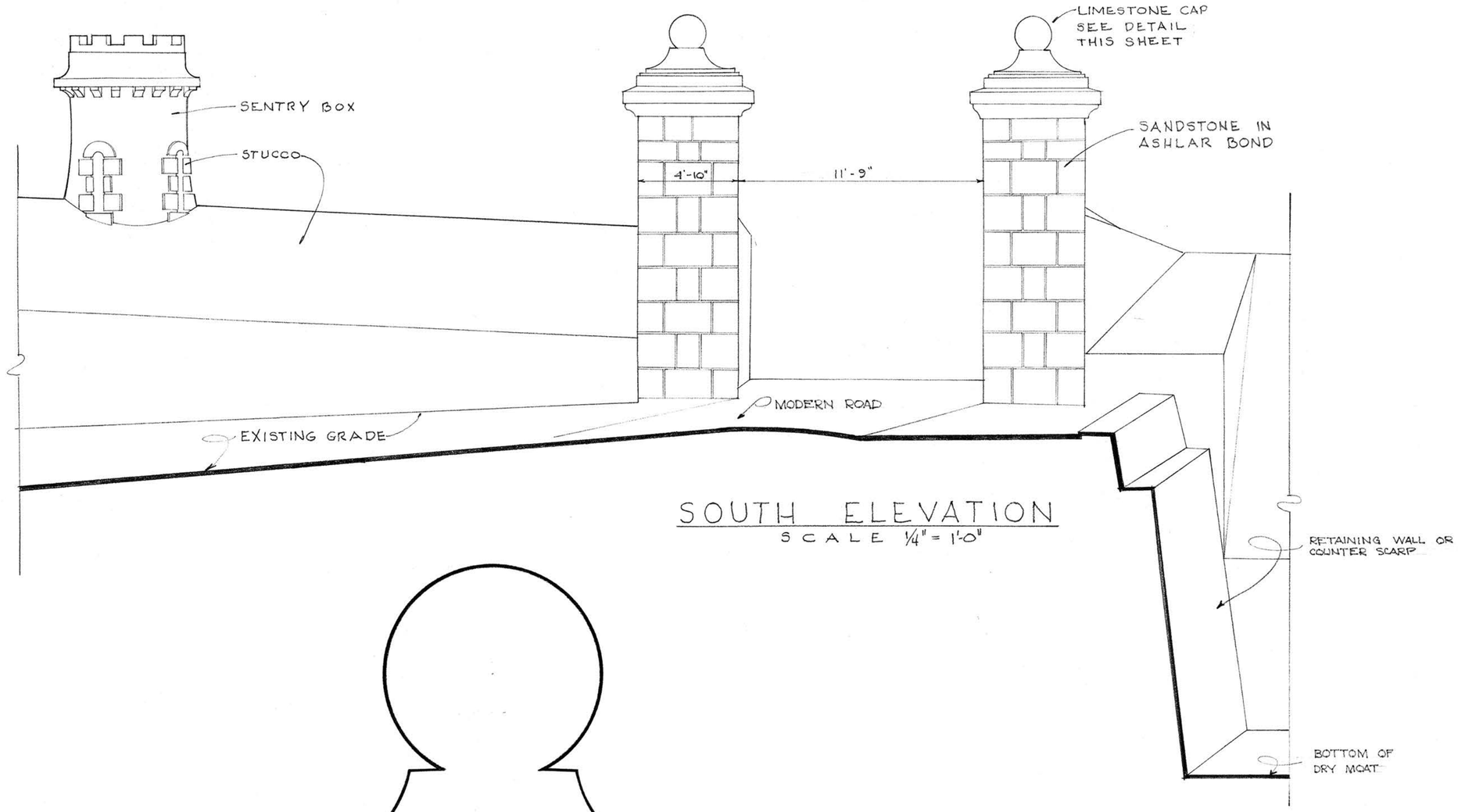
SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF THE NATIONAL PARK SERVICE, UNITED STATES DEPARTMENT OF THE INTERIOR	NAME AND LOCATION OF STRUCTURE SOUTH GATE, FUERTE EL ABANICO, CASTILLO DE SAN CRISTOBAL SAN JUAN, PUERTO RICO	SURVEY NO. PR-94-B	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 2 OF 3 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.

TRIM LINE

P. B. P. CO. 16-5559

TRIM LINE



SOUTH ELEVATION
SCALE 1/4" = 1'-0"

ONE EIGHTH SIZE
SECTION OF GATE
POST CAPS

N. P. ANTHONY 1963
DRAWN BY: REDRAWN BY D.L. JAHNCKE JR. 1965

SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF THE NATIONAL PARK SERVICE, UNITED STATES DEPARTMENT OF THE INTERIOR	NAME AND LOCATION OF STRUCTURE SOUTH GATE, FUERTE EL ABANICO, CASTILLO DE SAN CRISTOBAL SAN JUAN, PUERTO RICO	SURVEY NO. PR-94-B	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 3 OF 3 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

TRIM LINE

P. B. P. CO. 16-5559

DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.

Fuerte La Princesa, Castillo San Cristóbal, San Juan, PR. 1963. Historic American Buildings Survey, HABS PR-95.

Sheet Index

Sheet 1 Location Plan

Sheet 2 Plan

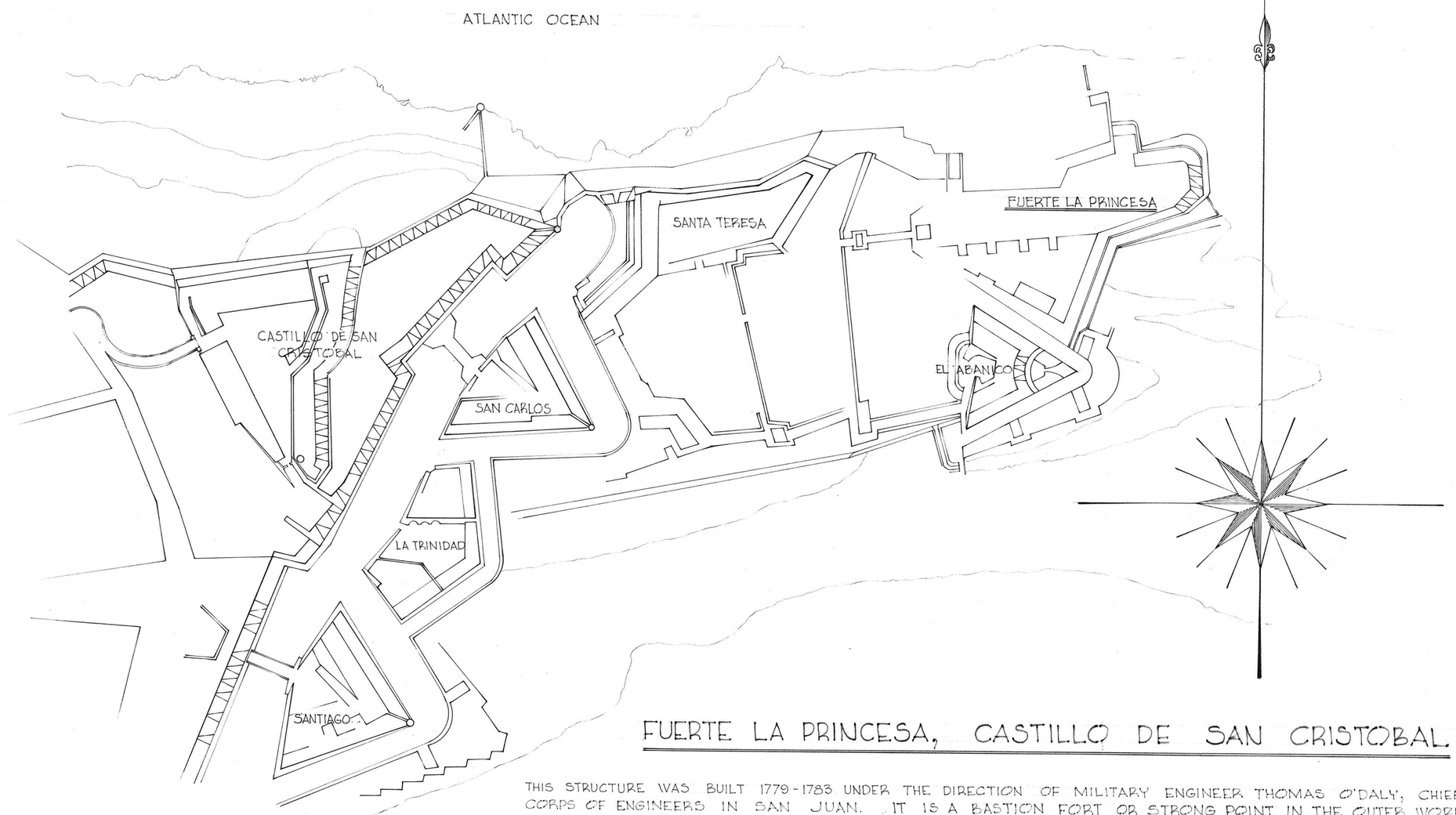
Sheet 3 Detail Plan of North Parapets

Sheet 4 Detail Plan: South & East Parapets

Sheet 5 North Elevation and Section B-B

Sheet 6 East Elevation and Section A-A

Sheet 7 Plan: Troop & Powder Rooms, Profile 1: North Covered Way, Profile 2: North Covered Way, Profile 3: Moat Banquette & Traverse, Profile 4: 19th Century Bomb-Proof



LOCATION PLAN
SCALE NONE

MAP REFERENCE: MAP PREPARED FOR CAPT. H.F HODGES, U.S. CORPS. OF ENGINEERS. MARCH 1899 (NHS SJ 9794)(DRAWING INCOMPLETE)

FUERTE LA PRINCESA, CASTILLO DE SAN CRISTOBAL.

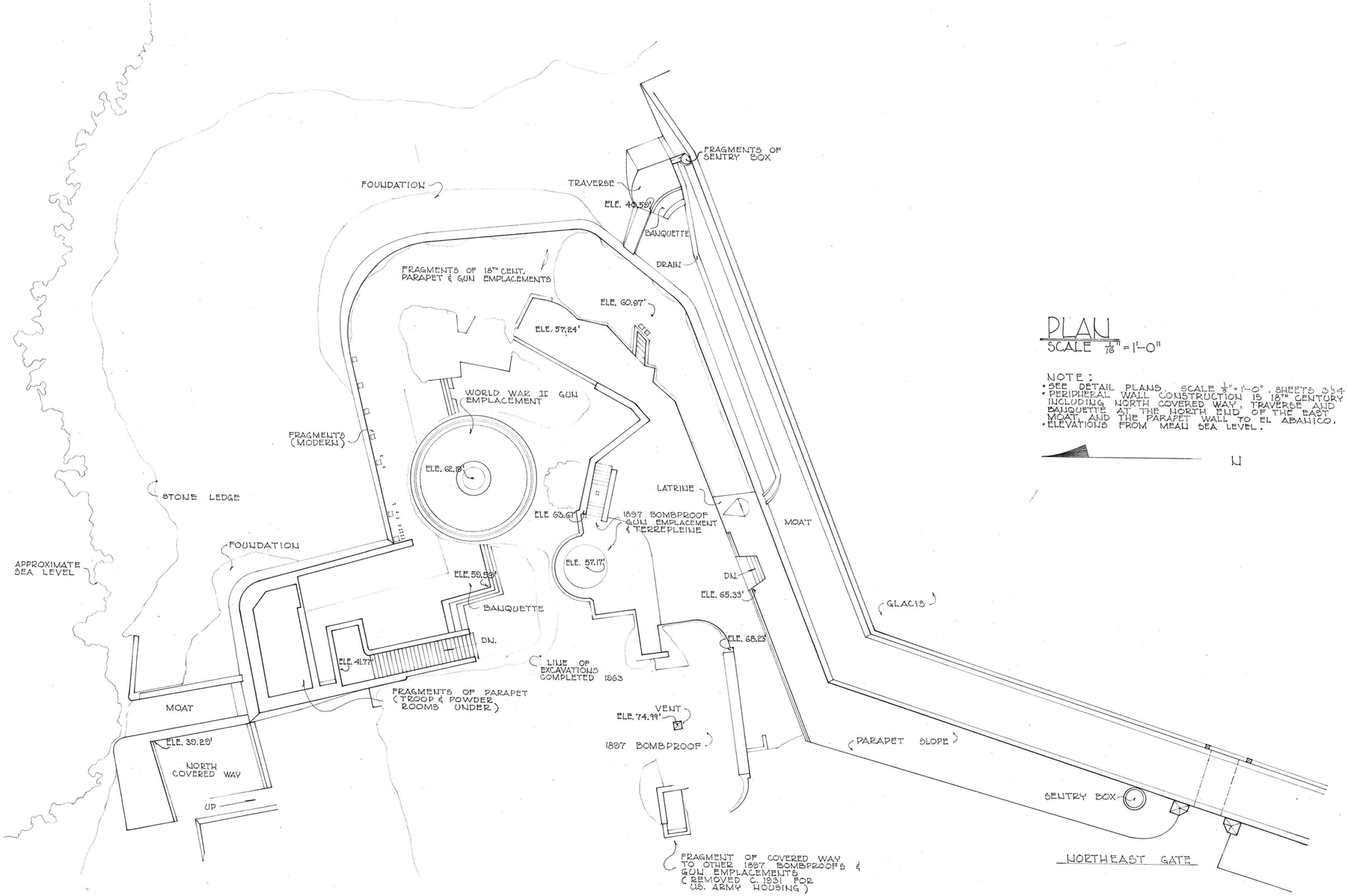
THIS STRUCTURE WAS BUILT 1779-1783 UNDER THE DIRECTION OF MILITARY ENGINEER THOMAS O'DALY, CHIEF OF THE SPANISH CORPS OF ENGINEERS IN SAN JUAN. IT IS A BASTION FORT OR STRONG POINT IN THE OUTER WORKS OF SAN CRISTOBAL AND A COASTAL ARTILLERY DEFENSE. IT WAS MODIFIED IN 1897 BY THE SPANISH AND IN THE 20th CENTURY BY UNITED STATES ARMY TO PROVIDE SPACE FOR HOUSING AND WORLD WAR II DEFENSES.

THIS PROJECT WAS FINANCED FROM FUNDS OF THE "MISSION 66" PROGRAM OF THE NATIONAL PARK SERVICE, MEASURED AND DRAWN DURING THE SUMMER OF 1963 UNDER THE DIRECTION OF HENRY JUDD, HISTORIC STRUCTURE, SUPERVISING ARCHITECT; FREDERIK C. GJESSING, ARCHITECT; F. BLAIR REEVES, ARCHITECT; AND STUDENT ASSISTANT ARCHITECTS: N. PAUL ANTHONY, UNIV. OF FLORIDA; FERNANDO A. BATLLE, UNIV. OF MICHIGAN; E. BLAIN CLIVER, CARNEGIE INSTITUTE OF TECHNOLOGY.

N. PAUL ANTHONY: DEL.

SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR NATIONAL PARK SERVICE : S.O.D.C.	FUERTE LA PRINCESA	NAME OF STRUCTURE CASTILLO DE SAN CRISTOBAL SAN JUAN, PUERTO RICO	SURVEY NO. PR-95	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 1 OF 7 SHEETS

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DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.



PLAN

SCALE 1/16" = 1'-0"

NOTE:
- SEE DETAIL PLANS, SCALE 1/4" = 1'-0", SHEETS 3 & 4
- PERIPHERAL WALL CONSTRUCTION IS 18TH CENTURY INCLUDING NORTH COVERED WAY, TRAVERSE AND BANQUETTE AT THE NORTH END OF THE EAST MOAT, AND THE PARAPET WALL TO EL ABANICO.
- ELEVATIONS FROM MEAN SEA LEVEL.

N

N. P. ANTHONY DEL., E. B. CLIVER DEL.

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR NATIONAL PARK SERVICE : E. O. D. C.

FUERTE LA PRINCESA

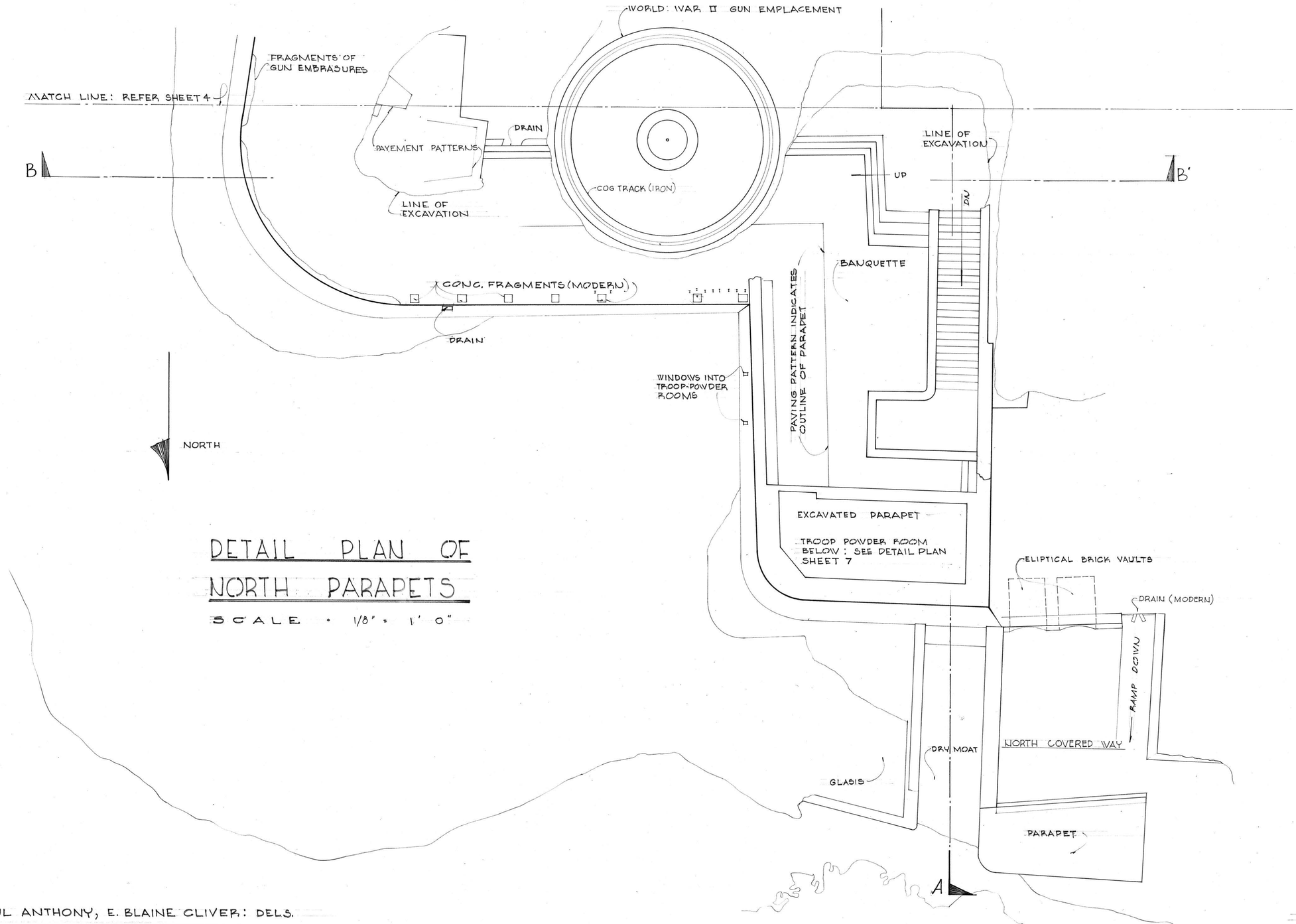
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO. PR-95

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 2 OF 7 SHEETS

LIBRARY OF CONGRESS PRINTS AND PHOTOGRAPHS

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DETAIL PLAN OF NORTH PARAPETS

SCALE · 1/8" = 1' 0"

SCALE · 1/8" · 1' 0"
0 5 10 20 50 FT.

N. PAUL ANTHONY, E. BLAINE CLIVER: DELS.

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE: E. D. D. C.

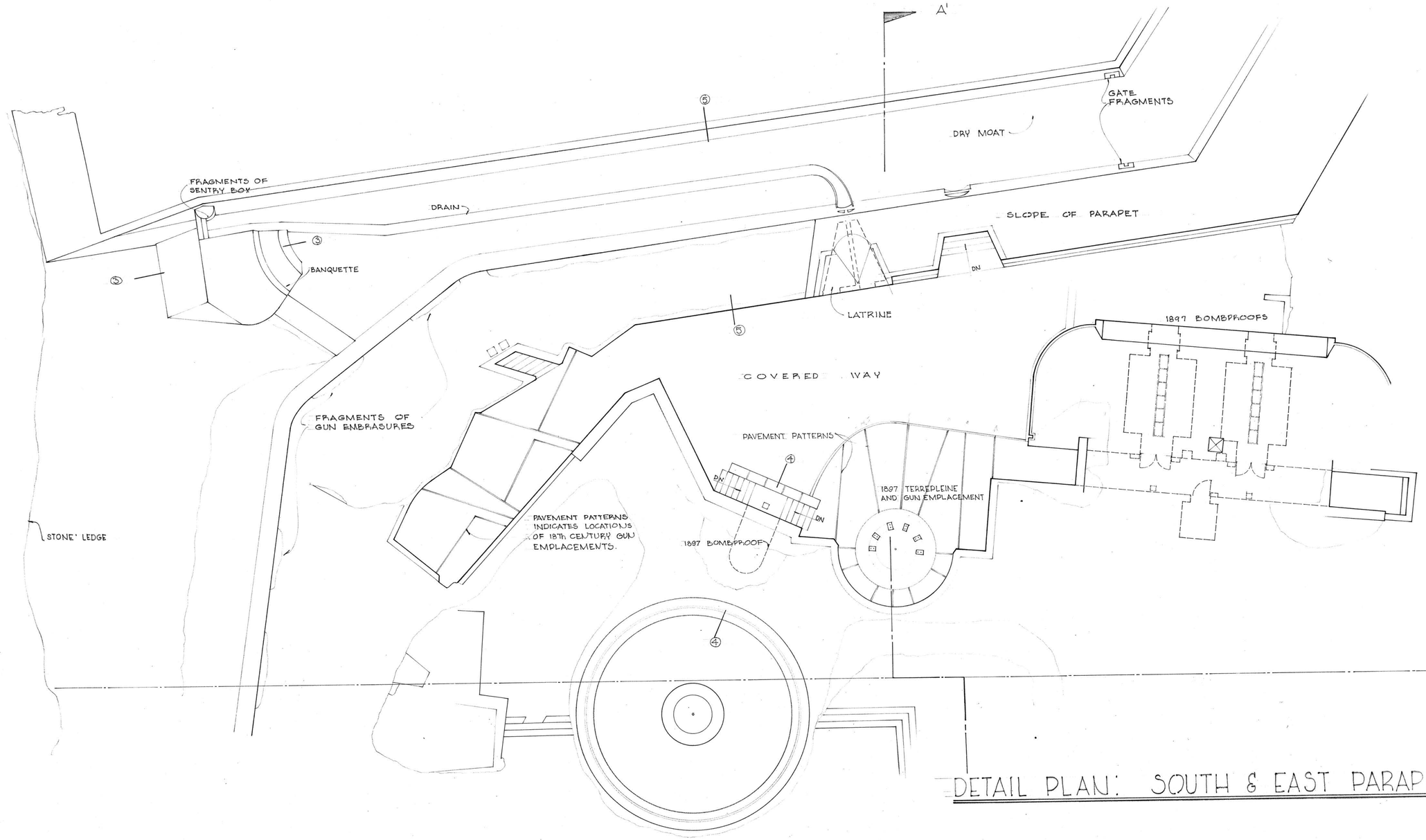
NAME OF STRUCTURE
FUERTE LA PRINCESA
CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO
PR-95

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 3 OF 7 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

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DETAIL PLAN: SOUTH & EAST PARAPETS

SCALE - 1" = 8' 0"
0 5 10 20 30 FT

E. BLAINE CLIVER, N. PAUL ANTHONY : DELS.

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE : E.O.D.C.

FUERTE LA PRINCESA

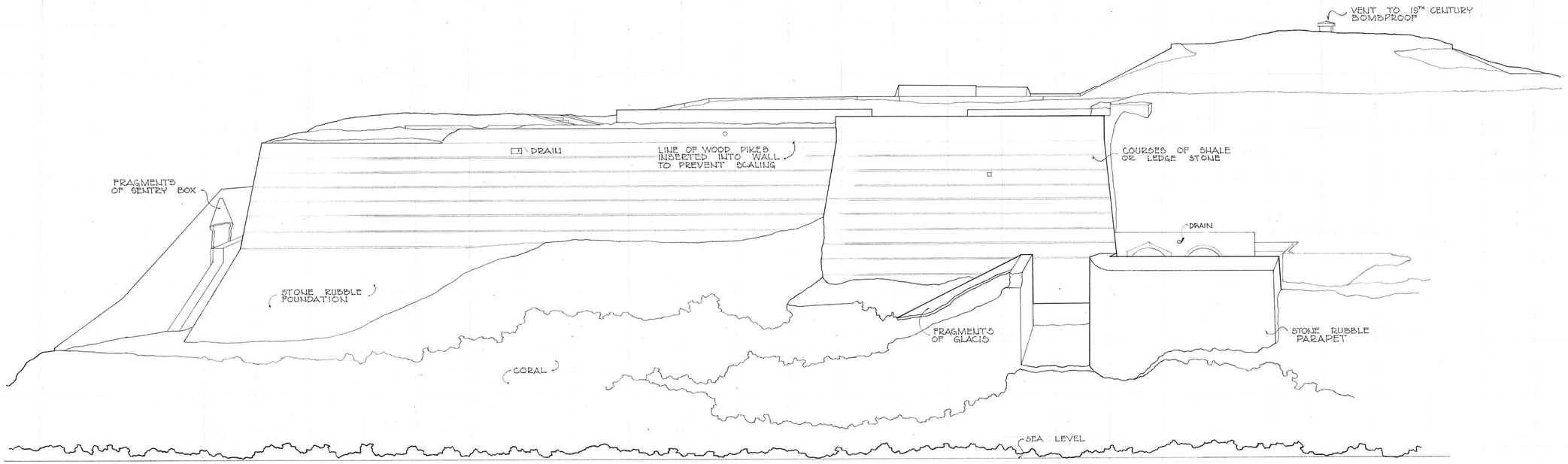
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO. PR-95

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 4 OF 7 SHEETS

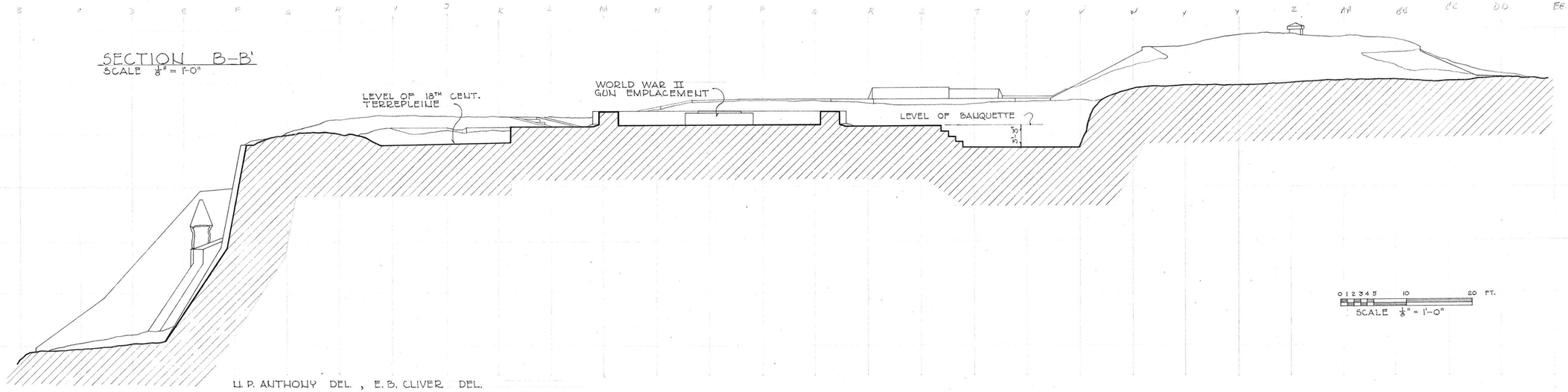
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NORTH ELEVATION
SCALE 1/8" = 1'-0"

SECTION B-B'
SCALE 1/8" = 1'-0"

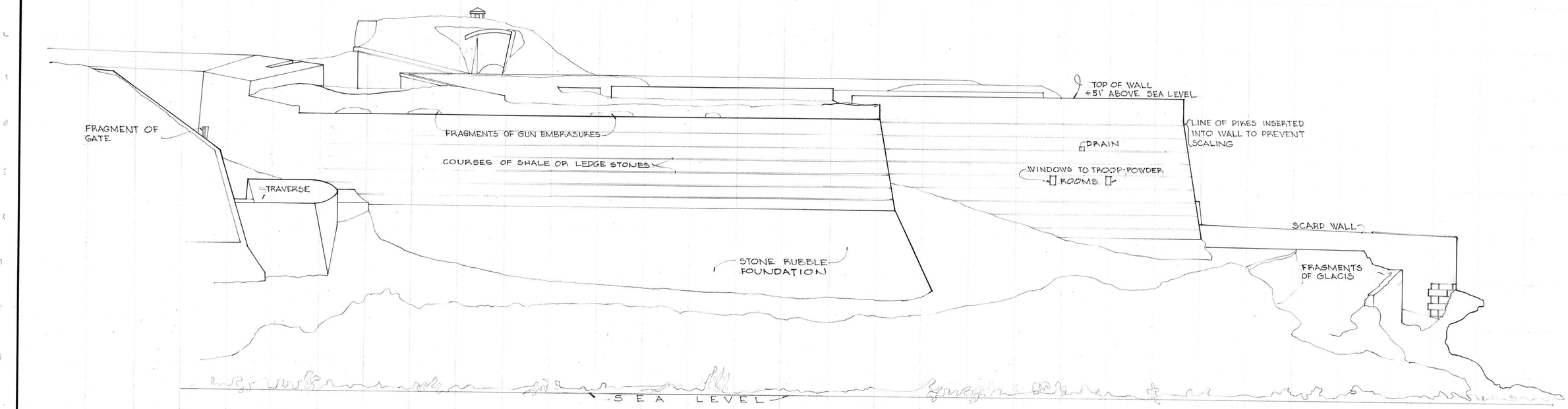


H. P. ANTHONY DEL., E. B. CLIVER DEL.

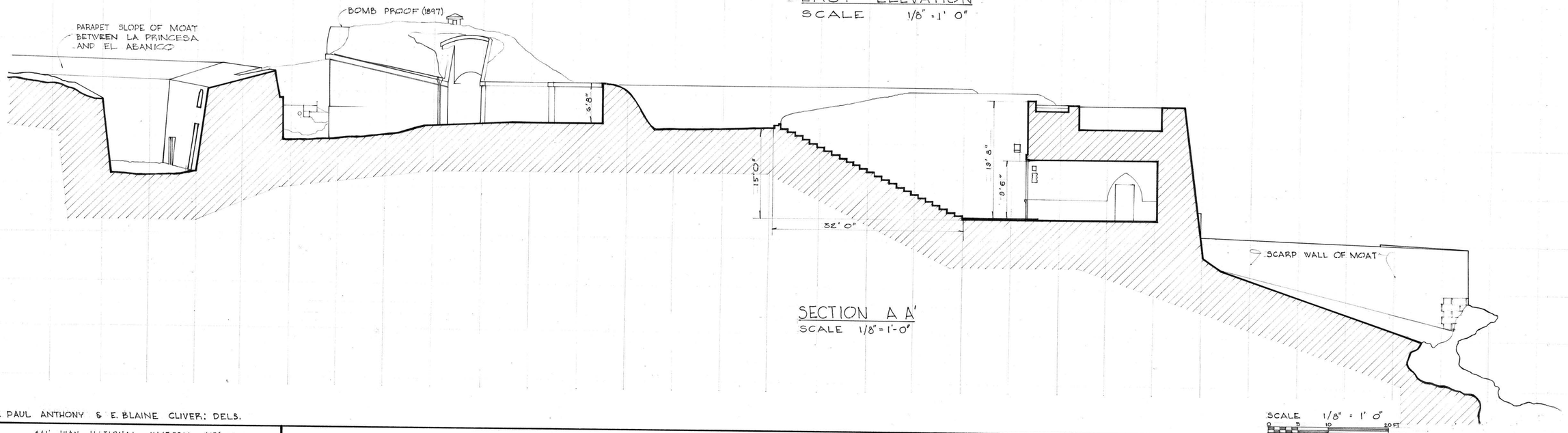
SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR NATIONAL PARK SERVICE : E. B. D. C.	NAME OF STRUCTURE FUERTE LA PRINCESA — CASTILLO DE SAN CRISTOBAL SAN JUAN, PUERTO RICO	SURVEY NO. PR-95	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 5 OF 7 SHEETS

LIBRARY OF CONGRESS INDEX SYMBOL

DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.



EAST ELEVATION
SCALE 1/8" = 1' 0"



SECTION A A'
SCALE 1/8" = 1'-0"

SCALE 1/8" = 1' 0"
0 5 10 20 FT

N. PAUL ANTHONY & E. BLAINE CLIVER; DELS.

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE : E. D. D. W.

FUERTE LA PRINCESA

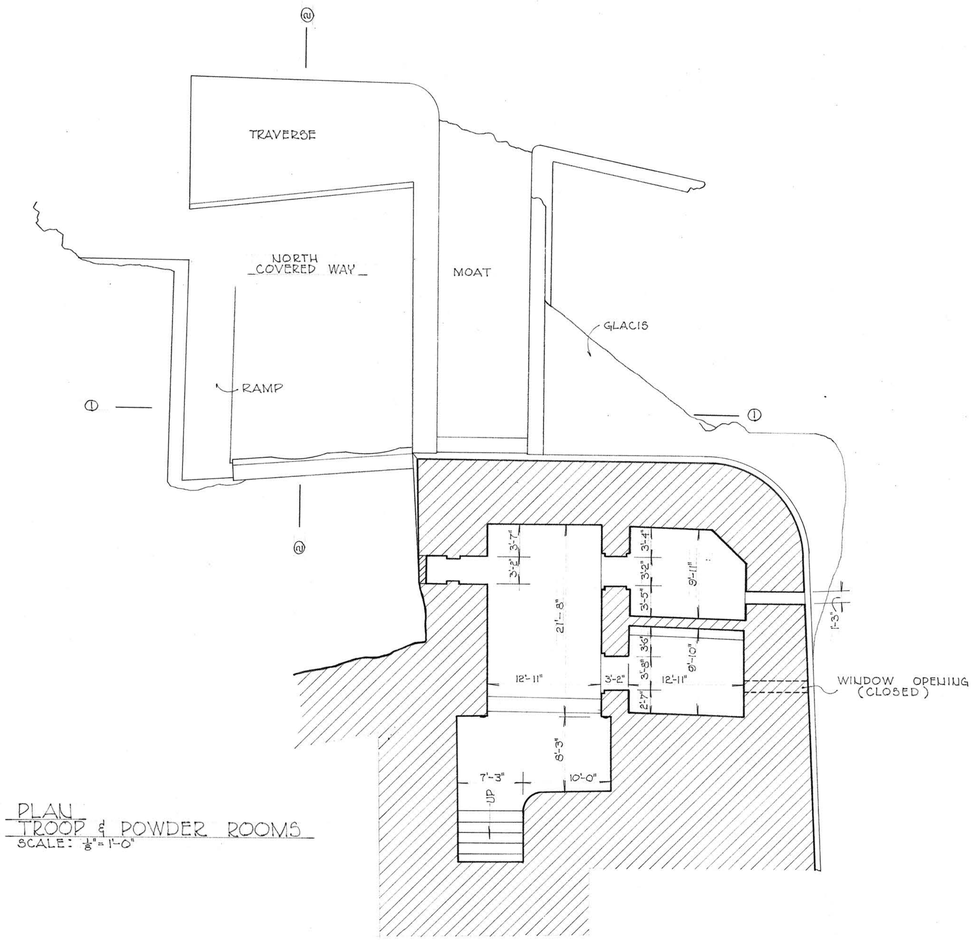
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO. PR-95

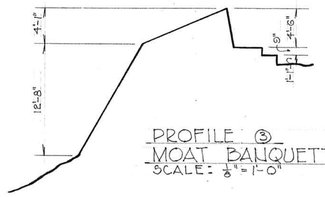
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 6 OF 7 SHEETS

MEMBER OF CONGRESS HOUSE WINGS

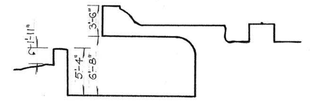
USE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING. THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.



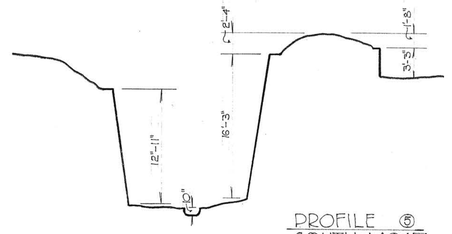
PLAN
TROOP & POWDER ROOMS
SCALE: 1/8" = 1'-0"



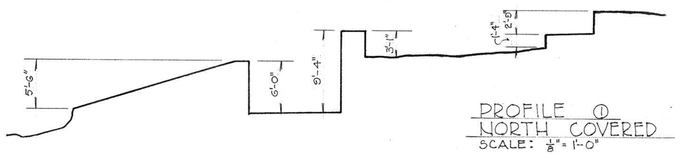
PROFILE ③
MOAT BANQUETTE & TRAVERSE
SCALE: 1/8" = 1'-0"



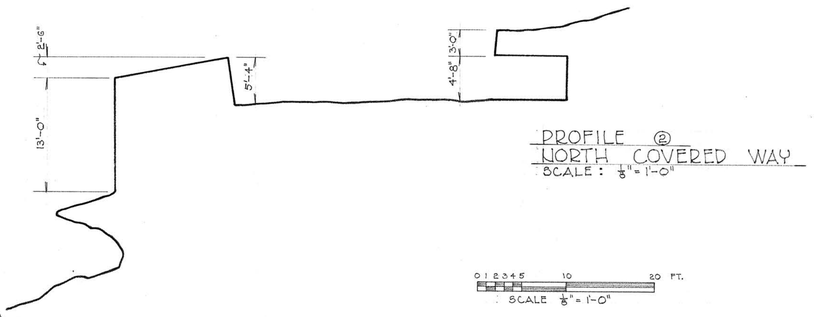
PROFILE ④
19TH CENT. BOMB-PROOF
SCALE: 1/8" = 1'-0"



PROFILE ⑤
SOUTH MOAT
SCALE 1/8" = 1'-0"



PROFILE ①
NORTH COVERED WAY
SCALE: 1/8" = 1'-0"



PROFILE ②
NORTH COVERED WAY
SCALE: 1/8" = 1'-0"

0 1 2 3 4 5 10 20 FT.
SCALE 1/8" = 1'-0"

F. BATLLE DEL. & E.B. CLIVER DEL.

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE : E.O.D.C.

FUERTE LA PRINCESA

NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL
SAN JUAN, PUERTO RICO

SURVEY NO. PR-95

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 7 OF 7 SHEETS

LIBRARY OF CONGRESS PHOTOGRAPHS

DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.

Castillo San Cristóbal – Officer's Quarters, San Juan, PR. 1961. Historic American Buildings Survey, HABS PR-98.

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Sheet 1 Map of Puerto Rico, Map of Old San Juan, and Site Plan – San Cristobal

Sheet 2 Floor Plan & Cistern Plan – Existing Conditions

Sheet 3 East Elevation and West Elevation

Sheet 4 North Elevation, Section C-C, F.S. Detail – Head & Jamb, F.S. Detail – Sill, F.S. Detail – Arcade Pilaster

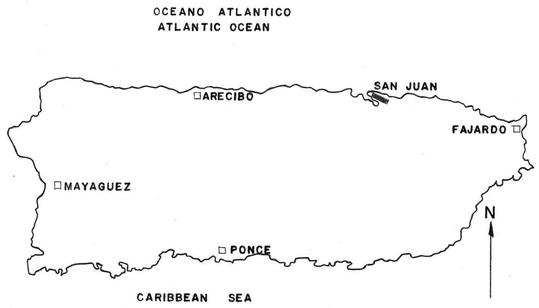
Sheet 5 Section A-A and Section B-B

Sheet 6 Gallery Elevation and Section, Plan Typical Door from Casemate No. 4 – Existing Conditions, F.S. Detail – Cornice Corbel Block, Officer's Bath, Typical Window from Casemate No. 3 Plan, Interior Elevation, and Section

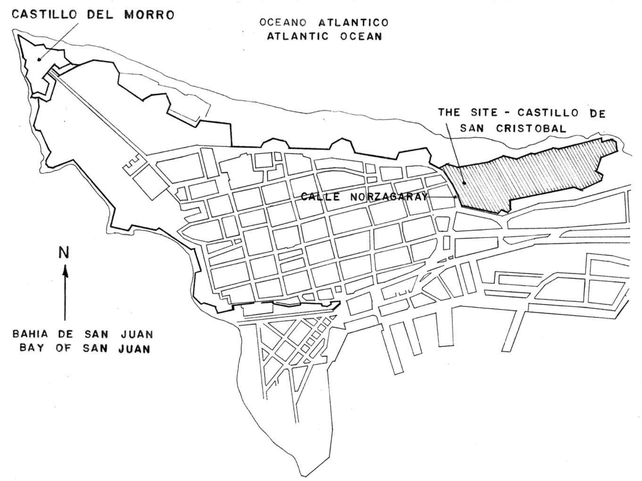
Sheet 7 F.S. Detail – Architrave, W. Facade, F.S. Detail – Cornice, E. Facade, F.S. Detail – Cornice, W. Facade, F.S. Detail – Cornice 1861, F.S. Detail – Plinth, W. Facade

CASTILLO DE SAN CRISTOBAL

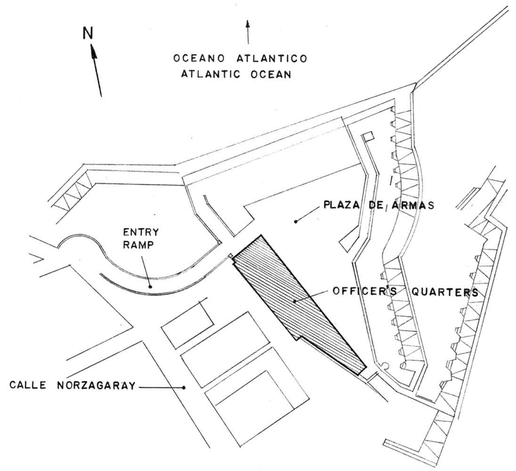
OFFICER'S QUARTERS



MAP OF PUERTO RICO



MAP OF OLD SAN JUAN



SITE PLAN — SAN CRISTOBAL

SAN JUAN PUERTO RICO

THE MASSIVE FORT OF SAN CRISTOBAL, LOCATED ON THE NORTHEAST CORNER OF THE OLD WALLED CITY OF SAN JUAN, WAS BEGUN AROUND 1631. AN IMPORTANT LINK IN THE CHAIN OF DEFENSIVE WORKS OF THE CITY, IT WAS PLANNED FOR DEFENSE IN DEPTH. THE OFFICERS QUARTERS, ONE OF THE LAST MAJOR STRUCTURES TO BE BUILT IN THE COMPLEX, WAS DESIGNED BY TOMAS O DALY, CHIEF OF THE MILITARY ENGINEERS FOR THE SPANISH CROWN, AND READY FOR OCCUPANCY IN MARCH, 1775. MAJOR ALTERATIONS WHICH OCCURRED UNDER THE DIRECTION OF MANUEL F. CASTRO IN 1861 DETERMINE TO A LARGE THE EXISTING CHARACTER. OCCUPIED BY THE U.S. ARMY AFTER THE SPANISH-AMERICAN WAR IN 1898, IT SERVED FOR VARIOUS MILITARY USES UNTIL 1960 WHEN IT BECAME UNOCCUPIED. THE FORT WAS TRANSFERRED TO THE SAN JUAN NATIONAL HISTORIC SITE ON SEPT. 13, 1961.

THIS PROJECT WAS FINANCED BY THE *"MISSION 66"* PROGRAM OF THE NATIONAL PARK SERVICE

DEL.: LADD EHLINGER 8/4/61

NHS - SJ 3015.

SUPERVISING ARCHITECT — CHARLES E. PETERSON, HISTORIC STRUCTURES
PROJECT SUPERVISOR — F. C. GJESSING, ARCHITECT
ASSISTANT PROJECT SUPERVISOR — W. W. WILKINS, ARCHITECT
DELINEATOR — L. EHLINGER, STU. ASS'T. ARCH.

SAN JUAN NATIONAL HISTORIC SITE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN

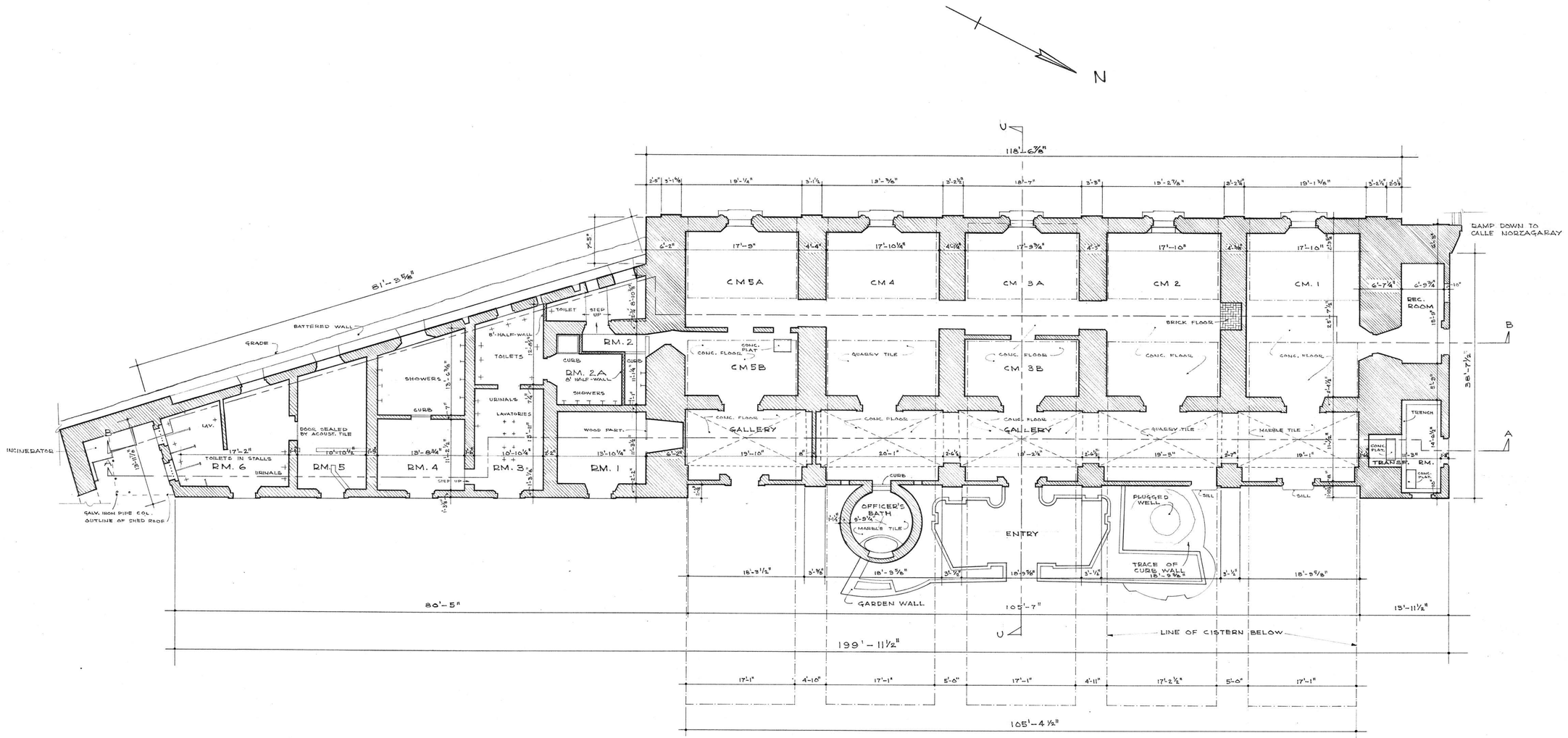
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL — OFFICER'S QUARTERS
ERECTED CIRCA 1775 — MODIFIED CIRCA 1861
SAN JUAN, PUERTO RICO

SURVEY NO. PR-98

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 1 OF 7 SHEETS

LIBRARY OF CONGRESS INDEX NUMBERS

DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.



FLOOR PLAN & CISTERN PLAN

SCALE : 1/8" = 1'-0"

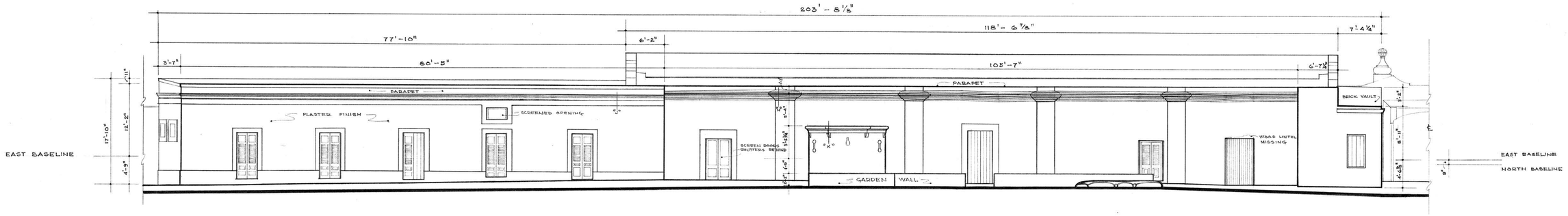
EXISTING CONDITIONS

GRAPHIC SCALE - FEET

NHS - SJ
3015

SAN JUAN NATIONAL HISTORIC SITE UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR NATIONAL PARK SERVICE BRANCH OF PLANS AND DESIGN	NAME OF STRUCTURE CASTILLO DE SAN CRISTOBAL — OFFICER'S QUARTERS ERECTED CIRCA 1775 — SAN JUAN, PUERTO RICO — MODIFIED CIRCA 1861	SURVEY NO. PR-98	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 2 OF 7 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.



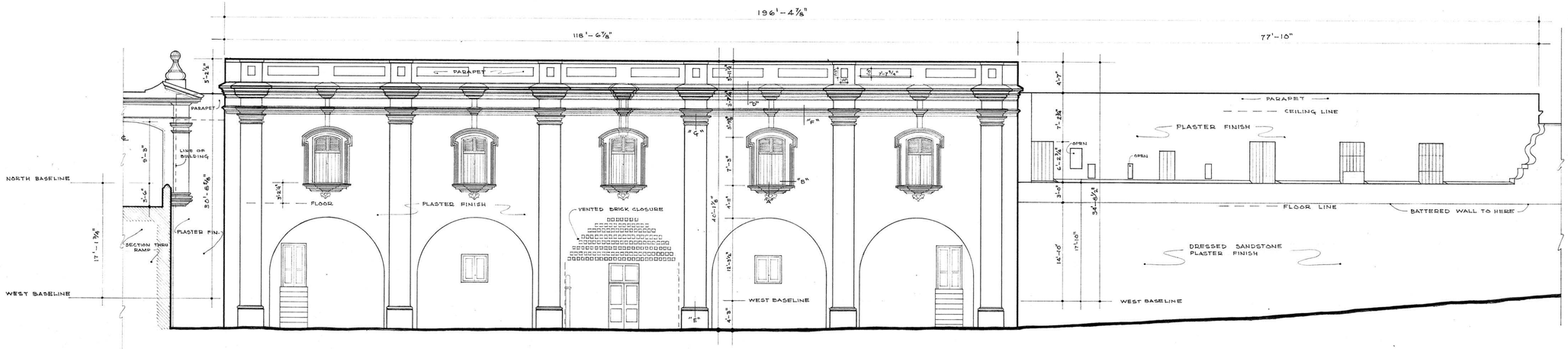
EAST ELEVATION

SCALE : 1/8" = 1'-0"

EXISTING CONDITIONS

0 5 10 15 20 25

GRAPHIC SCALE



WEST ELEVATION

SCALE : 1/8" = 1'-0"

EXISTING CONDITIONS

DEL. : LADD EHLINGER 6/2/61

NHS - SJ
3015

SAN JUAN NATIONAL HISTORIC SITE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN

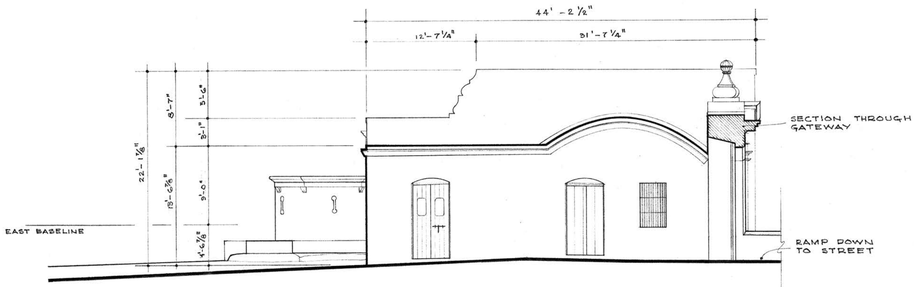
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL — OFFICER'S QUARTERS
ERECTED CIRCA 1775
SAN JUAN, PUERTO RICO
MODIFIED CIRCA 1861

SURVEY NO. PR-98

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 3 OF 7 SHEETS

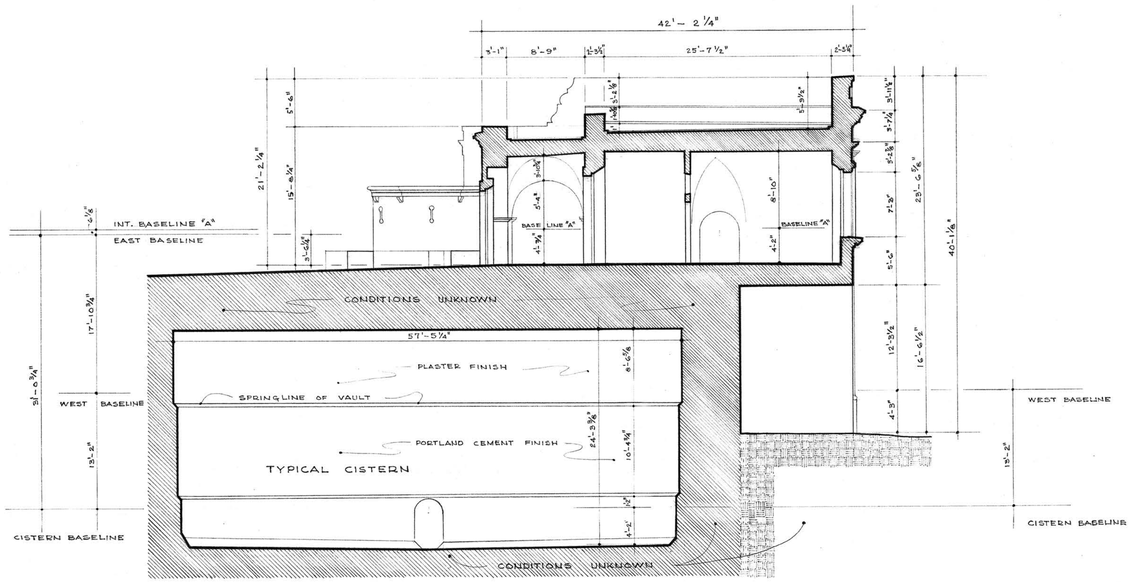
LIBRARY OF CONGRESS INDEX NUMBER

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NORTH ELEVATION

SCALE: 1/8"=1'-0"

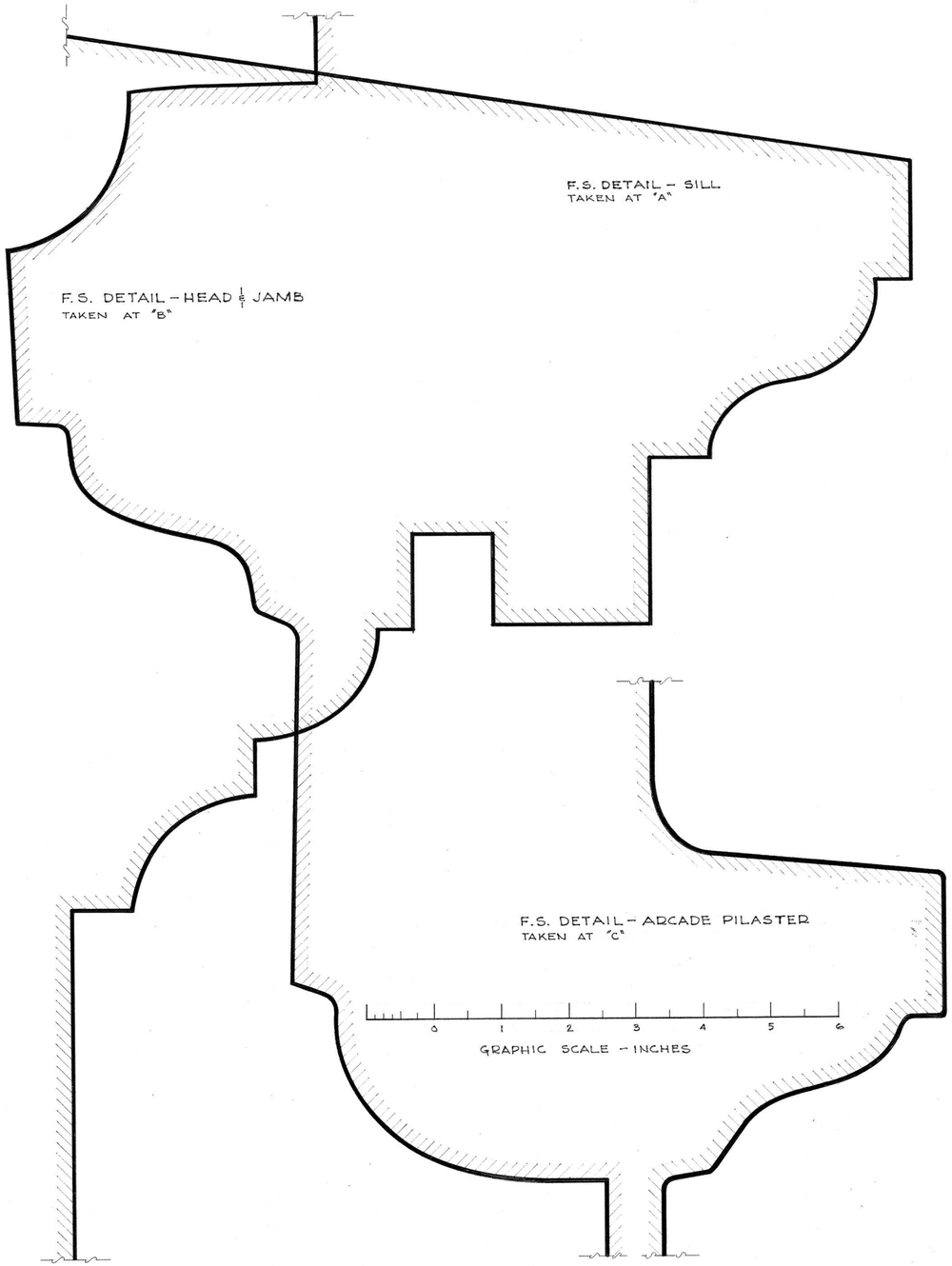


SECTION C-C

SCALE: 1/8"=1'-0"

0 5 10 15 20 25

GRAPHIC SCALE - FEET



NHS - SJ
3015

SAN JUAN NATIONAL HISTORIC SITE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN

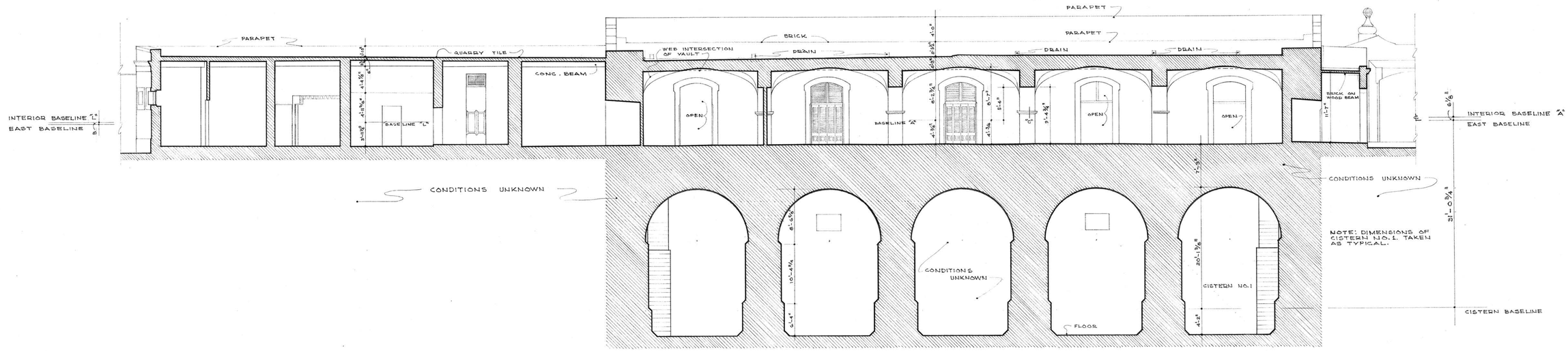
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL — OFFICER'S QUARTERS
ERECTED CIRCA 1775 — SAN JUAN, PUERTO RICO — MODIFIED CIRCA 1861

SURVEY NO. PR-98

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 4 OF 7 SHEETS

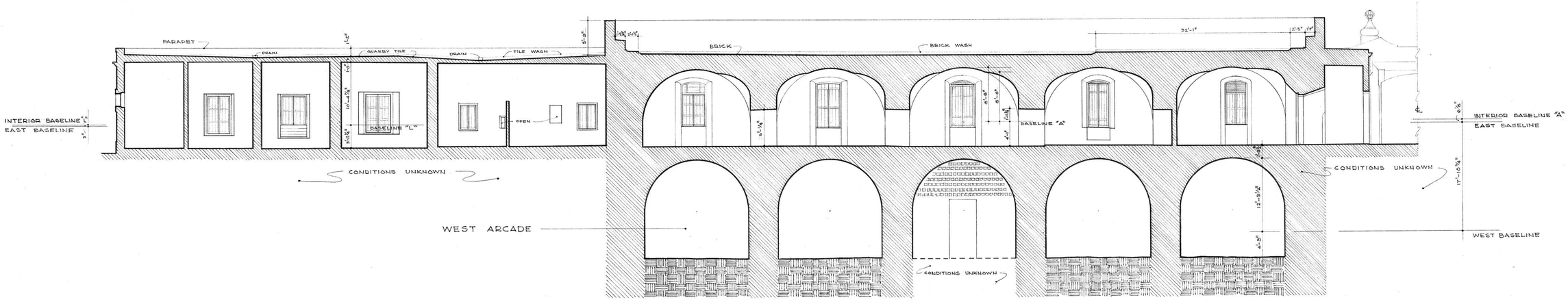
LIBRARY OF CONGRESS INDEX NUMBER

DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.



SECTION A–A

SCALE : 1/8" = 1'–0"



SECTION B–B

SCALE : 1/8" = 1'–0"

0 5 10 15 20 25

GRAPHIC SCALE

DEL. : LADD EHLINGER 8/4/61

NHS - SJ
3015

SAN JUAN NATIONAL HISTORIC SITE

UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE . BRANCH OF PLANS AND DESIGN

NAME OF STRUCTURE

CASTILLO DE SAN CRISTOBAL — OFFICER'S QUARTERS

ERECTED CIRCA 1775

SAN JUAN , PUERTO RICO

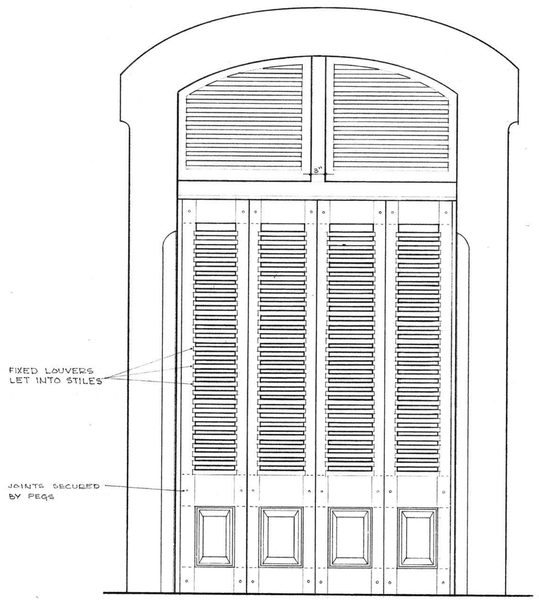
MODIFIED CIRCA 1861

SURVEY NO. PR-98

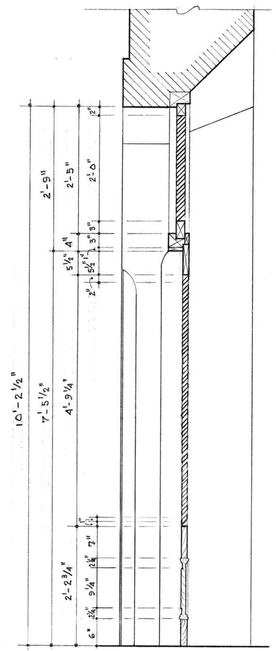
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 5 OF 7 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

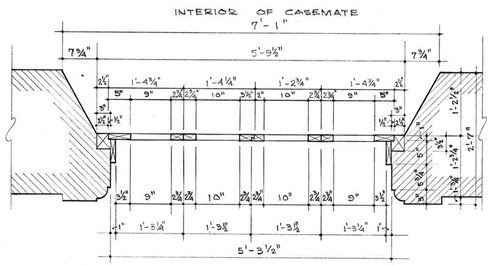
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GALLERY ELEVATION



SECTION



PLAN

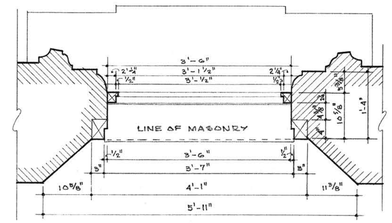
TYPICAL DOOR FROM CASEMATE NO. 4
EXISTING CONDITIONS
SCALE: 3/4" = 1'-0"

F.S. DETAIL - CORNICE
OFFICER'S BATH
TAKEN AT "K"

F.S. DETAIL - CORNICE CORBEL BLOCK
OFFICER'S BATH. TAKEN AT "K"

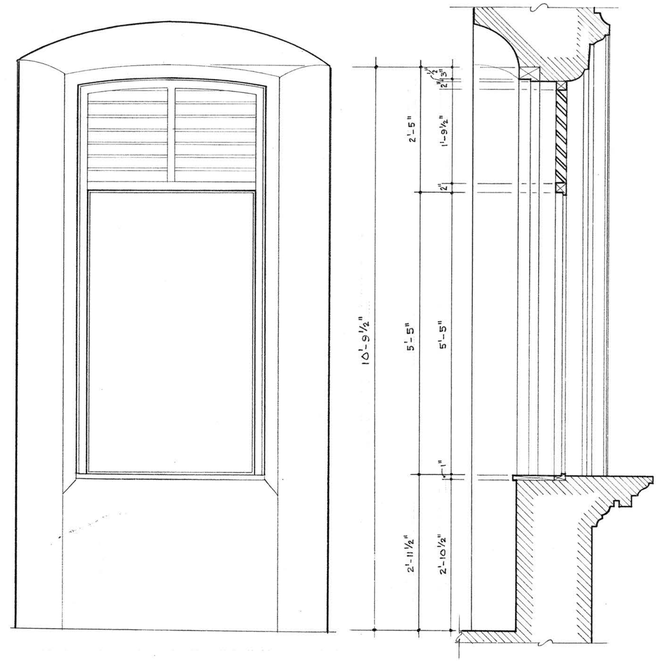
GRAPHIC SCALE IN INCHES

EXTERIOR



INTERIOR OF CASEMATE

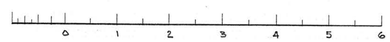
PLAN



INTERIOR ELEVATION

SECTION

TYPICAL WINDOW FROM CASEMATE NO. 3
EXISTING CONDITIONS
SCALE: 3/4" = 1'-0"



GRAPHIC SCALE
3/4" = 1'-0"

DEL.: LADD EHLINGER 8/22/61

NHS - SJ
3015

SAN JUAN NATIONAL HISTORIC SITE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN

NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL — OFFICER'S QUARTERS
SAN JUAN, PUERTO RICO
ERECTED CIRCA 1775
MODIFIED CIRCA 1861

SURVEY NO. PR-98

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 6 OF 7 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

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F.S. DETAIL – PILASTER CORNICE, W. FAC.
TAKEN AT "G"

F.S. DETAIL – PLINTH, W. FACADE
TAKEN AT "E"

F.S. DETAIL – CORNICE 1861 ADDITION
TAKEN AT "J"

F.S. DETAIL – CORNICE, W. FACADE
TAKEN AT "D"

F.S. DETAIL – CORNICE, E. FACADE
TAKEN AT "H"

10"

0 1 2 3 4 5 6
GRAPHIC SCALE – INCHES

F.S. DETAIL – ARCHITRAVE, W. FACADE
TAKEN AT "F"

NHS - SJ
3015

SAN JUAN NATIONAL HISTORIC SITE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE BRANCH OF PLANS AND DESIGN

NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL — OFFICER'S QUARTERS
ERECTED CIRCA 1775
SAN JUAN, PUERTO RICO
MODIFIED CIRCA 1861

SURVEY NO.
PR-98

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 7 OF 7 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

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Castillo San Cristóbal – Officer's Quarters, San Juan, PR. 1962, corrected 1964. Historic American Buildings Survey, HABS PR-98.

Sheet Index

Sheet 1 Plan Development – Officers' Quarters

Sheet 2 East Facade, Circa 1775, and East Facade, Circa 1846

Sheet 3 Gallery – Officers' Quarters and Location of Flooring Excavations

Sheet 4 Full Size Profile Original Moulding Jambs – Casemate Doors, Full Size Profile Original Moulding Gallery Piers, Full Size Profile 1861 Doors Jamb and Partition, Plan, and West Elevation

R.V. KEUNE, DEL., 1962 CORRECTED 1964, FC GIESSING

DRAWN AT SAN JUAN NATIONAL HISTORIC SITE

UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN

ADDENDUM TO

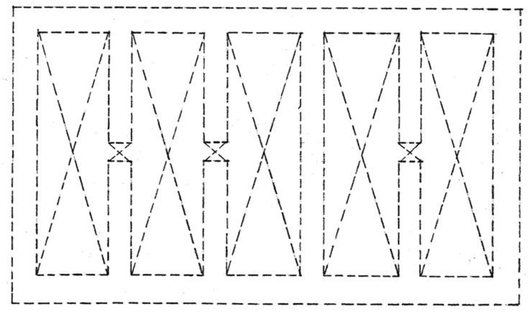
CASTILLO DE SAN CRISTOBAL - OFFICERS' QUARTERS

SAN JUAN, PUERTO RICO

NAME OF STRUCTURE

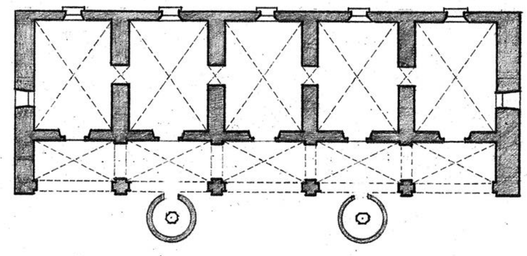
1774

(1) CONSTRUCTION REPORTS OF CHIEF ENGINEER O'DALY
JAN. 20, 1774 & JAN. 30, 1774
(2) MAP OF NEW WORKS BY CHIEF ENGINEER O'DALY
FEB. 26, 1778



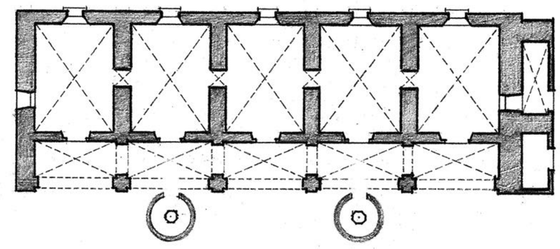
1775

(1) CONSTRUCTION REPORTS OF CHIEF ENGINEER O'DALY
JAN. 5, 1775 & MARCH 31, 1775



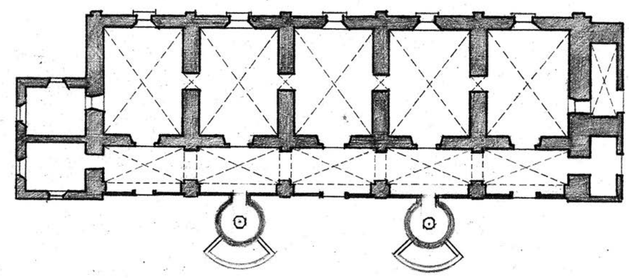
1783

(1) PLAN OF OFFICERS' QUARTERS BY JUAN MESTRE, 1783



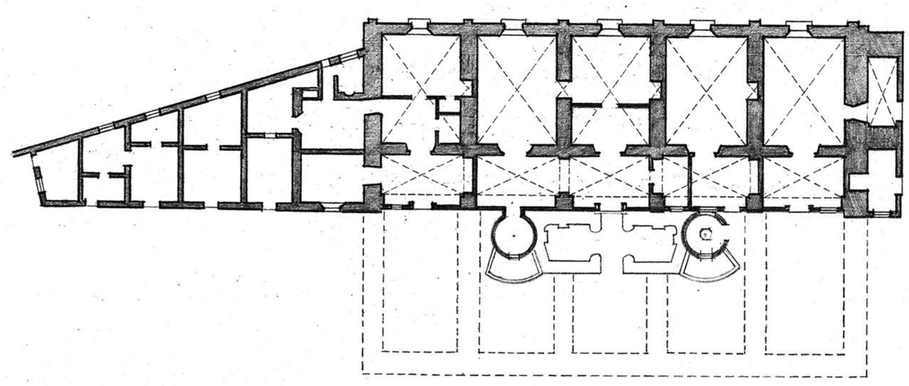
1846

(1) MODEL OF SAN CRISTOBAL FORTIFICATIONS BUILT BY MASTER BUILDER AND GIVEN TO KING OF SPAIN, 1846



1861

(1) PLAN OF PLAZA DE ARMAS BY MANUEL F. CASTRO, JUNE 4, 1861



PLAN DEVELOPMENT
OFFICERS' QUARTERS

NORTH

1861 PLAN TRACING SCALE USED THROUGHOUT
SCALE: (1861 PLAN) 1/300 PIES CASTELLS
APPROX. 11" = 300'-0"

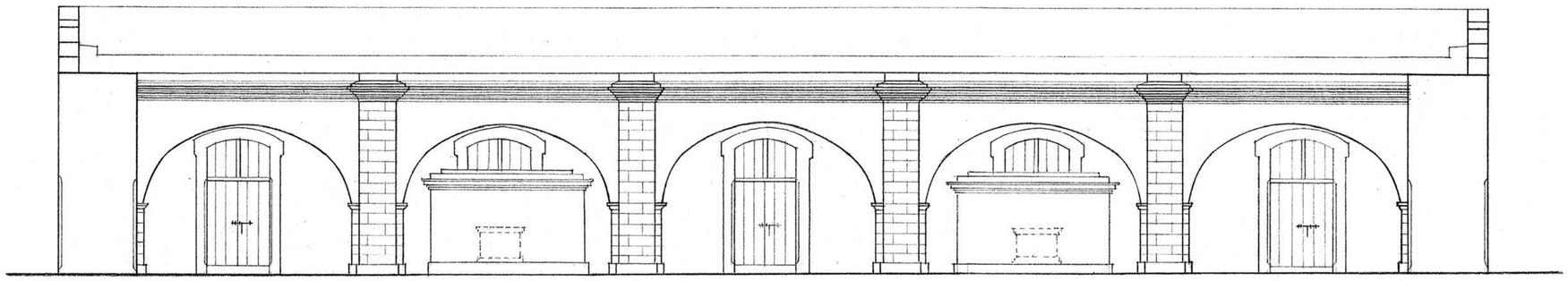
SURVEY NO. PR-98

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 1 OF 4 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

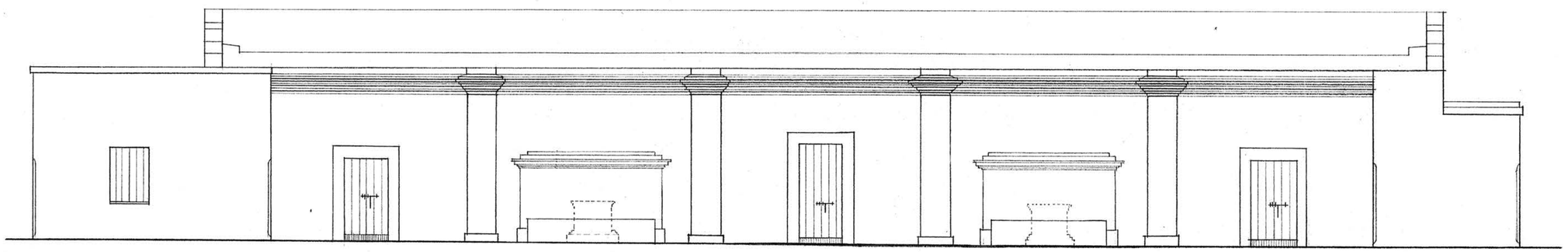
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TRIM LINE
TRIM LINE
DUE TO INSUFFICIENT [illegible] MATERIAL MAY NOT BE AT THE TIME OF EDITING, TO CONFORM TO HABS OR HAER STANDARDS.

TRIM LINE



EAST FACADE

CIRCA. 1775



EAST FACADE

CIRCA. 1846

NOTE:
DRAWINGS ARE CONJECTURAL AND ARE BASED ON EXISTING HISTORICAL PLANS, MODEL, AND PHYSICAL EVIDENCE UNCOVERED DURING ARCHITECTURAL INVESTIGATION.

B.V. KEUNE., DEL., 1962
CORRECTED 1964, F.C. GJESSING

SCALE 1/8" 0 1 5 10

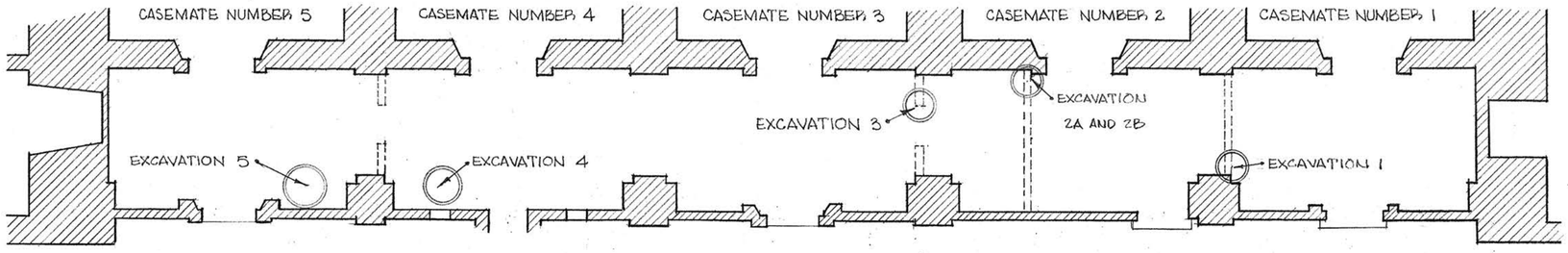
DRAWN AT SAN JUAN NATIONAL HISTORIC SITE UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN	NAME OF STRUCTURE ADDENDUM TO CASTILLO DE SAN CRISTOBAL - OFFICERS' QUARTERS SAN JUAN, PUERTO RICO	SURVEY NO. PR-98	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 2 OF 4 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.

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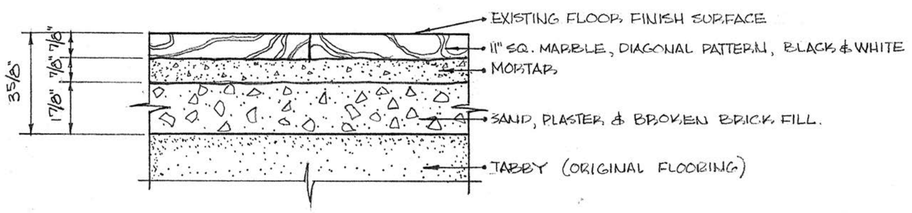
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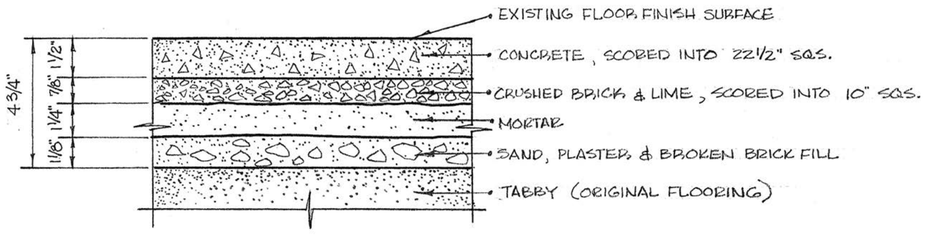
GALLERY - OFFICERS' QUARTERS

LOCATION OF FLOORING EXCAVATIONS

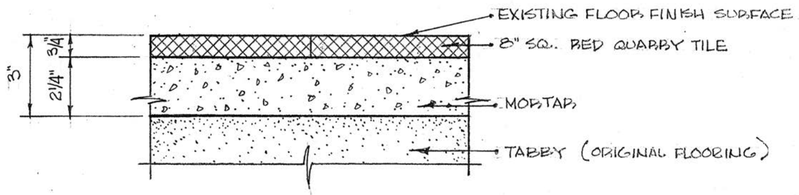
NORTH



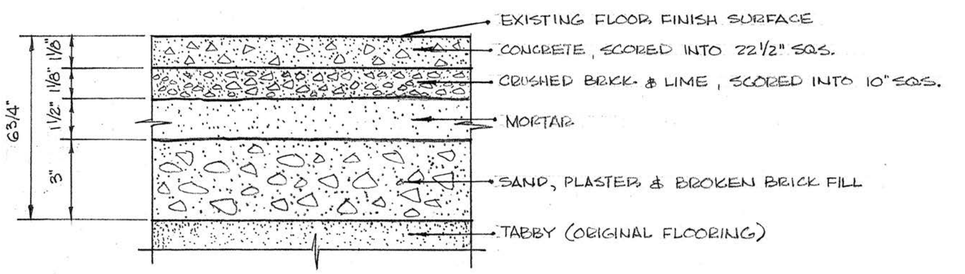
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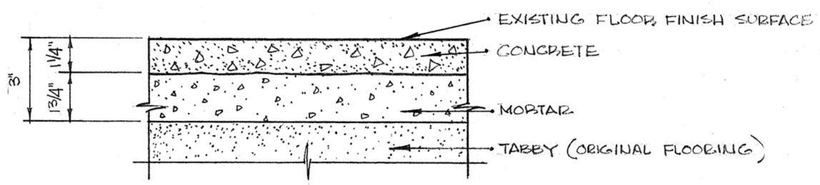
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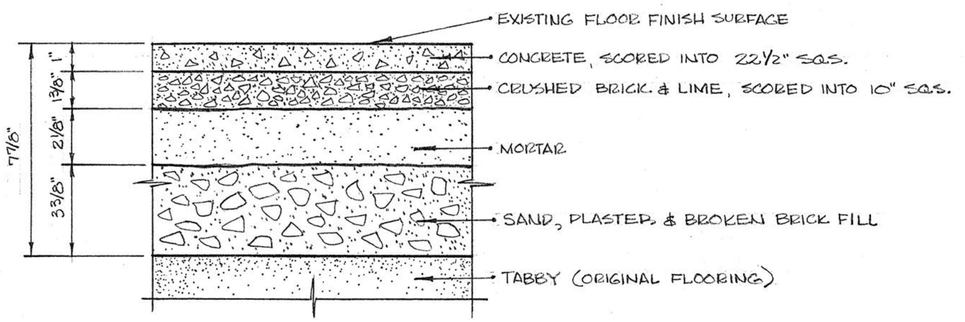
EXCAVATION 2A



EXCAVATION 4



EXCAVTION 2B



EXCAVATION 5

R.V. KEUNE, DEL., 1962

SCALE 3"=1'-0" 0 6" 1'-0"

DRAWN AT SAN JUAN NATIONAL HISTORIC SITE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN

ADDENDUM TO

NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL - OFFICERS' QUARTERS
SAN JUAN, PUERTO RICO

SURVEY NO. PR-98

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 3 OF 4 SHEETS

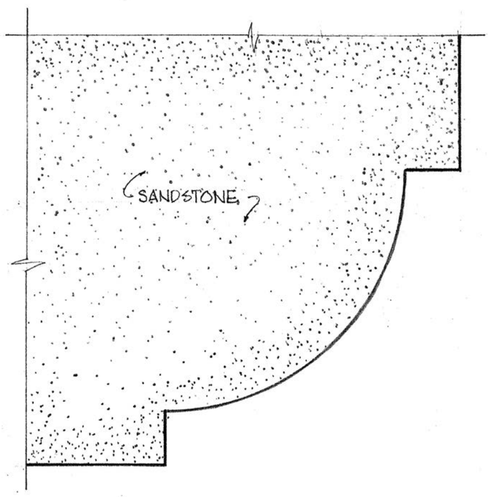
LIBRARY OF CONGRESS INDEX NUMBER

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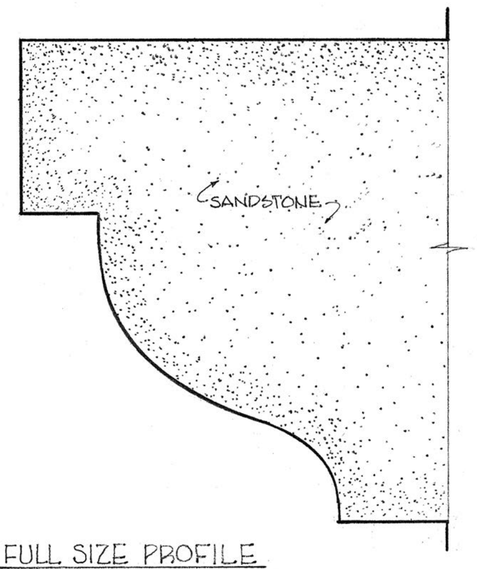
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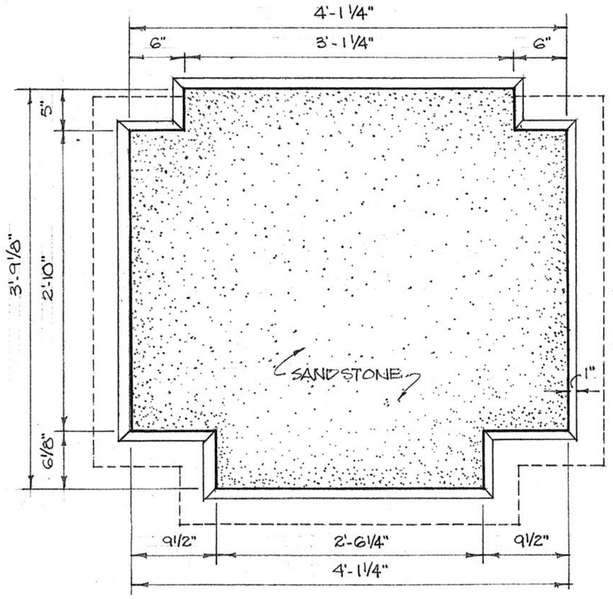
TRIM LINE



FULL SIZE PROFILE
ORIGINAL MOULDING
JAMBS - CASEMATE DOORS

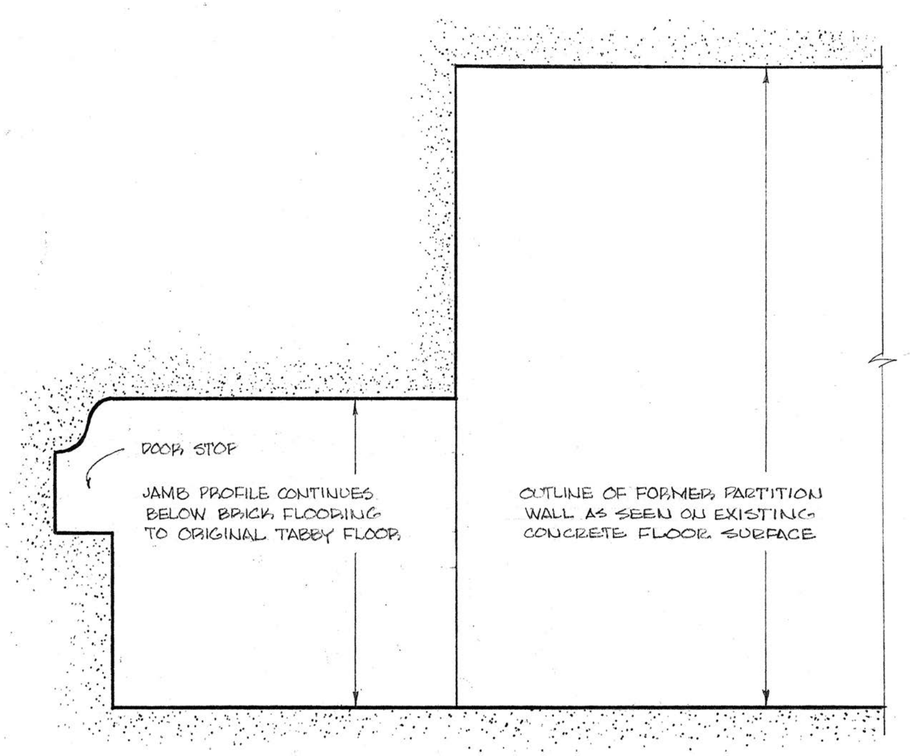


FULL SIZE PROFILE
ORIGINAL MOULDING
GALLERY PIERS

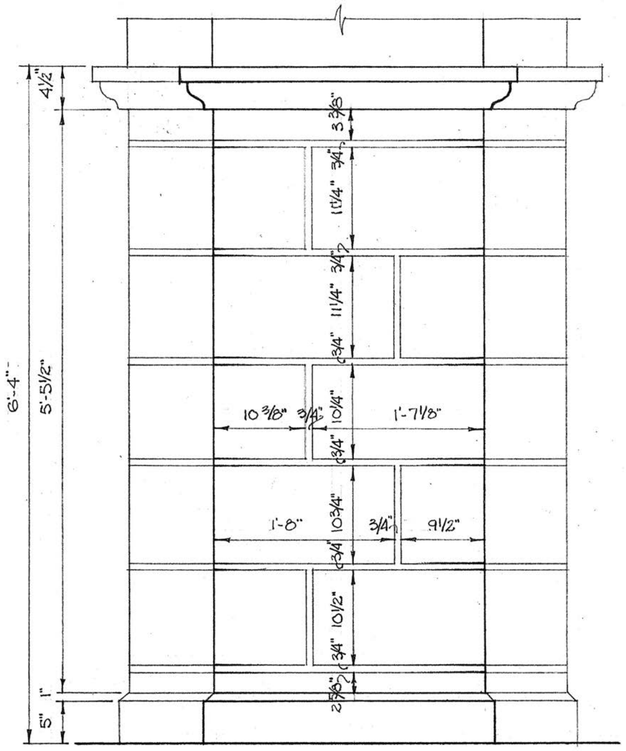


N

PLAN
(ORIGINAL CONDITIONS - 1775)
SCALE: 1"=1'-0"



FULL SIZE PROFILE
1861 DOOR JAMB AND PARTITION
IN GALLERY BETWEEN CASEMATES FOUR & FIVE



WEST ELEVATION
(NOTE RAISED MORTAR JOINTS)

SCALE: 1"=1'-0" 0 6" 1'-0" 2'-0"

B.V. KEUNE, DEL., 1962

DRAWN AT SAN JUAN NATIONAL HISTORIC SITE UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN	ADDENDUM TO	NAME OF STRUCTURE CASTILLO DE SAN CRISTOBAL - OFFICERS' QUARTERS SAN JUAN, PUERTO RICO	SURVEY NO. PR-98	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 4 OF 4 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

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U.S. GOVERNMENT PRINTING OFFICE 10—5559

TRIM LINE

Castillo de San Cristóbal – Troops' Quarters, San Juan, PR. 1962. Historic American Buildings Survey, HABS PR-100.

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Sheet 1 Map of Puerto Rico, Map of Old San Juan, Site Plan – San Cristóbal

Sheet 2 First Floor Plan

Sheet 3 Second Floor Plan

Sheet 4 Roof Plan

Sheet 5 East Elevation and West Elevation

Sheet 6 Section A-A, Section B-B, and Section C-C

Sheet 7 Section D-D, Section E-E, and Main Stair Details

Sheet 8 Section CC, Spiral Stairs Details, Reflected Ceiling Plan, and South Elevation

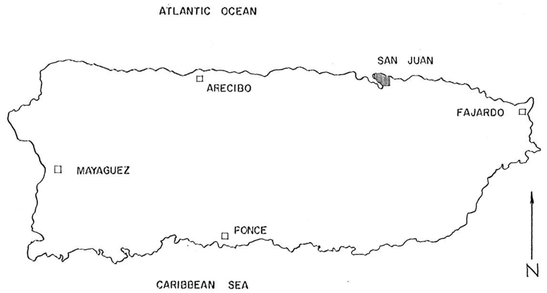
Sheet 9 South Elevation, Typical Door Detail, Rm. 2, Typical Window Detail Rm. 2, Sliding Pin Detail

Sheet 10 Solid Shutter, Rm. 2 Details, F.S. Detail Cornice, and W. Facade

Sheet 11 FS Detail Window Sill Second Floor, FS Detail Window Jamb, FS Detail Entrance Door Jamb, and FS Detail Belt Molding

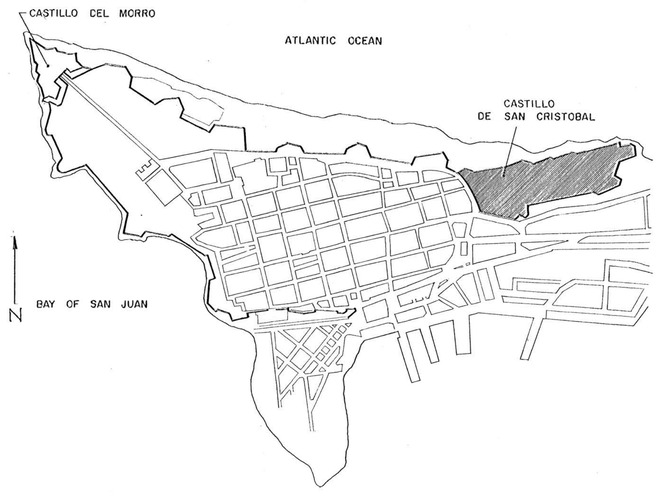
CASTILLO DE SAN CRISTOBAL

TROOPS' QUARTERS



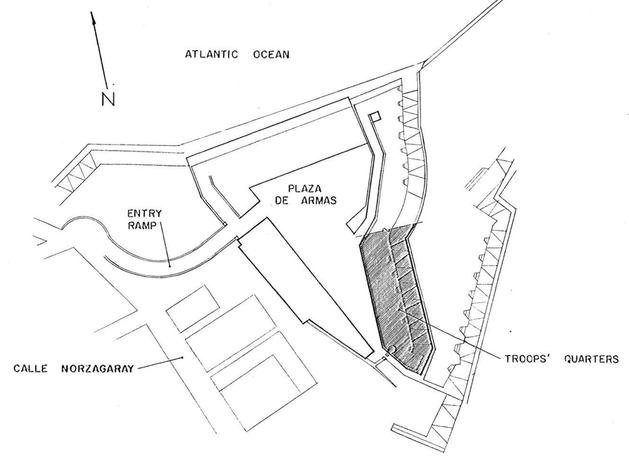
MAP OF PUERTO RICO

0 5 10 20 30 40 mi.



MAP OF OLD SAN JUAN

0 100 200 400 800 1200 ft.



SITE PLAN - SAN CRISTOBAL

0 50 100 200 300 ft.

SAN JUAN PUERTO RICO

THE MASSIVE FORT OF SAN CRISTOBAL, LOCATED ON THE NORTHEAST CORNER OF THE OLD WALLED CITY OF SAN JUAN, WAS BEGUN AROUND 1633. AN IMPORTANT LINK IN THE CHAIN OF DEFENSIVE WORKS OF THE CITY, IT WAS PLANNED FOR DEFENSE IN DEPTH. THE TROOPS' QUARTERS, ONE OF THE LAST MAJOR STRUCTURES TO BE BUILT IN THE COMPLEX, WAS DESIGNED BY TOMAS O'DALY, CHIEF OF THE SPANISH MILITARY ENGINEERS OF SAN JUAN, AND WAS READY FOR OCCUPANCY IN 1773. SOME ALTERATIONS OR REFINEMENTS IN ITS FAÇADE, WHICH OCCURRED BETWEEN 1846 AND 1861, DE-DETERMINE TO SOME EXTENT THE EXISTING CHARACTER. OCCUPIED BY THE U.S. ARMY AFTER THE SPANISH-AMERICAN WAR IN 1898, IT SERVED FOR VARIOUS MILITARY USES UNTIL 1960 WHEN IT BE-CAME UNOCCUPIED. THE FORT WAS TRANSFERRED TO THE SAN JUAN NATIONAL HISTORIC SITE ON SEPTEMBER 13, 1961.

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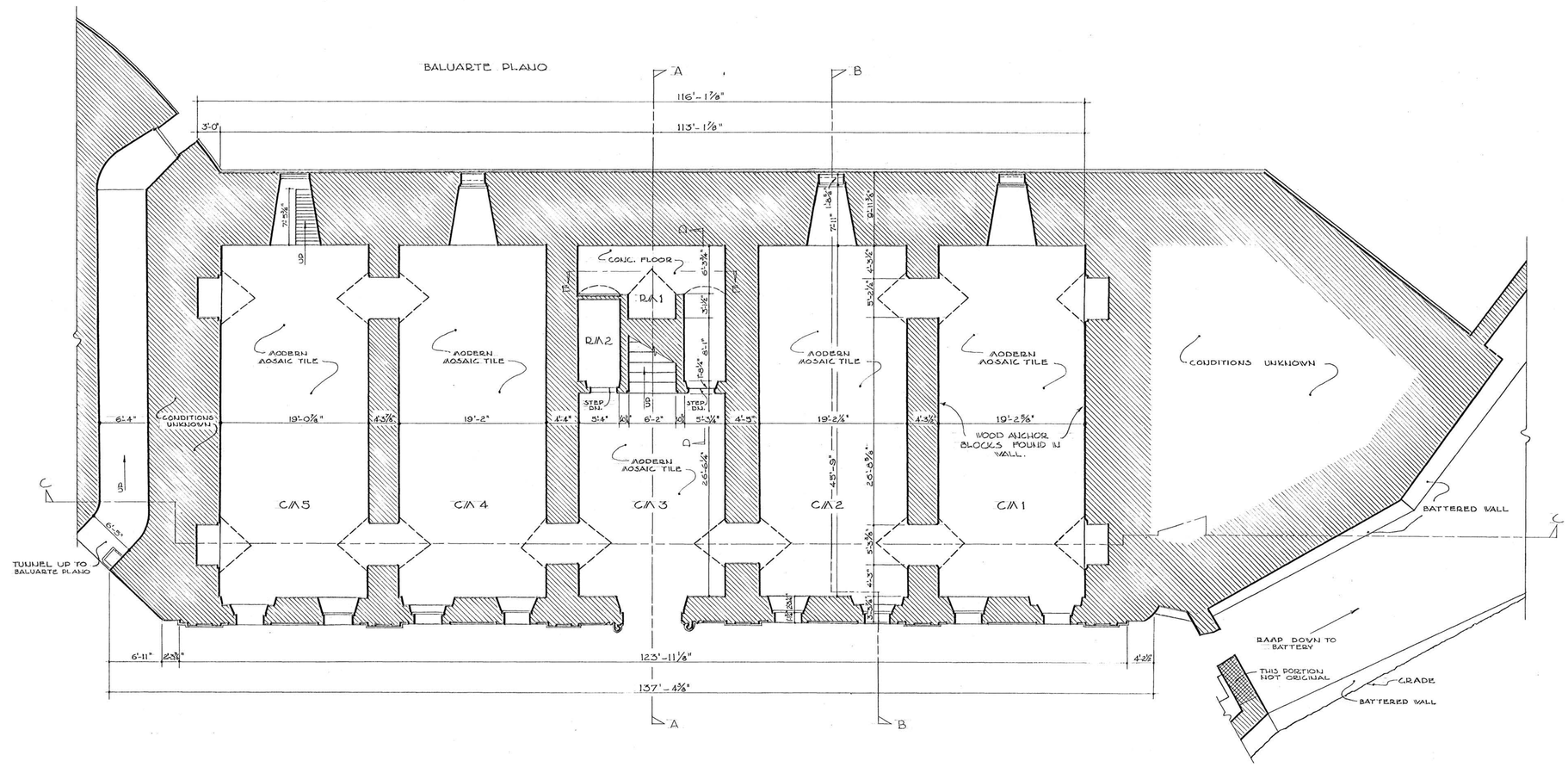
SUPERVISING ARCHITECT — CHARLES E. PETERSON, HISTORIC STRUCTURES
PROJECT SUPERVISOR — F.C. GJESSING, ARCHITECT
ASS'T. PROJECT SUPERVISOR — W.W. WILKINS, ARCHITECT
DELINEATORS — T. R. FROST, STU. ASS'T. ARCH. (PRINCETON U.)
E.B.L. TODD, STU. ASS'T. ARCH. (U. OF PENN)

DEL. E.B.L. TODD 8/23/62

SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE, BRANCH OF PLANS & DESIGN	NAME OF STRUCTURE CASTILLO DE SAN CRISTOBAL - TROOPS' QUARTERS ERECTED CIRCA 1773 — SAN JUAN, PUERTO RICO — MODIFIED 19TH CENTURY	SURVEY NO PR-100	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 1 OF 11 SHEETS	LIBRARY OF CONGRESS CATALOG NUMBER

USE TO OBTAIN CURRENT INFORMATION AT TIME OF EDITING. THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.

TRUE LINE



FIRST FLOOR PLAN

SCALE: ⅛" = 1'-0"

N

0 5 10 15 20 25 FT.

SCALE: ⅛" = 1'-0"

DEL. T.R. FROST 8/14/62

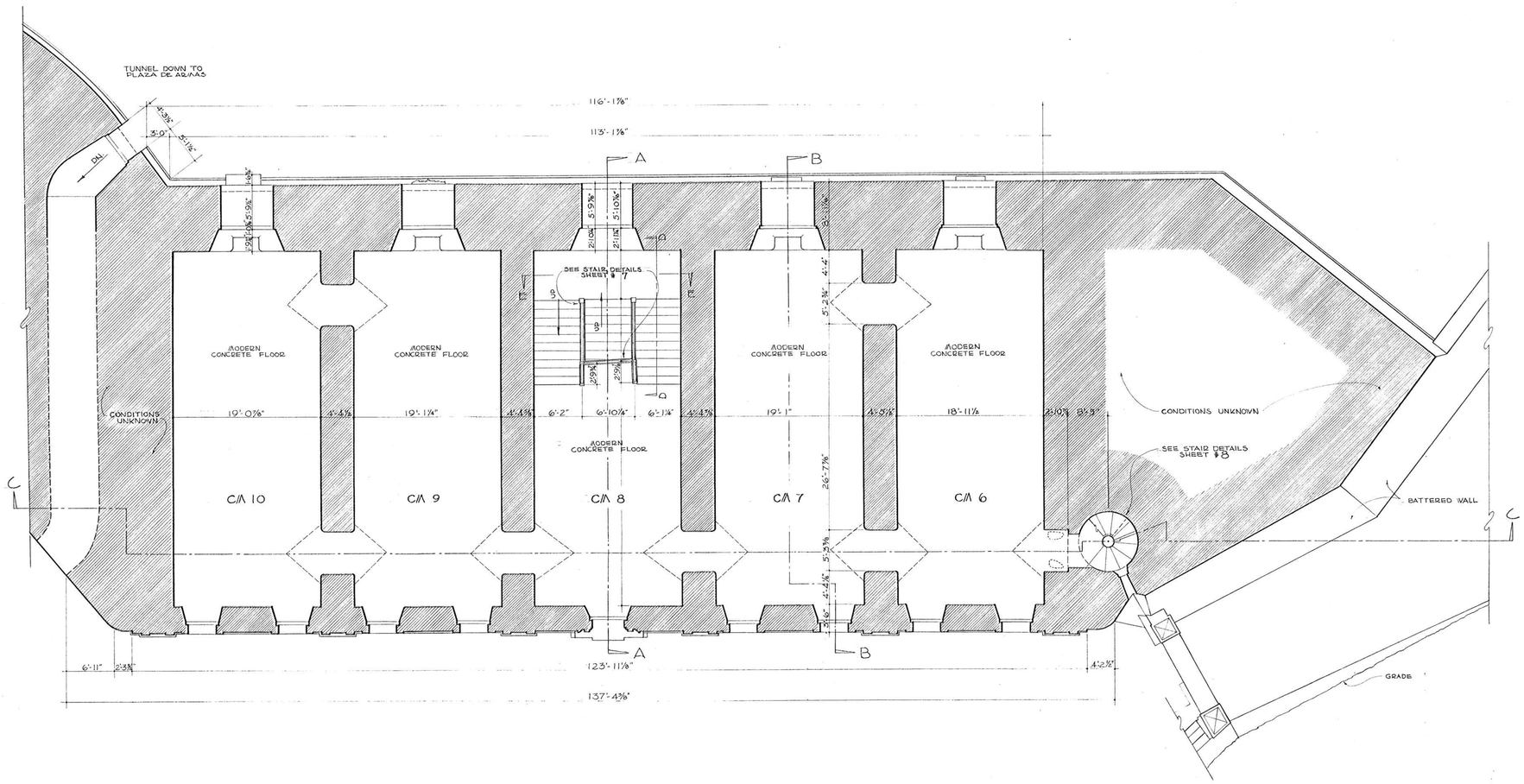
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SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE, BRANCH OF PLANS & DESIGN	NAME OF STRUCTURE CASTILLO DE SAN CRISTOBAL — TROOPS' QUARTERS ERECTED CIRCA 1773 SAN JUAN, PUERTO RICO MODIFIED 19TH CENTURY	SURVEY NO. PR-100	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 2 OF 11 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING, THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS.

TRUE LINE

TRUE LINE



SECOND FLOOR PLAN

SCALE 1/8" = 1'-0"

N

SCALE : ⅛" = 1'-0"

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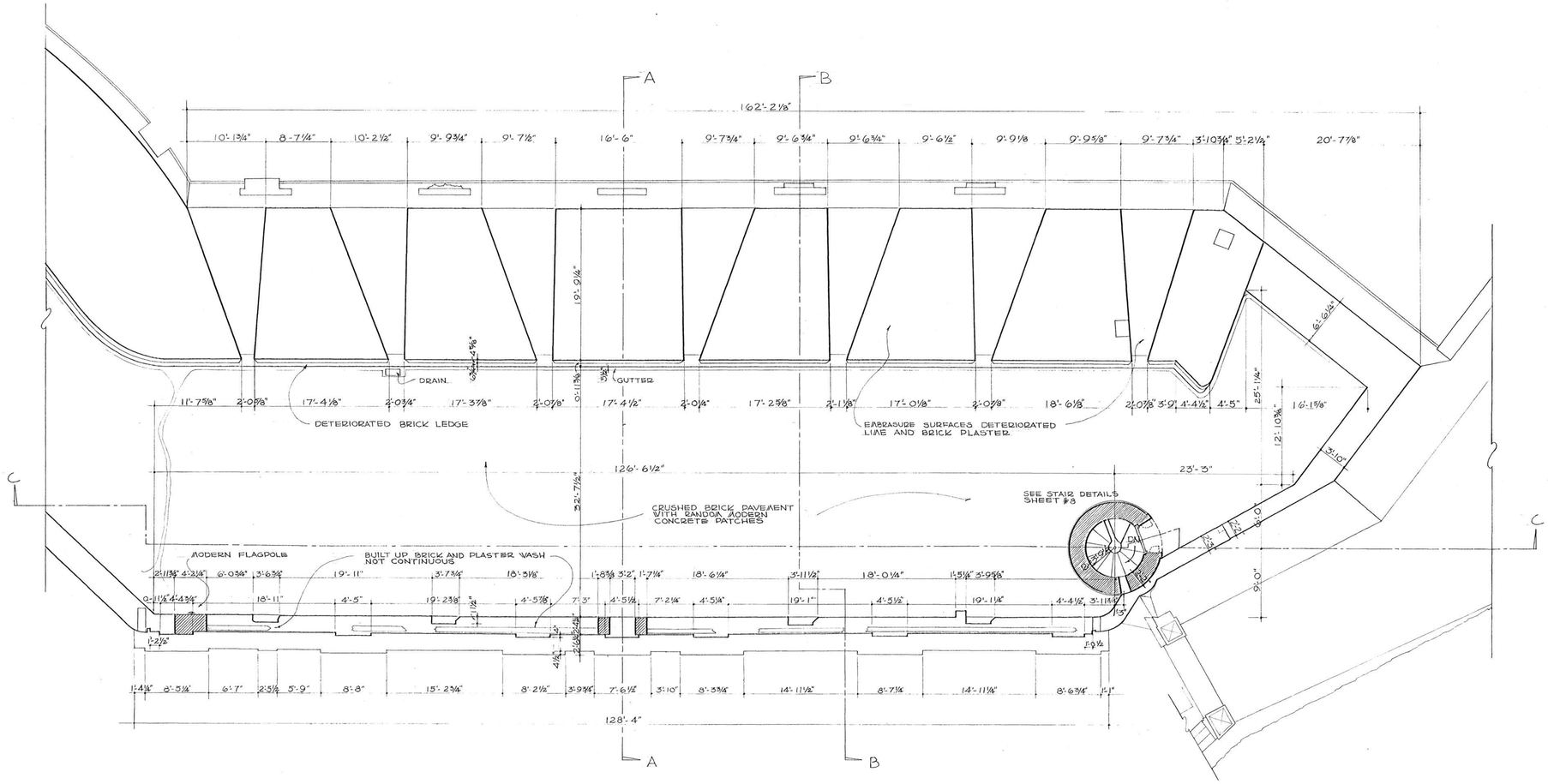
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SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN	NAME OF STRUCTURE CASTILLO DE SAN CRISTOBAL — TROOPS' QUARTERS ERECTED CIRCA 1773 — SAN JUAN, PUERTO RICO — MODIFIED 19TH CENTURY	SURVEY NO. PR-100	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 3 OF 11 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

DUE TO INSUFFICIENT INFORMATION AT THE TIME OF EDITING THIS MATERIAL MAY NOT CONFORM TO HABS OR HAER STANDARDS

TRUE LINE

TRIM LINE



ROOF PLAN

SCALE 1/8" = 1'-0"

N

0 5 10 15 20 25 FT.

SCALE: 1/8" = 1'-0"

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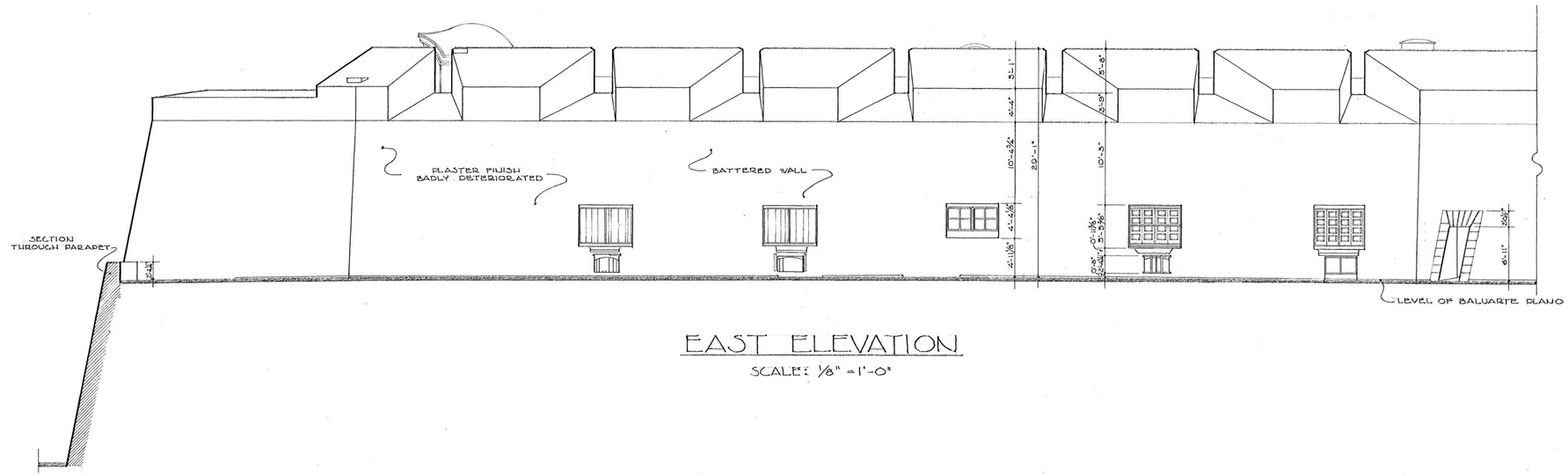
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SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE , BRANCH OF PLANS AND DESIGN	NAME OF STRUCTURE CASTILLO DE SAN CRISTOBAL — TROOPS' QUARTERS ERECTED CIRCA 1773 SAN JUAN , PUERTO RICO MODIFIED 19TH CENTURY	SURVEY NO. PR-100	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 4 OF 11 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER.

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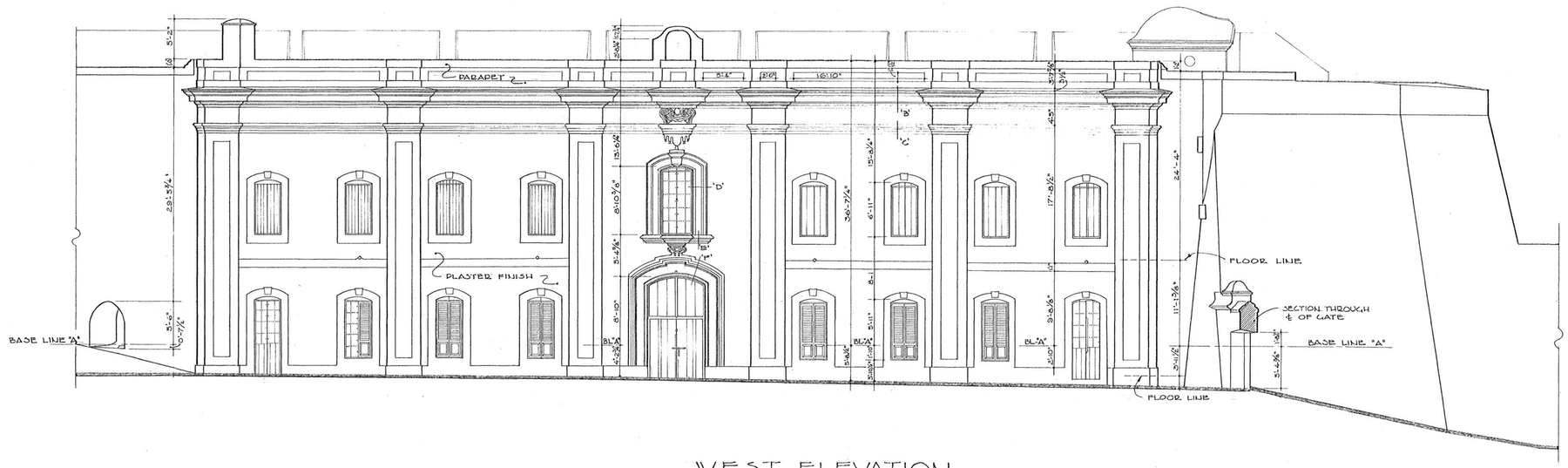
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TRIA LINE



EAST ELEVATION

SCALE: 1/8" = 1'-0"



WEST ELEVATION

SCALE: 1/8" = 1'-0"

0 5 10 15 20 25 FT.

SCALE: 1/8" = 1'-0"

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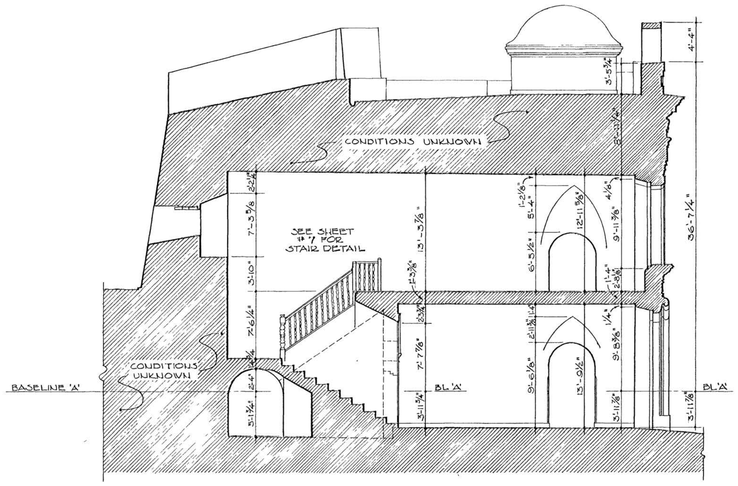
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SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE. UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE, BRANCH OF PLANS AND DESIGN	NAME OF STRUCTURE CASTILLO DE SAN CRISTOBAL — TROOPS' QUARTERS ERECTED CIRCA 1773 SAN JUAN, PUERTO RICO MODIFIED 19TH CENTURY	SURVEY NO. PR-100	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 5 OF 11 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

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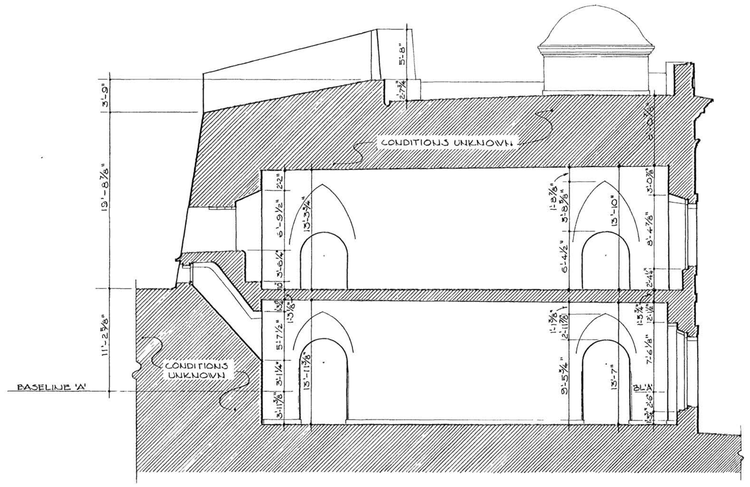
TRIA LINE

TRIM LINE



SECTION A-A

SCALE: 1/8" = 1'-0"



SECTION B-B

SCALE: 1/8" = 1'-0"

SECTION C-C

SCALE: 1/8" = 1'-0"

0 5 10 15 20 25 FT.

SCALE: 1/8" = 1'-0"

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SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPT. OF THE INT.
NATIONAL PARK SERVICE, BRANCH OF PLANS & DESIGN.

NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL – TROOPS' QUARTERS
ERECTED CIRCA 1773 SAN JUAN, PUERTO RICO MODIFIED 19TH CENTURY

SURVEY NO.
PR-100

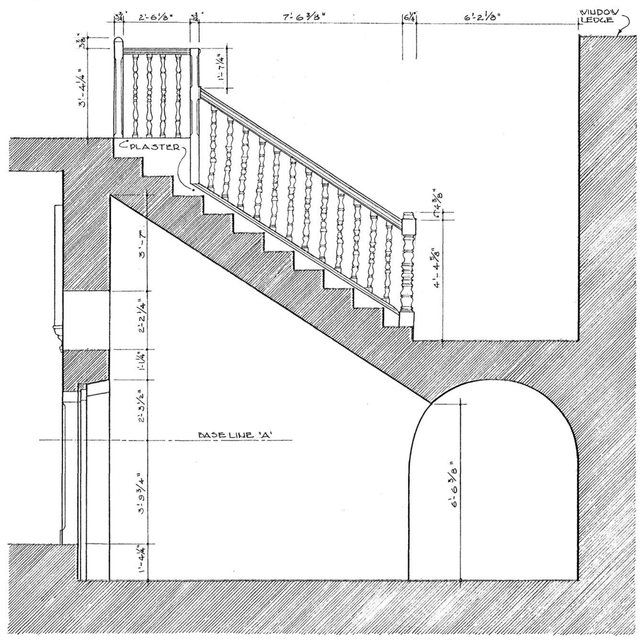
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 6 OF 11 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

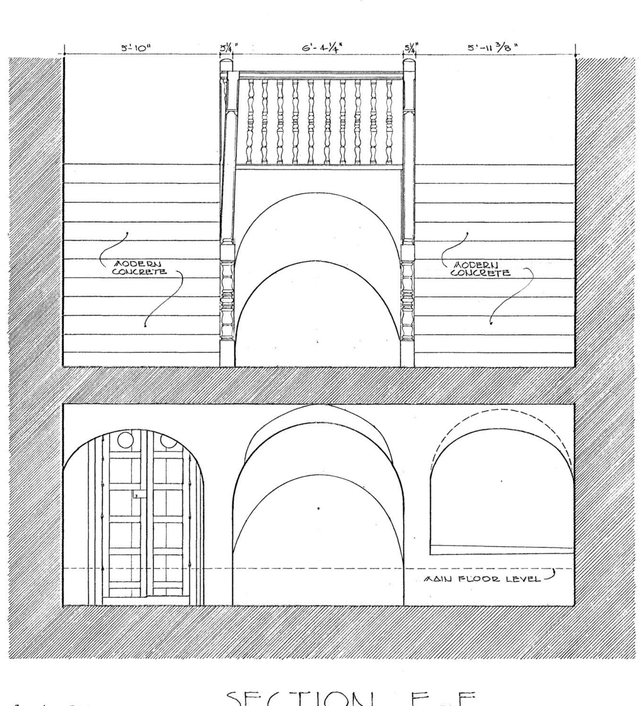
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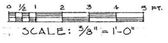
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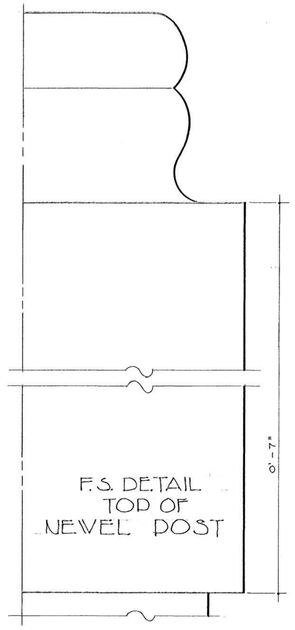
SECTION D-D
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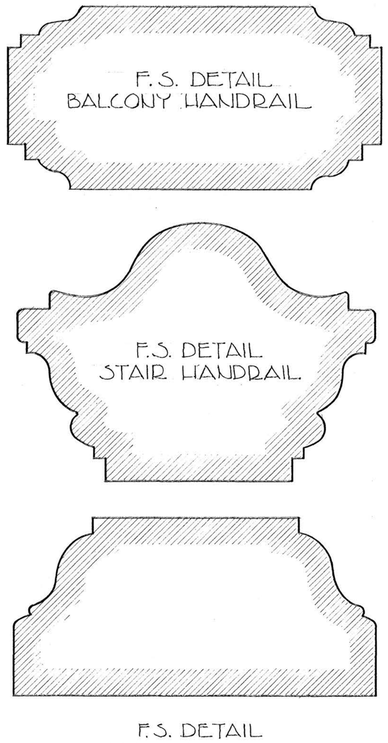


SECTION E-E
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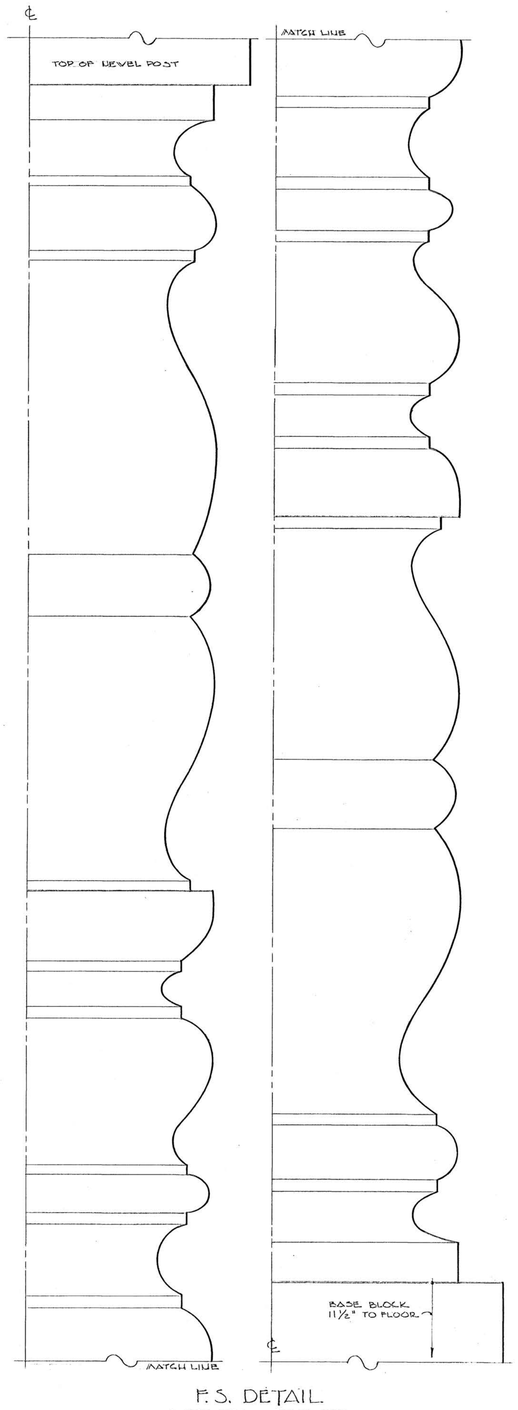


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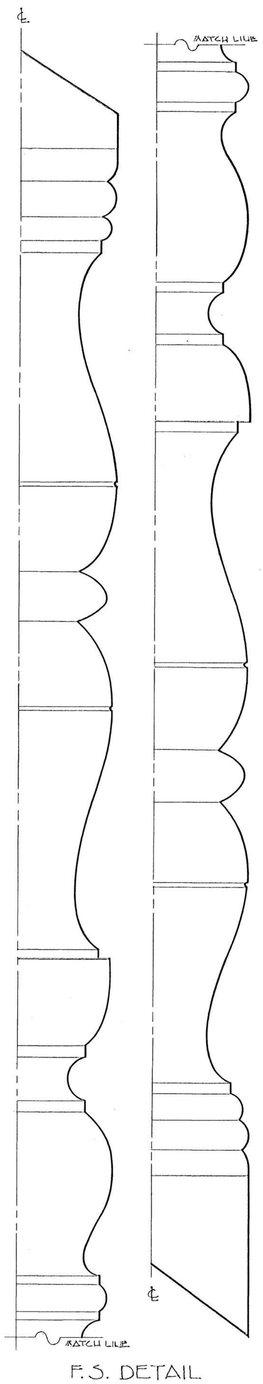




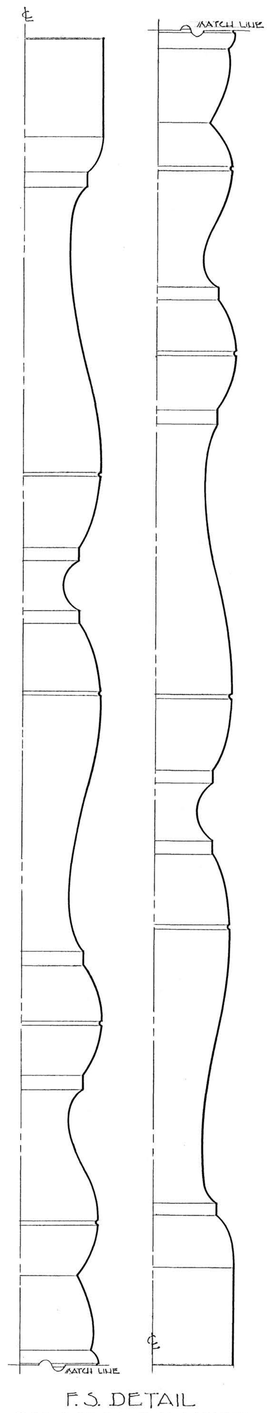
F.S. DETAIL
STAIR BASE-RAIL



F.S. DETAIL
NEWEL POST



F.S. DETAIL
STAIR BALUSTER



F.S. DETAIL
BALCONY BALUSTER

MAIN STAIRS DETAILS



SCALE : INCHES

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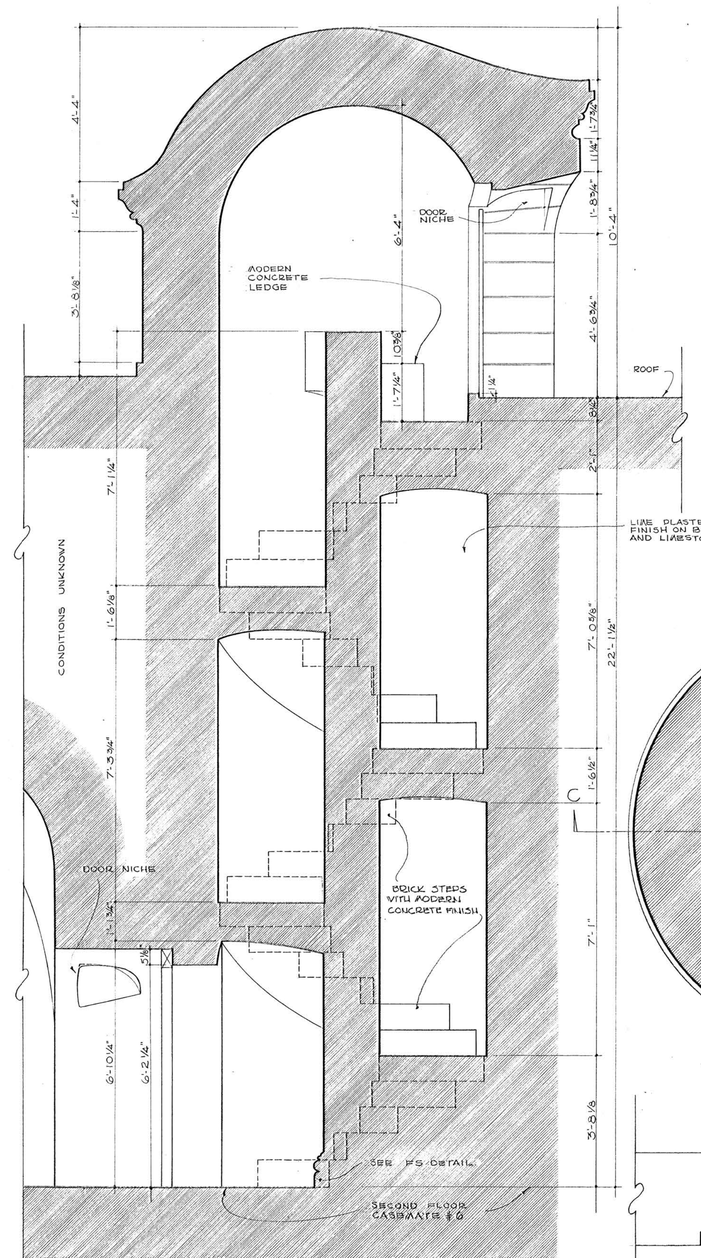
DEL. T.R. FROST 8/21/62

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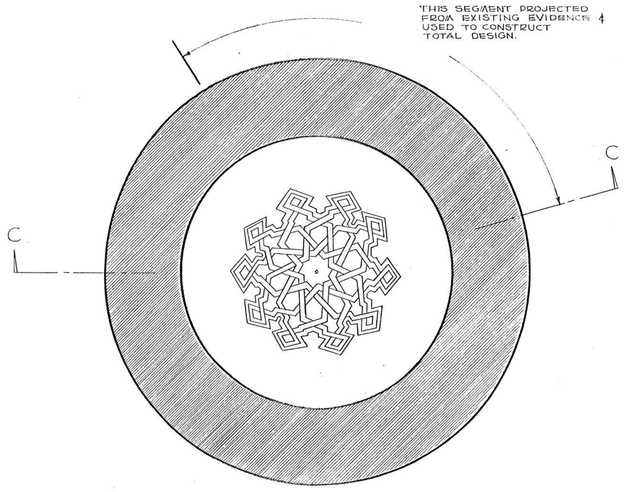
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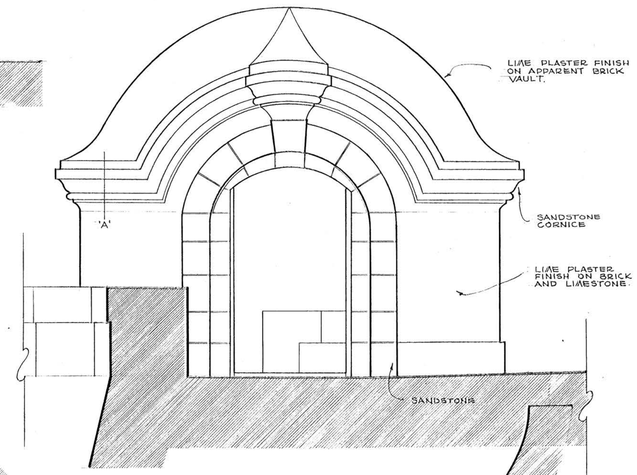
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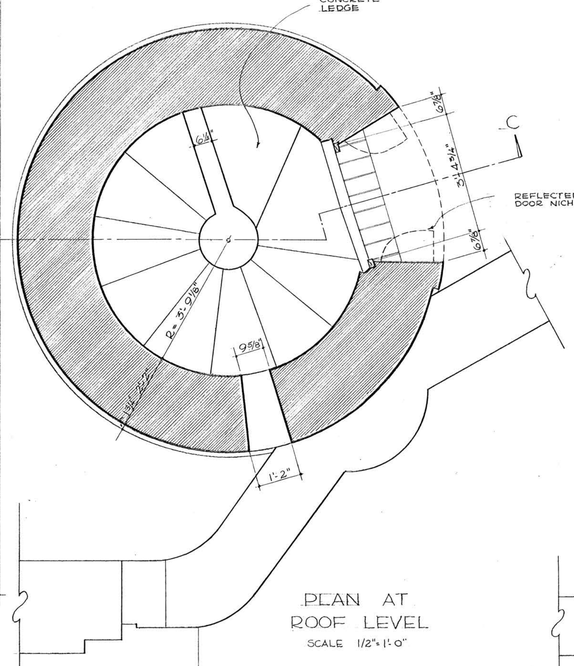
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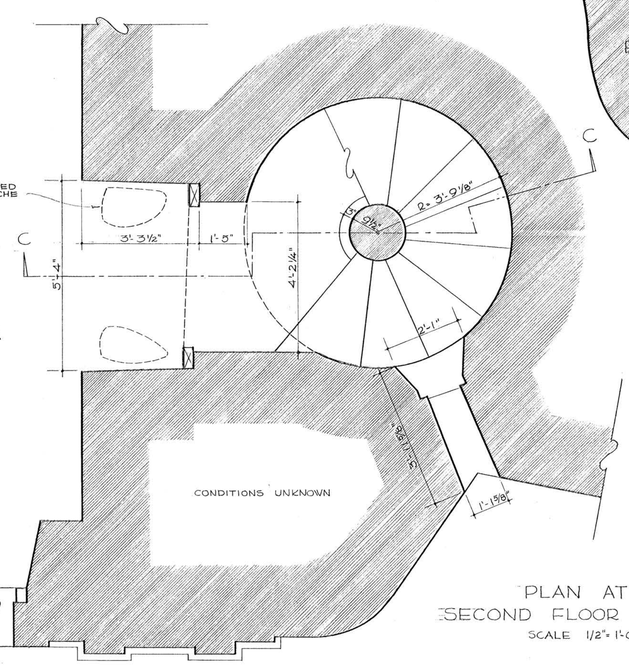
REFLECTED CEILING PLAN
SCALE 1/2" = 1'-0"



SOUTH ELEVATION
SCALE 1/2" = 1'-0"



PLAN AT ROOF LEVEL
SCALE 1/2" = 1'-0"



PLAN AT SECOND FLOOR LEVEL
SCALE 1/2" = 1'-0"

FS DETAIL
EXTERIOR CORNICE
TAKEN AT 'A'

FS DETAIL
COLUMN BASE

N

SCALE : INCHES

SCALE 1/2" = 1'-0"

SPIRAL STAIRS DETAILS

DEL. E.B.L. TODD - 8/15/62

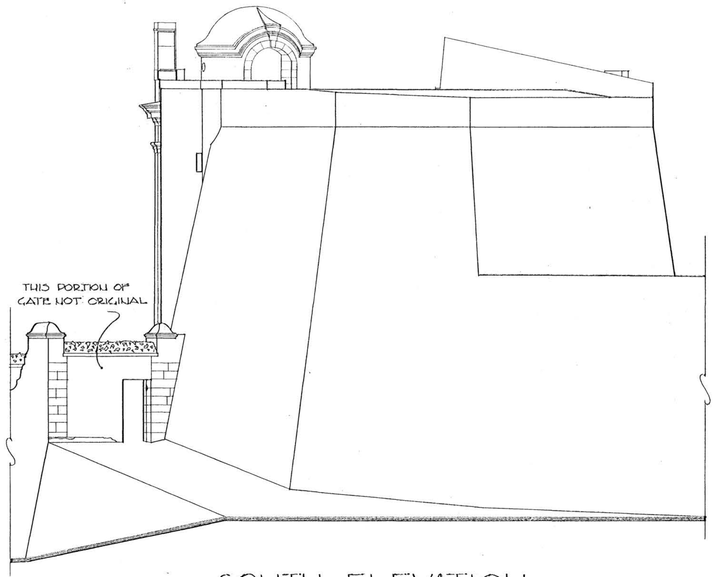
NHS - SJ
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SAN JUAN NATIONAL HISTORIC SITE SAN JUAN FIELD OFFICE UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR NATIONAL PARK SERVICE, BRANCH OF PLANS & DESIGN	NAME OF STRUCTURE CASTILLO DE SAN CRISTOBAL - TROOPS' QUARTERS ERECTED CIRCA 1773 — SAN JUAN, PUERTO RICO — MODIFIED 19TH CENTURY	SURVEY NO. PR-100	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 8 OF 11 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

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TRIA LINE

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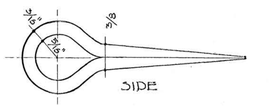


SOUTH ELEVATION

SCALE; 1/8" = 1'-0"

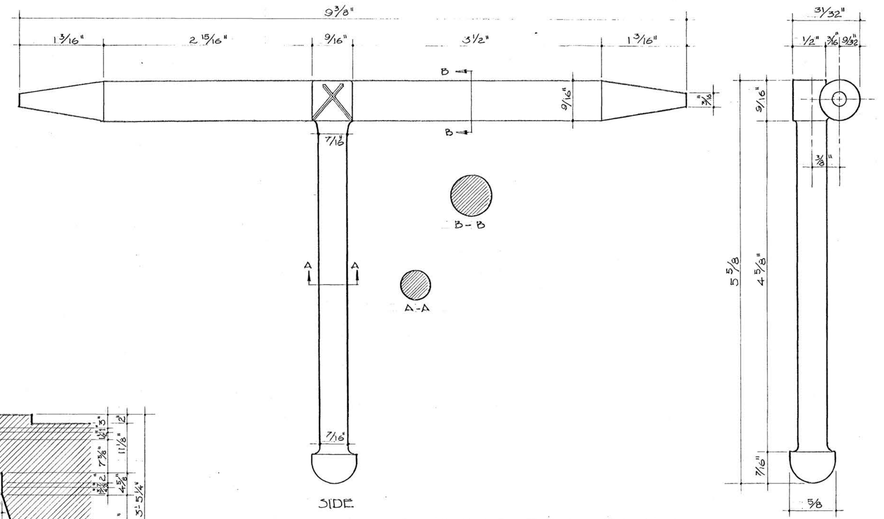
0 1 2 3 4 5 10 15 20 25 FT.

SCALE: 1/8" = 1'-0"



EYE DETAIL

FULL SCALE



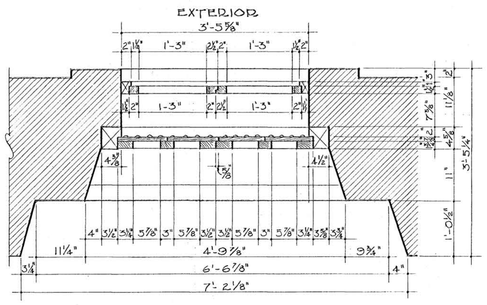
SLIDING PIN DETAIL

FROM LOUVERED SHUTTER, C.M.2

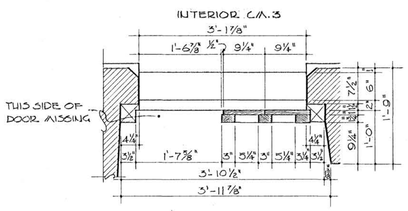
FULL SCALE

0 1/2 1 2 3 4 5 IN.

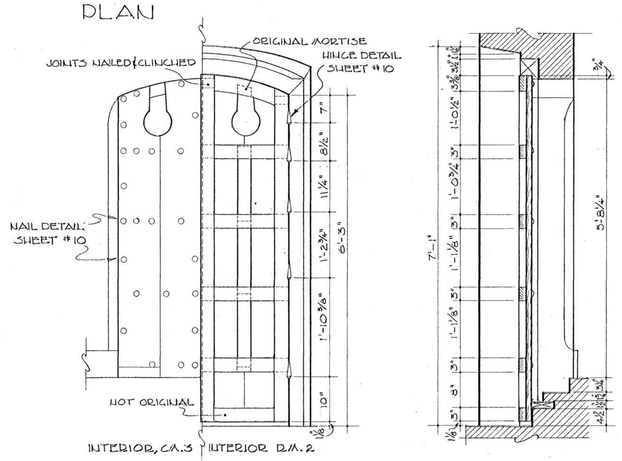
SCALE: INCHES



PLAN



PLAN

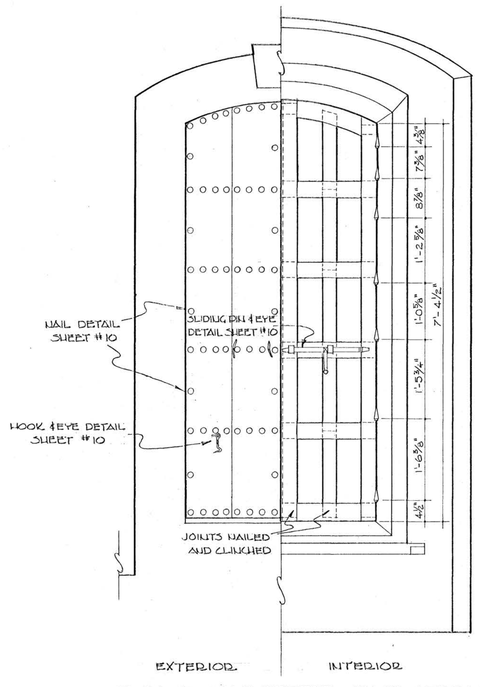


ELEVATION

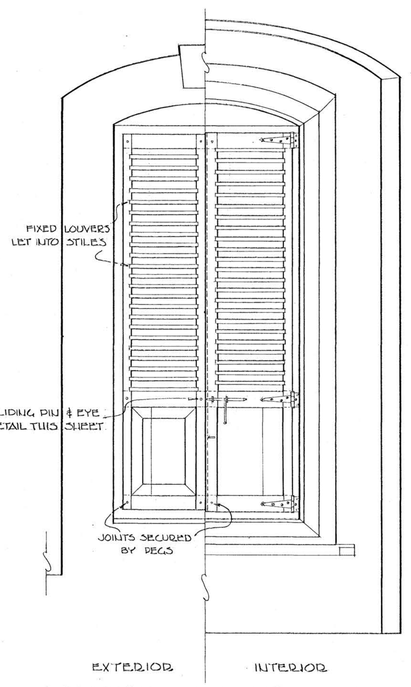
SECTION

TYPICAL DOOR DETAIL, R.M.2

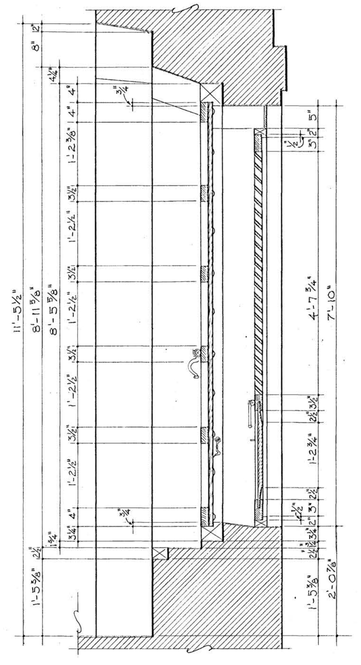
SCALE: 3/4"=1'-0"



SOLID SHUTTER ELEVATION



LOUVERED SHUTTER ELEVATION



SECTION

0 1/2 1 2 3 4 FT.

SCALE: 3/4" = 1'-0"

TYPICAL WINDOW DETAIL, C.M. 2

SCALE: 3/4" = 1'-0"

DEL. T. R. FROST 9/10/82

NHS-SJ 3067

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE, BRANCH OF PLANS & DESIGN

NAME OF STRUCTURE

CASTILLO DE SAN CRISTOBAL — TROOPS' QUARTERS

ERECTED CIRCA 1775 — SAN JUAN, PUERTO RICO — MODIFIED 19TH CENTURY

SURVEY NO. PR-100

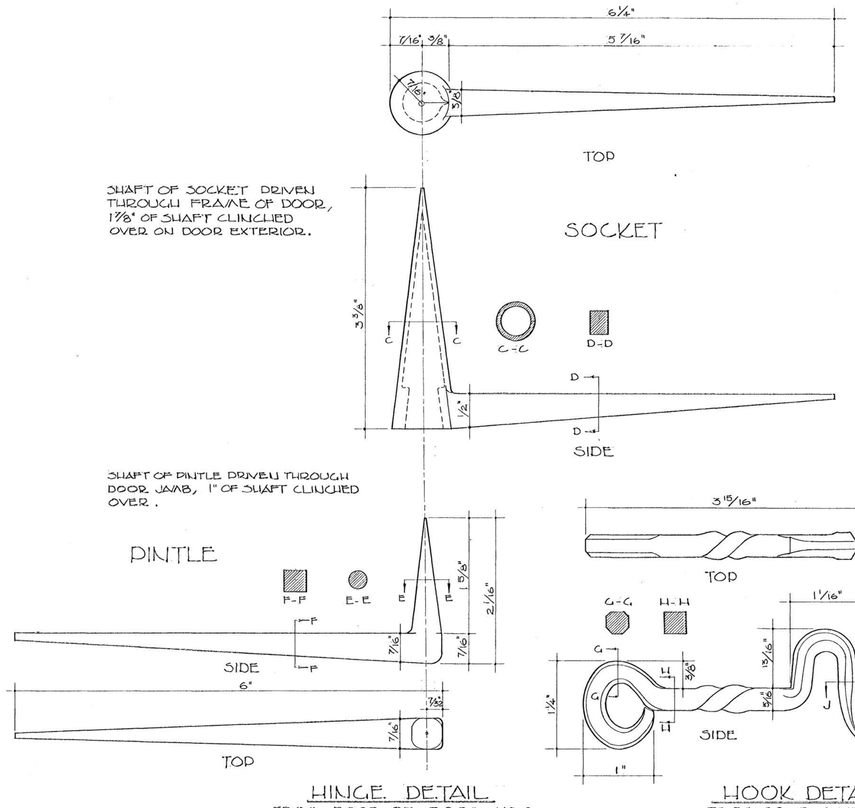
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 9 OF 11 SHEETS

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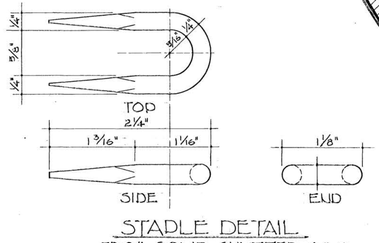
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TRIA LINE



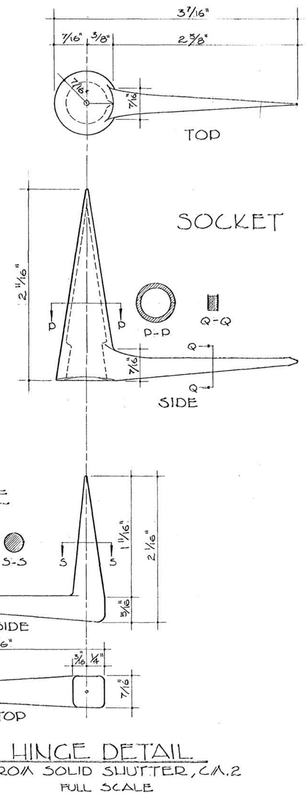
HINGE DETAIL
FROM DOOR OF ROOM NO.2
FULL SCALE

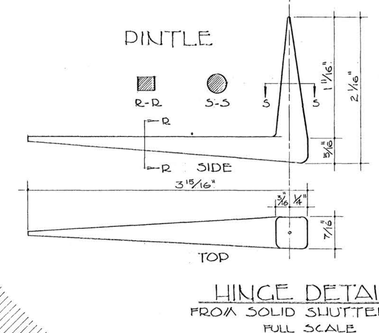
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FROM SOLID SHUTTER, C/M.2
FULL SCALE



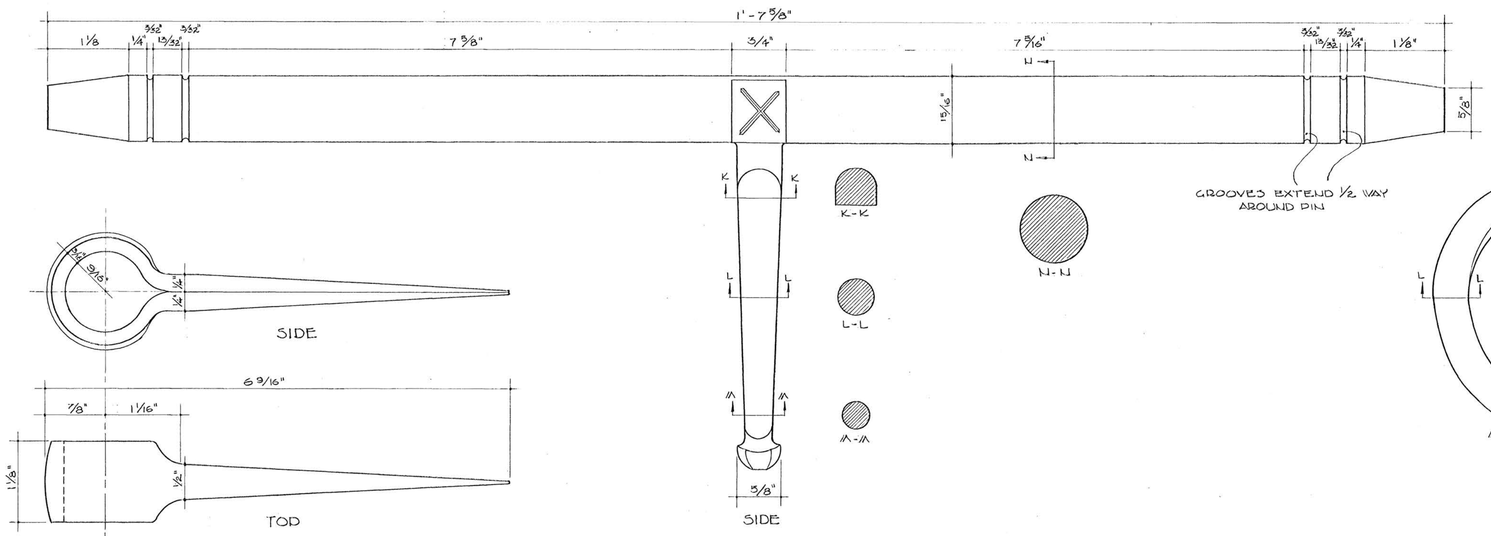
STADLE DETAIL
FROM SOLID SHUTTER, C/M.2.
FULL SCALE

NAIL DETAIL
FROM SOLID SHUTTER. C/M.2
FULL SCALE





HINGE DETAIL
FROM SOLID SHUTTER, C/M.2
FULL SCALE



EYE DETAIL
FROM SOLID SHUTTER, C/M.2
FULL SCALE

SLIDING PIN DETAIL
FROM SOLID SHUTTER, C/M.2
FULL SCALE

MATCH LINE

F. S. DETAIL
CORNICE, W. FACADE
TAKEN AT 'B'

MATCH LINE

0 ½ 1 2 3 4 5 in.
SCALE - INCHES

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DEL. T. R. FROST 9/13/62

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SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE, BRANCH OF PLANS & DESIGN

NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL — TROOPS' QUARTERS
ERECTED CIRCA 1775 — SAN JUAN, PUERTO RICO — MODIFIED 19TH CENTURY

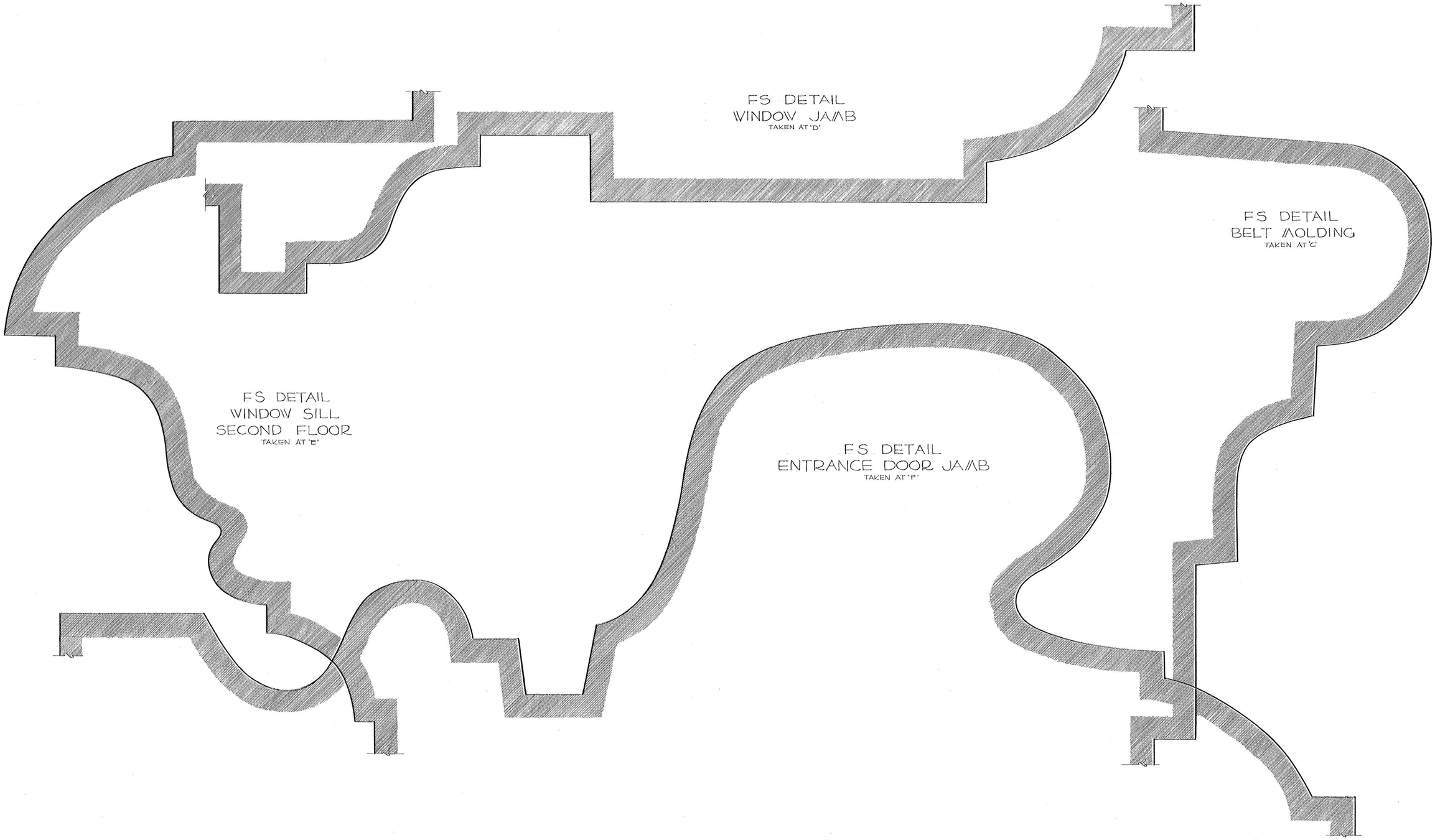
SURVEY NO. PR-100

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 10 OF 11 SHEETS

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SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE, BRANCH OF PLANS & DESIGN

NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL - TROOPS' QUARTERS
ERECTED CIRCA 1773 — SAN JUAN, PUERTO RICO — MODIFIED 19TH CENTURY

SURVEY NO.
PR-100

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 11 OF 11 SHEETS

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Castillo de San Cristóbal North Casemates, San Juan, PR. 1963. Historic American Buildings Survey, HABS PR-101.

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Sheet 1 Map of Puerto Rico, Map of Old San Juan, Site Plan – San Cristóbal

Sheet 2 First Floor Plan

Sheet 3 Roof Plan

Sheet 4 Section A-A, South Elevation of Information Center and West Elevation

Sheet 5 North Elevation and Longitudinal Section B-B

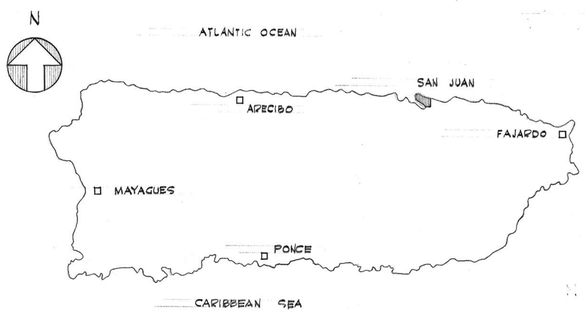
Sheet 6 Cross Section C-C and Cross Section D-D

Sheet 7 Profile of Cornice A-A, Profile of Cornice B-B, Profile of Cornice C-C, and Profile of Cornice D-D

Sheet 8 North Elevation of CM 10 and CM 11, First Floor Plan of CM 10 and CM 11, Second Floor Plan of CM 10 and CM 11, Roof Plan of CM 10 and CM 11and Longitudinal Section E-E

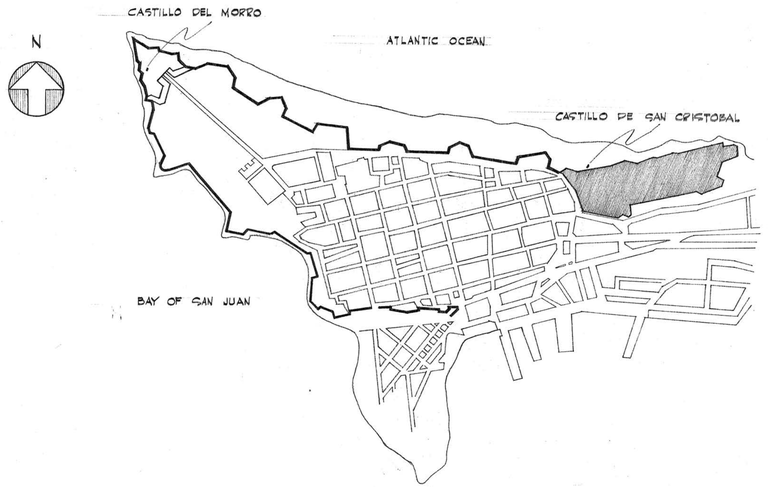
CASTILLO DE SAN CRISTOBAL

NORTH CASEMATES



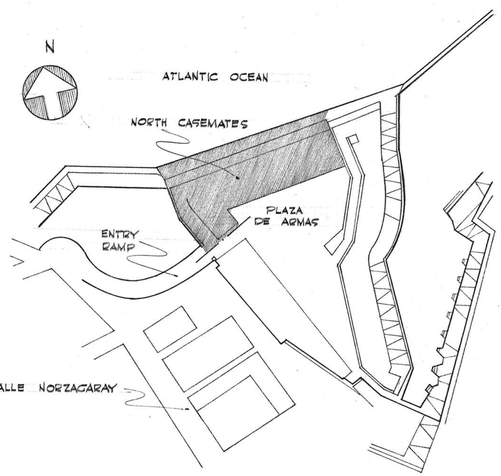
MAP OF PUERTO RICO

0 5 10 20 30 40 MI.



MAP OF OLD SAN JUAN

0 100 200 400 800 1200 FT.



SITE PLAN — SAN CRISTOBAL

0 50 100 200 300 FT.

SAN JUAN PUERTO RICO

THE MASSIVE FORT OF SAN CRISTOBAL, LOCATED ON THE NORTHEAST CORNER OF THE OLD WALLED CITY OF SAN JUAN, WAS BEGUN AROUND 1633. AN IMPORTANT LINK IN THE CHAIN OF DEFENSIVE WORKS OF THE CITY, IT WAS PLANNED FOR DEFENSE IN DEPTH. THE NORTH CASEMATES WERE DESIGNED AND BUILT AS VAULTS BY THOMAS O'DALY, CHIEF OF THE SPANISH MILITARY ENGINEERS OF SAN JUAN, AND WERE READY FOR USE AS STORAGE AND LIVING QUARTERS IN 1785. BETWEEN 1849 - 1858 THEY WERE CONVERTED INTO CASEMATES AND THE ARCHED GALLERY IN FRONT WAS BUILT. THESE MAJOR ALTERATIONS DETERMINE TO SOME EXTENT THE EXISTING CHARACTER. OCCUPIED BY THE U.S. ARMY AFTER THE SPANISH-AMERICAN WAR IN 1898 IT SERVED FOR VARIOUS MILITARY USES UNTIL 1960 WHEN IT BECAME UNOCCUPIED. THE FORT WAS TRANSFERRED TO THE SAN JUAN NATIONAL HISTORIC SITE ON SEPTEMBER 13, 1961.

NHS - SJ

DEL. PAUL E. ROBINSON 11/1/63

PROJECT SUPERVISOR: P.C. CUBBING
DELINEATORS: T.R. FROST ARCHITECT (PRINCETON U.); P.E. ROBINSON ARCHITECT (U. OF FLORIDA)

SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE BRANCH OF PLANS AND DESIGN

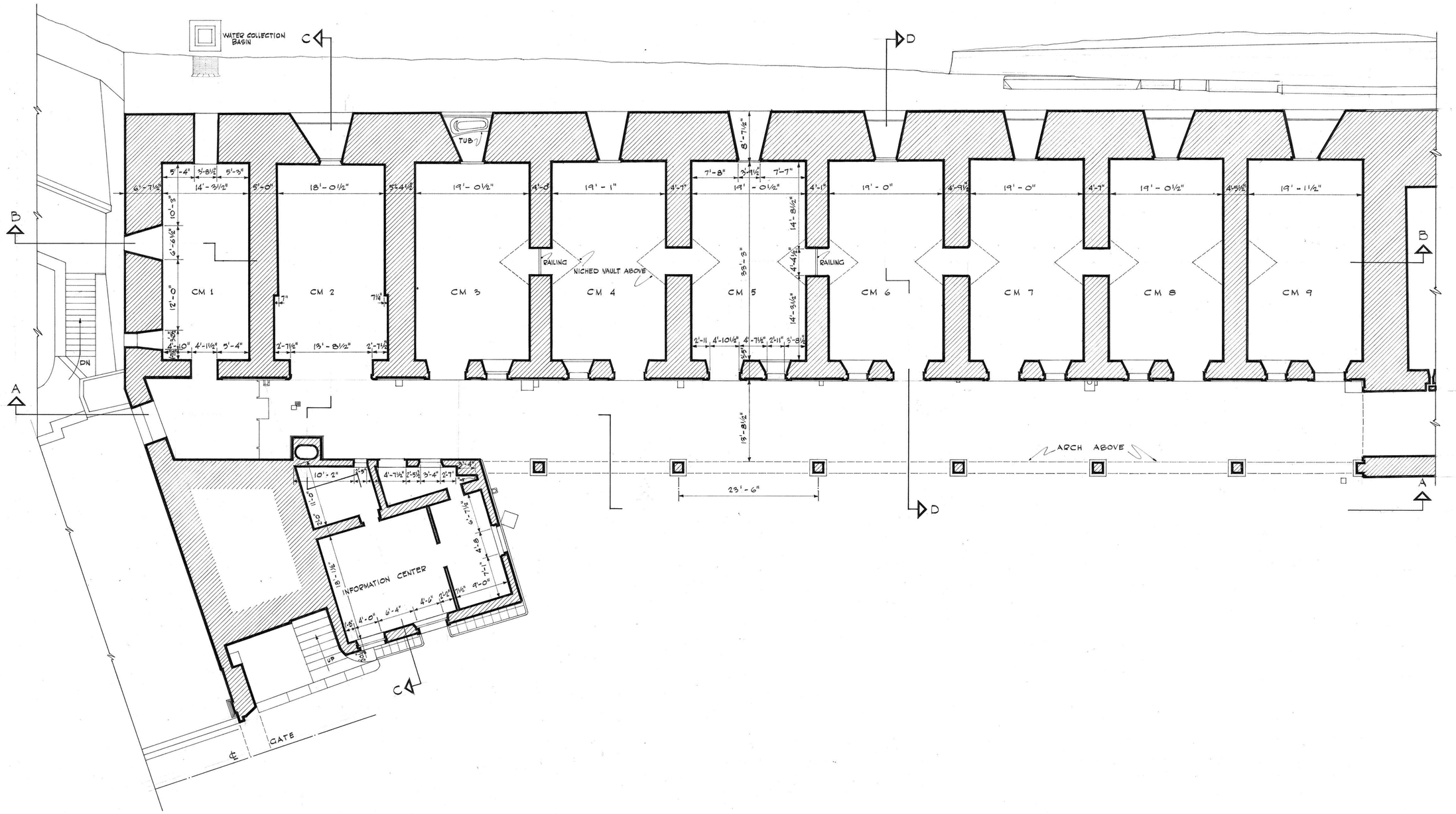
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL NORTH CASEMATES
SAN JUAN, PUERTO RICO

SURVEY NO. PR-101

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 1 OF 8 SHEETS

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FIRST FLOOR PLAN
SCALE : 1/8" = 1'-0"

DEL. { THOMAS R. FROST
PAUL E. ROBINSON 11/1/63

0 5 10 15 20 25
SCALE = 1/8" = 1'-0"

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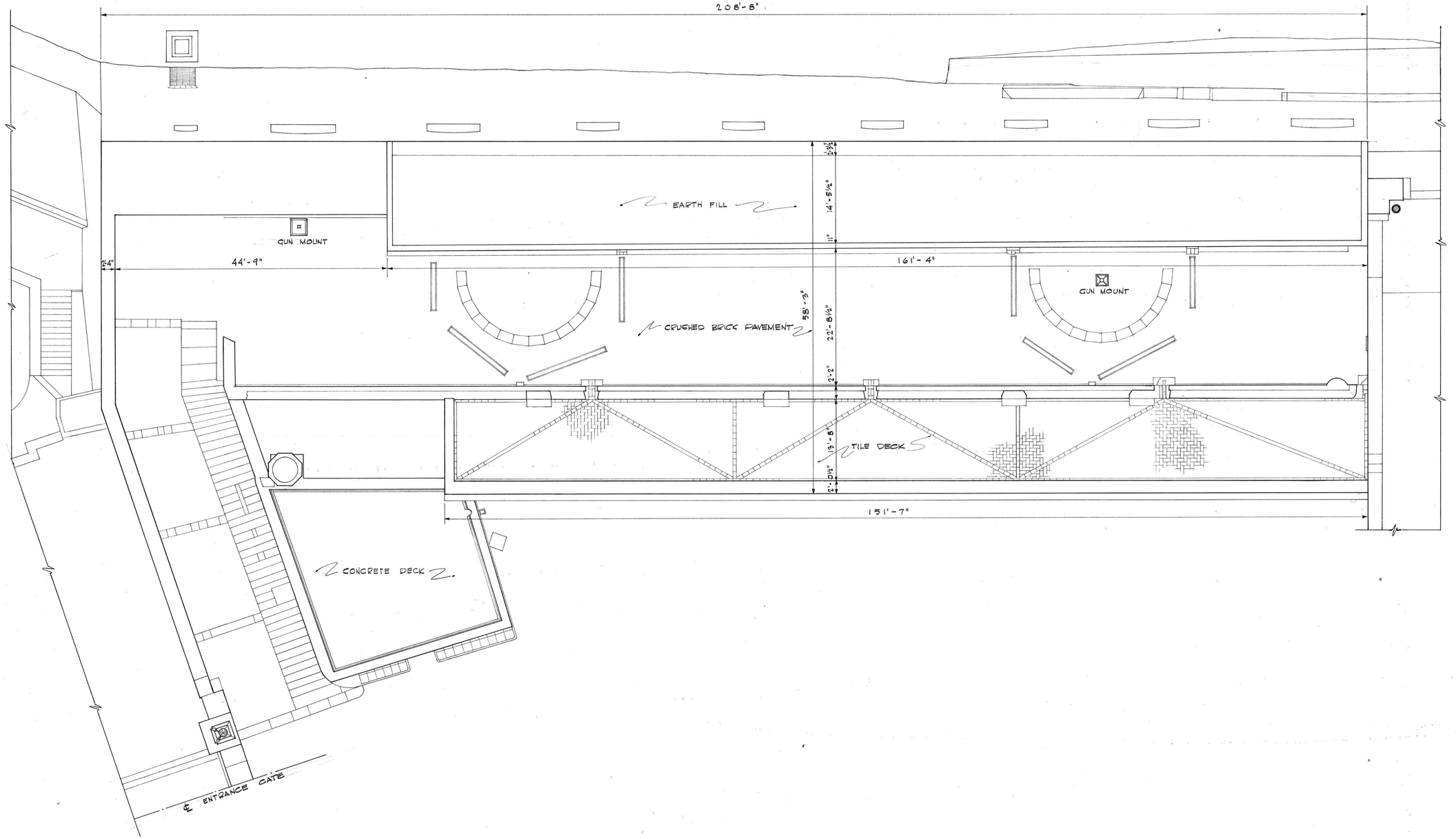
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL NORTH CASEMATES
SAN JUAN PUERTO RICO

SURVEY NO. PR-101

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 2 OF 8 SHEETS

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ROOF PLAN
SCALE : 1/8"=1'-0"

0 5 10 15 20 25
SCALE : 1/8"=1'-0"

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DEL. { THOMAS R. FROST
PAUL E. ROBINSON 11/1/63

SAN JUAN NATIONAL HISTORIC SITE
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UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE BRANCH OF PLANS AND DESIGN

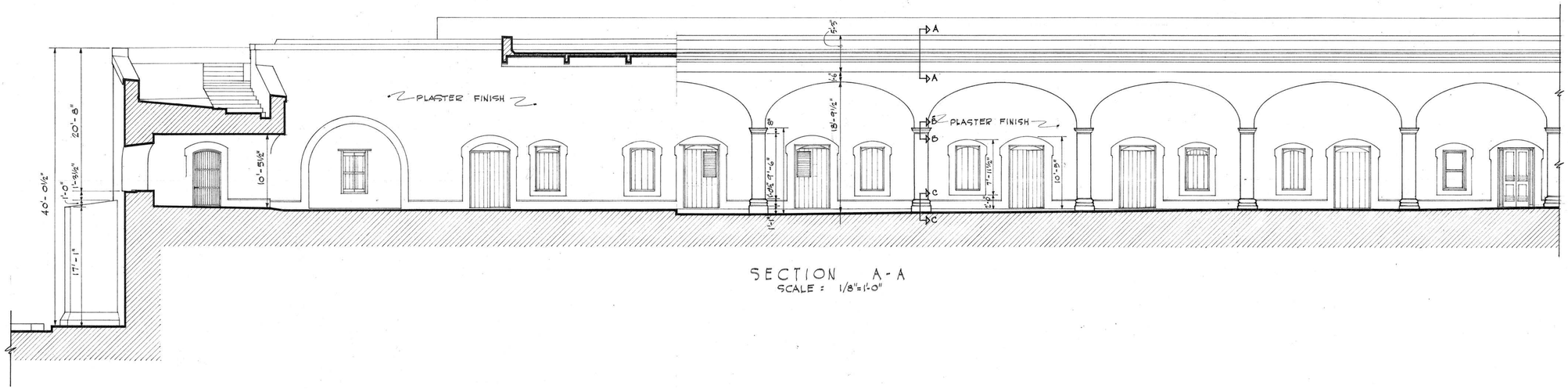
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL NORTH CASEMATES
SAN JUAN, PUERTO RICO

SURVEY NO. PR-101

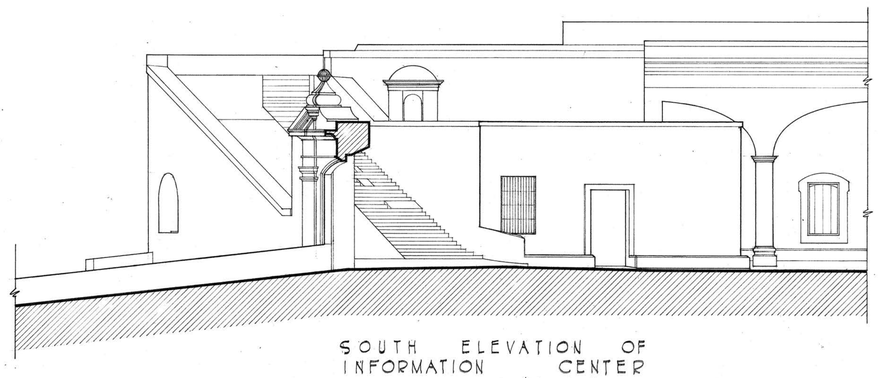
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 3 OF 8 SHEETS

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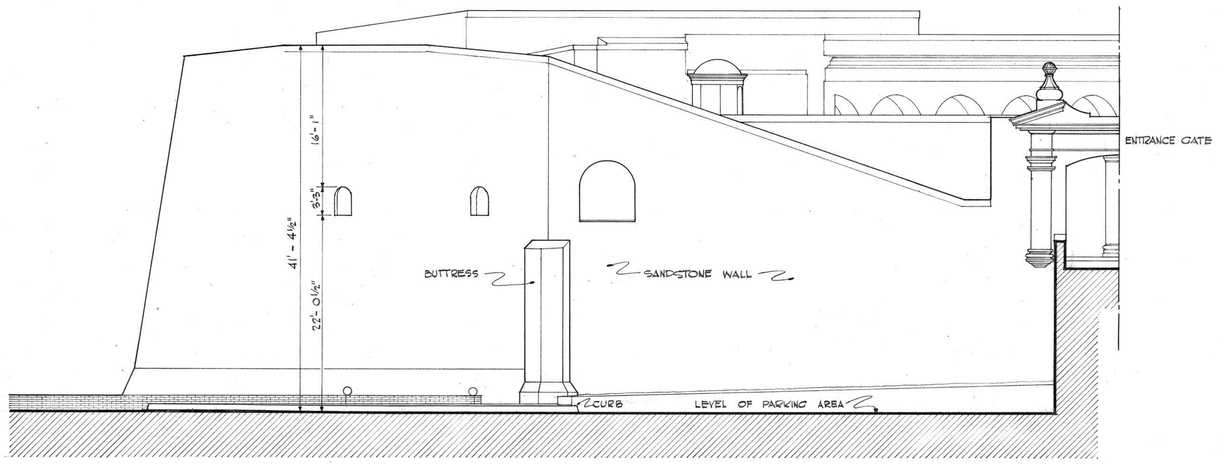
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SECTION A-A
SCALE : 1/8"=1'-0"



SOUTH ELEVATION OF INFORMATION CENTER
SCALE : 1/8" = 1'-0"



WEST ELEVATION
SCALE: 1/8" = 1'-0"

0 5 10 15 20 25
SCALE 1/8"=1'-0"

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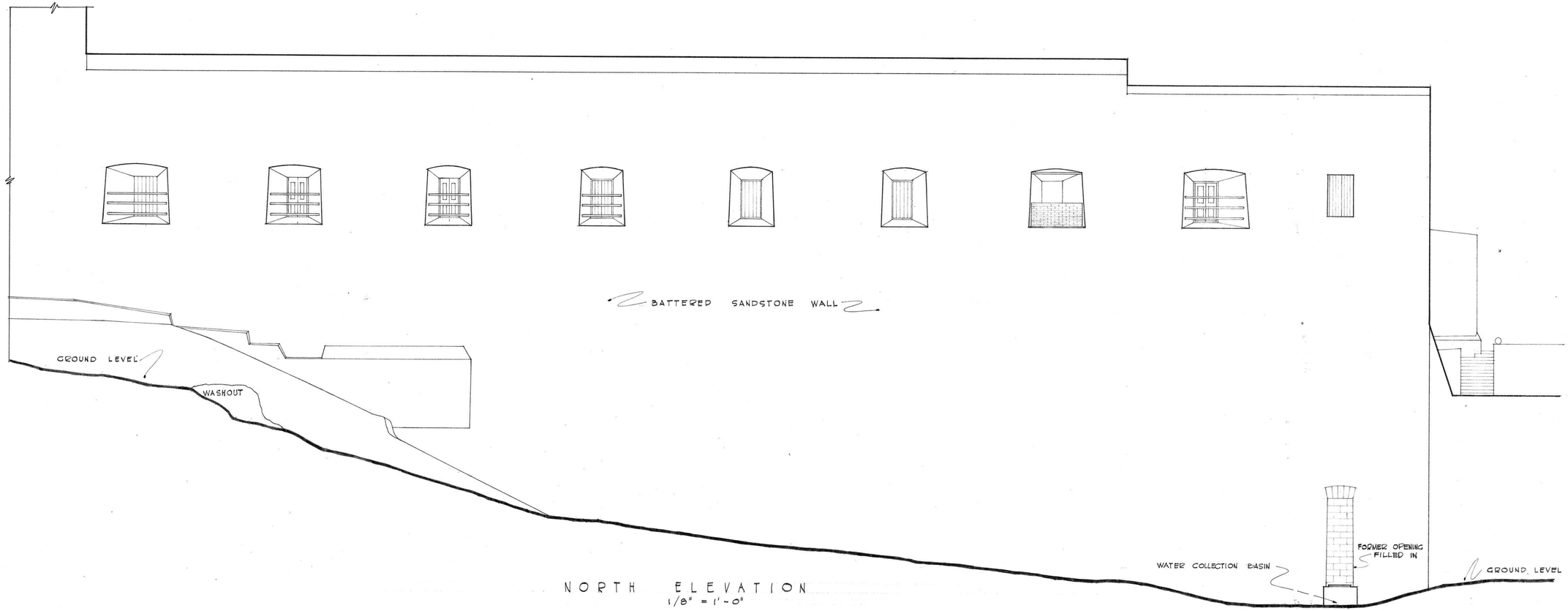
SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF THE UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE BRANCH OF PLANS AND DESIGN

NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL NORTH CASEMATES
SAN JUAN, PUERTO RICO

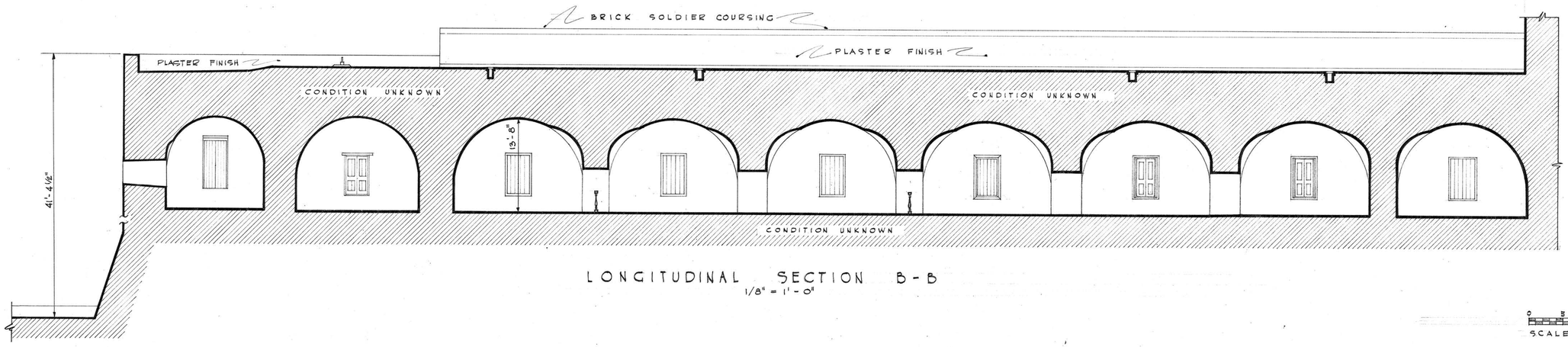
SURVEY NO. PR-101

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 4 OF 8 SHEETS

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NORTH ELEVATION
1/8" = 1'-0"



LONGITUDINAL SECTION B-B
1/8" = 1'-0"

0 5 10 15 20 25
SCALE : 1/8" = 1'-0"

DEL. P.E. ROBINSON 7/30/63

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SAN JUAN FIELD OFFICE
UNDER DIRECTION OF THE UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE. BRANCH OF PLANS AND DESIGN

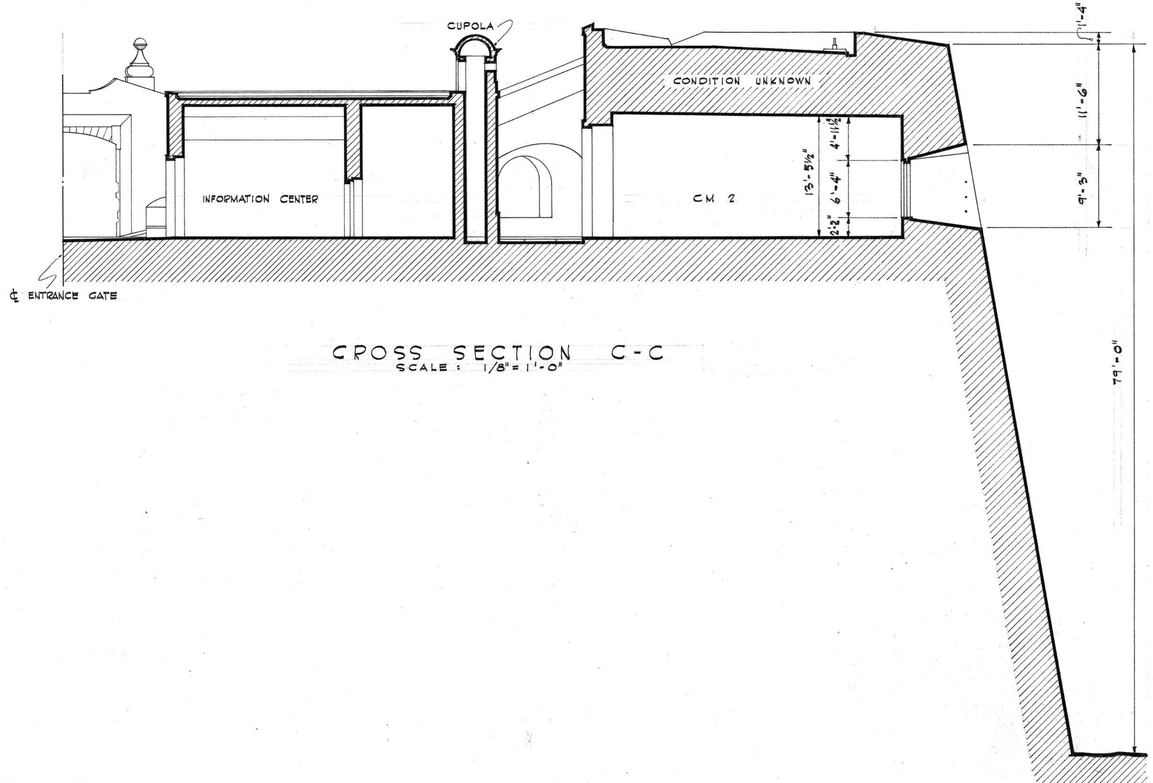
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL NORTH CASEMATES
SAN JUAN, PUERTO RICO

SURVEY NO. PR-101

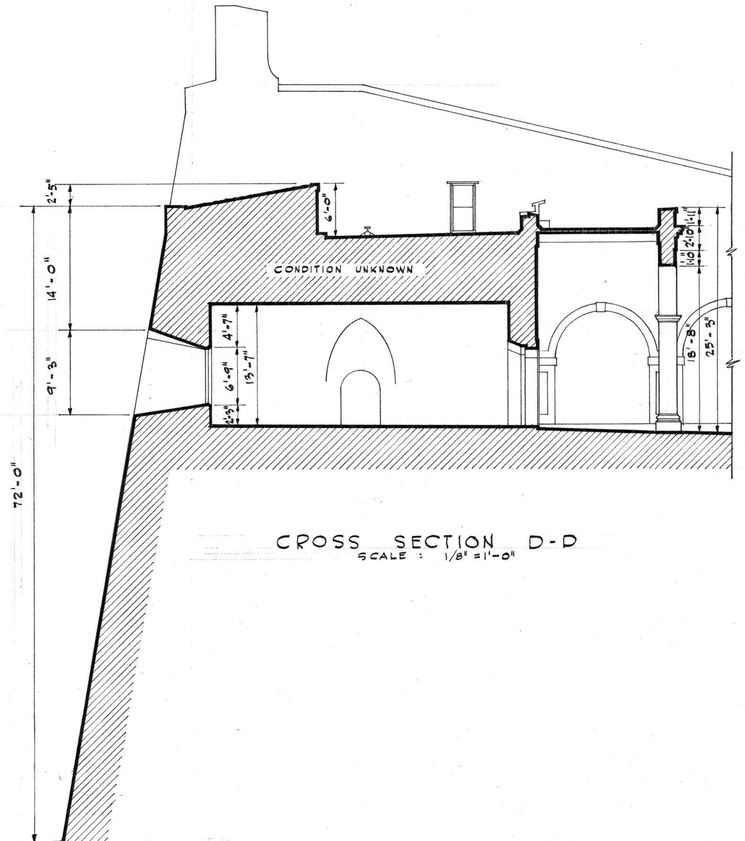
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 5 OF 8 SHEETS

LIBRARY OF CONGRESS INDEX NO.

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CROSS SECTION C-C
SCALE : 1/8"=1'-0"



CROSS SECTION D-D
SCALE : 1/8"=1'-0"

0 5 10 15 20 25
SCALE : 1/8"=1'-0"

NHS-SJ

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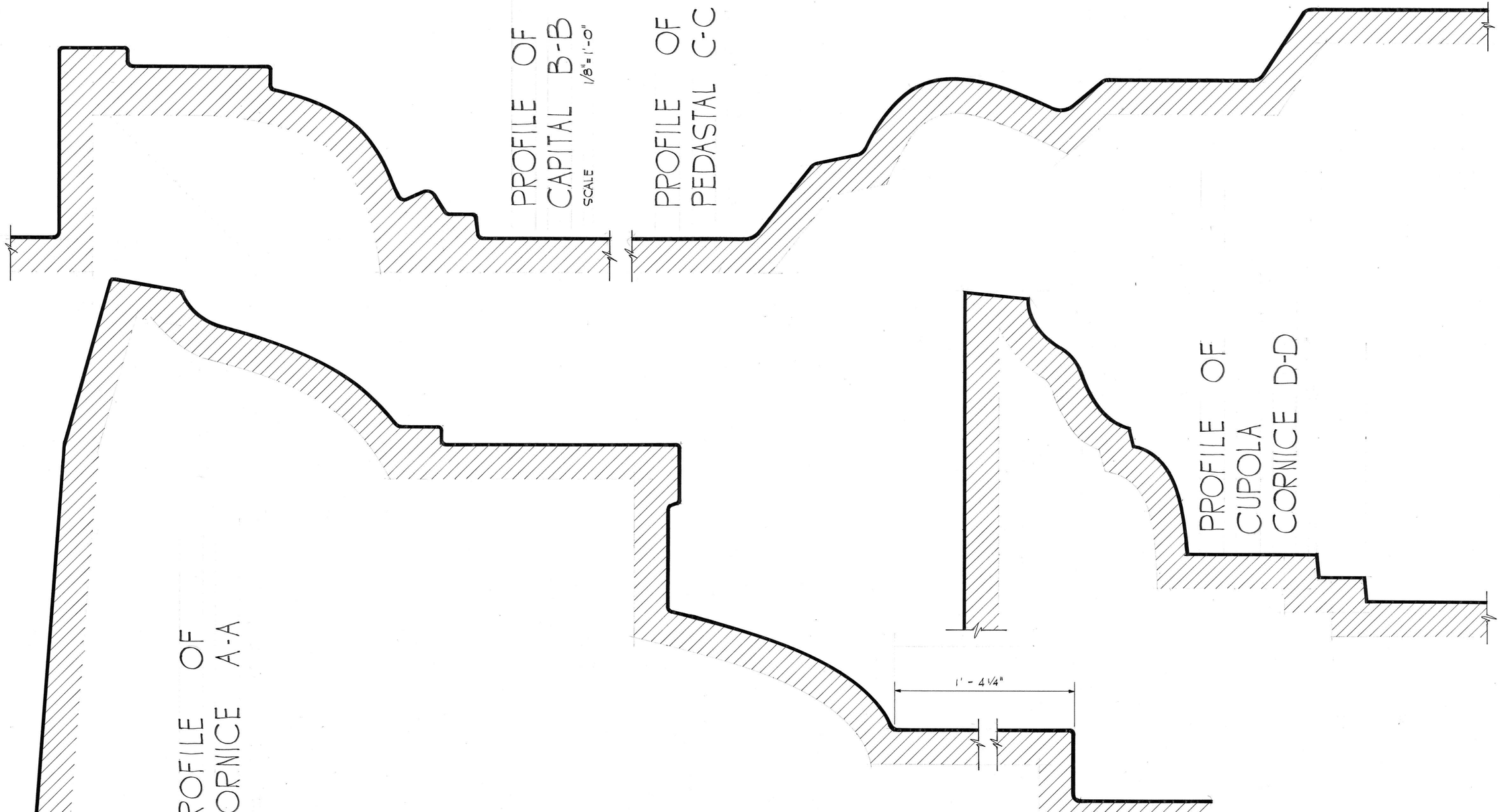
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL NORTH CASEMATES
SAN JUAN, PUERTO RICO

SURVEY NO: PR-101

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 6 OF 8 SHEETS

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FULL SIZE SCALE

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SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE BRANCH OF PLANS AND DESIGN

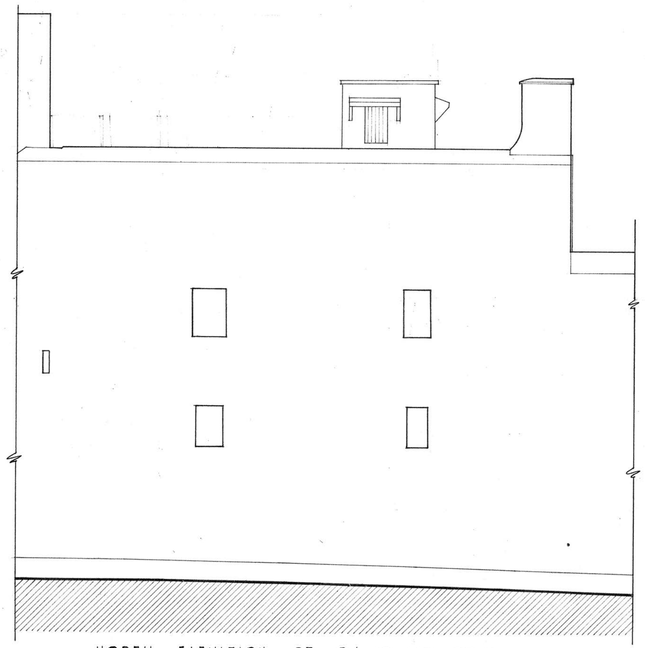
NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL NORTH CASEMATES
SAN JUAN, PUERTO RICO

SURVEY NO. PR-101

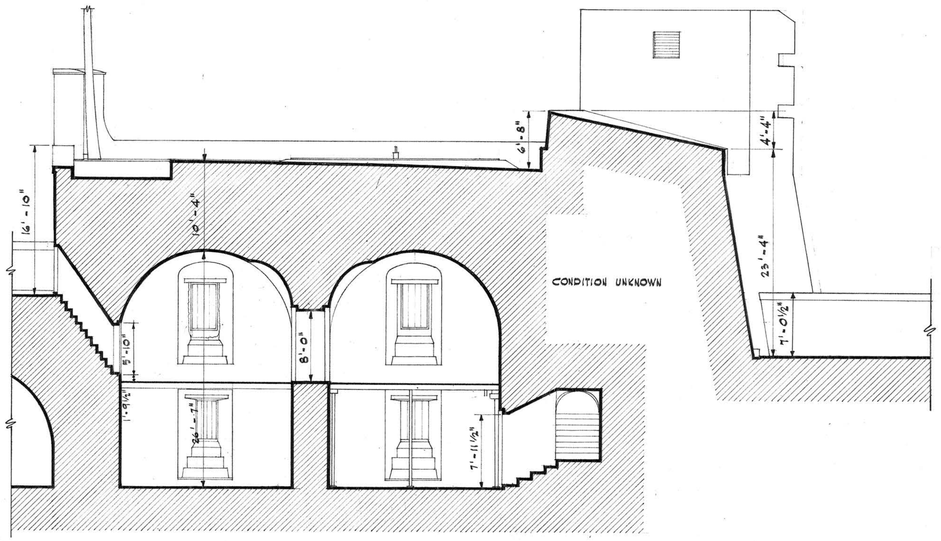
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 7 OF 8 SHEETS

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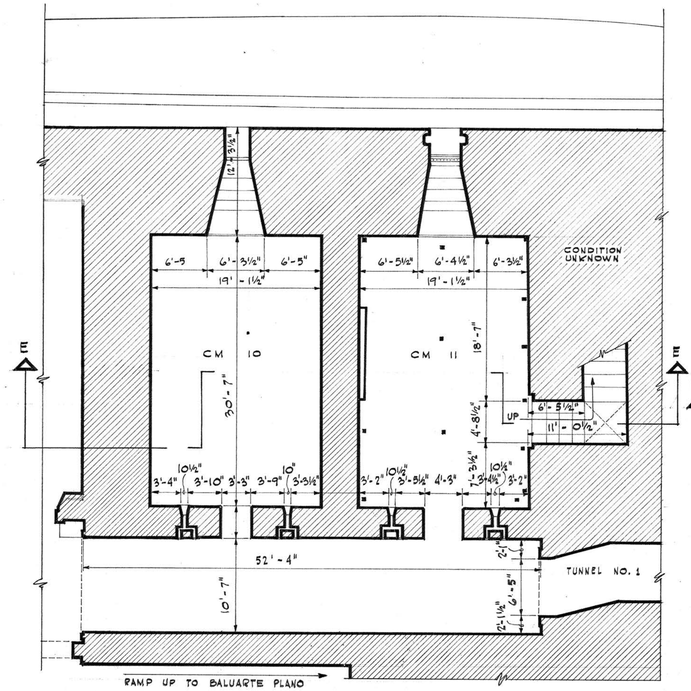
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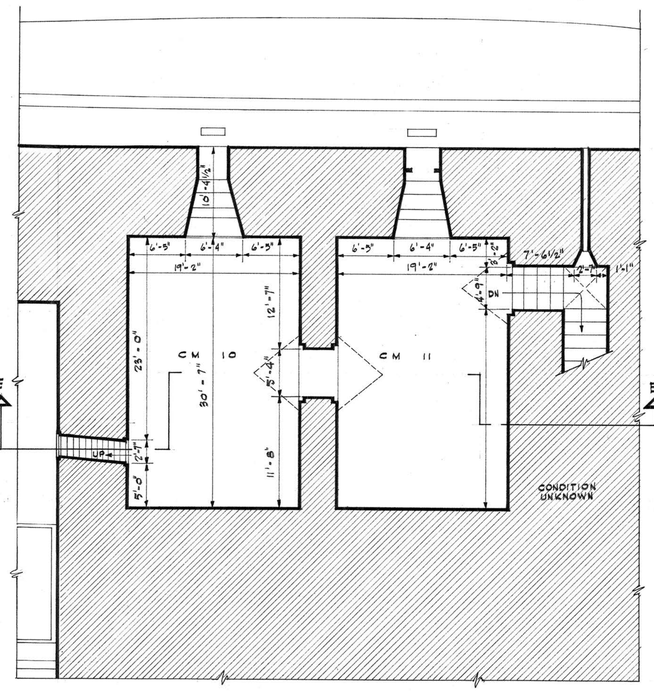
NORTH ELEVATION OF CM 10 AND CM 11
SCALE: 1/8" = 1'-0"



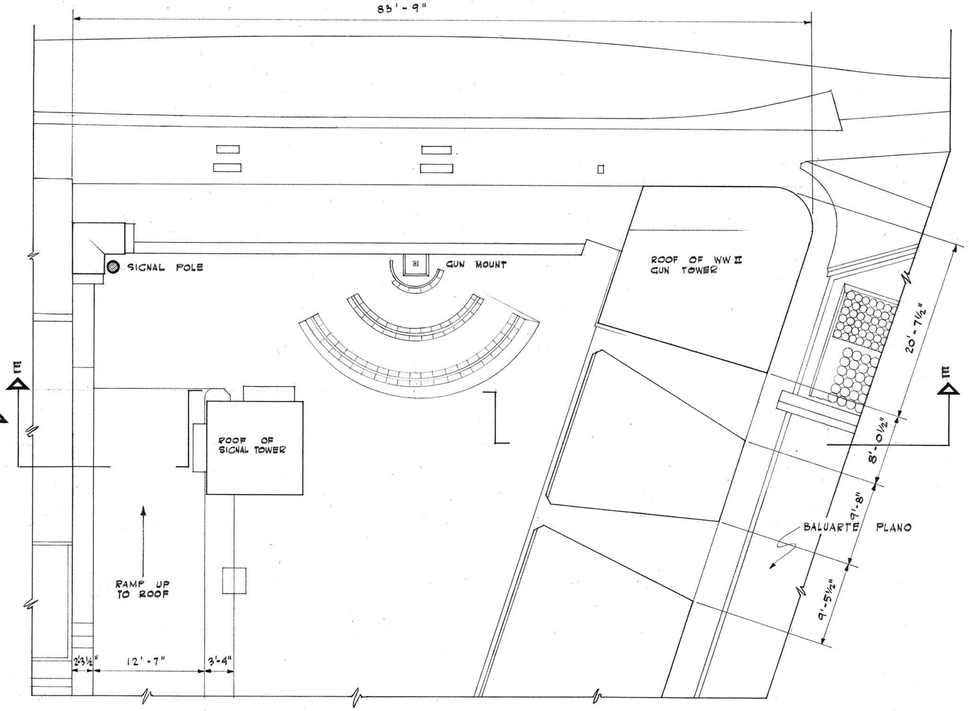
LONGITUDINAL SECTION E-E
SCALE 1/8" = 1'-0"



FIRST FLOOR PLAN OF CM 10 AND CM 11
SCALE: 1/8" = 1'-0"



SECOND FLOOR PLAN OF CM 10 AND CM 11
SCALE 1/8" = 1'-0"



ROOF PLAN OF CM 10 AND CM 11
SCALE 1/8" = 1'-0"

0 5 10 15 20 25
SCALE : 1/8" = 1'-0"

PAUL E. ROBINSON, DELINEATOR 10/29/63

NHS · SJ

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SAN JUAN NATIONAL HISTORIC SITE
SAN JUAN FIELD OFFICE
UNDER DIRECTION OF UNITED STATES DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE BRANCH OF PLANS AND DESIGN

NAME OF STRUCTURE
CASTILLO DE SAN CRISTOBAL NORTH CASEMATES
SAN JUAN, PUERTO RICO

SURVEY NO. PR-101

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 8 OF 8 SHEETS

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Cistern Heads, El Caballero, Castillo San Cristóbal, San Juan, PR. 1970. Historic American Buildings Survey, HABS PR-102.

Sheet Index

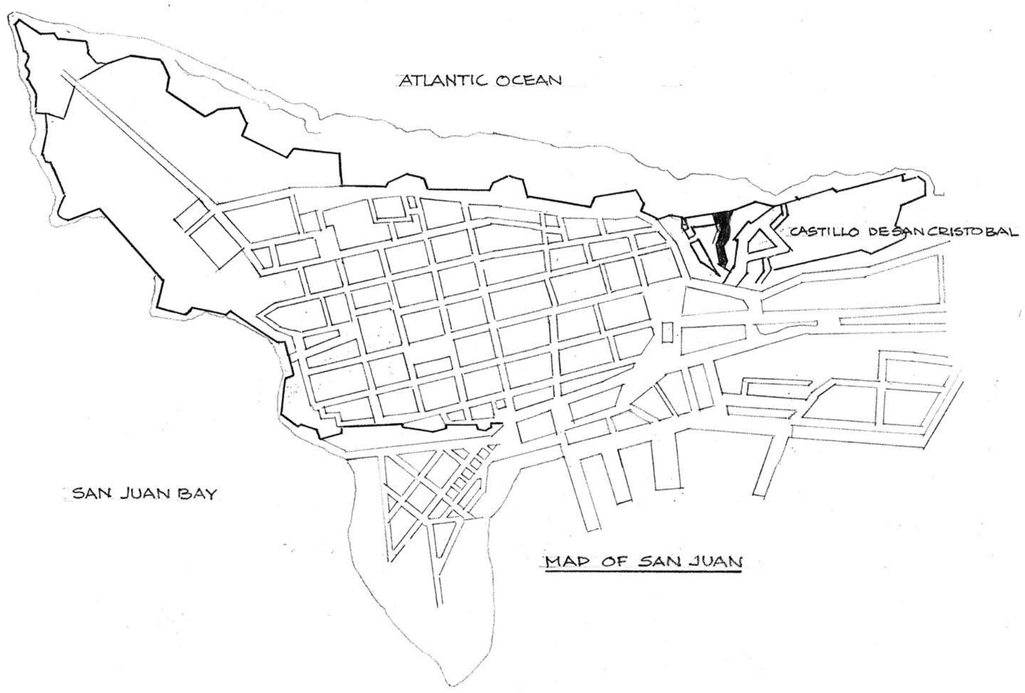
Sheet 1 Map of San Juan, Site Plan

Sheet 2 Elevation, Plan, Full Scale Detail of Collar and Base Mouldings

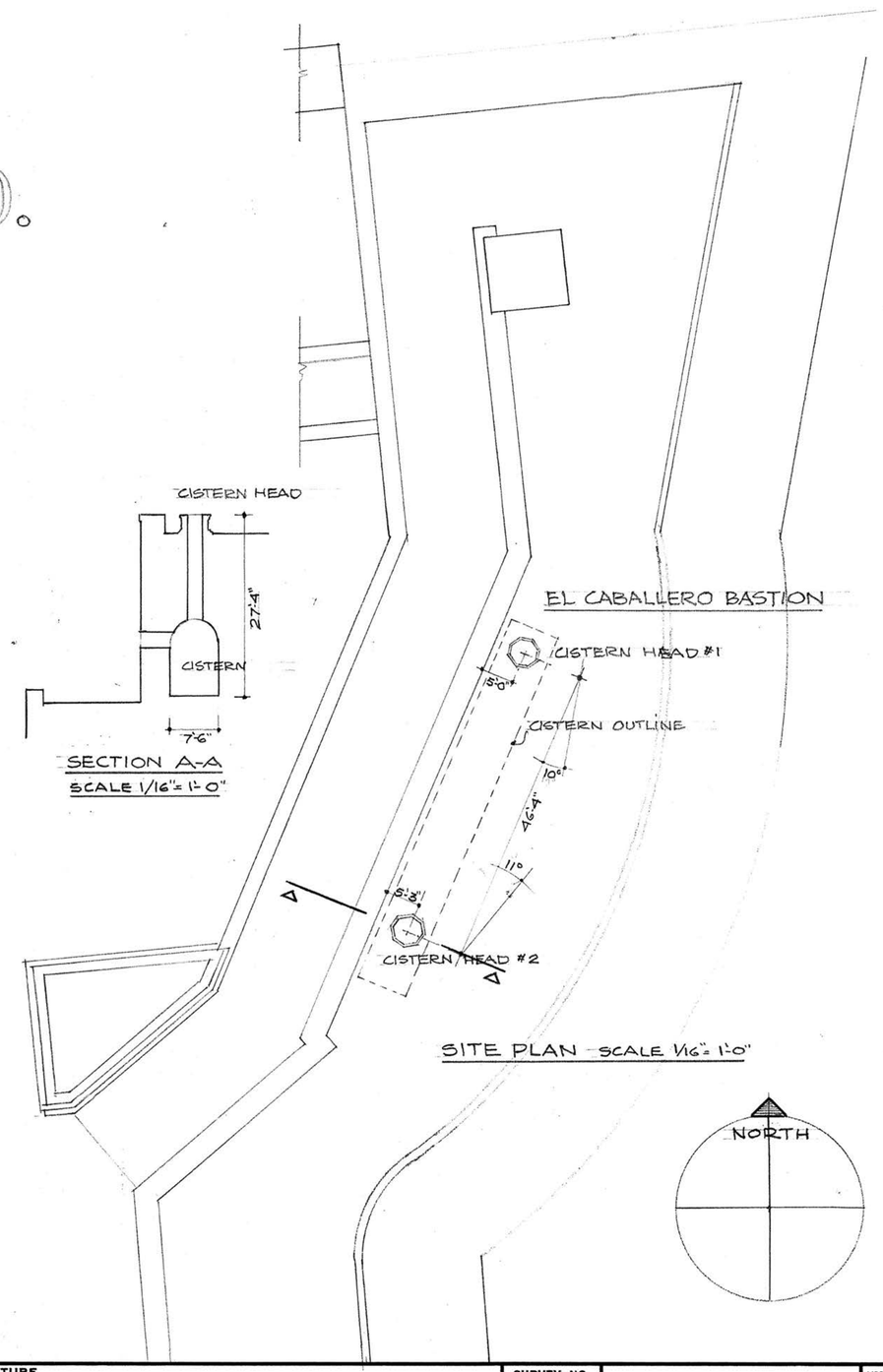
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CISTERN-HEADS, EL CABALLERO SAN CRISTOBAL

SAN JUAN, PUERTO RICO.



MAP OF SAN JUAN



SECTION A-A
SCALE 1/16"= 1'-0"

SITE PLAN SCALE 1/16"= 1'-0"

THE CISTERN HEADS ARE PART OF THE REMODELLING AND EXPANSION WORK ON CASTILLO DE SAN CRISTOBAL DESIGNED AND CARRIED OUT BY TOMAS O'DALY, CHIEF OF THE SPANISH MILITARY CORPS OF ENGINEERS IN SAN JUAN, PUERTO RICO, THAT WAS COMPLETED IN THE EARLY 1770'S.

RECORDED BY THE NATIONAL PARK SERVICE, U.S. DEPARTMENT OF THE INTERIOR. MEASURED OCTOBER 1969 AND DRAWN SEPTEMBER 1970 BY F.C.GJESSING, ARCHITECT-VIRGIN ISLANDS NATIONAL PARK

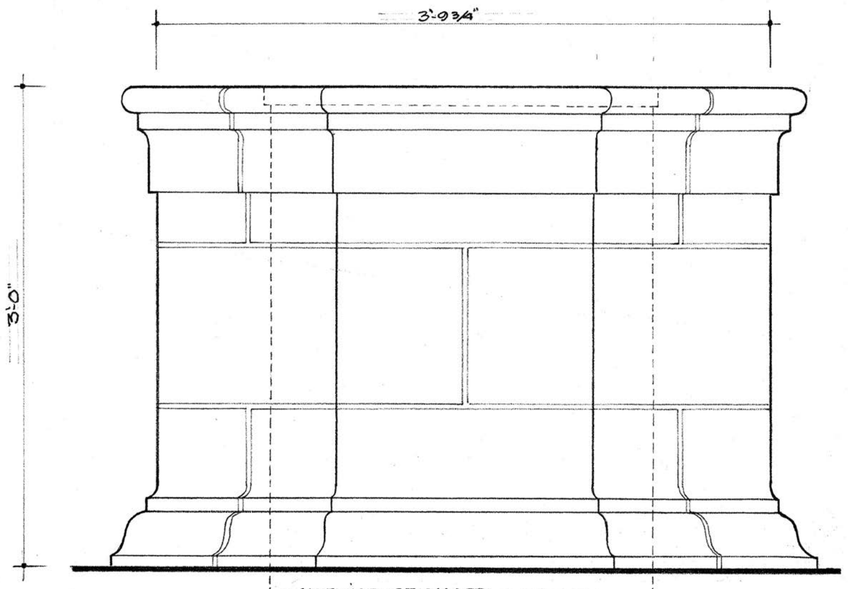
DRAWN BY: F.C.GJESSING SEPT 1970

FIELD OFFICE VIRGIN ISLANDS NATIONAL PARK UNDER DIRECTION OF THE NATIONAL PARK SERVICE, UNITED STATES DEPARTMENT OF THE INTERIOR	NAME AND LOCATION OF STRUCTURE CISTERN-HEADS EL CABALLERO BASTION, CASTILLO DE SAN CRISTOBAL, SAN JUAN, P.R.	SURVEY NO. PR 102	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 1 OF 2 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

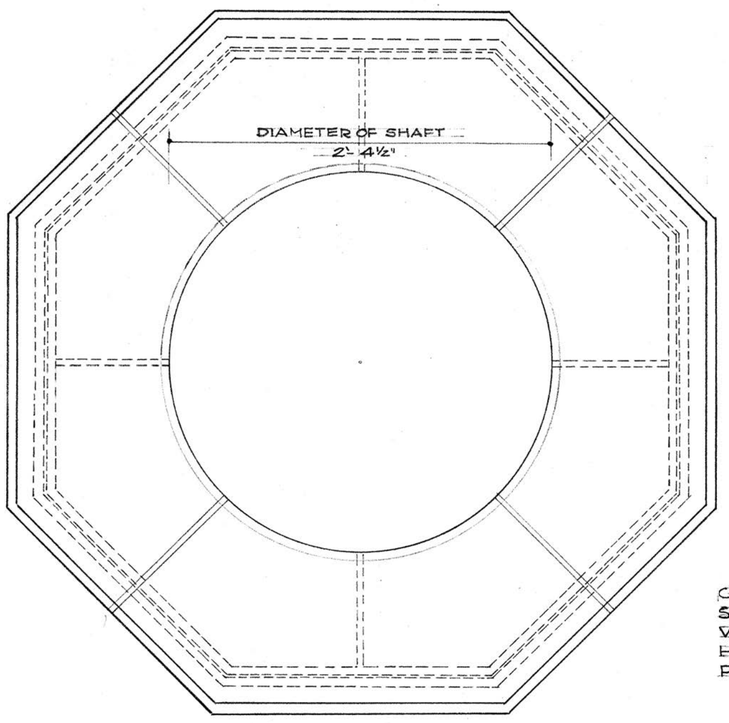
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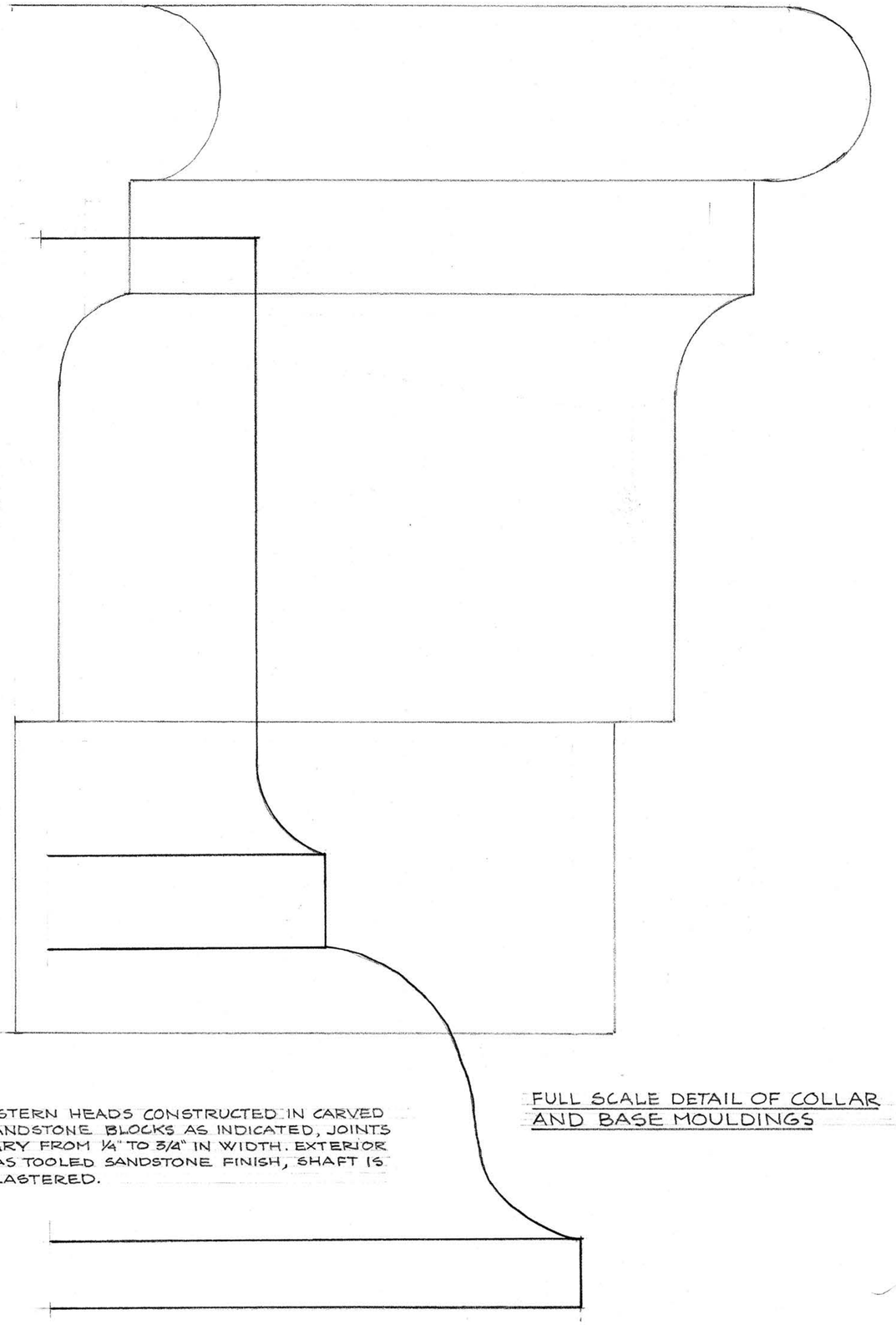


ELEVATION SCALE 1½"=1'-0"



PLAN SCALE 1½"=1'-0"

CISTERN HEADS CONSTRUCTED IN CARVED SANDSTONE BLOCKS AS INDICATED, JOINTS VARY FROM ¼" TO 3/4" IN WIDTH. EXTERIOR HAS TOOLED SANDSTONE FINISH, SHAFT IS PLASTERED.



FULL SCALE DETAIL OF COLLAR AND BASE MOULDINGS

DRAWN BY: FREDERIK C. GJESSING SEPT. '70

FIELD OFFICE, VIRGIN ISLANDS NATIONAL PARK UNDER DIRECTION OF THE NATIONAL PARK SERVICE. UNITED STATES DEPARTMENT OF THE INTERIOR	NAME AND LOCATION OF STRUCTURE CISTERN-HEADS EL CABALLERO BASTION, CASTILLO DE SAN CRISTOBAL, SAN JUAN, P. R.	SURVEY NO. PR 102	HISTORIC AMERICAN BUILDINGS SURVEY SHEET 2 OF 2 SHEETS	LIBRARY OF CONGRESS INDEX NUMBER

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La Trinidad Counterguard, San Juan, PR. 1984. Historic American Buildings Survey, HABS PR-121.

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Sheet 12 Lower Level Battlement Floor Plan, Section/Elevation L, and Section Detail M

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Sheet 14 Upper Casemates Floor Plan and Elevation

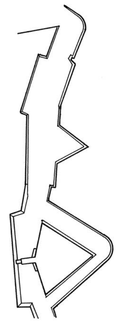
Sheet 15 Lower Casemates Floor Plan and Elevation

Sheet 16 Banquette Elevation Details – Upper Level, Banquette Elevation Details – Intermediate Level, and Parapet Elevation Details

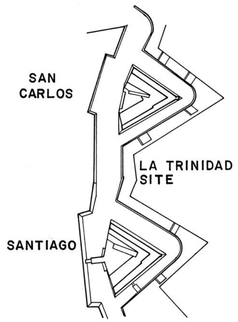
Sheet 17 Upper Level – Location Plan, Intermediate Level – Location Plan, and Lower Level - Location Plan

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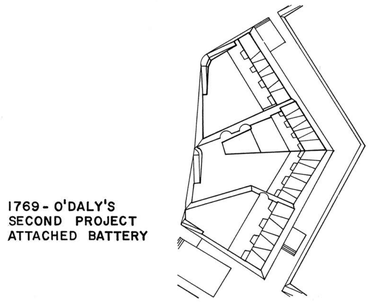
LA TRINIDAD COUNTERGUARD



1765 - O'DALY'S ARRIVAL

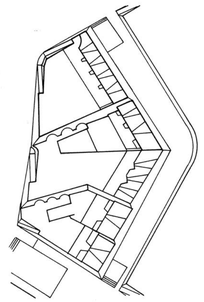


1765 - O'DALY'S FIRST PROJECT

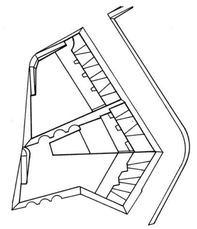


1769 - O'DALY'S SECOND PROJECT ATTACHED BATTERY

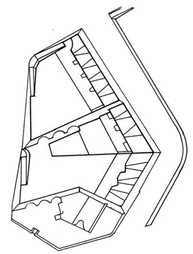
1773 - O'DALY'S LAST PROJECT



1783 - JUAN MESTRE'S COMPLETION



1892 - ROYAL DECREE PROJECTED DEMOLITION



1984

LA TRINIDAD COUNTERGUARD, BUILT BETWEEN 1765 – 1783 BY MILITARY ENGINEER THOMAS O'DALY, CHIEF OF THE SPANISH CORPS OF ENGINEERS IN SAN JUAN, REPRESENTS IN CAPSULE FORM THE SOLUTION TO TACTICAL PROBLEMS PRESENTED IN THE SITE OF THE CASTILLO DE SAN CRISTOBAL. THE CONDITIONS EXISTING AT THE FORT WERE THE BASTION'S WALLS OF SOMEWHAT ANTIQUATED HEIGHTS FACING A FLAT EXPANSE FROM WHICH ENEMY CANNONS COULD HIT ITS EXPOSED FLANKS. THIS WAS THE MOST APPROPRIATE POINT WHERE TO ATTACK THE TOWN. LA TRINIDAD, LOCATED WHERE THESE CONDITIONS MEET SERVED THE TWO FOLD PURPOSE OF DEFENDING THE BASTION BEHIND IT AND DEFENDING THE EXPOSED AND SCREENED APPROACH TO SAN CARLOS RAVELIN FROM ATTACK.

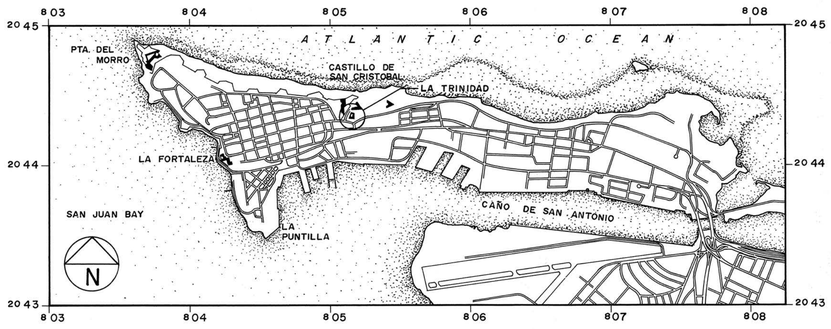
THE SAN CARLOS AND SANTIAGO RAVELINS APPEAR EARLY IN O'DALY'S SCHEMES AND ARE BUILT TO TEXTBOOK PERFECTION. THEY SHOW THE MORE RENAISSANCE SOLUTION OF RAMP AND PLATFORM WITH A PLACE OF ARMS - PLAZA DE ARMAS. LA TRINIDAD DEMONSTRATES A SURPRISING RANGE OF DESIGNS INDICATING EITHER DIFFERENT PERIODS OF CONSTRUCTION OR FUNCTIONAL ADOPTION TO THE TYPE OF ARTILLERY FIRE AND PIECES TO BE PLACED THERE. THE MORE BAROQUE SOLUTION PRESENT IN LA TRINIDAD INCLUDES DOUBLE STEPS, TERREPLEINS, DIFFERENT LEVELS OF BATTERIES AND PARAPETS WHICH RESPOND TO THE SITE AND ITS TACTICAL EXIGENCIES.

LA TRINIDAD AS DEVISED BY O'DALY IS A COUNTERGUARD AND NOT A DEMILUME AS MIGHT BE APPROPRIATE GIVEN ITS LOCATION BEFORE A BASTION BETWEEN TWO RAVELINS. INSTEAD, LA TRINIDAD IS COMPRISED OF TWO FACES WITH A SHALLOW ANGLE OF DEFLECTION AND CONSISTS IN A SERIES OF BATTERIES SET ON TERREPLEINS WITHOUT A CENTRAL UNIFYING PLACE OF ARMS.

LA TRINIDAD WAS A CRITICAL KEYSTONE TO THE SAN CRISTOBAL DEFENSE SYSTEM. ALONG WITH THE OTHER STRUCTURES IN THE SAN JUAN NATIONAL HISTORIC SITE AND LA FORTALEZA, THE SAN CRISTOBAL COMPLEX HAS BEEN DESIGNATED A WORLD HERITAGE SITE. THE DETERIORATION OF THE DIFFERENT ELEMENTS OF LA TRINIDAD IS INDICATION OF NEED OF URGENT EXTENSIVE REPAIRS.

THE LA TRINIDAD COUNTERGUARD DOCUMENTATION PROJECT WAS UNDERTAKEN BY THE WASHINGTON D.C. OFFICE OF THE HISTORIC AMERICAN BUILDING SURVEY (HABS) IN COOPERATION WITH THE SOUTHEAST REGION'S CULTURAL RESOURCES PRESERVATION CENTER AND CO-SPONSORED BY THE SAN JUAN NATIONAL HISTORIC SITE, THE AMERICAN INSTITUTE OF ARCHITECTS FOUNDATION AND THE INTERNATIONAL COUNCIL ON MONUMENTS AND SITES – U.S./ICOMOS.

THE FIELD RECORDING PROJECT WAS CONDUCTED BY THE HABS/HAER DIVISION, ROBERT J. KAPSCH, CHIEF, AND WAS INITIATED AND DIRECTED BY KENNETH L. ANDERSON, PRINCIPAL ARCHITECT, HABS. THE DOCUMENTATION WAS CONDUCTED BY PROJECT SUPERVISOR JOSE M. MARTINEZ-CANINO (GEORGIA INSTITUTE OF TECHNOLOGY), AND ARCHITECTURAL TECHNICIANS JUAN BLANCO (UNIVERSITY OF CALIFORNIA - BERKELEY), TODD A. WAMBACH (BALL STATE UNIVERSITY) AND JEAN CLAUDE FILLION (McGILL UNIVERSITY – U.S./ICOMOS) IN THE SUMMER OF 1984. SPECIAL ASSISTANCE PROVIDED BY CARLOS R. GARRET – ENGINEER (CARLOS R. GARRET Y ASOCIADOS) AND BY CARLOS SOTO GARCIA – SURVEYOR (CARLOS SOTO GARCIA AND ASSOCIATES).



TAKEN FROM: USGS SAN JUAN, P.R. QUADRANGLE 1969 (PHOTOREVISED 1982)
USGS BAYAMON, P.R. QUADRANGLE 1969 (PHOTOREVISED 1982)

UTM 19.805150.2044360

LOCATION MAP

FEET 1" = 1667' 0 1000 3000 5000

METERS 1:20000 0 1 KM 2 KM

NAME AND LOCATION OF STRUCTURE
LA TRINIDAD COUNTERGUARD
CASTILLO DE SAN CRISTOBAL OLD SAN JUAN
SAN JUAN NATIONAL HISTORIC SITE PUERTO RICO

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 1 OF 17 SHEETS

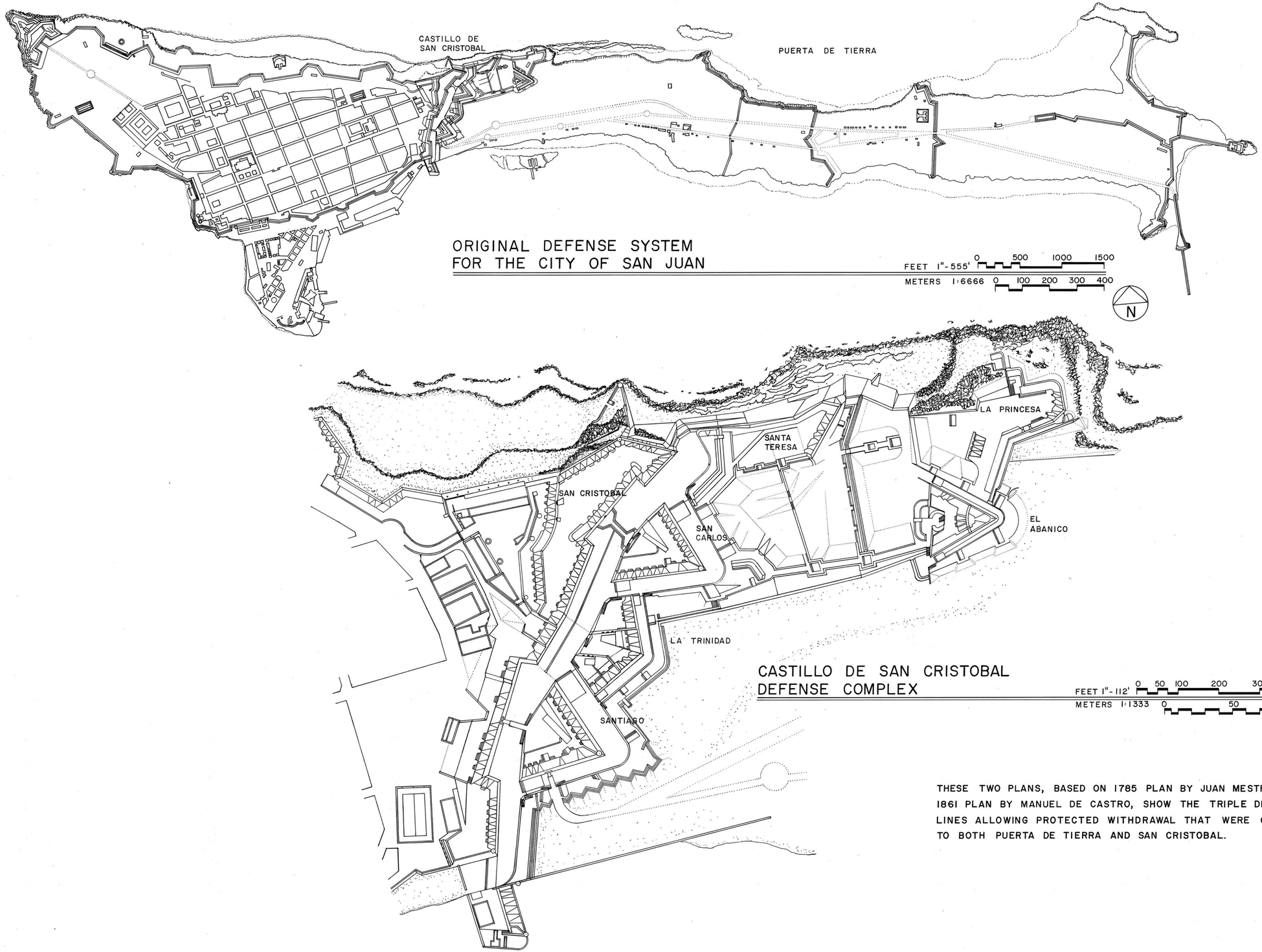
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NATIONAL ARCHITECTURAL AND ENGINEERING RECORD
HERITAGE CONSERVATION AND RECREATION SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

TRIM LINE

TRIM LINE

K&E 19 1253 4-83 A1340*



THESE TWO PLANS, BASED ON 1785 PLAN BY JUAN MESTRE AND 1861 PLAN BY MANUEL DE CASTRO, SHOW THE TRIPLE DEFENSE LINES ALLOWING PROTECTED WITHDRAWAL THAT WERE COMMON TO BOTH PUERTA DE TIERRA AND SAN CRISTOBAL.

NAME AND LOCATION OF STRUCTURE
LA TRINIDAD COUNTERGUARD
SAN JUAN NATIONAL HISTORIC SITE — OLD SAN JUAN — PUERTO RICO
CASTILLO DE SAN CRISTOBAL

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HISTORIC AMERICAN BUILDINGS SURVEY
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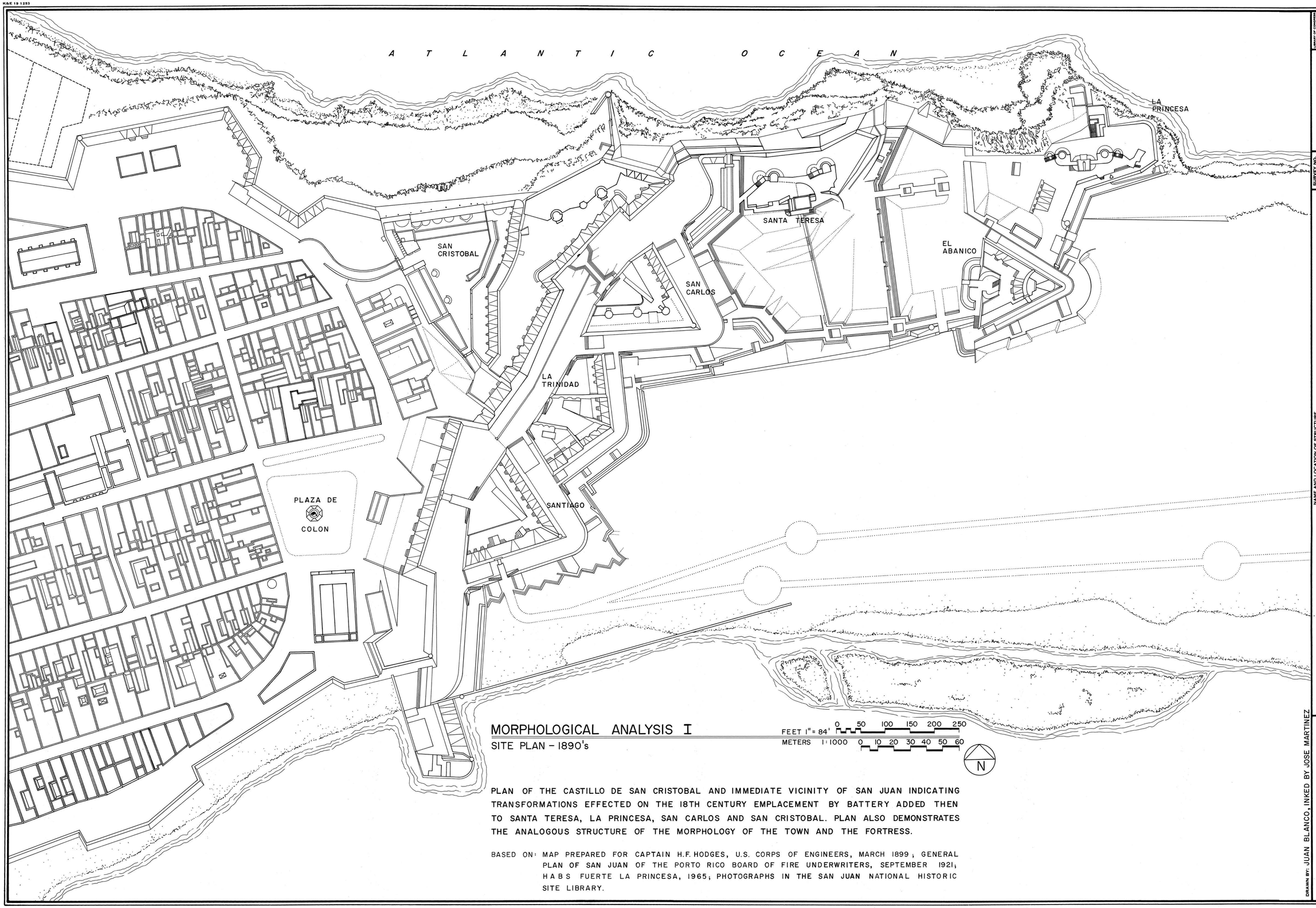
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TRIM LINE

K&E 19 1253



MORPHOLOGICAL ANALYSIS I

SITE PLAN – 1890's

FEET 1"= 84' 0 50 100 150 200 250

METERS 1:1000 0 10 20 30 40 50 60

N

PLAN OF THE CASTILLO DE SAN CRISTOBAL AND IMMEDIATE VICINITY OF SAN JUAN INDICATING TRANSFORMATIONS EFFECTED ON THE 18TH CENTURY EMPLACEMENT BY BATTERY ADDED THEN TO SANTA TERESA, LA PRINCESA, SAN CARLOS AND SAN CRISTOBAL. PLAN ALSO DEMONSTRATES THE ANALOGOUS STRUCTURE OF THE MORPHOLOGY OF THE TOWN AND THE FORTRESS.

BASED ON: MAP PREPARED FOR CAPTAIN H.F. HODGES, U.S. CORPS OF ENGINEERS, MARCH 1899; GENERAL PLAN OF SAN JUAN OF THE PORTO RICO BOARD OF FIRE UNDERWRITERS, SEPTEMBER 1921; HABS FUERTE LA PRINCESA, 1965; PHOTOGRAPHS IN THE SAN JUAN NATIONAL HISTORIC SITE LIBRARY.

DRAWN BY: JUAN BLANCO, INKED BY JOSE MARTINEZ

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1984

NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE

LA TRINIDAD

CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 3 OF 17 SHEETS

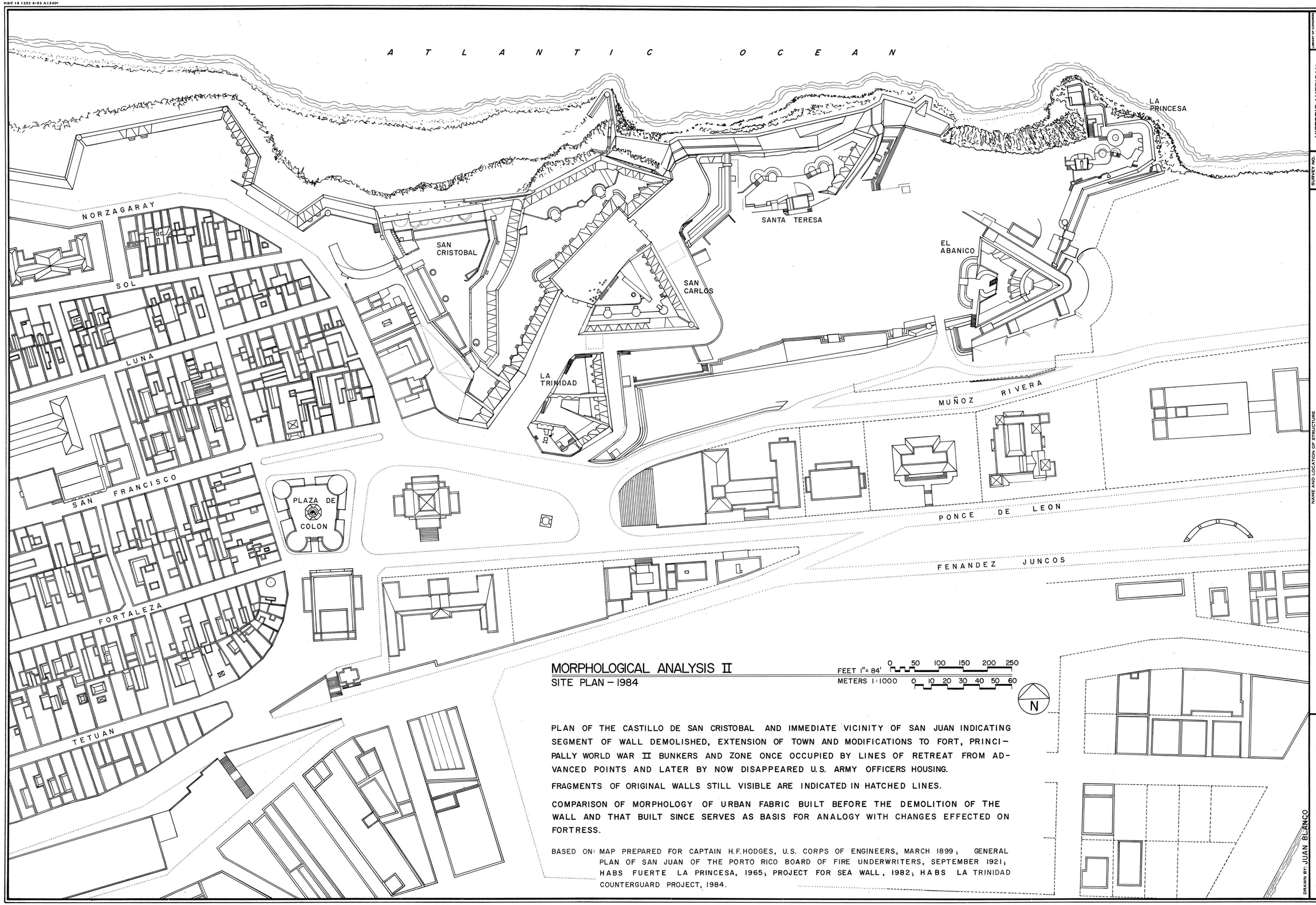
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MORPHOLOGICAL ANALYSIS II

SITE PLAN – 1984

FEET 1"= 84' 0 50 100 150 200 250

METERS 1:1000 0 10 20 30 40 50 60

N

PLAN OF THE CASTILLO DE SAN CRISTOBAL AND IMMEDIATE VICINITY OF SAN JUAN INDICATING SEGMENT OF WALL DEMOLISHED, EXTENSION OF TOWN AND MODIFICATIONS TO FORT, PRINCIPALLY WORLD WAR II BUNKERS AND ZONE ONCE OCCUPIED BY LINES OF RETREAT FROM ADVANCED POINTS AND LATER BY NOW DISAPPEARED U.S. ARMY OFFICERS HOUSING.

FRAGMENTS OF ORIGINAL WALLS STILL VISIBLE ARE INDICATED IN HATCHED LINES.

COMPARISON OF MORPHOLOGY OF URBAN FABRIC BUILT BEFORE THE DEMOLITION OF THE WALL AND THAT BUILT SINCE SERVES AS BASIS FOR ANALOGY WITH CHANGES EFFECTED ON FORTRESS.

BASED ON: MAP PREPARED FOR CAPTAIN H.F.HODGES, U.S. CORPS OF ENGINEERS, MARCH 1899; GENERAL PLAN OF SAN JUAN OF THE PORTO RICO BOARD OF FIRE UNDERWRITERS, SEPTEMBER 1921; HABS FUERTE LA PRINCESA, 1965; PROJECT FOR SEA WALL, 1982; HABS LA TRINIDAD COUNTERGUARD PROJECT, 1984.

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HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 4 OF 17 SHEETS

SURVEY NO.
PR
121

NAME AND LOCATION OF STRUCTURE

LA TRINIDAD COUNTERGUARD

CASTILLO DE SAN CRISTOBAL OLD SAN JUAN PUERTO RICO

SAN JUAN NATIONAL HISTORIC SITE

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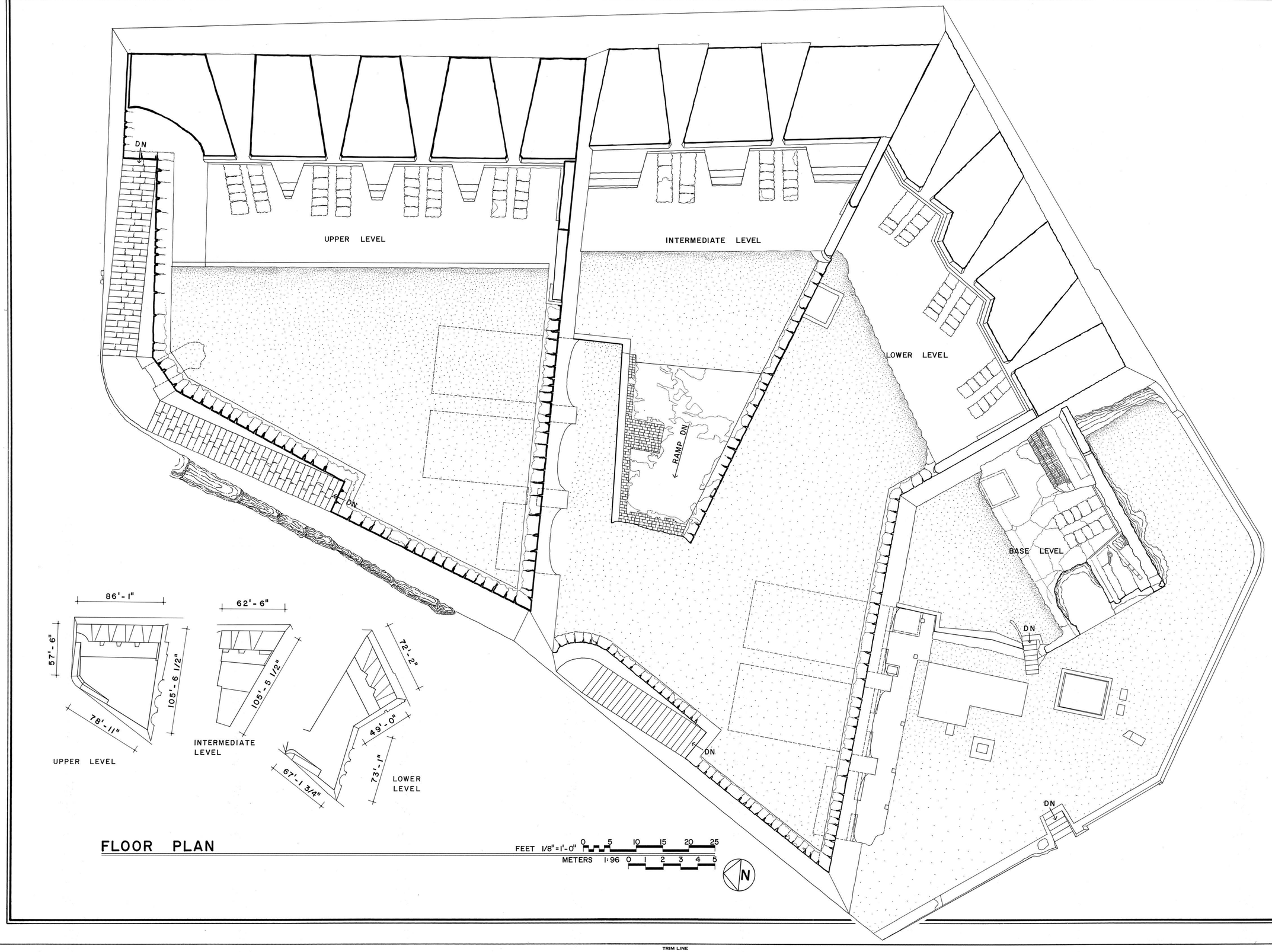
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K&E 19 1253



NAME AND LOCATION OF STRUCTURE

LA TRINIDAD COUNTERGUARD

CASTILLO DE SAN CRISTOBAL OLD SAN JUAN PUERTO RICO

SAN JUAN NATIONAL HISTORIC SITE

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY SHEET 5 OF 17 SHEETS

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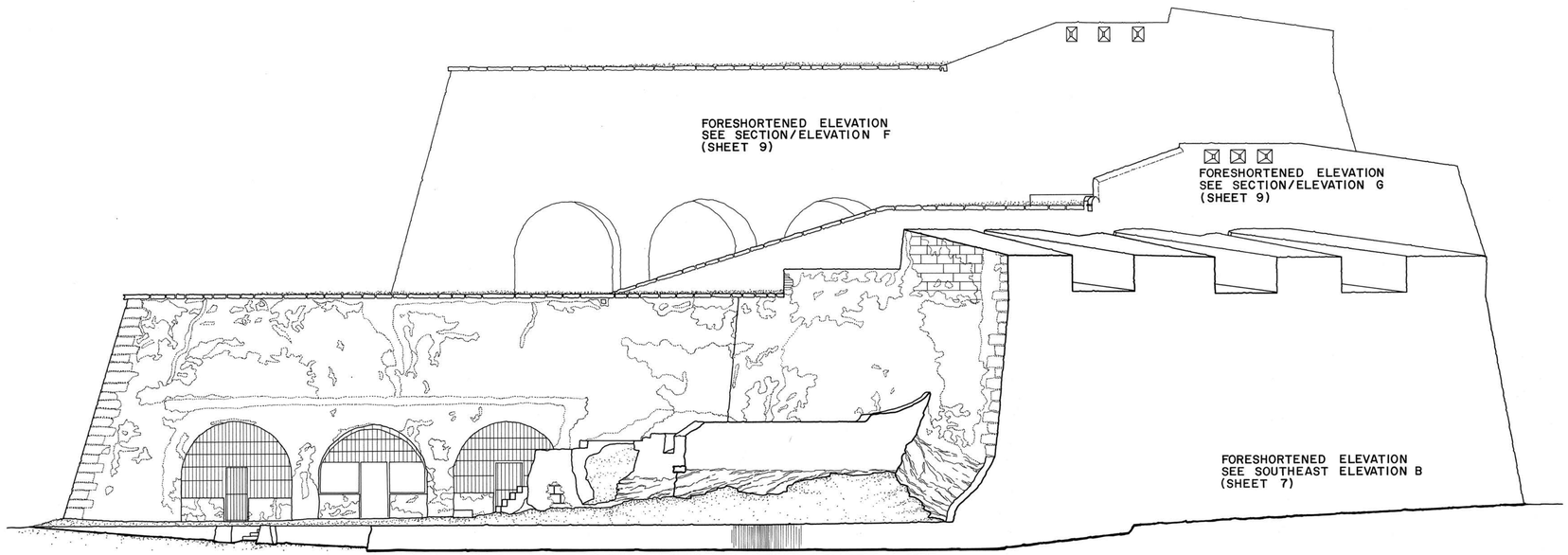
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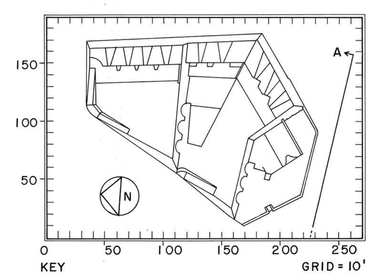
73'-1"



SOUTH ELEVATION A

FEET 1/8"=1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5



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NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE

LA TRINIDAD COUNTERGUARD

CASTILLO DE SAN CRISTOBAL OLD SAN JUAN SAN JUAN NATIONAL HISTORIC SITE PUERTO RICO

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY
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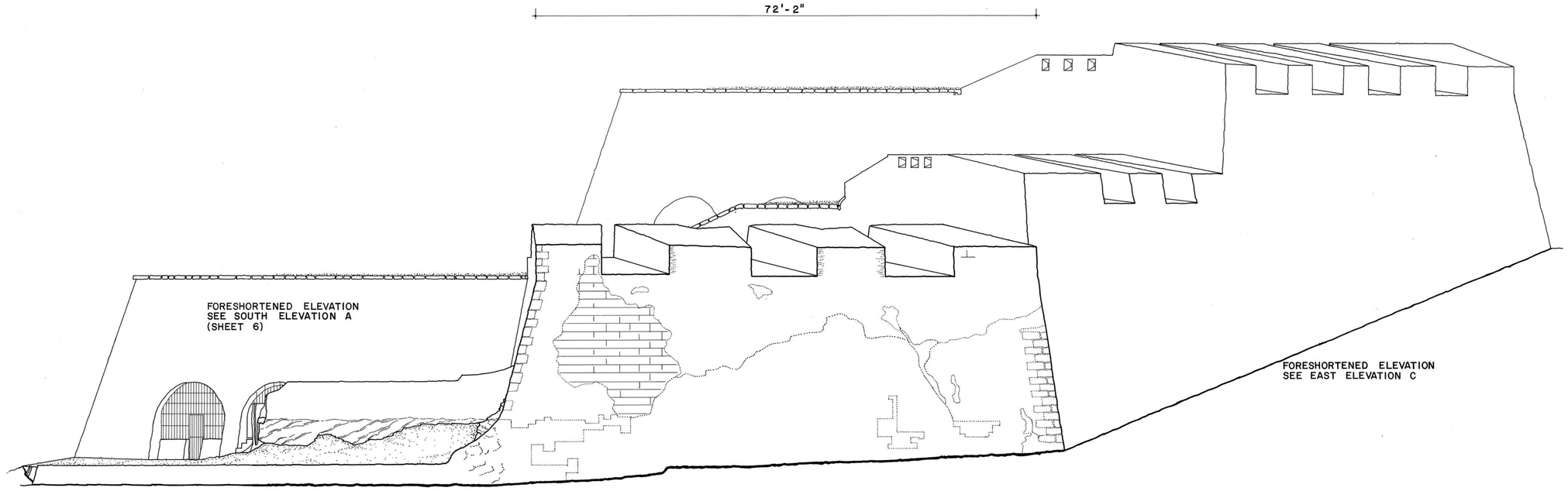
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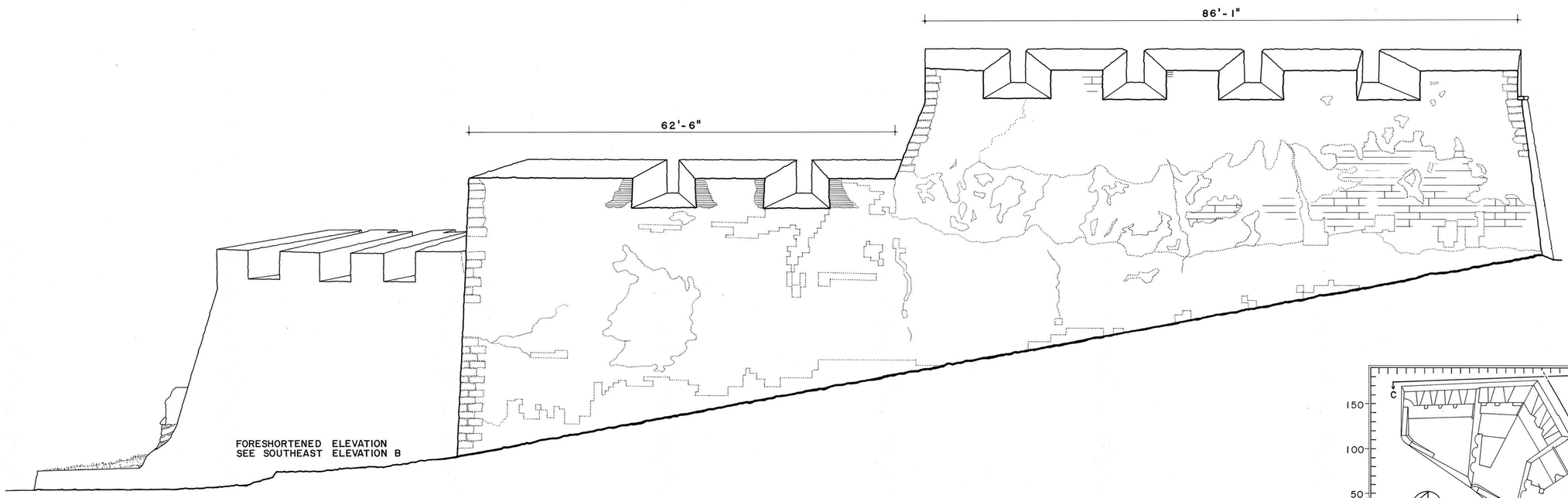
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SOUTHEAST ELEVATION B



EAST ELEVATION C

FEET 1/8"=1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5

NAME AND LOCATION OF STRUCTURE
LA TRINIDAD COUNTERGUARD
CASTILLO DE SAN CRISTOBAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 7 OF 17 SHEETS

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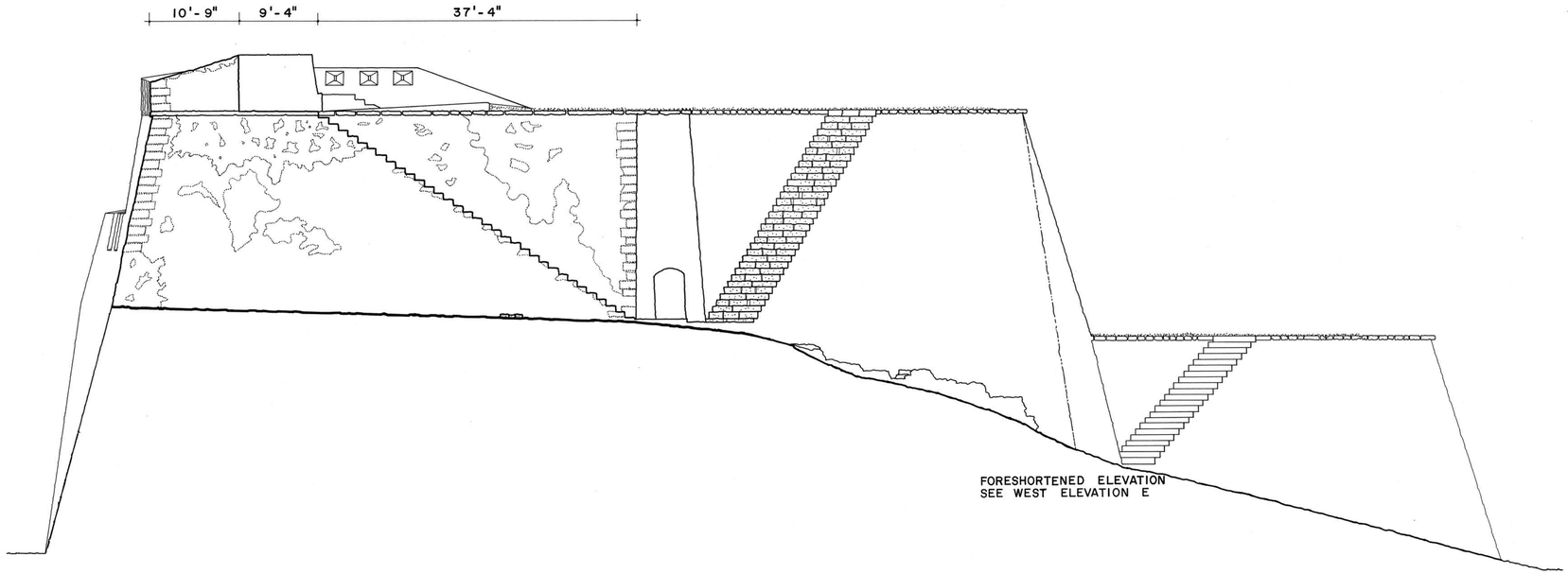
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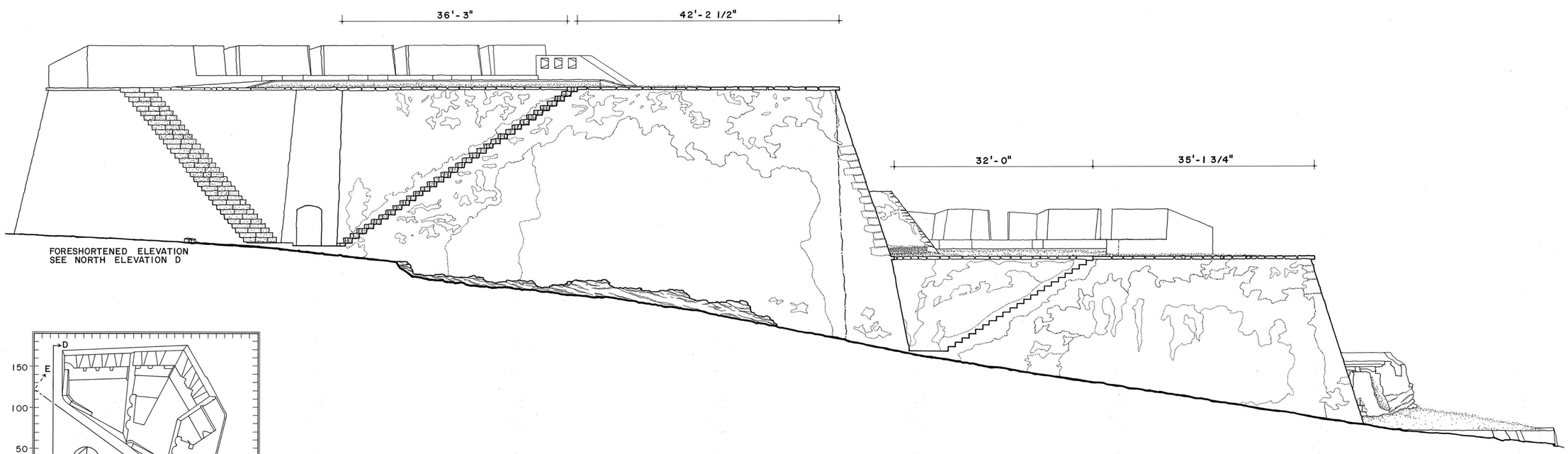
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NORTH ELEVATION D



WEST ELEVATION E

FEET 1/8" = 1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5

NAME AND LOCATION OF STRUCTURE
LA TRINIDAD COUNTERGUARD
CASTILLO DE SAN CRISTOBAL — OLD SAN JUAN — PUERTO RICO

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 8 OF 17 SHEETS

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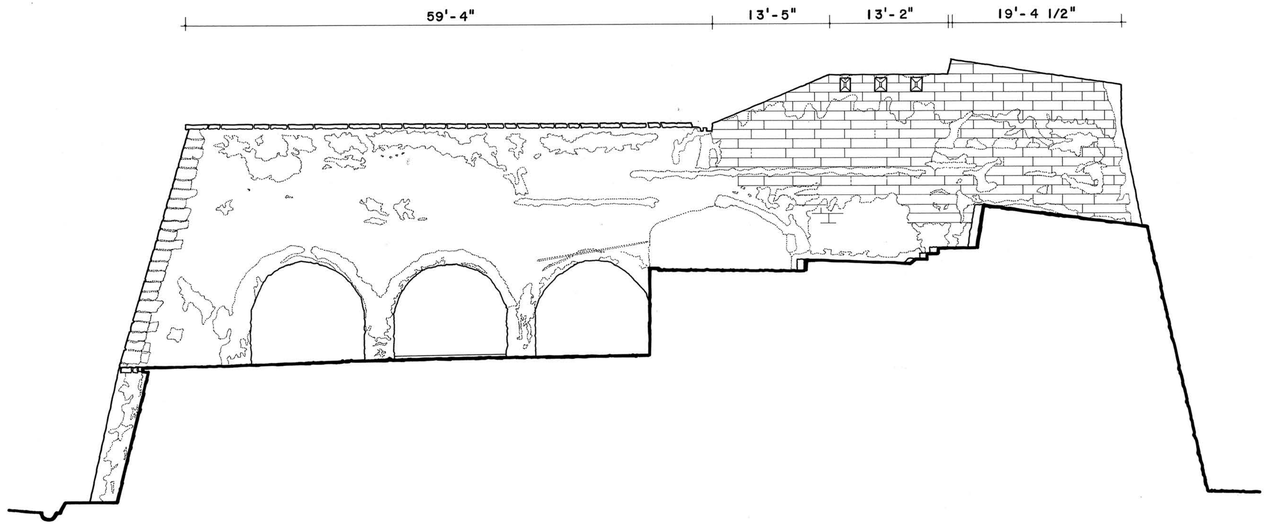
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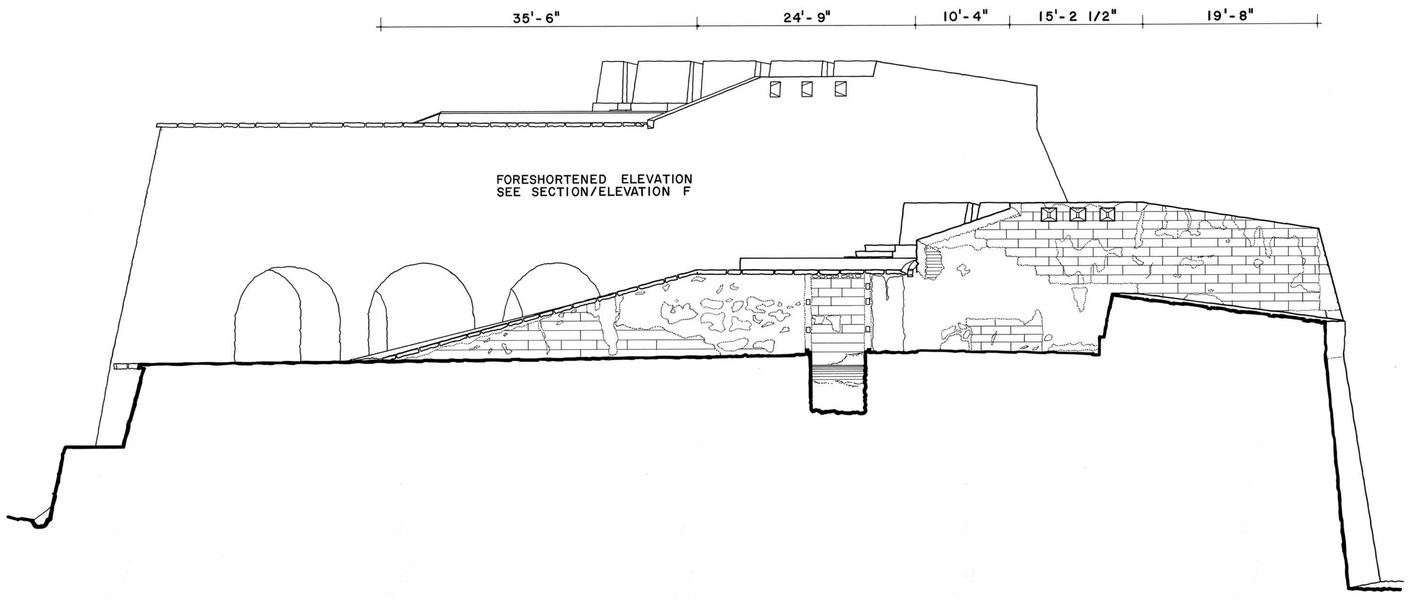
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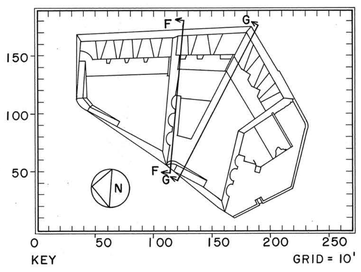
SECTION / ELEVATION F



SECTION / ELEVATION G

FEET 1/8"=1'-0" 0 5 10 15 20 25

METERS 1:96 0 1 2 3 4 5



NAME AND LOCATION OF STRUCTURE

LA TRINIDAD COUNTERGUARD

CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

DRAWN BY: TODD WAMBACH AND JOSE MARTINEZ, INKED BY JOSE MARTINEZ

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NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

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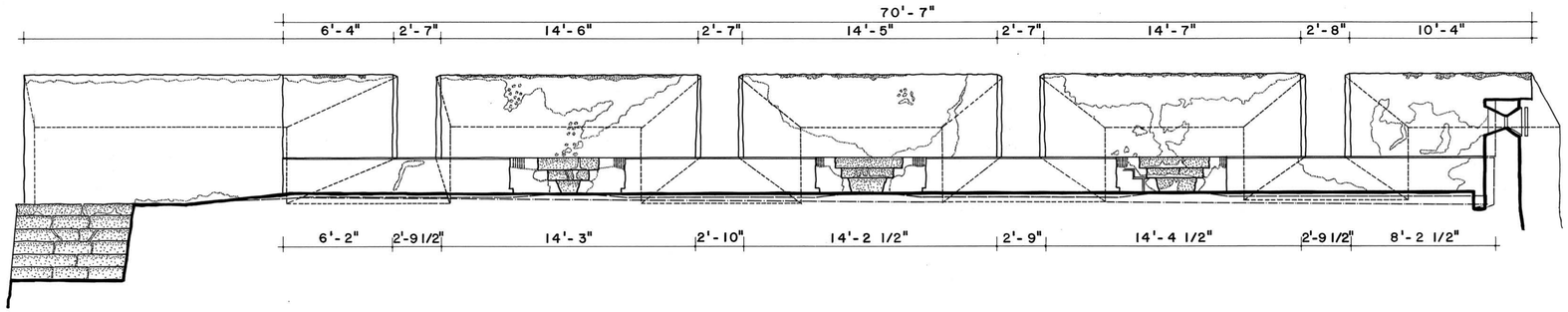
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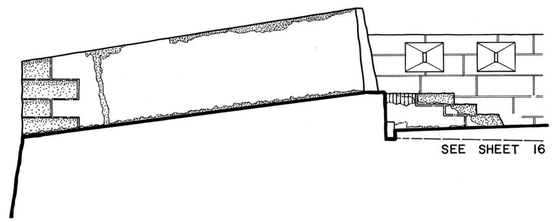
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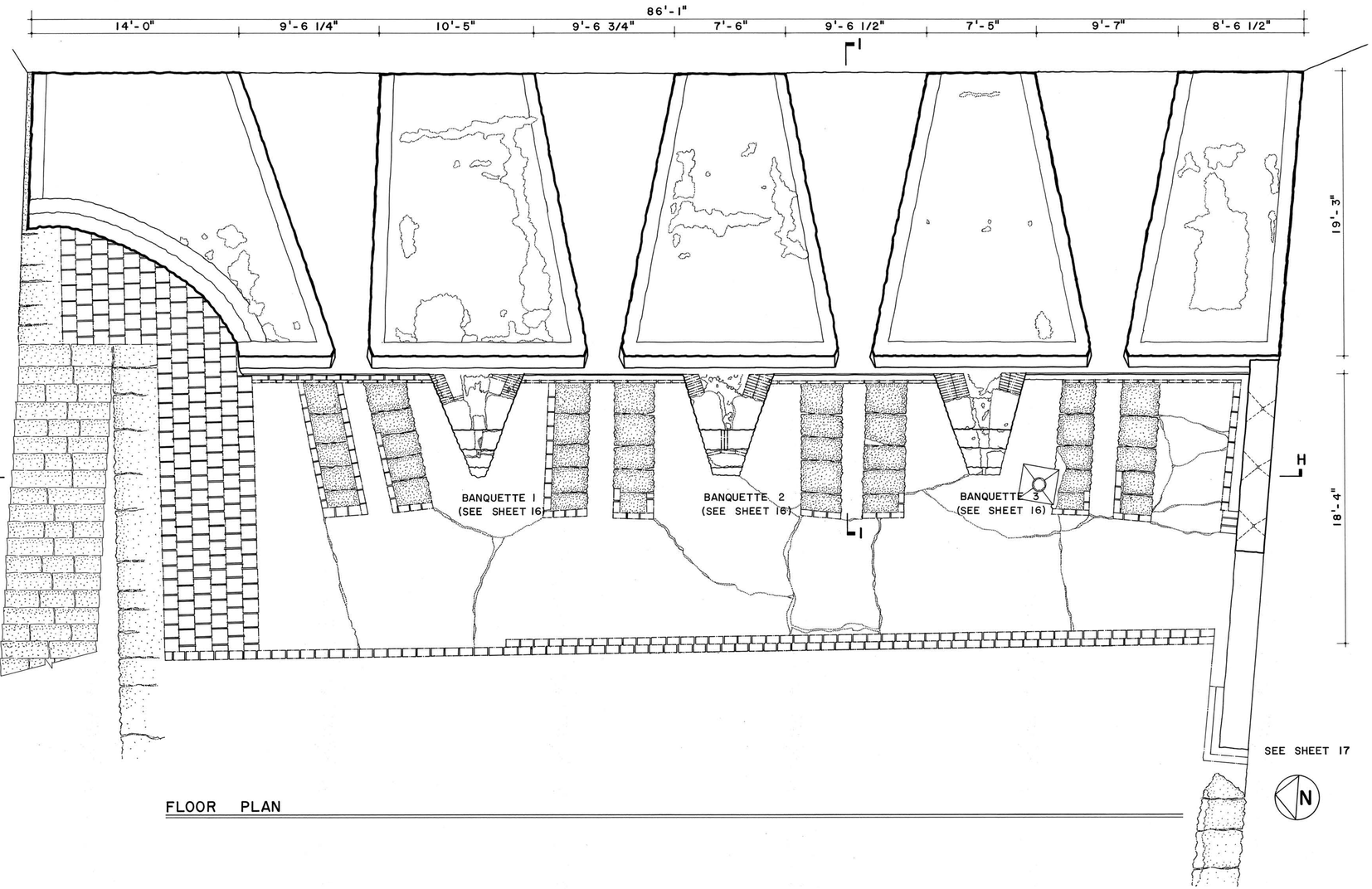
K&E 19 1253 4-83 A1340*



SECTION / ELEVATION H



SECTION DETAIL I

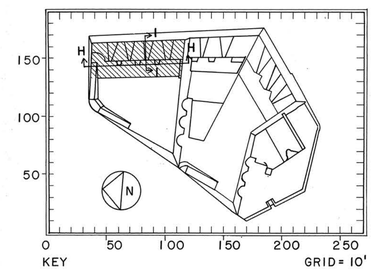


FLOOR PLAN

UPPER LEVEL
BATTLEMENT

FEET 1/4"=1'-0" 0 1 2 3 4 5 10

METERS 1:48 0 1 2 3



NAME AND LOCATION OF STRUCTURE
LA TRINIDAD COUNTERGUARD
CASTILLO DE SAN CRISTOBAL OLD SAN JUAN PUERTO RICO
SAN JUAN NATIONAL HISTORIC SITE

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 10 OF 17 SHEETS

LIBRARY OF CONGRESS PRINTS AND PHOTOGRAPHS

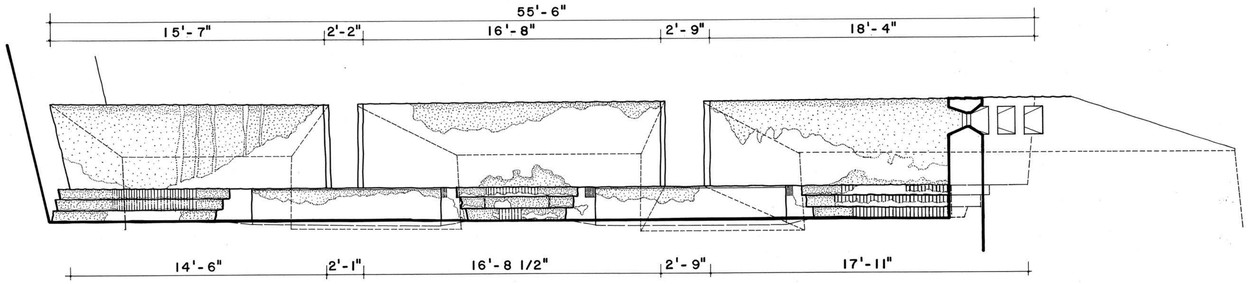
DRAWN BY: TODD WAMBACH
SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1984
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

IF REPRODUCED, PLEASE CREDIT: HISTORIC AMERICAN BUILDINGS SURVEY, NATIONAL PARK SERVICE. NAME OF DELINEATOR, DATE OF THE DRAWING

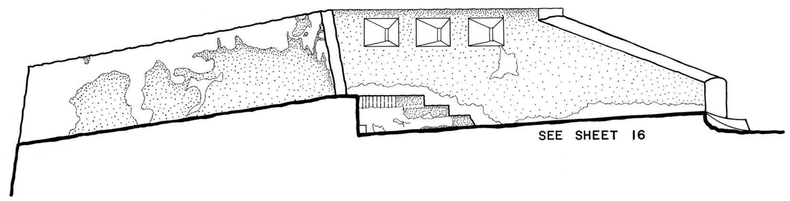
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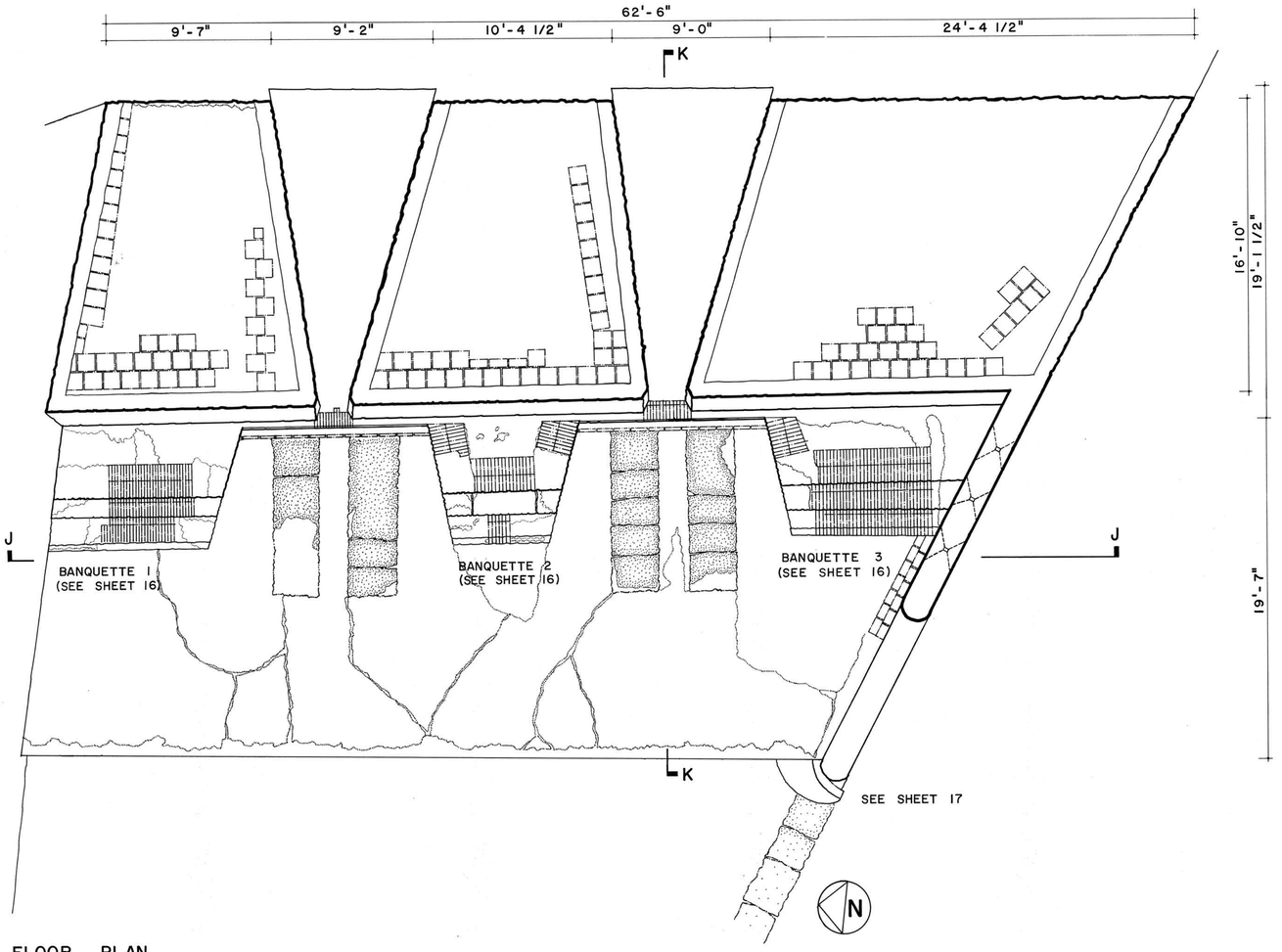
K&E 19 1253 4-83 A1340+



SECTION / ELEVATION J



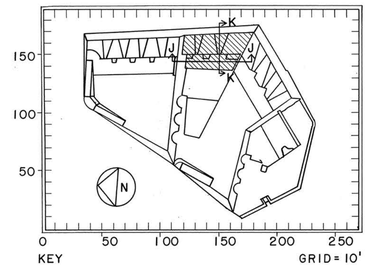
SECTION DETAIL K



FLOOR PLAN

INTERMEDIATE LEVEL BATTLEMENT

FEET 1/4"=1'-0" 0 1 2 3 4 5 10
METERS 1:48 0 1 2 3



NAME AND LOCATION OF STRUCTURE
LA TRINIDAD COUNTERGUARD
CASTILLO DE SAN CRISTOBAL OLD SAN JUAN PUERTO RICO
SAN JUAN NATIONAL HISTORIC SITE

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 11 OF 17 SHEETS

SURVEY NO. PR 121

LIBRARY OF CONGRESS HABS FLORIDA

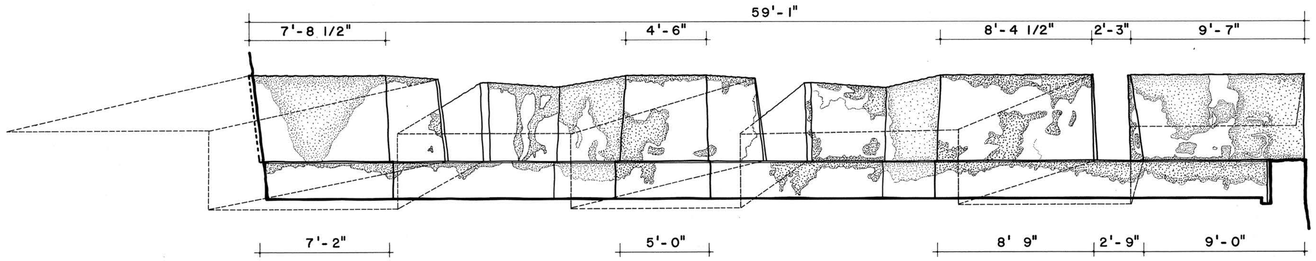
DRAWN BY: TODD WAMBACH
SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1984
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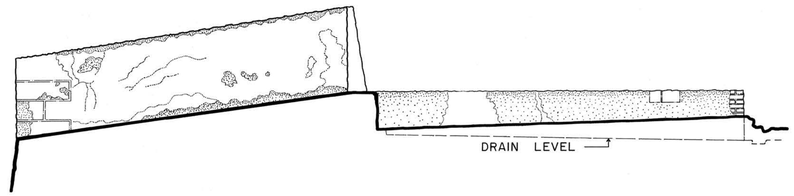
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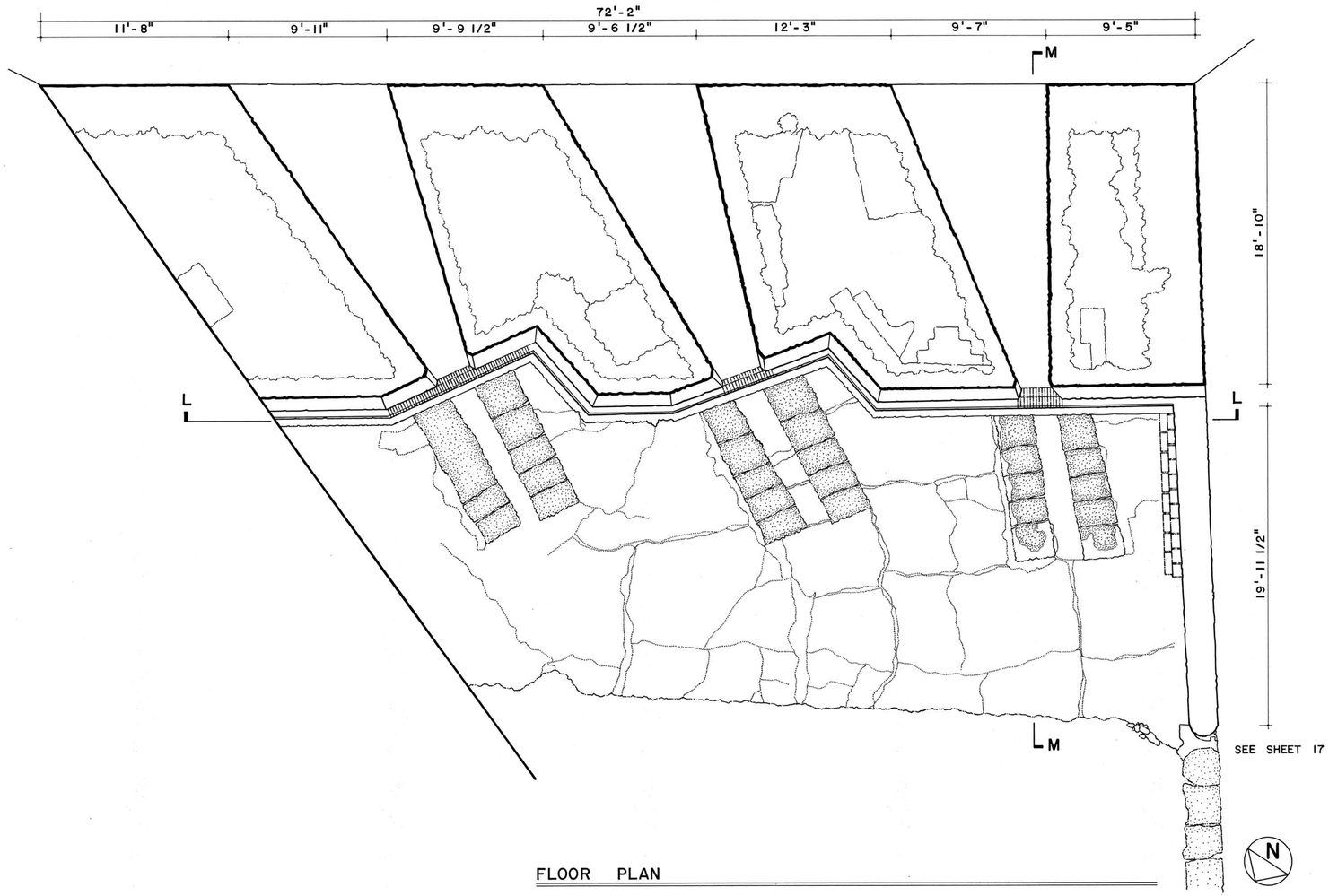
K&E 19 1253 4-83 A1340*



SECTION / ELEVATION L



SECTION DETAIL M

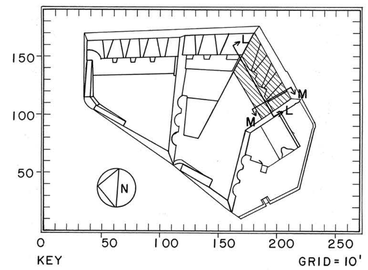


FLOOR PLAN

LOWER LEVEL BATTLEMENT

FEET 1/4"=1'-0" 0 1 2 3 4 5 10

METERS 1:48 0 1 2 3



NAME AND LOCATION OF STRUCTURE

LA TRINIDAD COUNTERGUARD

CASTILLO DE SAN CRISTOBAL OLD SAN JUAN PUERTO RICO

SAN JUAN NATIONAL HISTORIC SITE

DRAWN BY: TODD WAMBACH

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1984

NATIONAL PARK SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY

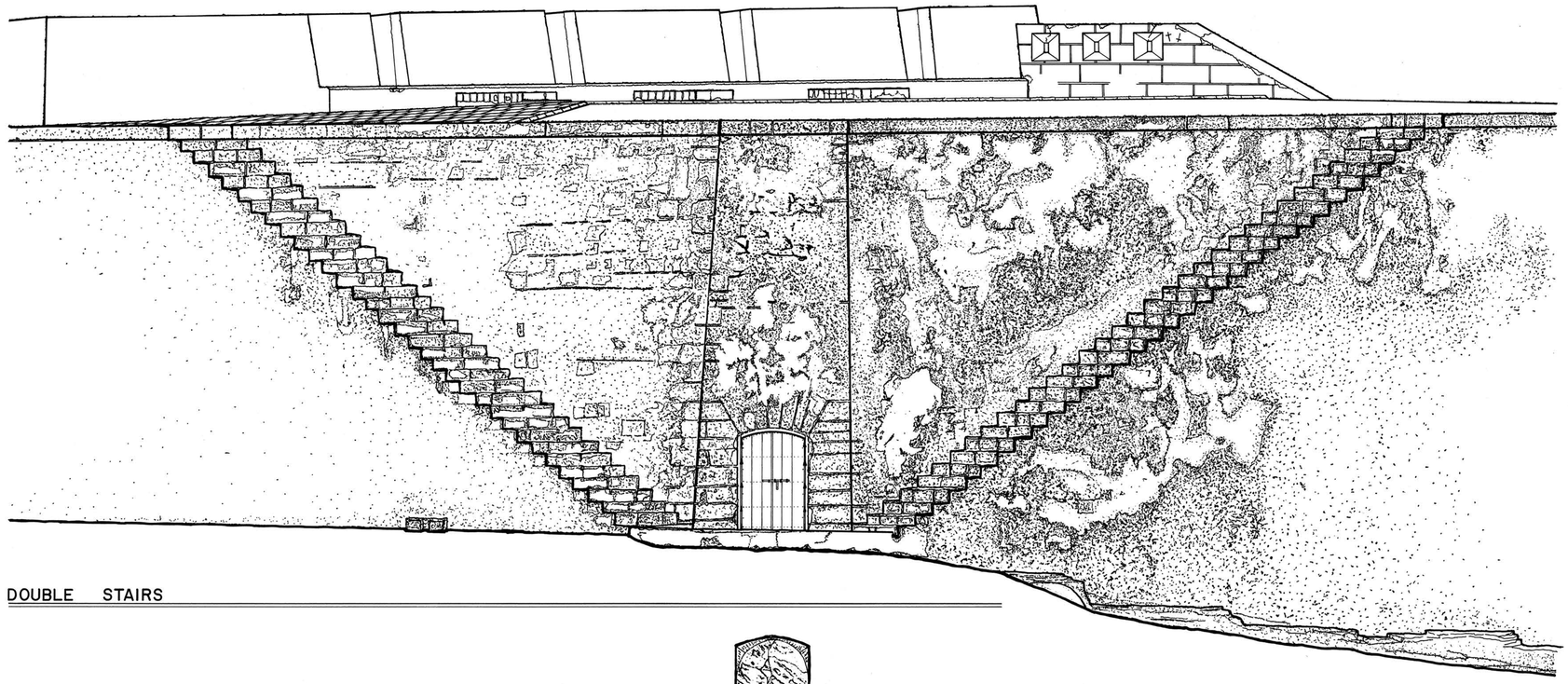
SHEET 12 OF 17 SHEETS

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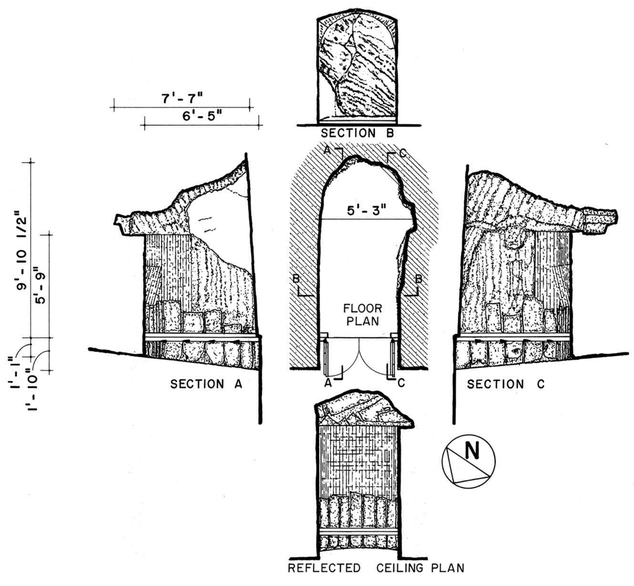
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DOUBLE STAIRS



CORNER ROOM

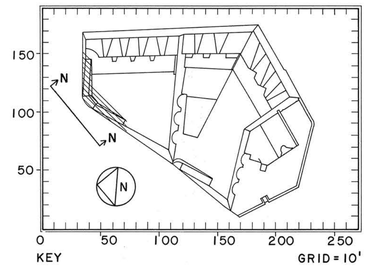
NORTHWEST CORNER ELEVATIONS

FEET 1/4"=1'-0" 0 1 2 3 4 5 10

METERS 1:48 0 1 2 3

LEGEND

A - SECTION LOOKING LEFT
B - SECTION LOOKING BACK
C - SECTION LOOKING RIGHT



DRAWN BY: JUAN BLANCO

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1984
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE

LA TRINIDAD COUNTERGUARD

CASTILLO DE SAN CRISTOBAL HISTORIC SITE OLD SAN JUAN SAN JUAN NATIONAL HISTORIC SITE PUERTO RICO

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 13 OF 17 SHEETS

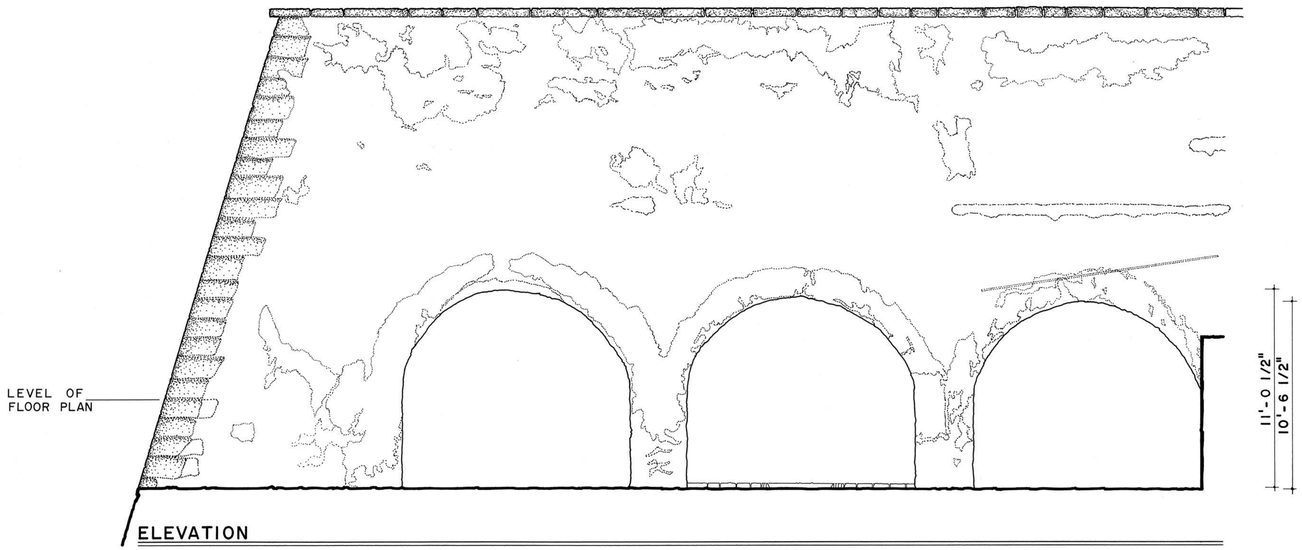
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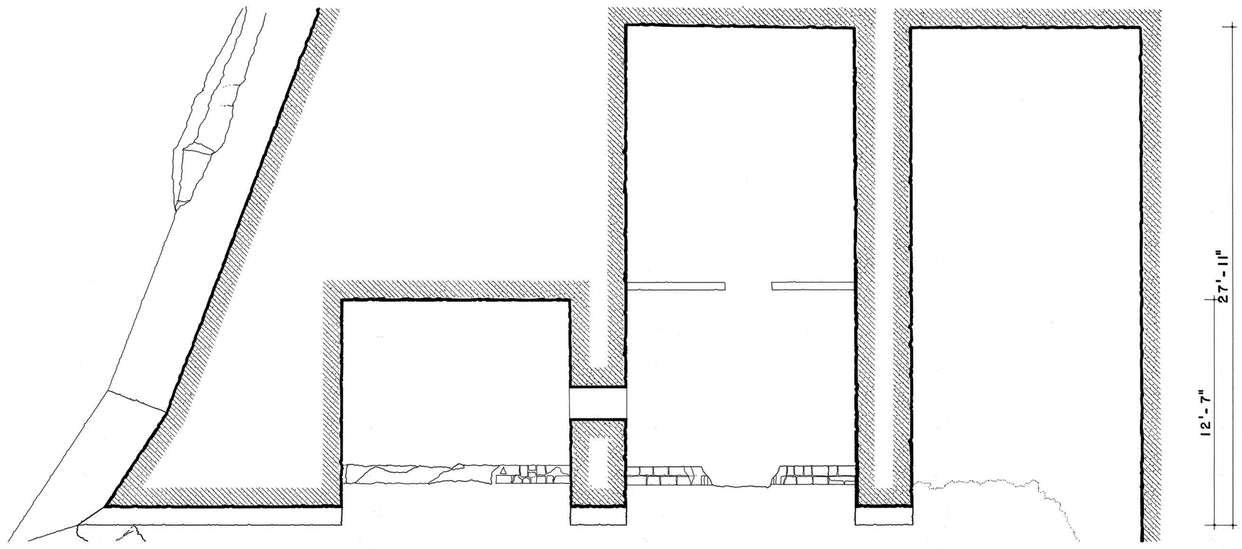
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K&E 19 1253



ELEVATION



UPPER CASEMATES - FLOOR PLAN

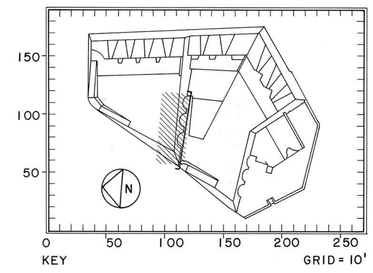
FEET 1/4"=1'-0" 0 1 2 3 4 5 10

METERS 1:48 0 1 2 3

N

14'-9 1/2" | 12'-9 1/2" | 3'-2" | 12'-10" | 3'-3" | 12'-8 1/2"

59'-6 1/2"



NAME AND LOCATION OF STRUCTURE

LA TRINIDAD COUNTERGUARD

CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

LIBRARY OF CONGRESS INDEX NUMBER

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY SHEET 14 OF 17 SHEETS

DRAWN BY: JOSE MARTINEZ

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1984

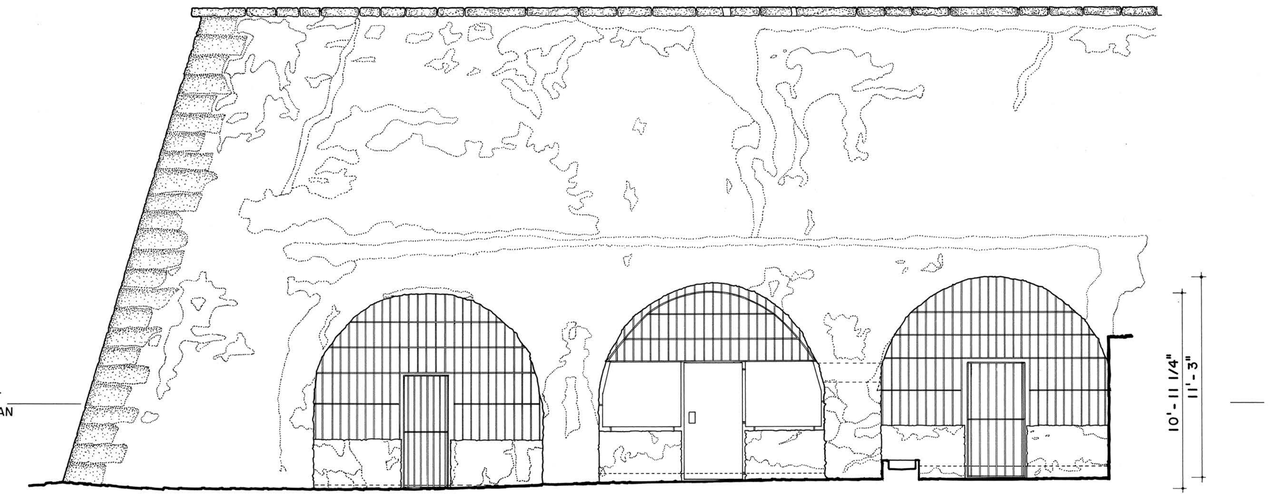
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

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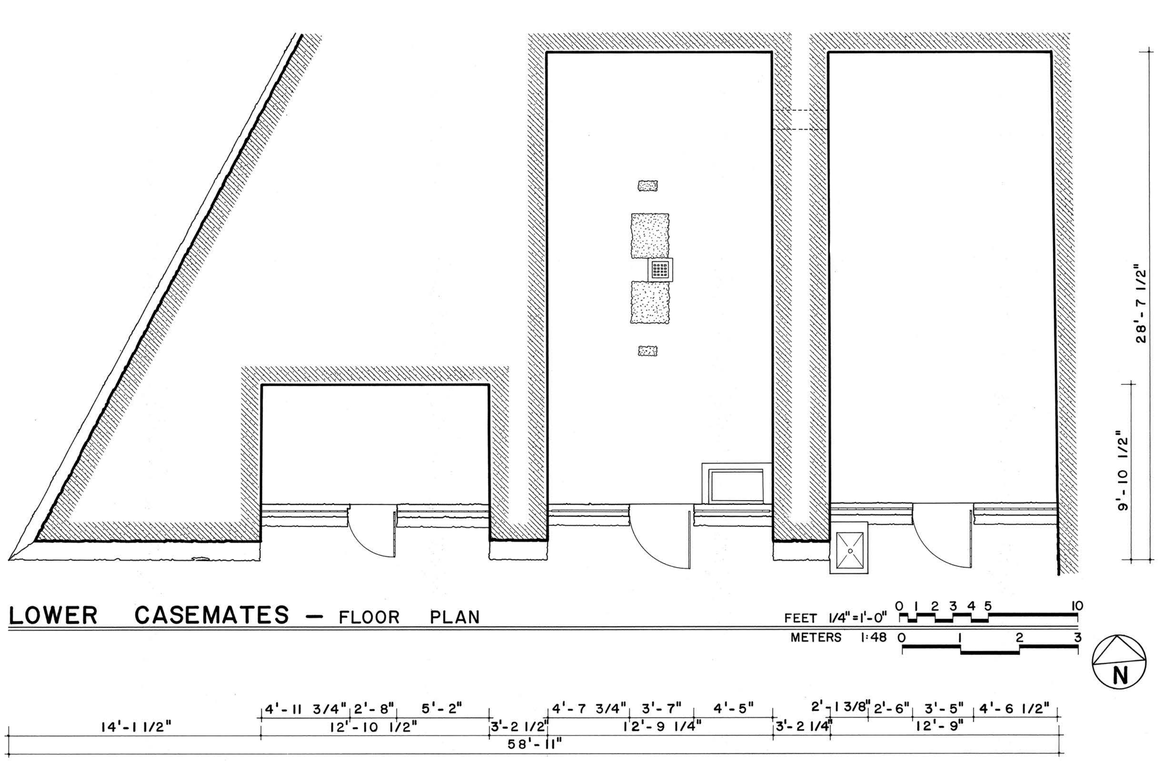
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TRIM LINE

K&E 19 1253



ELEVATION

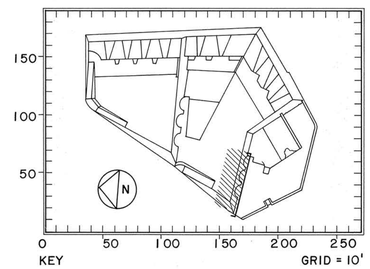


LOWER CASEMATES — FLOOR PLAN

FEET 1/4"=1'-0" 0 1 2 3 4 5 10

METERS 1:48 0 1 2 3

N



NAME AND LOCATION OF STRUCTURE

LA TRINIDAD COUNTERGUARD

CASTILLO DE SAN CRISTOBAL OLD SAN JUAN PUERTO RICO

SAN JUAN NATIONAL HISTORIC SITE

LIBRARY OF CONGRESS INDEX NUMBER

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY SHEET 15 OF 17 SHEETS

DRAWN BY: JOSE MARTINEZ

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1984

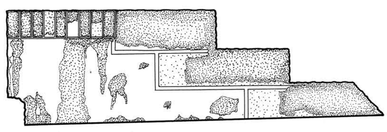
NATIONAL PARK SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR

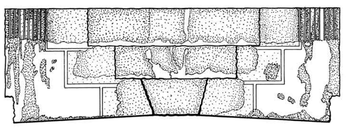
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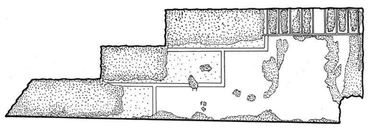
BANQUETTE 1



LEFT SIDE

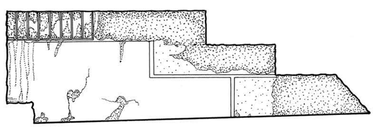


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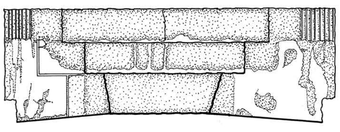


RIGHT SIDE

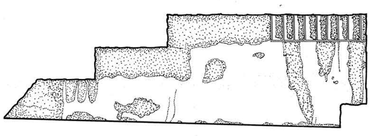
BANQUETTE 2



LEFT SIDE

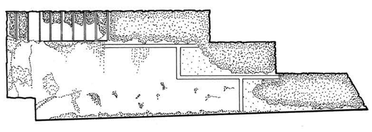


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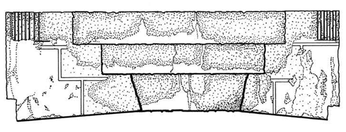


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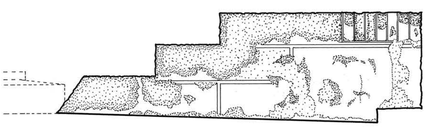
BANQUETTE 3



LEFT SIDE



FRONT

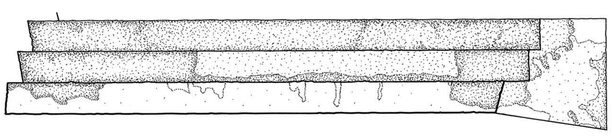


RIGHT SIDE

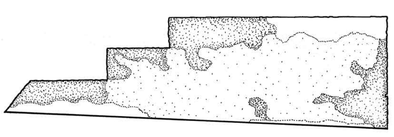
BANQUETTE ELEVATION DETAILS - UPPER LEVEL

(SEE SHEET 10)

BANQUETTE 1

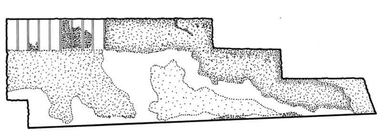


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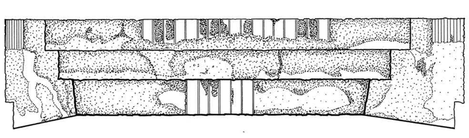


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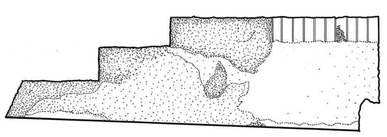
BANQUETTE 2



LEFT SIDE

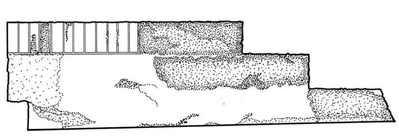


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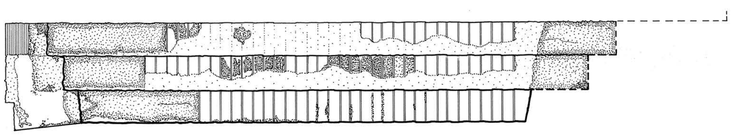


RIGHT SIDE

BANQUETTE 3



LEFT SIDE



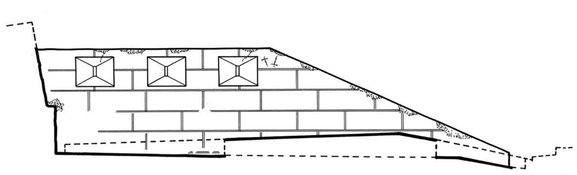
FRONT

BANQUETTE ELEVATION DETAILS - INTERMEDIATE LEVEL

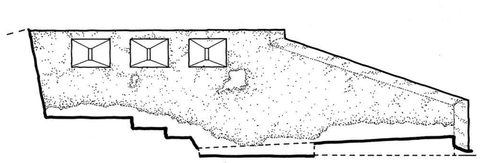
(SEE SHEET 11)

FEET 3/4"=1'-0" 0 1 2 3 4 5

CENTIMETERS 1:16 0 50 100 150



UPPER LEVEL PARAPET

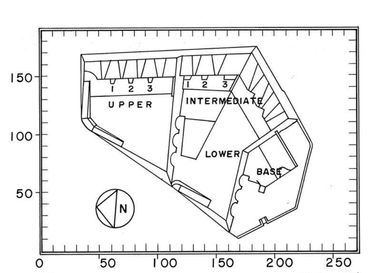


INTERMEDIATE LEVEL PARAPET

PARAPET ELEVATION DETAILS

FEET 1/4"=1'-0" 0 1 2 3 4 5 10

METERS 1:48 0 1 2 3



DRAWN BY: JEAN CLAUDE FILLION, INKED BY JOSE MARTINEZ

SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1984
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE

LA TRINIDAD COUNTERGUARD

CASTILLO DE SAN CRISTOBAL SAN JUAN NATIONAL HISTORIC SITE OLD SAN JUAN PUERTO RICO

SURVEY NO. PR 121

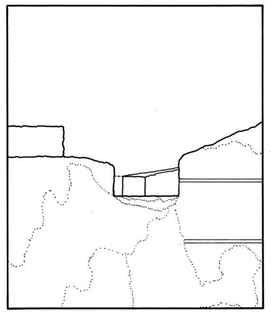
HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 16 OF 17 SHEETS

LIBRARY OF CONGRESS INDEX NUMBER

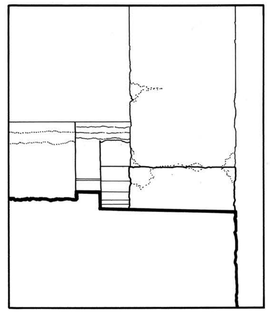
IF REPRODUCED, PLEASE CREDIT: HISTORIC AMERICAN BUILDINGS SURVEY, NATIONAL PARK SERVICE, NAME OF DELINEATOR, DATE OF THE DRAWING

TRIM LINE

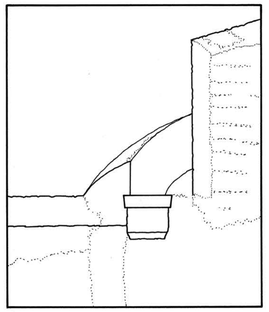
K&E 19 1253



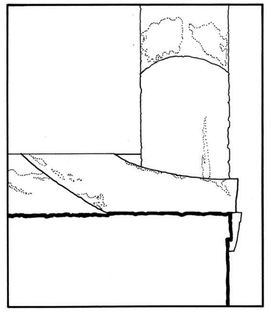
ELEVATION A-A



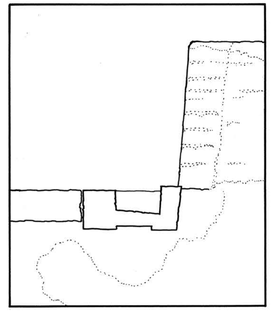
SECTION B-B



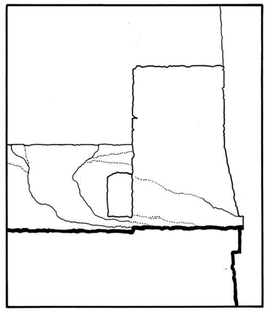
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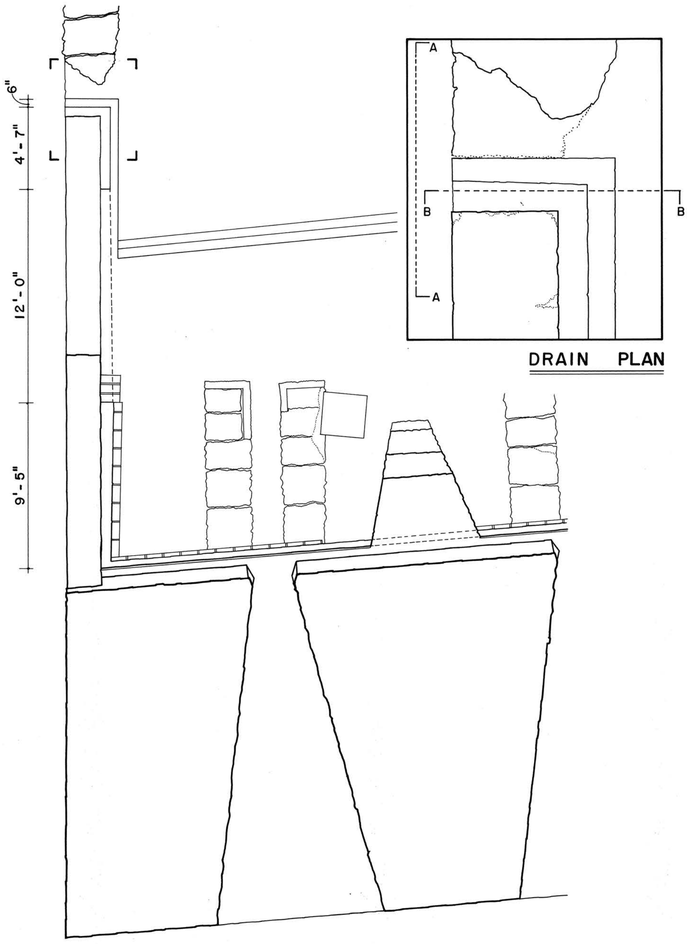
SECTION B-B



ELEVATION A-A

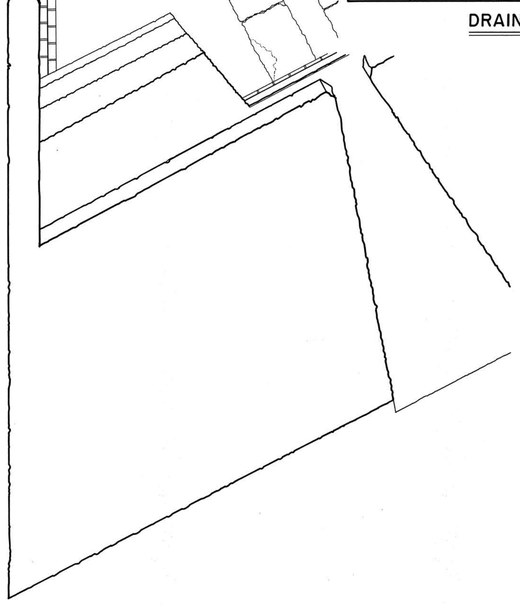


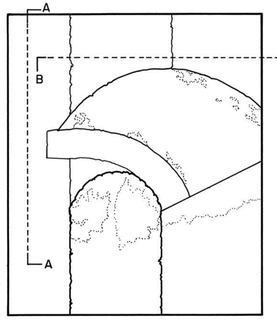
SECTION B-B



DRAIN PLAN

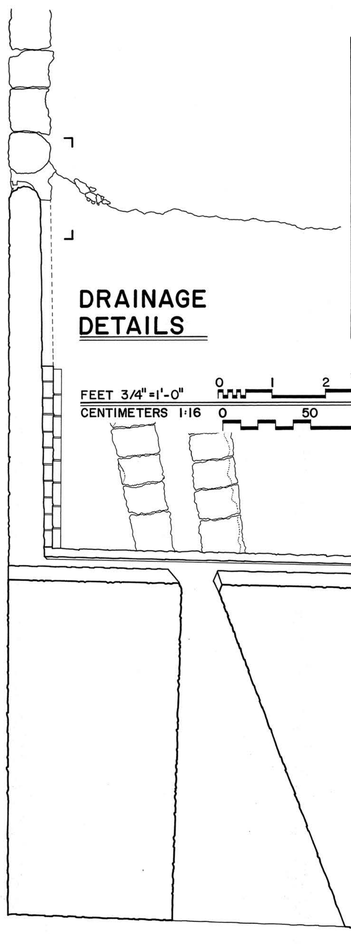
UPPER LEVEL — LOCATION PLAN



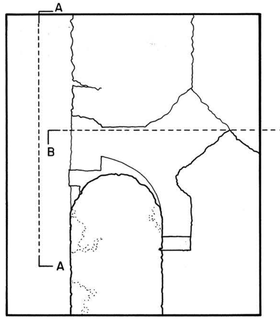


DRAIN PLAN

INTERMEDIATE LEVEL — LOCATION PLAN



DRAINAGE DETAILS



DRAIN PLAN

LOWER LEVEL — LOCATION PLAN

FEET 1/4"=1'-0" 0 1 2 3 4 5 10
METERS 1:48 0 1 2 3

TRIM LINE

DRAWN BY: JEAN CLAUDE FILLION, INKED BY JOSE MARTINEZ
SAN JUAN NATIONAL HISTORIC SITE PROJECT - 1984
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

NAME AND LOCATION OF STRUCTURE
LA TRINIDAD COUNTERGUARD
CASTILLO DE SAN CRISTOBAL OLD SAN JUAN PUERTO RICO
SAN JUAN NATIONAL HISTORIC SITE

SURVEY NO. PR 121

HISTORIC AMERICAN BUILDINGS SURVEY
SHEET 17 OF 17 SHEETS

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Appendix C: Structural Analysis

Structural Analysis – Draft

Introduction and Background

Castillo San Cristóbal and the associated defenses are located at the northeastern corner of the historic portion of San Juan. The site is bounded by Calle Norzagaray to the west, Avenida Luis Muñoz Rivera to the south, and the Atlantic Ocean to the north and east. The 27-acre site consists of several structures, including the main fortification and El Caballero de San Miguel at the west end of the site, with San Carlos Ravelin and La Trinidad counterguard to the east on the opposite side of the great moat. The outer defenses are located on the east end of the site and consist of Santa Teresa Battery, La Princesa, and El Abanico. The earliest construction of portions of Castillo San Cristóbal was from the mid-seventeenth century. Construction of various structures on site continued through the late eighteenth century. Additions and modifications were completed as late as the 1940s, during World War II. Figure 1 shows an overall view of the site.



Figure 1. Overall satellite view of Castillo San Cristóbal. (Source: *The National Map*, USGS)

As part of the work performed for the Historic Structures Report (HSR) to which this report is an appendix, Wiss, Janney, Elstner Associates, Inc. (WJE) collected field measurements and conducted limited non-destructive evaluation, with assistance from National Park Service (NPS) representatives, to assess the structural condition of selected representative components of Castillo San Cristóbal and the associated defenses. Structural analysis of representative structural elements was also performed. The purpose of the structural assessment is to provide the NPS with information regarding the structural characteristics of Castillo San Cristóbal structures, in support of recommendations developed for this HSR and for reference by the NPS in planning for continuing use and stewardship of the structures.

Based on information provided by the NPS, the buildings at Castillo San Cristóbal will not be undergoing a change of occupancy and no repair or alteration of the structural system is intended at this time. The current governing building code for existing buildings in Puerto Rico, 2018 Puerto Rico Existing Building Code, eighth edition (PREBC), applies for Repairs, Alterations, Change in Occupancy, and Addition. However, the code document does not provide criteria for evaluation of existing structures, such as the scope of this assessment. Loading criteria required by the current code for new construction in Puerto Rico, 2018

International Building Code (IBC), was used for the structural analysis of representative structural elements of Castillo San Cristóbal.

Description of Structures

A detailed description of each structure is provided in the Existing Conditions chapter of the Historic Structures Report. The following describes pertinent information of specific structures that pertain to this structural analysis study.

Most of the structures at Castillo San Cristóbal are composed of mass brick and stone masonry. The main fortification is located at the west end of the site and is the largest structure in the complex. It includes the officers' quarters, troops' quarters, north casemates, Plaza de Armas, and eastern defenses (north and south bastions and the curtain wall). The walls of the main fortification are primarily composed of limestone rubble with rough-cut ashlar blocks, set with brick spacers at the salient angles, the bastions, the embrasures, and the sentry boxes.

Sentry boxes are located at certain corners of the perimeter walls. These structures are typically circular in plan with a domed roof. At the north bastion, part of the main fortification, a sentry box is located at the top of the northeast corner of the bastion (Figure 2). Built integrally with the north bastion wall, the bottom of the sentry box is corbelled into the perimeter wall. Large enough to fit one person comfortably, the walls and roof are composed of cut stone masonry set in mortar with multiple, slender, vertically oriented rectangular openings to provide several vantage points. The entryway to the sentry box is accessed from the north bastion terreplein. The northmost outpost of Castillo San Cristóbal has a sentry box, known as La Garita del Diablo (Figure 3), which is located at the base of the north escarpment bordering the Atlantic Ocean. The walls are constructed of brick masonry laid in mortar. It has openings similar to the typical sentry box.

The main fortification structures surrounding Plaza de Armas include the troops' quarters, north casemates, and the officers' quarters (Figure 4). The exterior walls of these structures are composed of brick masonry with projecting parapets along portions of the walls. All masonry walls are coated with a parge coat and lime wash. The parapets vary in heights and thicknesses.

Multiple tunnels are located below the main fortification and Santa Teresa Battery. The ceiling structure of all tunnels consists of brick masonry barrel vaults supported by brick or stone masonry walls on each side (Figure 5). At the northernmost tunnel in the main fortification (Tunnel 1), a branch to the south leads to the dungeon room, which sees heavy foot traffic due to the historic drawings on the wall. At all tunnels, the masonry surfaces are typically coated with a parge coat. At the southmost tunnel in Santa Teresa Battery (Tunnel 7), the tunnel passageway is blocked by earthen fill and stone (Figure 6).



Figure 2. A garita at northeast corner of north bastion.



Figure 3. La Garita del Diablo.



Figure 4. Overall view of main fortification plaza.



Figure 5. Typical view of tunnel cross section.



Figure 6. View of obstructed tunnel passageway at Santa Teresa Battery.

Document Review

WJE reviewed the following documents as part of this study. Following each listed document is a summary of pertinent information, particularly as it pertains to the preliminary structural analysis of the selected representative structural components at Castillo San Cristóbal.

1. National Hurricane Center Tropical Cyclone Report - Hurricane Maria, prepared by National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service (NWS) on September 16-30, 2017, and updated on January 3, 2023.
   - Hurricane Maria was a high-end Category 4 hurricane when it made landfall in Puerto Rico.
   - Although most weather stations went offline during the hurricane event, the highest recorded wind gusts in San Juan were 95 knots or approximately 110 miles per hour (mph).
   - The maximum recorded storm surge during the hurricane event was 2.35 feet above mean sea level.
2. SAJU 244836 Refill Eroded Shoreline at El Cañuelo – Wave Analysis Report, prepared by Croft & Associates, Inc. on October 25, 2021
   - This project scope included a wave analysis to support the refill of eroded shoreline at Fortín San Juan de la Cruz (El Cañuelo). This site is located on Palo Seco, across the San Juan Bay directly west of Old San Juan.
   - Table 2-3 provides a list of 96 total hurricane and storm events from 1867 to 2018 within approximately 230 miles of the project site. The associated date, name, maximum wind speed and pressure, and storm Category were also listed. Eighteen total events categorized between a Category 4 and Category 5 hurricane. Hurricane Maria had a recorded maximum wind speed of 173 mph as a Category 5 hurricane, although the specific wind speed at the project site in Puerto Rico was not listed.
   - Based on "various global and regional projections of [sea level rise] and vertical land movement applicable to the project [site]", assumed relative sea level rise of 2.02 feet is appropriate for a project life from 2022-2062.
   - Numerical models for future operational conditions show the probability of exceedance of an 8.4-foot-tall offshore wave is 1% in a 30-year period. Additional offshore wave heights and probability of exceedances are provided in Table 3-1.
   - During extreme weather events, a water level change and significant wave height of +4.5 feet above mean sea level and 15.8 feet, respectively, has a return period of 25 years, offshore from the project site. Other extreme weather scenarios with associated return periods are provided in Table 3-3.
   - The 25-year return period offshore wave conditions were used to simulate the water level and wave heights at the shoreline, considering "diffraction, refraction, breaking, and transmission through the breakwaters before impacting the El Cañuelo shoreline." Multiple scenarios with varying wave angles were studied. The results demonstrated that the selected modelled offshore parameters yielded wave heights impacting the shoreline ranging from 2.5 to 3.3 feet at the project location.
3. National Data Buoy Center – Station 41053, owned and maintained by Caribbean Integrated Coastal Ocean Observing System (CarlCOOS). Data provided by NOAA and NWS
   - Station 41053 is an offshore buoy located approximately 0.8 miles northeast of La Garita del Diablo
   - Operational offshore wave heights typically reach a maximum of approximately 6 feet, above sea level.
   - During Hurricane Maria, on September 20, 2017, this station recorded a maximum wave height of approximately 18.4 feet, above sea level.[1]

Condition Assessment

A visual condition assessment was conducted for the structures at Castillo San Cristóbal. Findings of the assessment are provided in the Existing Conditions chapter of the Historic Structures Report.

1. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. n.d. "NDBC Station Page." www.ndbc.noaa.gov. https://www.ndbc.noaa.gov/station_page.php?station=41053, accessed March 2024.

A list of structural concerns was provided by NPS for WJE's consideration during the condition assessment. It included the items summarized below:

1. Large cracks in the masonry walls, especially in the underground dungeon walls and outside corners of the fort walls
2. "Partially collapsed" tunnel at Santa Teresa Battery (Outer Defenses)
3. Bulging or bowing of masonry walls at the following locations
   - Troops' quarters facade
   - Tunnel walls
   - Exterior wall at the dry moat
   - San Cristóbal guardhouse back wall
   - Officers' quarters walls, facing the guardhouse
4. Staircase in La Princesa Battery
5. Cracks in plaza pavement
6. Stability of arch structure at the north casemates. No cracks were observed.
7. Structural capacity of parapet walls
8. In general, any evidence of underlying structural distress beyond the parge coat cracks

As part of the condition assessment, inspection opening locations were chosen based on access, feasibility, impact on historic fabric, and potential to uncover concealed conditions. As no embedded elements are present in the mass masonry structures, no inspection openings were completed at locations with exposed brick masonry (i.e., no concealed conditions). Based on these criteria, one inspection opening was made during this assessment at the officers' quarters, at the bottom west corner of the west window opening. A discrete location on the south wall of the south addition to the officers' quarters was selected for the inspection opening, where a small section of cracked parge coating (5 inches by 3 inches) was removed to expose the brick masonry structure below (Figure 7 and Figure 8). Representatives of NPS were present to assist with removing the parge coat and to provide input on the size of the opening. The following summarizes the conditions observed.

- A crack through the brick unit and mortar joint was observed to match the location of the crack found in the parge coat (Figure 9).
- The parge coat, which measured approximately 2 inches thick at this location, is comprised of a cementitious material with pieces of brick aggregate (Figure 10). An electric wire was also found embedded between the brick masonry and the parge coat.
- The vertical dimension of the horizontal mortar joint between two courses of brick was approximately 1 inch.
- The brick and masonry were relatively hard when scratched with a 5-in-1 tool.



Figure 7. Overall view of south facade of south addition of officers' quarters.



Figure 8. Location of inspection opening shown with dashed box.



Figure 9. Crack in brick masonry structure telegraphing through parge coat.



Figure 10. Crushed brick and electric wire embedded in parge coat.

Preliminary Structural Analysis

Representative components of the various structures at Castillo San Cristóbal were selected for additional preliminary structural analysis. These components were chosen based on lack of structural redundancy, exposure, level of deterioration of existing materials, and the list of structural concerns provided by NPS. WJE selected four locations based on the visual condition assessment: the west parapet at the officers' quarters (Figure 11), the parapet at northwest corner El Caballero de San Miguel (Figure 12), the sentry box at the northeast corner of the north bastion (refer to Figure 2), and La Garita del Diablo (refer to Figure 3).



Figure 11. West parapet at officers' quarters.



Figure 12. Northwest corner parapet at El Caballero.

Section strength was evaluated for minimum loadings and load combinations per the requirements of the current governing code for new construction, the 2018 Puerto Rico Building Code, which references the following standards: American Society of Civil Engineers "Minimum Design Loads for Buildings and Other Structures," dated 2016 (ASCE 7-16), and The Masonry Society "Building Code for Masonry Structures," dated 2016 (TMS 402-16).

The lateral loading considered in this preliminary structural analysis was limited to hurricane wind loading only. Although the structures at Castillo San Cristóbal are also exposed to seismic loading, a seismic analysis of the representative components was not within the scope of work of this study.

Assumptions

Assumed material properties were used for the analysis due to the limited scope of the assessment. Assumptions are both inferred from observed conditions and based on available information about properties of construction materials contemporary with the building's construction. The following assumptions have been made for purposes of this preliminary analysis:

- The following material assumptions were made about the brick masonry at Castillo San Cristóbal.
  - Specific weight of brick masonry, γ=115 pcf.
  - Brick masonry compressive strength, f`m = 1000 pounds per square inch (psi).
  - Mortar type is Lime Putty, Type N. The allowable flexural tensile stresses for clay masonry provided in Table 8.2.4.2 is reduced by 50 percent to account for the character of the original masonry construction.
- Foundations of masonry structure are sufficiently constructed to resist vertical and lateral loading.
- The topographic geometry of the escarpment on the north border of Castillo San Cristóbal was assumed to be approximately 100 feet in height between sea level and grade at the main west gate, as suggested by the USGS 7.5-minute topographical map.
- Wind loads applied to both the officers' quarters west parapet and El Caballero de San Miguel north parapet are assumed to be essentially the same in magnitude, given the similar height and exposure.

Officers' Quarters West Parapet

The section strength of the west parapet of the officers' quarters, which is approximately 5 feet 8 inches tall and 2 feet 5 inches thick, was evaluated for gravity and lateral loading, as summarized below.

- Dead load of actual weight of structural framing elements.

- Components and cladding lateral wind load, based on a maximum design basic wind speed of 160 miles per hour (mph) for a Risk Category II structure per ASCE7-16.

The design basic wind speed of 160 mph is taken from the current governing building code and corresponds to a 3-second gust speed at 33 feet above ground for Exposure Category D. As part of the wind load analysis, the wind pressure is factored to accommodate for height, topographic, and exposure effects.

The combined applied axial and flexural stresses were compared to the code-permitted allowable stresses of the masonry. The ratio of the applied stress at a design limit state to the allowable capacity is commonly referred to as the demand-to-capacity ratio (DCR). Typically, a DCR greater than 1.0 indicates that the calculated demand on a member exceeds the allowable capacity of the member, while a DCR equal to or less than 1.0 indicates that the demand on the individual frame members does not exceed the published allowable stresses of the individual members. The allowable capacity is the nominal capacity reduced by a factor of safety.

The parapet at this location was found to have tensile stresses due to the maximum transient applied load, but the tensile stresses are below the reduced code-permitted allowable stress. The DCRs for flexural tensile and compressive stresses were approximately 0.97 and 0.09, respectively. A DCR close to 1.0 for flexural tensile stress indicates that the applied stresses nearly meet the code-permitted tensile stress, with little residual stress in capacity. However, this preliminary analysis is conservative based on assumed low material strength properties. The flexural capacity of the masonry may increase if the in-situ material exhibits stronger properties than initially assumed, which may only be confirmed through destructive testing. Based on the preliminary analysis and associated assumptions, the as-built construction of the west parapet at the officers' quarters is demonstrably adequate to meet the gravity and lateral load demand.

El Caballero de San Miguel Northwest Corner Parapet

The parapet at the northwest corner of El Caballero de San Miguel is L-shaped in plan with 3-feet-4-inches thick and 9-feet-10-inches tall walls. The plan dimensions of the parapet are limited to 5 feet 7 inches in each direction. The section strength was evaluated for gravity and lateral loading, as summarized above in the officers' quarters west parapet section. The analysis method used to analyze the parapet remains consistent with that described above.

The parapet at this location was found to have tensile stresses due to maximum transient applied load, but the tensile stresses are below the reduced code-permitted allowable stress. The DCRs for the flexural tensile and compressive stresses were approximately 0.25 and 0.03, respectively. Based on the preliminary analysis and associated assumptions, the as-built construction of the northwest corner parapet at El Caballero de San Miguel is demonstrably adequate to meet the gravity and lateral load demand.

Garita at North Bastion

The garita at the northeast corner of the north bastion extends above the perimeter walls from the salient angle. WJE analyzed the section strength of the masonry wall to resist gravity and lateral loading, as summarized below.

- Dead load of actual weight of structural framing elements.
- Components and cladding lateral wind load, based on a maximum design basic wind speed of 160 miles per hour (mph) for a Risk Category II structure per ASCE7-16.

The analysis method used to analyze the garita walls remains consistent with that described above. For this preliminary analysis, the domed roof structure of the garita was not analyzed. The 8-feet-4-inches tall and 9-

inch-thick garita wall was conservatively assessed, per foot length, as a one-way element spanning from the base of the garita to the roof dome structure.

Based on the preliminary analysis and associated assumptions, the masonry wall of the garita exhibited large tensile stress due to dead and wind loads, which significantly exceeds the reduced code-permitted allowable stress. The DCR for the flexural tensile and compressive stresses were approximately 3.3 and 0.24, respectively.

La Garita del Diablo

La Garita del Diablo is located at the base of the north escarpment. The base of the garita wall is approximately 17 feet above mean sea level[2]. WJE analyzed the section strength of the masonry wall to resist gravity and lateral loading, as summarized below.

- Dead load of actual weight of structural framing elements.
- Components and cladding lateral wind load, based on a maximum design basic wind speed of 160 miles per hour (mph) for a Risk Category II structure per ASCE7-16.
- Flood wave loads per ASCE7-16, based on site-specific base flood elevation and freeboard requirements.

The analysis method used to analyze the garita walls remains consistent with that described above. For this preliminary analysis, the domed roof structure of the garita was not analyzed. The 7-foot-tall and 13-inch-thick garita wall was conservatively assessed, per foot circumference, as a one-way element spanning from the base of the garita to the roof dome structure. The site-specific design base flood elevation (BFE) is the elevation of flooding, including wave height, having a 1% chance of being equaled or exceeded in any given year. Puerto Rico is included in Region 2 of the Federal Emergency Management Agency (FEMA). The flood map for this location, produced by FEMA, show a BFE of 4.6 meters, or 15 feet[3] (based on North American Vertical Datum of 1988). The required freeboard for San Juan, height between the BFE and the lowest floor level, is 1 foot[4]. The design flood elevation (DFE) is the addition of the BFE and required freeboard height.

Based on ASCE 7-16, the design flood elevation was found to be below the elevation of the base of the garita walls. Therefore, the garita walls are not exposed to flood loading in present-day operational conditions. However, the wave analysis at El Cañuelo provided an assumed relative sea level rise of 2.02 feet by 2062, at a site approximately 1.75 miles west of La Garita del Diablo. WJE assumed the same relative sea level rise at la garita and added the extra depth to the design flood elevation to estimate future flood loading. Including relative sea level rise, the lower 0.2 feet of the garita wall would be impacted by flood loading.

WJE analyzed two load combinations. The first combination included dead load and wind load (negative pressure). The negative wind pressure acts away from the wall surface and is the most extreme wind case (compared to positive pressure). The second combination included dead load, wind load (positive pressure), and flood load including relative sea level rise. The positive wind pressure and flood wave force both act in the same direction toward the garita wall.

2. "US Topo: Maps for America | U.S. Geological Survey." n.d. Www.usgs.gov. https://www.usgs.gov/programs/national-geospatial-program/us-topo-maps-america.
3. FEMA. 2018. Review of FEMA Puerto Rico Advisory Base Flood Elevations. FEMA. FEMA. December 11, 2018. https://gis-r2-fema.hub.arcgis.com/apps/31dfa15671944086b54b55bfc03344d7/explore.
4. De, Gobierno, Puerto Rico, Junta De Planificacion, and San Juan. 2021. "SPECIAL FLOOD HAZARD AREAS REGULATION (Planning Regulation No. 13) EIGHTH REVISION Guia Operacional Para Las Determinaciones de Danos Y Mejoras Sustanciales." https://jp.pr.gov/wp-content/uploads/2022/08/22966-Reglamento-de-inundaciones-Feb-2021-English-RM-JP-Rev-3.29.21-Final-RM-cert-1.pdf.

For the first load combination (dead and negative wind loads), the DCRs for the flexural tensile and compressive stresses were approximately 0.3 and 0.05, respectively. For the second load combination (dead, positive wind, and flood wave loads including relative sea level rise), the DCRs for the flexural tensile and compressive stresses were approximately 0.2 and 0.05, respectively. Based on the preliminary analysis and associated assumptions, the as-built construction of the masonry wall at La Garita del Diablo is demonstrably adequate to meet the gravity and lateral load demand.

Discussion and Conclusion

Mass masonry construction relies on net compressive stresses at all sections of load-bearing elements to transfer lateral and gravity load to foundations. Generally, tensile stresses in mass masonry structures would be designed to be minimal because unreinforced masonry has a low tensile capacity. A combined gravity and lateral load analysis on representative structural components was completed. The selected components generally are the most exposed to extreme loading and have more limited structural redundancy.

Components and cladding wind forces were used to assess these components of the structure. Based on commentary in ASCE7-16, a basic wind speed of 160 miles per hour for a Risk Category II structure corresponds to 700-year return period and a Saffir-Simpson Hurricane Category 4. From historic data collected by the NOAA and the National Weather Service, it is evident that hurricanes with wind speeds at or close to the ASCE7-16 design wind speed have occurred multiple times since the construction of Castillo San Cristobal, without significant recorded damage. This shows that the structural elements analyzed in this study, parapets and garitas, have historically performed adequately during a design event, as they are still standing and in serviceable condition.

The structural component exposed the most to flood loading is La Garita del Diablo. The design flood load per ASCE7-16 has a 100-year return period. During operational conditions, offshore waves typically do not reach higher than 6 feet, based on Station 41053 data, which is 0.8 miles northeast of la garita. However, it is likely that during extreme weather events, the sea level rises, and wave heights increase with the storm's high wind speeds. During Hurricane Maria, an 18.4-foot-tall wave was measured at the same location, Station 41053. It is unknown how the offshore wave heights translate to shoreline wave heights. An extreme wave height measured more than 0.5 miles from a project site does not correlate to the structure being exposed to the same wave condition. Site specific bathymetry and topography affect wave action between offshore and shoreline locations. The wave analysis conducted by Croft & Associates simulated models to gather shoreline wave information based on gathered offshore wave data at El Cañuelo, which is 1.75 miles west of La Garita del Diablo and located within the San Juan Bay. Although the site conditions may vary drastically between La Garita del Diablo and El Cañuelo, this study provides insight on the level of analysis to determine wave heights at a specific shoreline and potentially similar results for La Garita del Diablo. The models found that a rise in sea level of 4.5 feet and a wave height of 15.8 feet will result in shoreline waves between 2.5 and 3.3 feet at El Cañuelo. A similar study could be completed for the offshore and shoreline conditions at La Garita del Diablo to provide further information regarding wave impact on the structure, outside the design flood loads provided in ASCE7-16.

The analyzed parapets demonstrated sufficient capacity to meet self-weight and design wind load demand. La Garita del Diablo masonry walls are also constructed adequately to meet dead load and design wind and flood loading, including an assumed relative sea level rise of 2 feet, based on the wave analysis study. Without the predicted sea level rise, the height of the garita falls above the design flood elevation, according to current mean sea level and code requirements.

The analysis of the masonry walls of the garita at the North Bastion predicted excessively high tensile stresses due to dead and design wind loads. However, the simplified one-way analysis of the garita wall is a

conservative method to analyze the garita. The walls, in reality, exhibit two-way action, due to the construction of the ashlar stone units laid in running bond, and the circular shape of the garita walls. Two-way action recognizes that the travel path to the foundation for applied forces is not limited to one direction only but may be in two orthogonal directions in the plane of the wall. A two-way analysis would be more complex but would yield a lower applied flexural stress in the masonry walls, which should more accurately represent the in-situ condition of the garita. The preliminary analysis is also conservative based on assumed material strength properties, believed to be lower bound. The flexural capacity of the masonry may increase if the in-situ material exhibits stronger properties than initially assumed. This would be confirmed through destructive testing, which involves removal of masonry material and/or load testing. Also, since construction, this garita has most likely experienced several hurricane events with wind speeds at or close to the ASCE7 design wind speed and successfully resisted the high wind loads. Although the analysis predicted a significant level of overstress in the walls, a more advanced analysis and materials testing may reasonably account for the overstress and explain the good historical performance of the wall.

The NPS made WJE aware of other structural components of Castillo San Cristóbal with items of concern. In general, during the visual assessment, WJE did not find any conditions that warranted further structural analysis of the listed structural concerns. However, a few items may require further investigation to determine whether a structural concern is present.

Representatives of NPS stated that monitoring of the masonry cracks in the dungeon walls shows no change in crack thickness since the installation of the crack gauges. Also, no signs of movement or settlement of the exterior east masonry wall of the dungeon were observed. The WWII Joint Command Center, now the visitor's center and NPS offices, was constructed directly adjacent to the west exterior wall of the dungeon. The concrete bunker may have affected the adjacent masonry during construction, but there is no evidence of recent movement in the masonry walls.

The masonry arch and walls in the "partially collapsed" tunnel at Santa Teresa Battery were observed to be intact throughout the visible and accessible length of the tunnel until the soil blocked the tunnel's passageway. No signs of distress or instability in the masonry walls or arch were observed at this location. It is likely that the tunnel was intentionally blocked with rocks and sand for an unknown reason. However, no structural concern was identified at this location.

The underside of the arcade concrete roof structure at the north casemates exhibited cracks perpendicular to the span of the roof slab. Depending on the construction of the concrete slab and finishes, this may be indicative of flexural overstress. No sign of an imminent hazardous condition, such as sagging of the slab, was observed. However, further investigation is required to understand the reason for and extent of the cracking.

The isolated opening made at the south addition of the officers' quarters building showed that the crack in the stucco finish extended through the brick masonry structure. An electrical wire was found in the plaster at this location. The regular pattern of large cracks in the stucco finish suggests that the cracking may be related to the conduit installation. However, the full extent of the cracks extending into the masonry back up is unknown currently. Further investigation, including additional openings at other cracks, will be required to understand the reason and extent of the cracking.

Generally, given the stiffness and size of the main structures comprising Castillo San Cristóbal, visual observations and structural analysis of these components suggests that significant damage is unlikely to occur to the main structural elements in a high wind event, based on the assumptions made above and the as-built conditions observed. Further analysis and investigation are required to determine the adequacy of isolated components, such as the garita at the north bastion and isolated cracking.

Recommendations

Masonry and concrete deterioration and distress should be repaired using repair techniques and procedures described in the Treatments chapter of the Historic Structures Report.

Although the structural analysis of La Garita del Diablo showed that the as-built structure has adequate capacity to resist the current design wind (700-year return period) and flood loads (100-year return period), further investigation will be necessary to determine the structure's behavior during extreme weather events with extreme waves. A large wave was recorded during Hurricane Maria offshore from the garita. A wave analysis may be completed to provide further information regarding offshore and shoreline wave impact on La Garita del Diablo, outside the design flood loads provided in ASCE7-16.

Further structural analysis, such as finite element modeling, of the entire north bastion garita structure is recommended to accurately assess the applied stresses on the masonry from design wind loads. Due to the destructive nature of confirming material strength properties of masonry, testing is not recommended at this time. If further analysis shows that the garita does not have adequate capacity with the assumed strength properties, less invasive strengthening options may include deep repointing with joint reinforcement.

Additional investigation is recommended at the underside of the roof slab of the arcade at the north casemate, as well as the south addition of the officers' quarters, to understand the reason and extent of the cracking, and develop appropriate repairs if necessary.

Appendix D: Materials and Finishes Analysis

WJE

MATERIALS AND FINISHES ANALYSIS

Below is a list of the samples removed from Castillo San Cristóbal including their location, material, anticipated evaluation approach, and a photo of the location from which they were removed.

Sample ID	Location	Material	Field Photograph at Sample Location	Evaluation
1	Troops' quarters	Stucco		Petrography
2	Troops' quarters	Stucco		Petrography
3	Troops' quarters	Stucco		Petrography
4	Troops' quarters	Stucco		Petrography
5	Troops' quarters	Plaster		Petrography

Sample ID	Location	Material	Field Photograph at Sample Location	Evaluation
6	Troops' quarters	Mortar		Petrography
7	Santa Teresa	Mortar		Petrography
8	Santa Teresa	Mortar		Petrography
9	Santa Teresa	Mortar		Petrography
10	Santa Teresa	Parging		Petrography

Sample ID	Location	Material	Field Photograph at Sample Location	Evaluation
11	Officers' quarters	Stucco patch		Petrography
12	North casemate	Stucco and finish		Finishes analysis
13	Officers' quarters	Stucco and finish		Finishes analysis
14	Officers' quarters	Stucco and finish		Finishes analysis
15	Officers' quarters	Stucco and finish		Finishes analysis

Sample ID	Location	Material	Field Photograph at Sample Location	Evaluation
16	Officers' quarters	Stucco and finish		Petrography and finishes analysis
17	Officers' quarters	Stucco and finish		Finishes analysis
18	Officers' quarters	Stucco and finish		Petrography and finishes analysis
19	Officers' quarters	Stucco and finish		Finishes analysis
20	Officers' quarters	Stucco and finish		Finishes analysis

Sample ID	Location	Material	Field Photograph at Sample Location	Evaluation
21	Officers' quarters	Stucco and finish		Petrography and finishes analysis
22	Plaza ramp wall	Stucco and finish		Petrography and finishes analysis
23	El Abanico	Stucco and finish		Finishes analysis
24	El Abanico	Stucco and finish		Finishes analysis
25	El Abanico	Stucco and finish		Finishes analysis

Sample ID	Location	Material	Field Photograph at Sample Location	Evaluation
26	El Abanico	Stucco and finish		Finishes analysis
27	San Carlos	Plaster and finish		Finishes analysis
28	La Princesa	Stucco and finish		Petrography and finishes analysis
29	La Garita Del Diablo	Stucco and finish		Finishes analysis
30	Dungeon	Plaster and finish		Petrography and finishes analysis

Sample ID	Location	Material	Field Photograph at Sample Location	Evaluation
31	Troops' quarters	Wood and finish		Finishes analysis
32	Troops' quarters	Plaster and finish		Petrography and finishes analysis
33	La Princesa	Plaster and finish		Finishes analysis
34	Santa Teresa	Plaster		Finishes analysis

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Petrographic Examination of Building Material Samples

CASTILLO SAN CRISTÓBAL HISTORIC STRUCTURE REPORT

Petrographic Examination of Building Material Samples

Petrographic studies were conducted on various materials extracted from the Troop's Quarters, Santa Teresa Battery, El Abanico, San Carlos, Garita del Diablo, and La Princesa structures to characterize the composition of the materials. Examinations were conducted to characterize the materials. Petrographic studies were completed by Daniela Mauro, Senior Associate and Petrographer, of the Wiss, Janney, Elstner Associates, Inc. (WJE) Janney Technical Center.

SAMPLES

Sample identifications, removal location and sample description information, and a brief description of the samples in their as-received condition in WJE's Janney Technical Center laboratory are given in Table 1. Images of the samples are shown in Figure 1 through Figure 20.

Table 1. Sample Descriptions

Sample Name	Building	Field Description	Sample Description
Sample A	Troop's Quarters	Base exterior wall; two-part stucco with top and scratch coats which debonded upon removal	▪ Multiple fragments of visually similar material ▪ Fragments are nominally 1/4 in. thick ▪ One face is relatively smooth, and opposing face is possibly fractured ▪ Samples contain sand which is variable shades of brown within a very light gray binder ▪ Binder is relatively hard and moderately absorptive to water on fractured faces
Sample B	Troop's Quarters	North end of exterior wall, adjacent to existing stucco distress; two-part stucco with scratch coat and friable finish coat that did not remain intact	▪ Multiple fragments of visually similar material and crushed powder of likely same material ▪ Fragments are nominally 1/4 in. thick ▪ One face is relatively smooth, and opposing face is possibly fractured ▪ Fragments are friable, soft, and somewhat absorptive on fracture faces
Sample C	Troop's Quarters	North end of exterior wall, two-part stucco with top and scratch coats which debonded upon removal	▪ Two fragments of different materials: one labeled scratch (interior coat) and one labeled finish (exterior coat) ▪ Both layers have a light grayish tan binder ▪ The scratch coat is 3/8 in. thick, contains visible white lime lumps, is soft, somewhat friable, and somewhat absorptive to water ▪ The finish coat is 5/16 in. thick, soft, friable, and moderately to readily absorptive to water

Sample Name	Building	Field Description	Sample Description
Sample E	Troop's Quarters	Second-floor interior stucco; hard stucco with three to four finish layers applied over brick substrate	▪ Multiple fragments of visually similar material ▪ Fragments typically contain coating layers on exterior ▪ Some fragments contain adhered brick substrate ▪ Stucco is hard and somewhat absorptive to water on fractured surfaces
Sample F	Troop's Quarters	Mortar extracted between brick units at the sill of a first-floor interior unit	▪ Two fragments of visually similar pieces, each contain two materials ▪ Samples are comprised of predominantly gray mortar coated in brick dust. Mortar is hard, dense, and not absorptive to water ▪ Relatively smaller fragments of red mortar are adhered to the gray mortar; red mortar is hard, dense, and moderately absorptive to water ▪ The red mortar remains bonded to the gray mortar when fractured with a hammer and chisel
Sample G	Santa Teresa	Mortar extracted between brick units at the exterior wall coping near Santa Teresa	▪ Two fragments of similar joint material, one of which has a large portion of adhered brick ▪ Joint contains two mortars ▪ The exterior mortar is gray and similar to that in Sample F (hard, dense, and not absorptive to water) ▪ The interior mortar is very light gray, contains visible white lime lumps, is somewhat hard, and somewhat absorptive to water
Sample H	Santa Teresa	Mortar extracted between exterior stone coping units	▪ Two materials were received, labeled parge and mortar; only the mortar was examined ▪ The exterior faces of the mortar are dark green, likely from soiling and plant growth ▪ The binder is very light gray; the mortar is hard, dense, and somewhat absorptive to water on fractured faces
Sample I	Santa Teresa	Fragment of stone and colored stucco or mortar exterior from between exterior stone units	▪ Multiple fragments of irregularly shaped material, some of which have red dust on faces ▪ Stucco/parge is brick red color, soft, easily broken by hand, and readily absorptive to water

Sample Name	Building	Field Description	Sample Description
Sample J	Santa Teresa	Material extracted from the roof of a bunker which is 3/8 in. thick with a black coating applied over top	▪ Irregularly shaped fragment which has black apparent coating or debris on one face and even, irregular opposing face ▪ The binder of the bulk of the material is very light gray ▪ The bulk material is hard, dense, and is moderately absorptive to water
Sample K	Santa Teresa	Plaster extracted from interior of the west guard house at Santa Teresa; approximately 3/8 in. thick	▪ Multiple fragments of visually similar material, some are partially coated with brick dust ▪ Fragments are nominally 1/4 in. thick ▪ One face is relatively smooth, and opposing face is possibly fractured ▪ Samples contain sand which is variable shades of brown within a very light gray binder ▪ Binder is relatively hard and moderately absorptive to water on fractured faces
Sample L	El Abanico	Two tinted stucco fragments from the exterior upper parade that had delaminated from brick substrate	▪ Multiple irregularly shaped fragments of visually similar material ▪ One face is relatively smooth and brownish orange color ▪ Opposing face is irregular, with slight texture ▪ Thickness is variable ▪ The material is somewhat soft, not friable, and readily absorptive to water on fractured surfaces
Sample M	El Abanico	Original stucco and finishes from the exterior west wall	▪ Portions of stucco that exhibit slightly textures surfaces ▪ Exterior exhibit orange and brown color ▪ Fractured surfaces are white to light grey
Sample N	San Carlos	Plaster extracted from the interior which was 3/8 in. thick; could not be determined whether the sample has a surface coating	▪ Portions of stucco that contain an uneven interior surface and relatively flat exterior surface ▪ Materials are somewhat soft, slightly friable, and slightly absorptive of water ▪ Interior stucco contains abundant visible sand; exterior thin layer appears to contain lower volume of sand
Sample O	Garita Del Diablo	Previously debonded stucco at the exterior perimeter wall adjacent to Garita del Diablo; 1/4 in. thick and has pigmented surface finish	▪ Multiple fragments of similar material, up to 1/4 in. thick ▪ One surface is relatively smooth and a light yellowish-brown color

Sample Name	Building	Field Description	Sample Description
			▪ Opposing surface is rough and irregular, with localized green discoloration ▪ Fractured edges reveal variable color sand within very light gray binder ▪ Fragments are easily breakable by hand and readily absorptive to water on fractured faces
Sample 4a	Officer's Quarters	Arcade	▪ Multiple fragments of visually similar material ▪ The binder of the material is a brick red color, has visibly low sand content, and contains visible white lumps ▪ The material is soft, friable, and extremely absorptive to water on fractured surfaces
Sample 6	Officer's Quarters	Arcade, extracted 18 in. above grade	▪ Irregularly shaped fragments of visually similar material ▪ Fragments are nominally 5/16 in. thick, sand content is visually low, and the binder is a very light gray with visible white lumps ▪ The material is moderately soft, somewhat friable, and readily absorptive to water on fractured faces
Sample 10	Troop's Quarters	Interior, extracted 12 in. above first floor	▪ Chips of coating and a small irregularly shaped fragment of stucco were received; only the stucco was examined petrographically ▪ The material is light gray color
Sample 18	La Princesa	Exterior	▪ Irregularly shaped fragment of material, one surface coated in red dust ▪ The binder is a very light gray color with visible white lumps ▪ The material is soft, friable, and readily absorptive to water

PETROGRAPHIC STUDIES

Methods

Petrographic studies were conducted in accordance with ASTM C856, *Standard Practice for Petrographic Examination of Hardened Concrete*, which also applies to mortar, stucco, plaster, and other materials. Each sample was examined visually, and detailed studies of the as-received surfaces were conducted at magnifications up to 40X using a stereomicroscope. Fracture surfaces and unlapped portions of each sample were examined as part of the studies. Thin sections were prepared from portions of each sample

to assess paste and aggregate constituents. The thin sections were examined at magnifications ranging from 25X to 500X using a petrographic (polarized light) microscope.

Findings

Mortars

Samples F, G, and H represent mortars extracted from different locations of the Troops' Quarters (Sample F) and the Santa Teresa Battery (Samples G and H). Therefore, the mortars are composed of different materials. Below is a summary of findings relevant to each mortar sample:

- **Sample F**: composed of a red repointing mortar and gray bedding mortar extracted from a joint between spalling brick units.
  - The red mortar is composed of natural sand consisting of siliceous quartz and calcareous particles such as shell fragments within portland cement-hydrated lime binder with brick dust that acts as a pigment (Figure 21).
    - Represents a repointing mortar.
  - The gray mortar is composed of natural siliceous quartz sand and calcareous shell and fossil fragments within a white portland cement binder (Figure 22).
    - Cement content is visually high, and the mortar is hard and dense, with lumps of cement observed, indicating the cement was not uniformly dispersed.
- **Sample G**: composed of two gray mortars extracted from between spalled brick coping units at the battery wall.
  - The exterior-most mortar, which appears to represent a repointing mortar, contains quartz sand dispersed in an ordinary portland cement binder (Figure 23).
    - This mortar is hard and dense.
  - The interior-most mortar is composed of natural siliceous quartz sand and rounded calcareous fragments of shells within a hydrated lime and portland cement binder (Figure 24).
    - The volume of portland cement is low compared to lime, hydrated lime lumps are large and abundant.
- **Sample H**: composed of a single mortar extracted from between intact stone coping units.
  - The mortar is composed of predominantly calcareous shell and fossil sand particles with lesser amounts of siliceous quartz sand within a portland cement-lime mortar (Figure 25).
    - Portland cement particles are abundant, hydrated lime lumps are present at a visually lower volume. Cementitious materials exhibit advanced to near complete degree of hydration (Figure 26).
    - Compared to other samples examined, the sand content is visually high.

Cementitious Roof Parging

Sample J represents material from the roof of the bunker at Santa Teresa Battery. The sample is composed of a cementitious parge coating with a black-colored liquid-applied coating on the surface. The parge material in Sample J is composed of natural siliceous quartz sand and calcareous shell and fossil sand within a portland cement-hydrated lime binder (Figure 27). The portland cement particles are very

large and irregularly shaped and are consistent with cement from before the 1920s. Some observed hydrated lime lumps are larger than sand particles within the parge coat.

Stucco and Parge Coatings

Exterior stucco samples from several buildings were examined, including Sample I (Santa Teresa Battery), Samples L and M (El Abanico), Sample N (San Carlos), Sample O (Garita del Diablo), and Sample 18 (La Princesa). Sample substrates and materials vary between locations. Below is a summary of findings relevant to each stucco or parge sample:

- **Sample I**: composed of a siliceous quartz and crushed aggregate sand within a hydrated lime binder. No other cementitious materials were observed.
  - The stucco/parge has an ochre paste color and appears to contain a pigment. The paste exhibits concentrations of pigment around angular aggregate particles (Figure 29), and some particles may represent crushed brick fragment.
  - Some observed hydrated lime nodules are large and coarser in size than the sand (Figure 30).
  - Paste is altered from repeated water exposure, and calcite (efflorescence) is observed depositing along the edges of air voids.
- **Sample L**: composed of two layers of stucco, applied to brick exterior walls (Figure 31).
  - The interior-most layer of stucco is composed of predominantly rounded calcareous shell fragments with lesser amount of siliceous quartz sand within a portland cement-hydrated lime binder.
    - The binder is predominantly lime-based, with infrequent large portland cement particles throughout
    - The paste contains shrinkage cracks, which are common in high-lime materials.
  - The exterior-most layer of stucco is composed of predominantly rounded calcareous shell and fossil fragments with lesser amounts of siliceous quartz sand within a portland cement binder (Figure 32).
    - Particles of portland cement are large and irregularly shaped.
- **Sample M**: composed of two layers of stucco, applied to brick exterior wall (Figure 33)
  - The interior-most layer of stucco is composed of a low volume of natural quartz sand within a hydrated lime binder (Figure 34).
    - The lime is coarse, and appears to represent lime made from burning seashells, some particles exhibit texture of original parent seashell.
    - Remnants of burned wood were observed.
    - Contains shrinkage cracks typical of lime-based materials were observed, many of which have autogenously healed with calcite deposits infilling the cracks.
  - The exterior-most layer of stucco is composed of a trace amount of natural quartz sand within a portland cement binder (Figure 35).
    - The portland cement is coarse, consistent with portland cements manufactured in the late 1800s to early 1900s.
    - This layer appears to represent a skim or parge coat applied onto the lime-based original stucco layer.

- **Sample N**: composed of two layers of stucco, applied to a stair wall; overall appearance is similar to the lime-based layer in Sample M (Figure 34)
  - The interior-most layer of stucco is composed of natural siliceous quartz and calcareous shell sand within a hydrated lime binder.
    - This layer is likely the original stucco.
    - Contains shrinkage cracks typical of lime-based materials, many of which have autogenously healed with calcite deposits.
  - The exterior-most layer of stucco is composed of natural siliceous and calcareous shell fragments sand within a portland cement binder.
    - A low volume of portland cement particles is coarse and irregularly shaped.
  - A layer of calcite was observed along the exterior face of the sample.
- **Sample O**: composed of a single stucco layer, applied to a rubble masonry perimeter wall (Figure 35)
  - The stucco is composed of predominantly quartz sand with a low volume of seashells within a hydrated lime binder.
    - The lime may be slightly hydraulic based on the observation of hydraulic phases.
    - No limewash or oiled coating was observed.
    - The binder does not exhibit shrinkage cracks but appears to contain smaller lime lumps.
- **Sample 18**: composed of two layers of stucco, applied to a stone and brick perimeter wall (Figure 36)
  - The interior-most layer of stucco is composed of a low volume of quartz sand within a hydrated-lime binder.
    - The binder is fully carbonated.
    - This layer is likely the original stucco.
    - Contains shrinkage cracks typical of lime-based materials were observed, many of which have autogenously healed with calcite deposits.
  - The exterior-most layer of stucco is composed of predominantly quartz sand with a low volume of seashells within a portland cement-lime binder.
    - The portland cement particles are coarse, likely from before the 1920s, and exhibit advanced to near complete hydration.
    - The binder is carbonated along a thin zone along the flat surface, which appears to represent the exterior surface.

Interior Plaster Coatings

Plaster samples from several buildings were examined, including Sample K (Santa Teresa Battery), Samples 4A and 6 (Officer's Quarters), and Samples E and 10 (Troops' Quarters). Extraction locations and materials vary between locations. Below is a summary of findings relevant to each plaster sample:

- **Sample E**: composed of multiple layers of plaster extracted from an interior wall.
- The plaster is composed predominantly of shell fragments with a low volume of quartz sand within a portland cement binder (Figure 37).
  - The portland cement particles are coarse, likely from before the 1920s.

    - Particles that appear similar to hydrated lime are present, but appear to represent shell fragments, or shell fragments that were not fired at high enough temperatures to convert the shells to lime.
    - The binder is fully carbonated.
- **Sample K**: composed of multiple fragments of a plaster sample with a thin parge coat, extracted from an interior chamber.
    - The plaster is composed predominantly of quartz sand with a low volume of rounded calcareous shells sand within a hydrated lime binder.
    - A thin, neat lime layer is applied to the exterior of the sample (Figure 38).
    - Remnants of a green or blue coating are not present on the sample.
- **Sample 4A**: composed of a single layer of stucco applied at various locations throughout the portico.
    - The stucco is composed of somewhat angular predominantly siliceous sand with trace amounts of limestone sand within a hydrated lime binder (Figure 39).
        - The hydrated lime lumps are very large and are often much larger than the sand.
        - Portions of the aggregate represent crushed brick, and particles likely representing brick dust, are present, giving the sample its overall color.
- **Sample 6**: composed of a single layer of stucco applied to a brick substrate.
    - The stucco is composed of a trace amount of quartz sand within a hydrated lime binder (Figure 40).
        - Hydrated lime lumps are very large, often larger than sand particles.
        - The sand content appears visually low, with the majority of the sample representing paste.
        - The binder is fully carbonated.
        - A low volume of shrinkage cracks is observed, most of which are within lime lumps and not the overall binder.
- **Sample 10**: composed of a plaster applied to a stone substrate and containing multiple coatings on the exterior face.
    - The plaster is composed of natural siliceous and fragments of calcareous shell fragment sand within a portland cement binder (Figure 41).
        - Portland cement particles are large and abundant; no hydrated lime was observed.

Stucco Repair Materials

Samples A, B, and C represent stucco repair materials from the west elevation of the Troops' Quarters; repairs were reportedly performed in 2003 and 2017, but repairs from 2017 were failing. All samples were composed of two layers of stucco, although both layers were only captured in Sample C, and were applied to clay brick and stone masonry substrates. Below is a summary of findings relevant to each repair stucco sample:

- **Sample A:** composed of the interior scratch coat stucco layer.
    - The stucco layer is composed of a low volume of manufactured siliceous sand within a non-air entrained hydrated lime binder (Figure 42).
        - Portland cement was not visually detected in the binder, but some particles that may represent hydraulic materials were observed.

    - The binder is fully carbonated.
    - While the material is not air entrained, occasional spherical air voids are observed.
    - The material does not exhibit shrinkage cracking, which is typical in high lime systems, indicting an additional cementitious material may be present, but was not visually detected.
- **Sample B:** composed of the interior scratch coat stucco layer.
    - The stucco layer is composed of a low volume of large, angular, natural siliceous sand within a hydrated lime binder (Figure 43).
        - Hydrated lime lumps are very large, often larger than sand particles.
        - A high volume of shrinkage cracks is observed in the binder, which is typical of high-lime materials.
- **Sample C:** composed of two layers of stucco (interior scratch and exterior finish coats) which are intact during examination (Figure 44)
    - The interior scratch coat is composed of a somewhat low volume of siliceous and calcareous sand within a hydrated lime binder.
    - The exterior finish coat is composed of siliceous sand within a hydrated lime binder.
    - Shrinkage cracks within the binder are observed in both stucco layers; the volume of shrinkage cracks is relatively lower than that in Sample B, which is also softer.

FIGURES



Figure 1. Sample A. Images of the sample, as received, in WJE's Janney Technical Center laboratory.

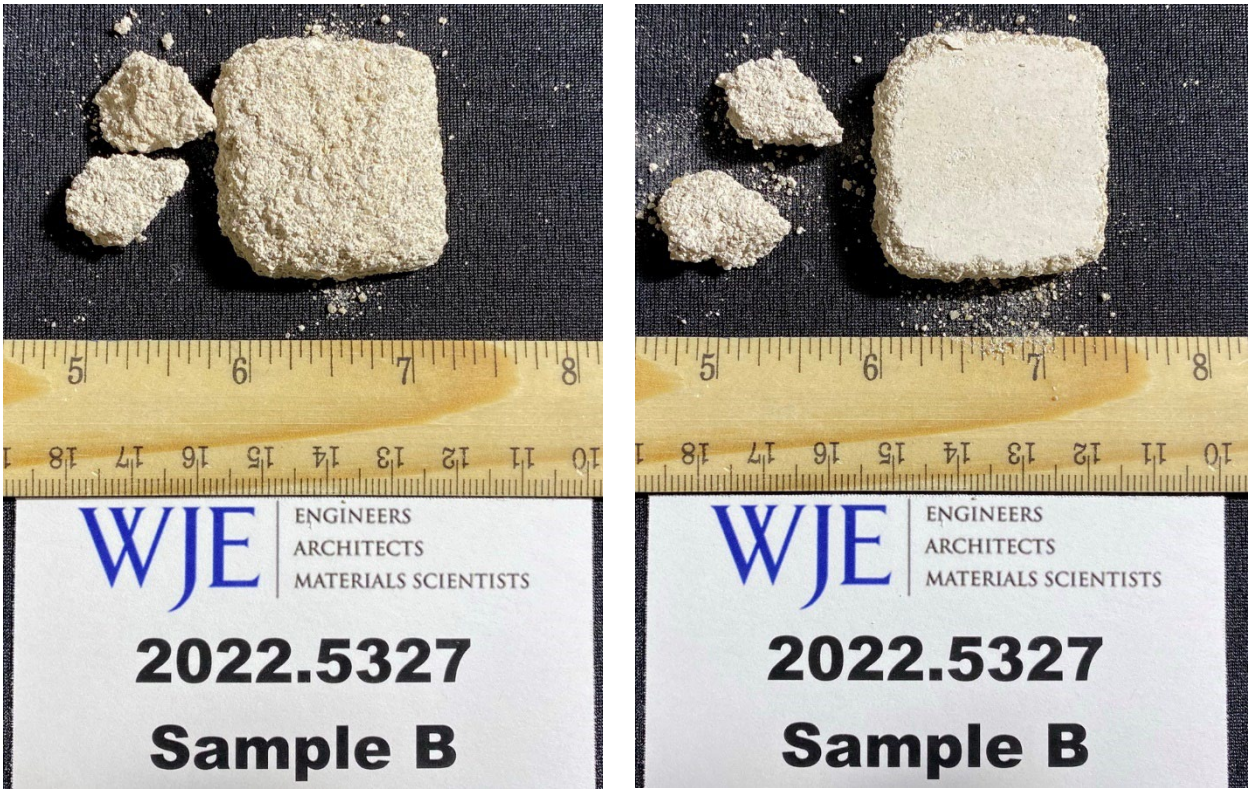


Figure 2. Sample B. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 3. Sample C. Images of the sample, as received, in WJE's Janney Technical Center laboratory. The sample on the left represents the finish coat and the sample on the right represents the scratch coat.



Figure 4. Sample E. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 5. Sample F. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 6. Sample G. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 7. Sample H. Images of the sample, as received, in WJE's Janney Technical Center laboratory. The parge coat is on the left and the mortar is on the right. Only the mortar was examined petrographically.



Figure 8. Sample I. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 9. Sample J. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 10. Sample K. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 11. Sample L. Images of the sample, as received, in WJE's Janney Technical Center laboratory.

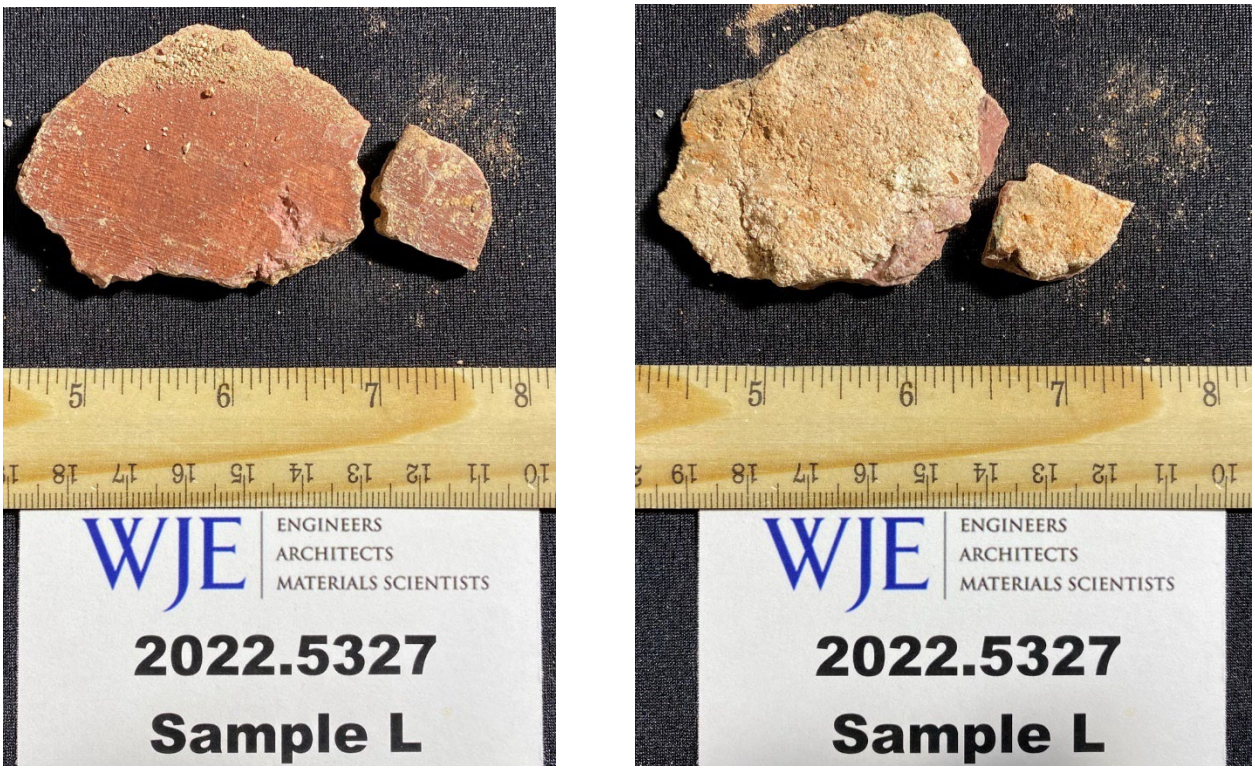


Figure 12. Sample L. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 13. Sample M. Removal location of the examined sample. Left image shows the location before removal, with a red arrow pointing to the removal location. Right image shows the area after the sample was removed.



Figure 14. Sample N. Location of sample removal. The sample consists of plaster that contains two layers of material.



Figure 15. Sample O. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 16. Sample 4A. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 17. Sample 6. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 18. Sample 10. Images of the sample, as received, in WJE's Janney Technical Center laboratory.



Figure 19. Sample 10. Images of the sample, as received, in WJE's Janney Technical Center laboratory.

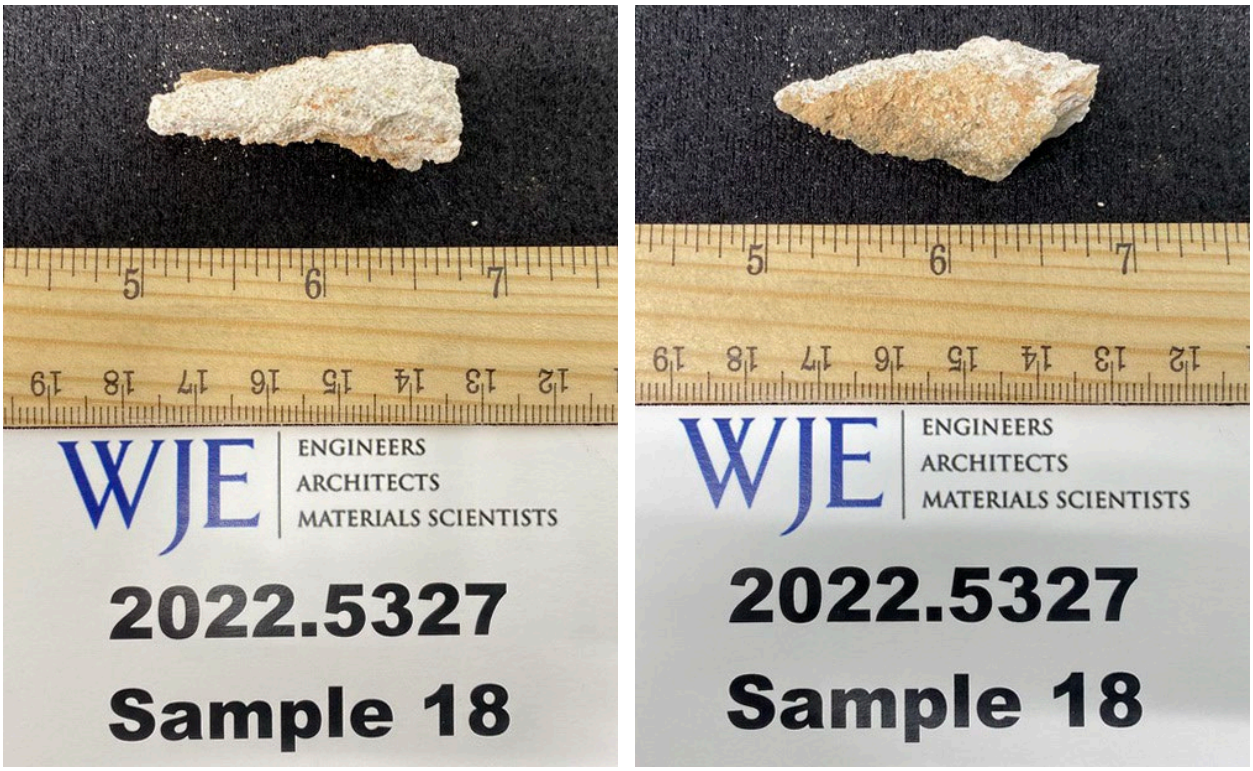


Figure 20. Sample 18. Images of the sample, as received, in WJE's Janney Technical Center laboratory.

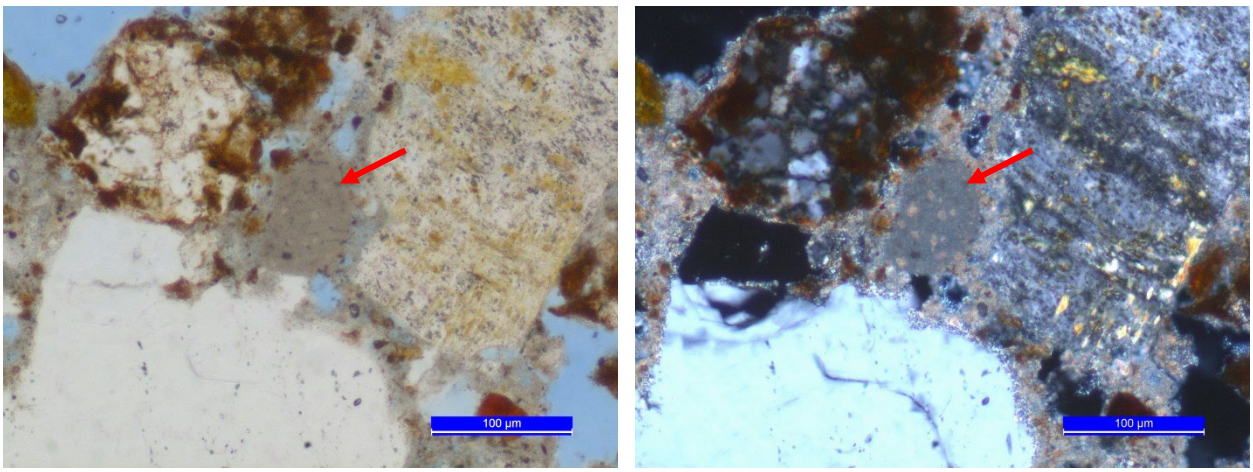


Figure 21. Sample F. Plane-polarized light (left) and cross-polarized light (right) images of the same area showing a relatively small, hydrated lime lump within the binder of the red repointing mortar (red arrows).

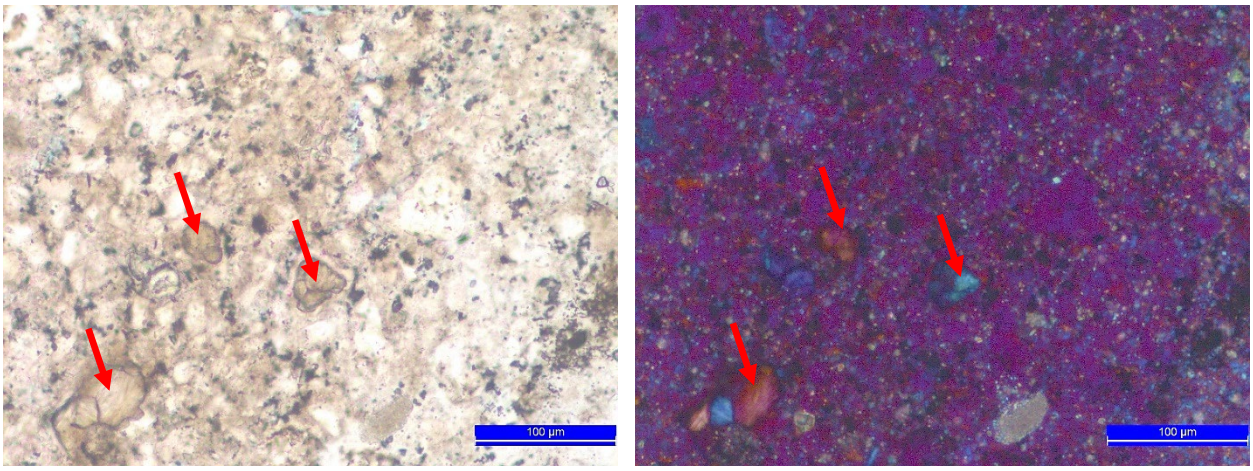


Figure 22. Sample F. Typical appearance of the white portland cement (red arrows) in the grey mortar layer. Left image shown in plane-polarized light, right image shown in cross-polarized light with a gypsum plate inserted.

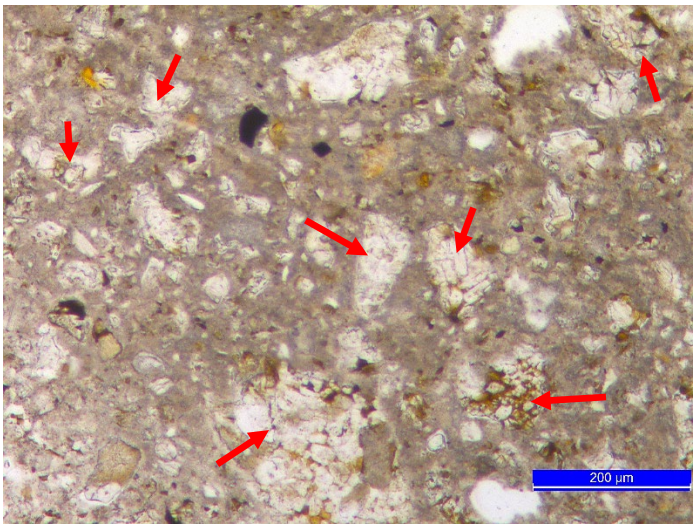


Figure 23. Sample G. Plane-polarized light image showing the typical appearance of the portland cement (red arrows) in the exterior mortar.

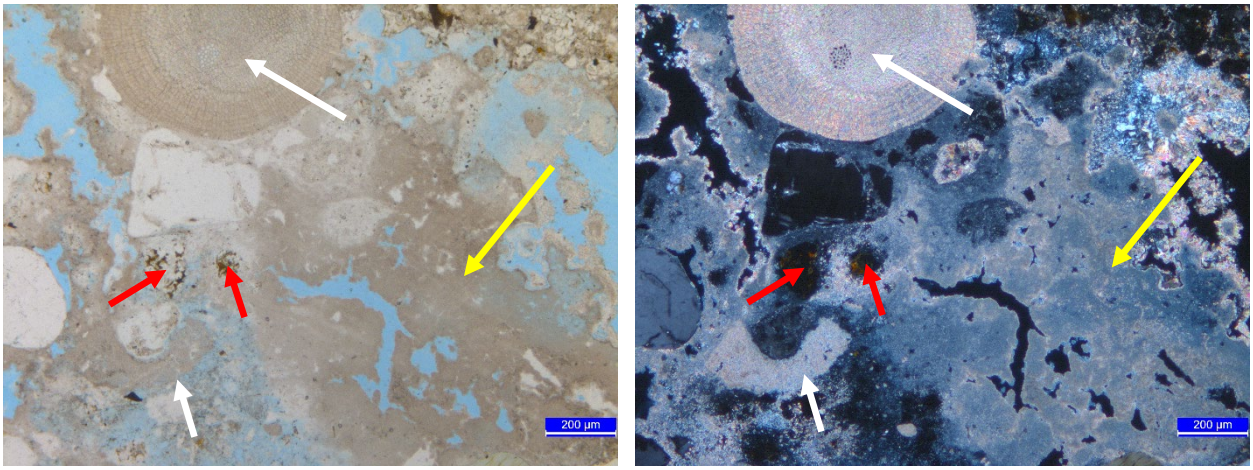


Figure 24. Sample G. Plane-polarized light (left) and cross-polarized light (right) images of the same area of Sample G showing portland cement (yellow arrows) and a large, hydrated lime lump within the binder (red arrows). White arrows point to shell particles present as part of the aggregate.

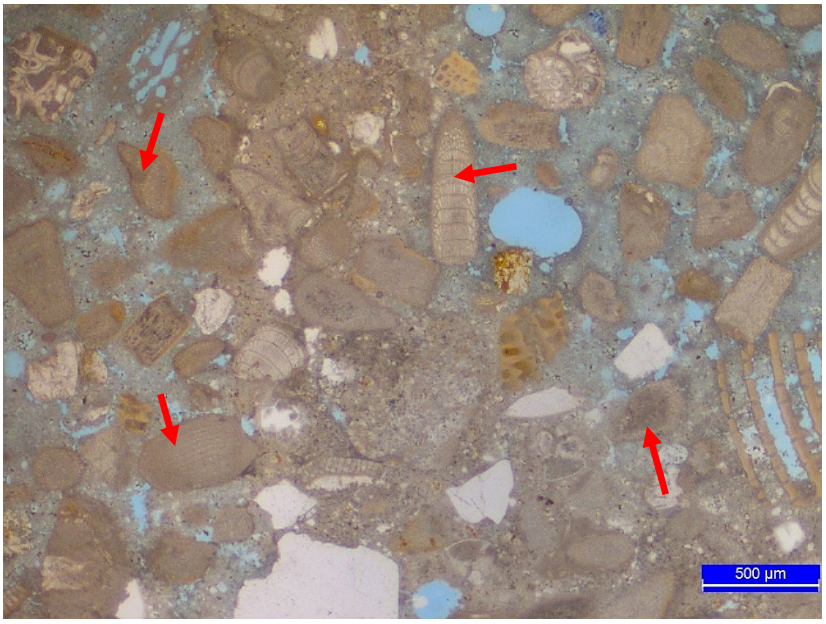


Figure 25. Sample H. Representative image of the mortar, showing the abundant shell; and fossil sand particles. Image taken in plane-polarized light. Red arrows point to some of the sand.

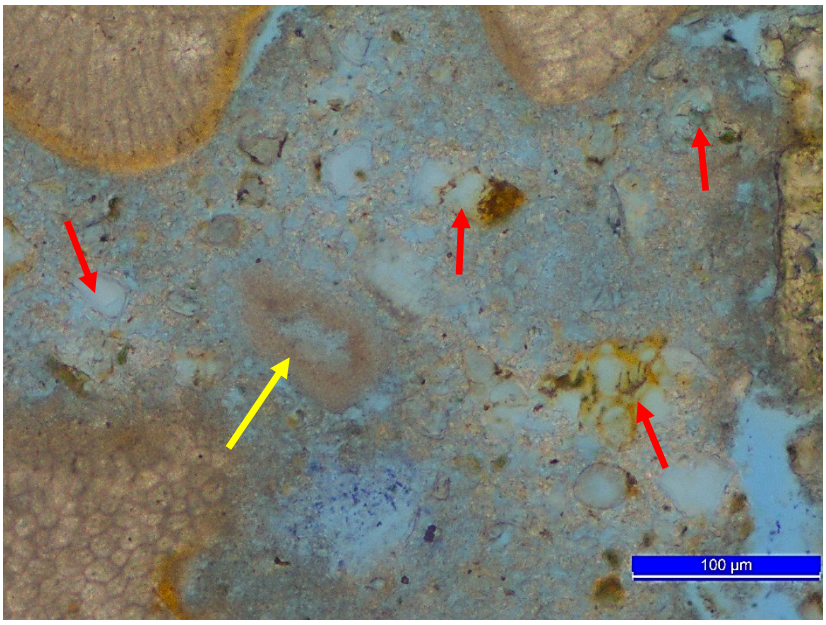


Figure 26. Sample H. Portland cement particles (red arrows) exhibit an advanced to almost complete degree of hydration. Yellow arrow points to a hydrated lime lump.

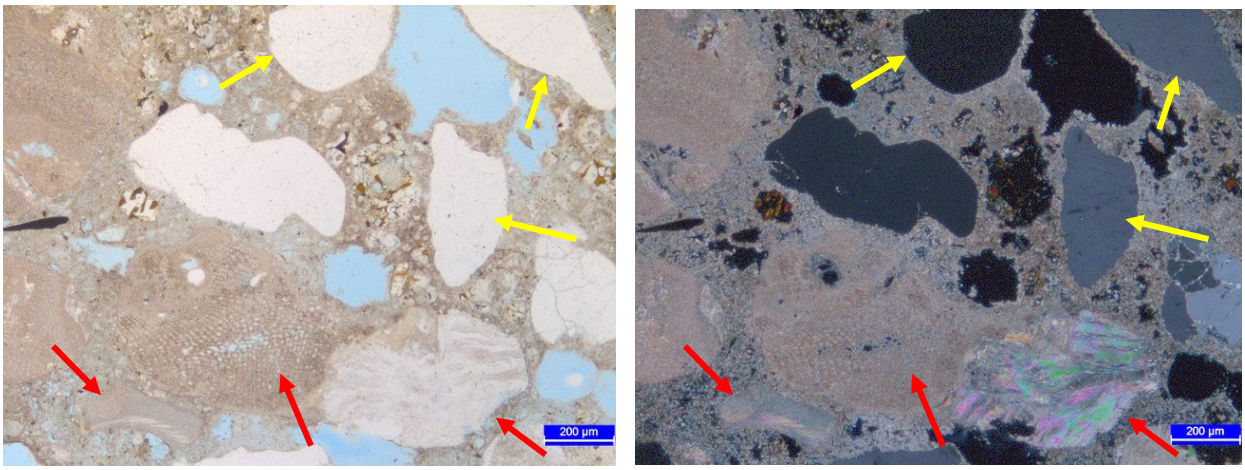


Figure 27. Sample J. Plane-polarized light (left) and cross-polarized light (right) images of the same area showing shell fragments (red arrows) and quartz sand (yellow arrows) within a fully carbonated binder.

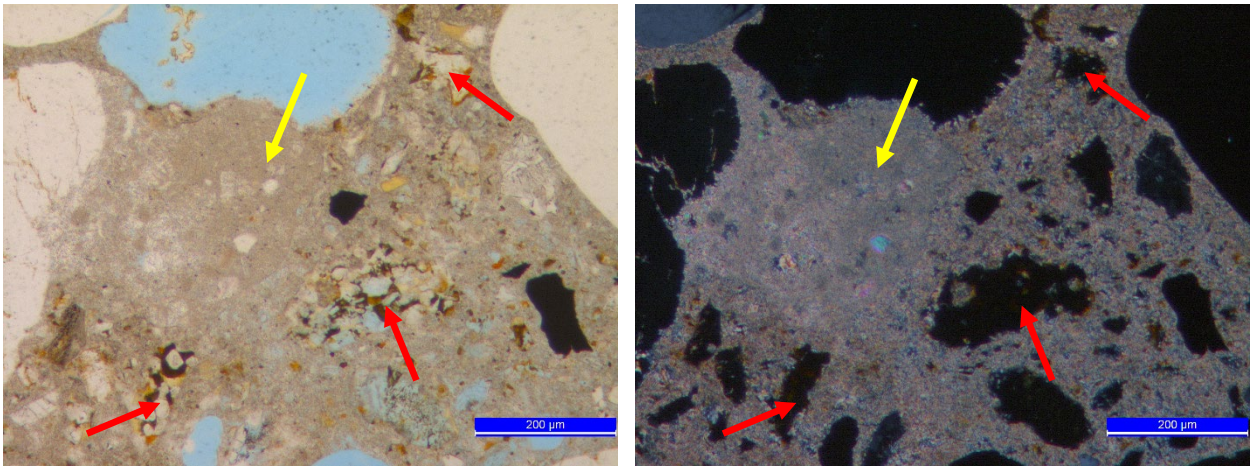


Figure 28. Sample J. Plane-polarized light (left) and cross-polarized light (right) images of the same area, showing the appearance of the portland cement (red arrows) and the hydrated lime (yellow arrows).

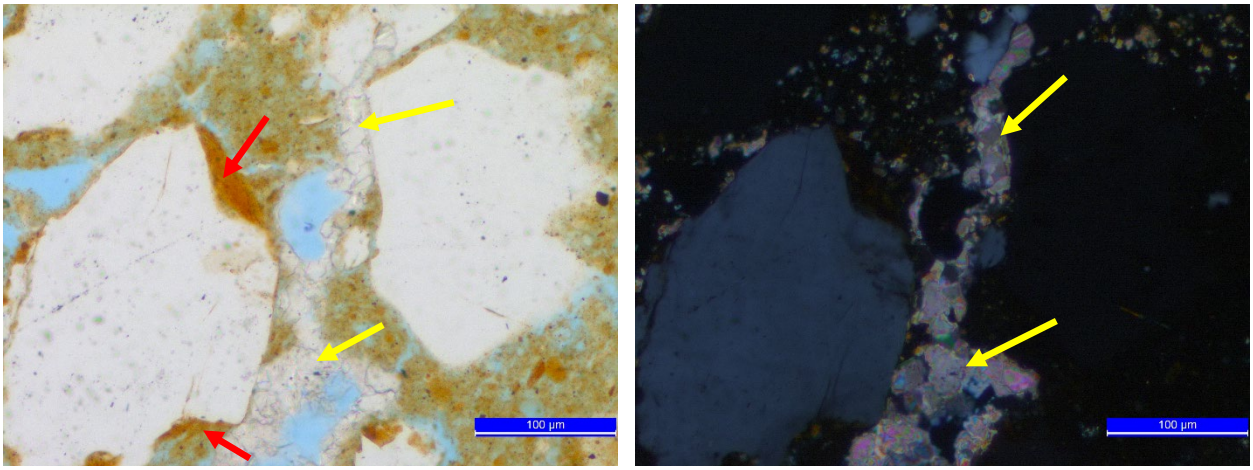


Figure 29. Sample I. Plane-polarized light (left) and cross-polarized light (right) images of the same area, showing the accumulation of pigment (red arrows) around a quartz sand particle, and the deposition of calcite (yellow arrows) within void space.

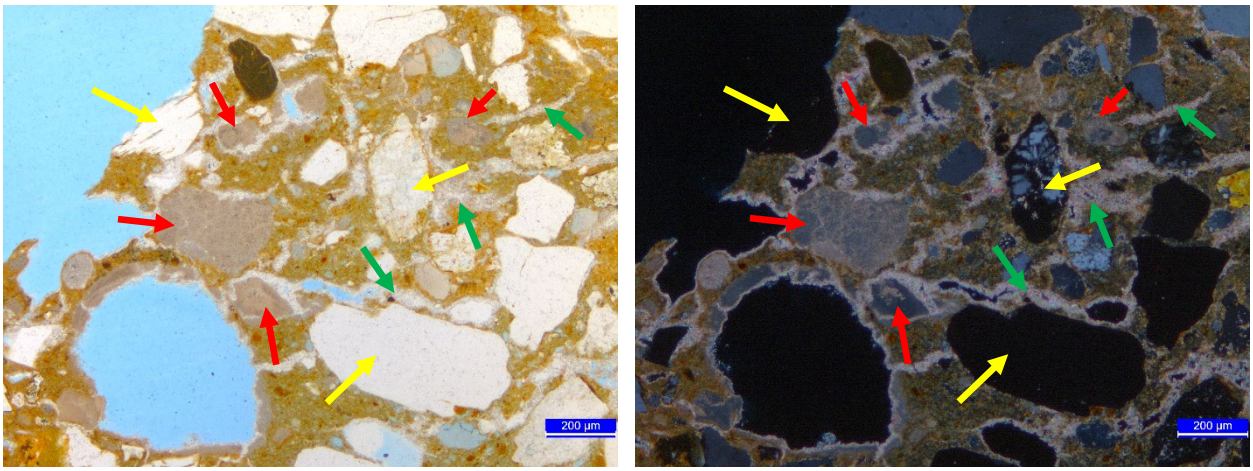


Figure 30. Sample I. Plane-polarized light (left) and cross-polarized light (right) images of the same area, showing the size of the hydrated lime lumps (red arrows) compared to the sand particles (yellow arrows). Within cracks and void space, secondary deposits of calcite (green arrows) are present.

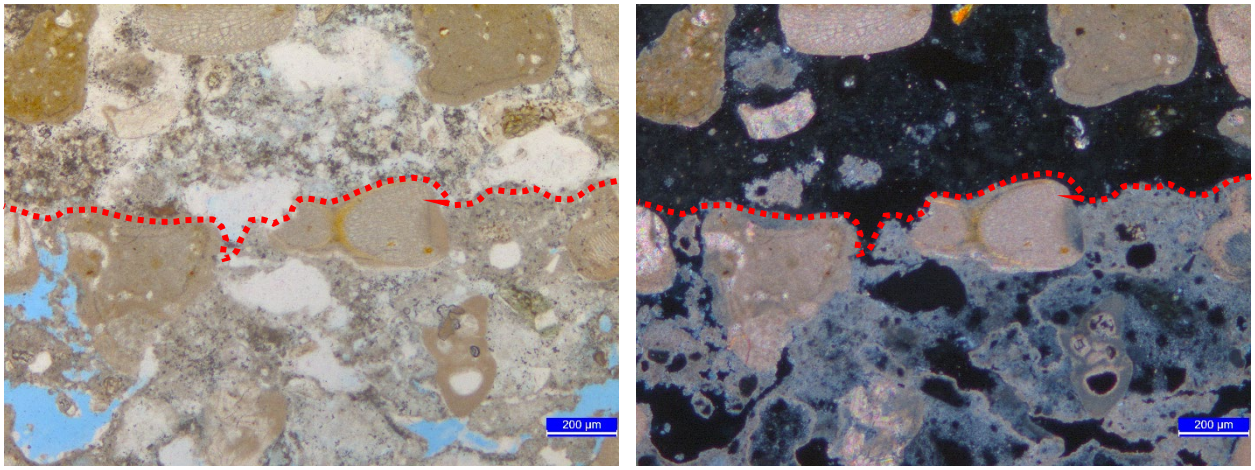


Figure 31. Sample L. Plane-polarized light (left) and cross-polarized light (right) images of the same area, showing the bond line between the exterior cement-based stucco (above red dotted line) and the interior, cement-lime based stucco layer (below dotted red line).

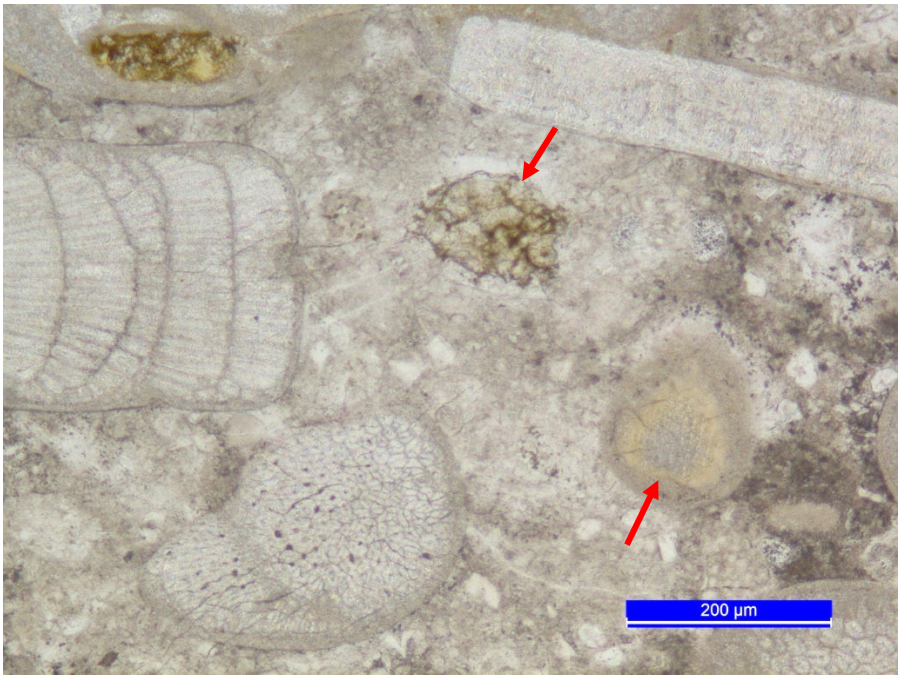


Figure 32. Sample L. Plane-polarized light image of the exterior stucco layer showing the typical appearance of the portland cement (red arrows).

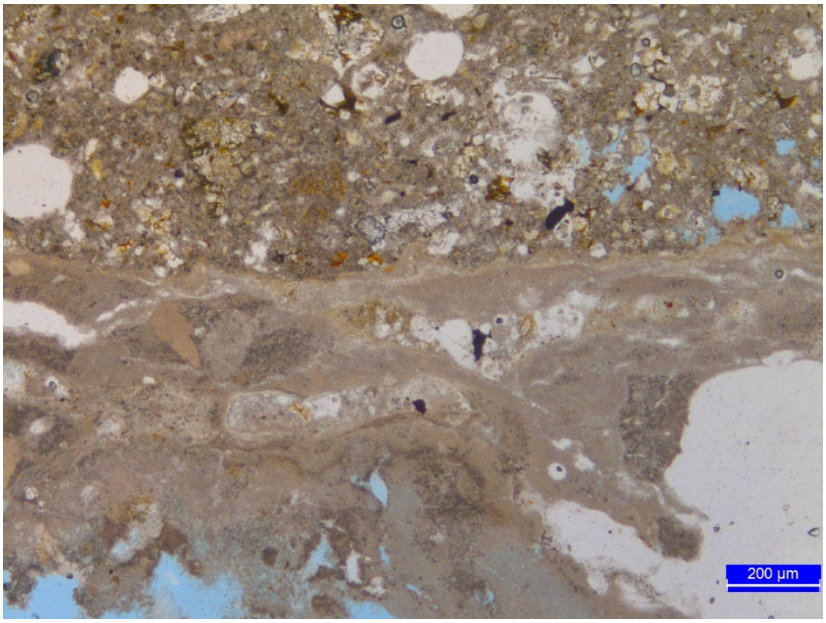


Figure 33. Sample M. Plane-polarized light image showing the bond line between the cement-based layer (above red dotted line) and the lime-based layer (below red dotted line).

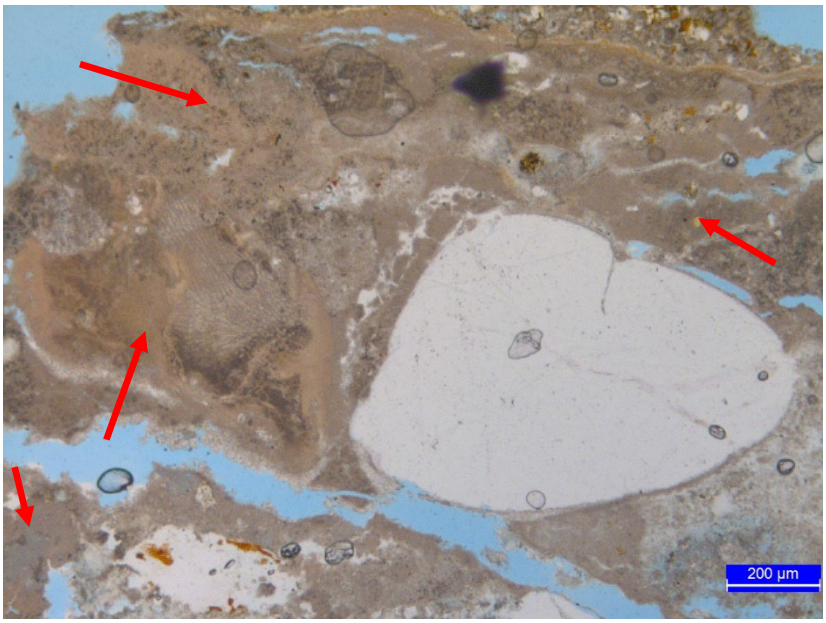


Figure 34. Sample M. Plane-polarized light image showing a representative field of view of the lime-based layer. Red arrows point to hydrated lime. The large white area represents a natural quartz sand.

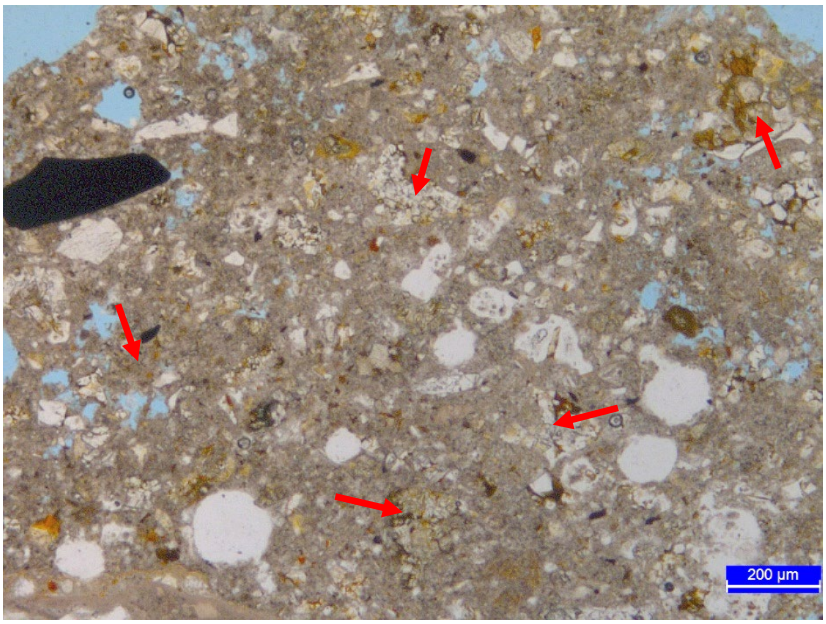


Figure 35. Sample M. Plane-polarized light image showing the appearance of the portland cement (red arrows) in the cement-based layer.

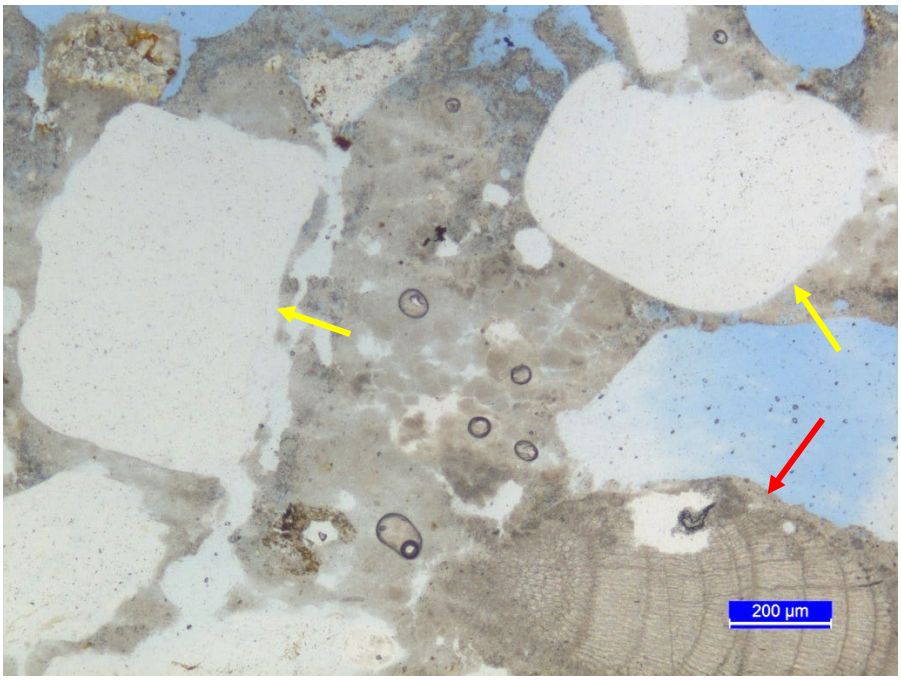


Figure 36. Sample N. Plane-polarized light image of an area from Sample N showing shell fragments (red arrows) and quartz sand (yellow arrows) within a lime binder.

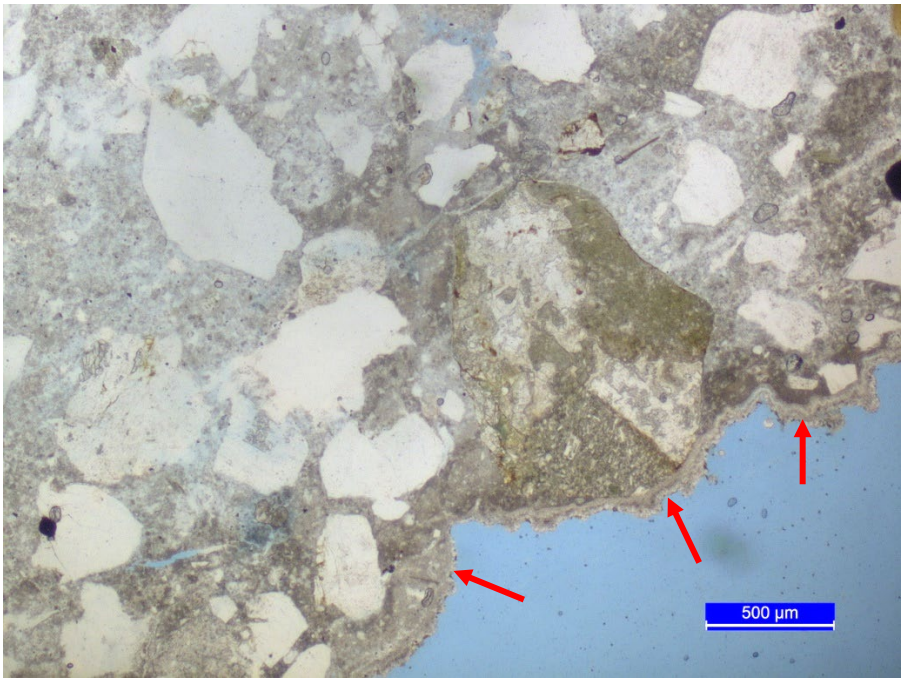


Figure 37. Sample O. Plane-polarized light image of an area from Sample O showing a thin layer of efflorescence along the exterior face (red arrows).

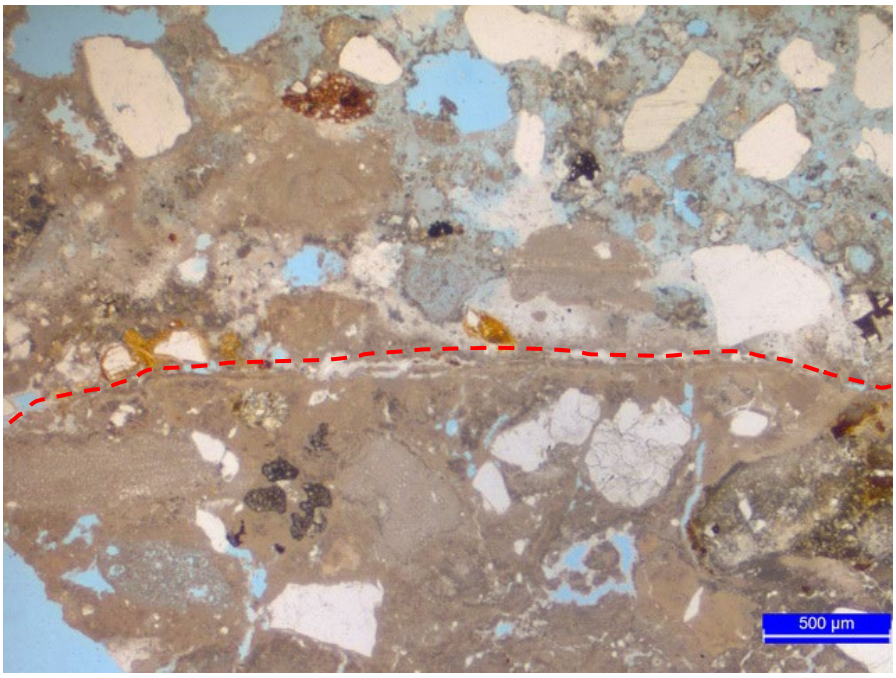


Figure 38. Sample 18. Plane-polarized light image of an area showing the bond line between two layers (red dashed line).

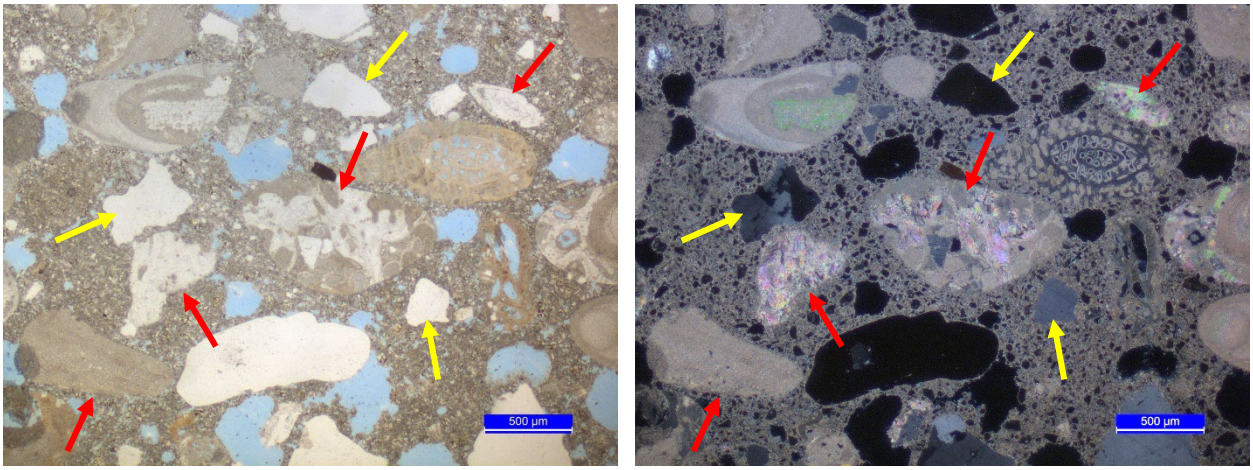


Figure 39. Sample E. Plane-polarized light (left) and cross-polarized light (right) images of the same area showing shell fragments (red arrows) and quartz sand (yellow arrows) within a fully carbonated cement binder.

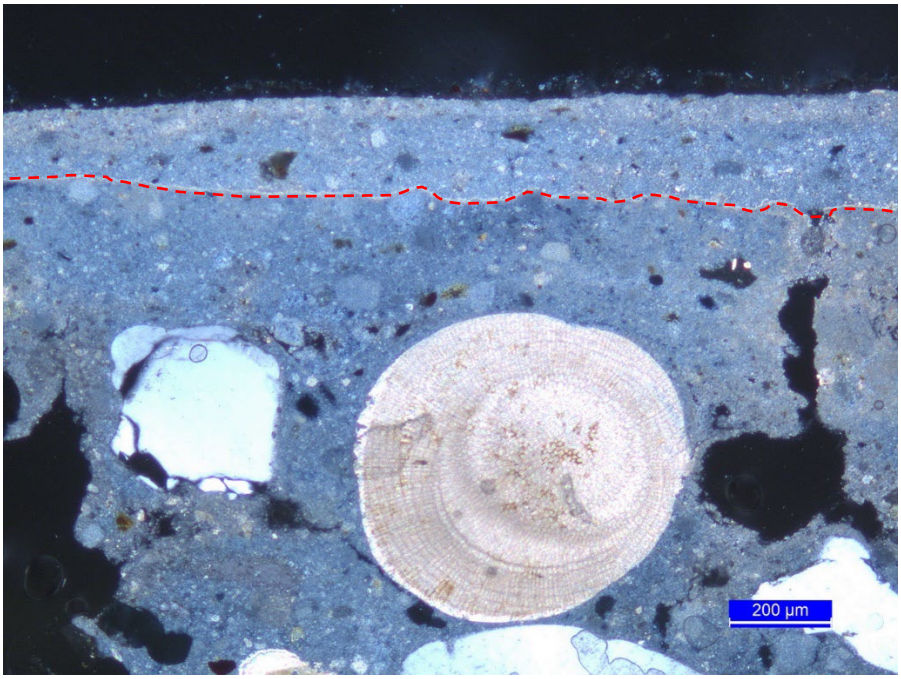


Figure 40. Sample K. Cross-polarized light image of a representative area near the exterior of the sample, showing a thin, neat (does not contain aggregate) lime layer applied along the exterior surface (above the red dashed line).

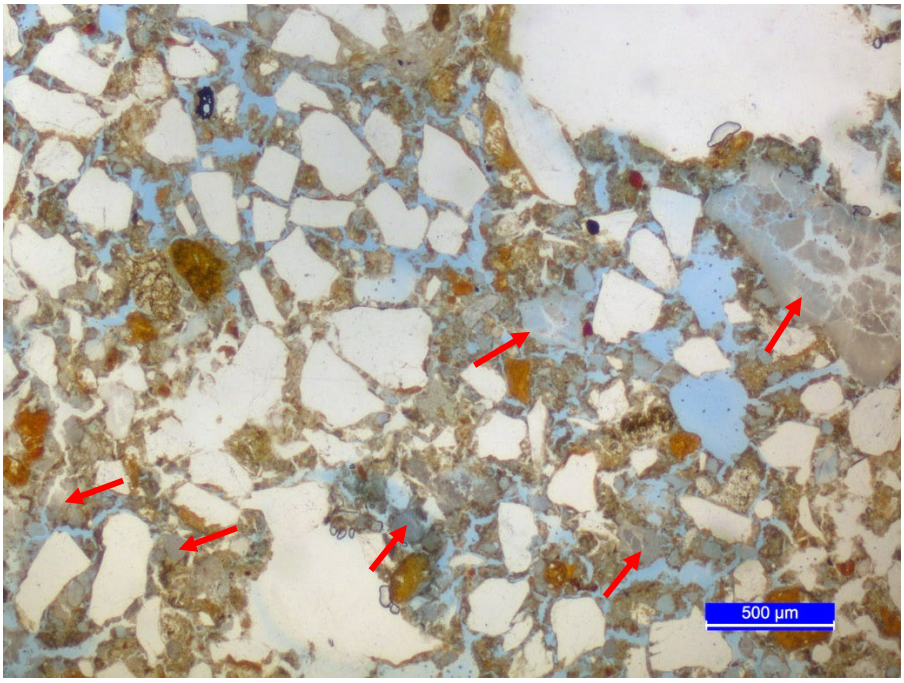


Figure 41. Sample 4a. Plane-polarized light image of a representative area showing large lime lumps (red arrows) and an ochre binder, likely from the addition of brick fragments or dust used as a pigment.

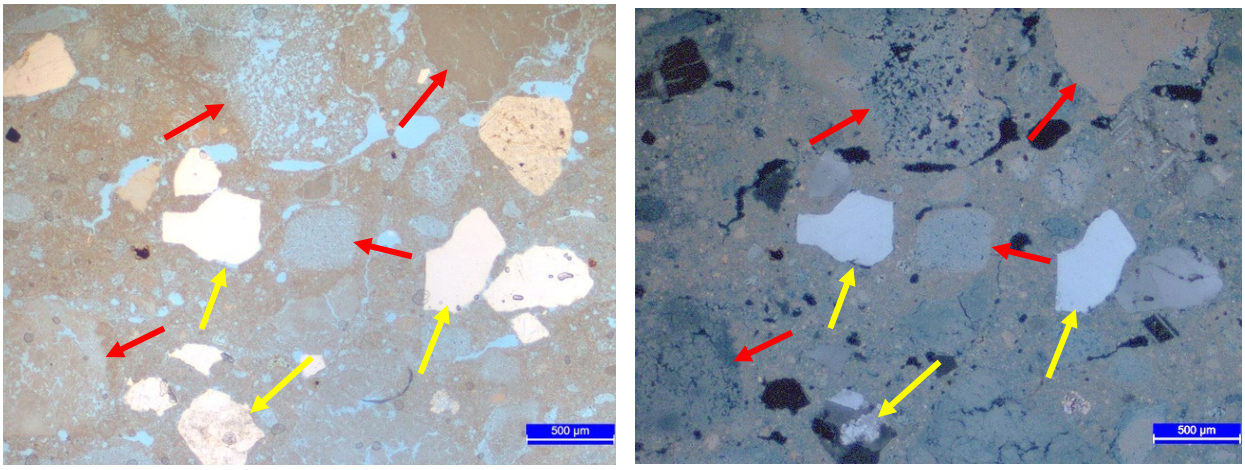


Figure 42. Plane-polarized light (left) and cross-polarized light (right) images of the same area of Sample 6 showing the large, hydrated lime lumps (red arrows) compared to particles of quartz/quartzite (yellow arrows). Shrinkage cracks are indicated with orange arrows. Note that sand content is visually low.

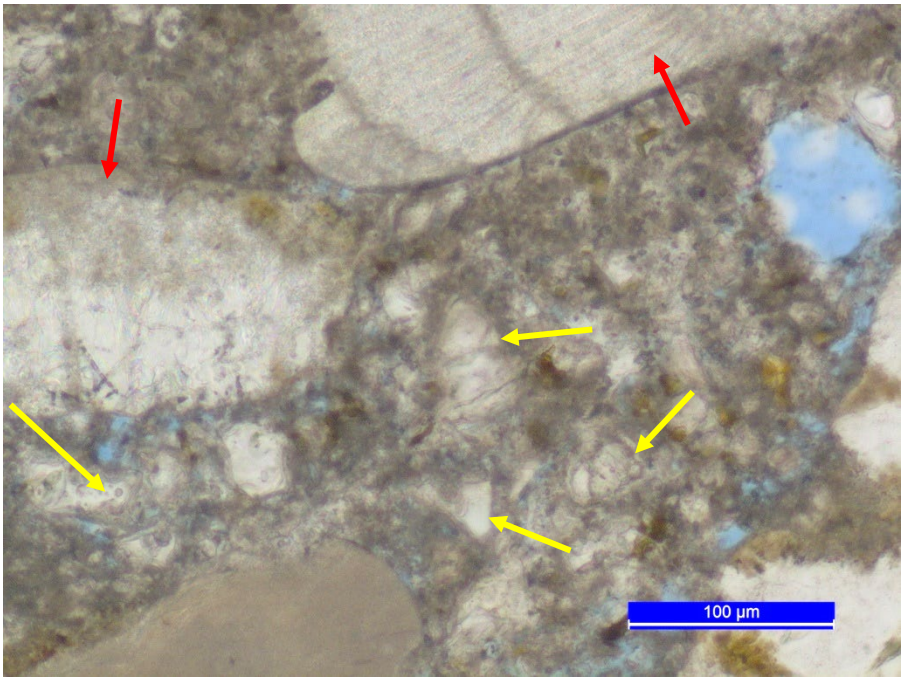


Figure 43. Sample 10. Plane-polarized light image of an area showing shell fragments (red arrows) and portland cement (yellow arrows).

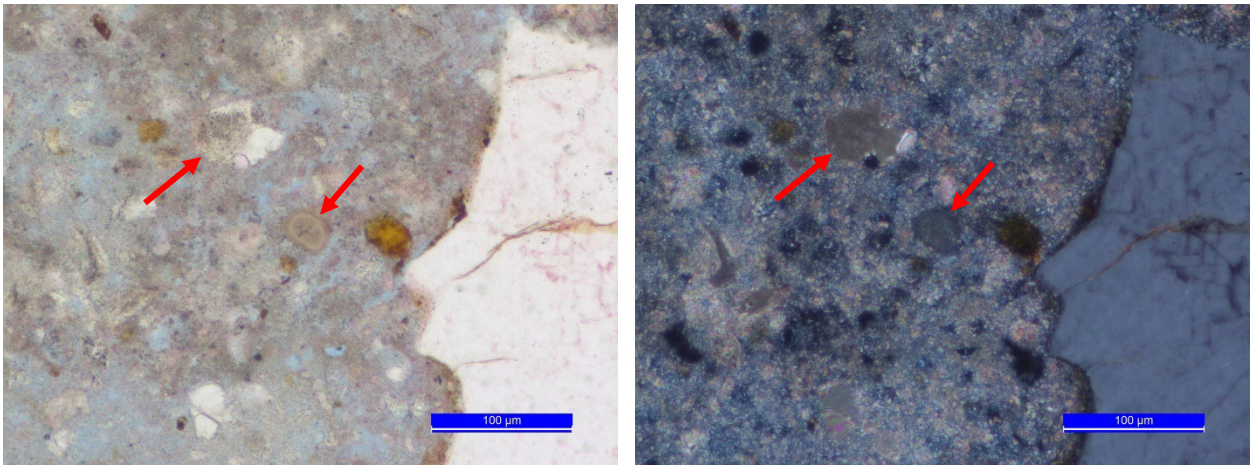


Figure 44. Sample A. Plane-polarized light (left) and cross-polarized light (right) images of the same area of Sample A showing relatively small, hydrated lime lumps within the binder (red arrows).

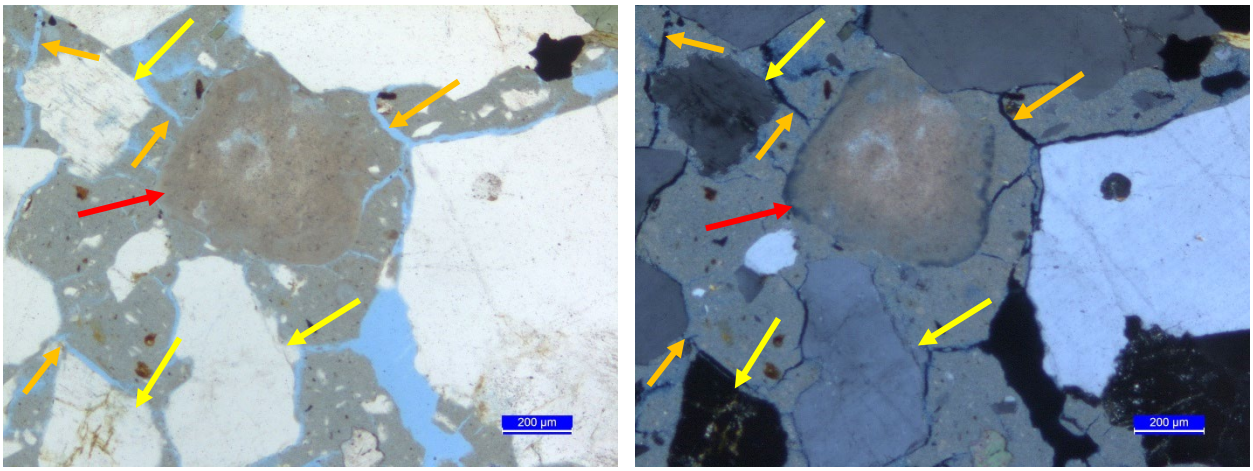


Figure 45. Sample B. Plane-polarized light (left) and cross-polarized light (right) images of the same area of Sample B showing the relative size of a hydrated lime lump (red arrows) compared to particles of quartz/quartzite (yellow arrows). Shrinkage cracks are indicated with orange arrows.

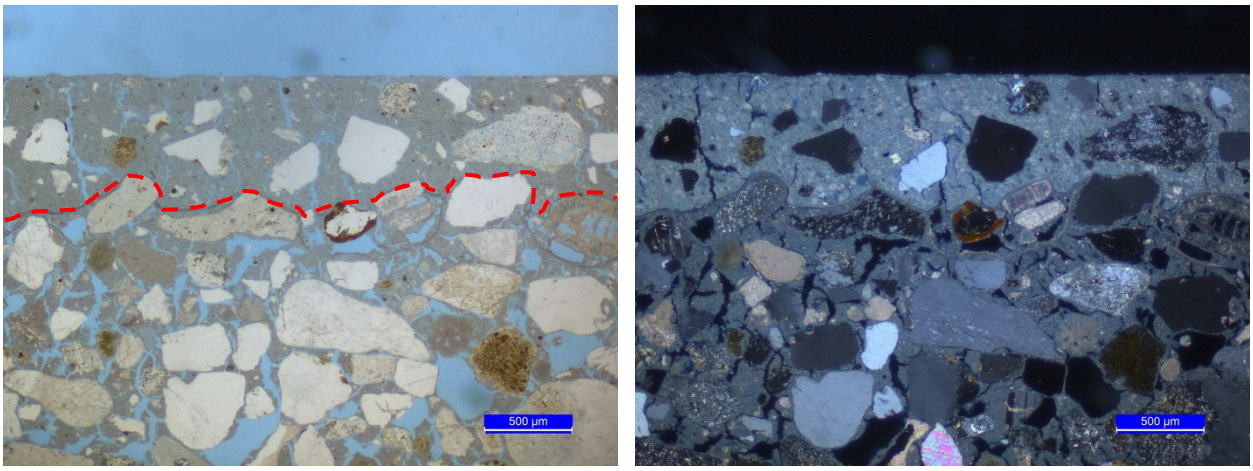


Figure 46. Sample C. Plane-polarized light (left) and cross-polarized light (right) images of the same area showing the bond line between the two layers of stucco, approximately along the red dashed line.

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Historic Finishes Investigation Report

Longevity
ART PRESERVATION

CASTILLO SAN CRISTÓBAL HISTORIC STRUCTURE REPORT

HISTORIC FINISHES INVESTIGATION REPORT

Date: September 9, 2024

Prepared by: Emily MacDonald-Korth

Site: Castillo San Cristóbal, San Juan National Historic Site, 501 Norzagaray Street Castillo San Cristóbal, San Juan, PR 00901

Client: WJE Inc., 330 Pfingsten Road, Northbrook, Illinois 60062, 847-272-740

Analyst: Emily MacDonald-Korth, President and Chief Conservator-Scientist, Longevity Art Preservation, Miami, FL, 33133, emilymk@artlongevity.com, 305-677-8217

Executive Summary

Longevity Art Preservation, via WJE Inc., carried out historic paint analysis for Castillo San Cristóbal, San Juan National Historic Site, with an aim to identify the earliest extant paint colors and finishes, and full chromachronology of surfaces. Through the use of cross-sectional optical microscopy, seventeen samples were analyzed to identify the paint layer stratigraphy. Microexposures were carried out on each layer of each sample; the client selected one target layer for Munsell color matching per sample however, more than one layer was matched because indications of possible decorative finishes were observed during exposure. From the analysis of this sample set and associated microexposure investigation, the plaster layers are largely similar and toned light orange, several samples included a likely shellac-based component in finish layers, and the earliest extant paint layers were likely lime-based or fresco. Dark red hues were frequently observed.

Introduction

Longevity Art Preservation, LLC, via Mike Ford of WJE Inc., carried out historic paint analysis for Castillo San Cristóbal with an aim to identify the earliest extant paint colors and finishes, and full chromachronology, of decorative surfaces. In September 2023, Longevity received 17 paint samples by mail; the samples were mounted in cross-section and imaged. Microexposures were carried out on each layer of each sample, and the client selected the earliest extant finish layer for Munsell color matching. More than one layer was matched in several samples because indications of possible decorative finishes were observed during exposure. The findings from the paint investigation will be discussed in the following report.

Purpose

- Mount and analyze 17 cross-section samples from decorative surfaces to determine the color of original finishes and identify the layer stratigraphy.
- Carry out microexposure windows on all layers and match one or more target layers per sample using the Munsell color system.

- Report the chromachronology of the entire layer structure with cross-section diagrams and Munsell color system matches of targeted layers for each sample, to inform future preservation efforts and restoration campaigns.

Procedure

Optical Microscopy

In September 2023, Longevity received 17 paint samples by mail. All samples were named by the client and those sample names were retained. In the laboratory, the samples were examined with a stereomicroscope under low power magnification (20x) to identify the areas of sample with the most complete layering structure, therefore having the potential to give the most information during cross-sectional analysis while leaving a large remaining sample for subsequent microexposure steps.

Samples aimed at studying the stratigraphy of the finishes were cast in resin cylinders, sanded, and polished to expose the cross-section surface; 17 samples were mounted and imaged. Once mounted, the cross- section samples were examined and digitally photographed under reflected visible light and ultraviolet radiation (UV) at 40x – 200x. Cross-sectional optical microscopy provided information about paint layer stratigraphy and some characterization of binders and coatings, based on the morphology of layers and particles and autofluorescence of the layers under varying wavelengths.

Images collected during optical microscopy can be found in Appendix II.

Microexposures and color matching

Microexposure (very small exposure windows) sites were selected for each sample based on proximity to the cross-section sample locations and completeness of the projected stratigraphy. Any remaining sample material that was not cast for examination or used in the microexposure process was retained for future study. Using a small stainless steel microscalpel blade, and other mechanical techniques, each paint layer was carefully scraped and cleaved away under low power magnification (20x) to reveal the layer beneath, from the uppermost paint layer to the substrate, layer by layer. The appearance of each layer and the total number of existing finish layers was compared to observations made during optical microscopy. After each microexposure was completed, each target layer was visually matched to a swatch from the Munsell Book of Color (matte edition; a color standard used in the Architectural Preservation field) using a color-corrected light source and/or daylight, followed by commercial color matches when requested. Analytical techniques can be found in Appendix I.

Reporting

The chromachronology of each sample is reported in the following “Results” section using a cross- section image and stratigraphic diagram that labels each layer with a partial boundary line and layer number; layers are numbered from earliest (#1) to current (# variable). Each diagram is coupled with a table that defines and describes each layer and reports the matching Munsell color swatch code when applicable. These color measurements can be used to select a modern paint in a matching hue.

Notes on complementary techniques

Cross-sectional optical microscopy and exposure windows are valuable complementary techniques for multiple reasons. Cross-sectional optical microscopy is necessary to compare the layers revealed in the exposure window to the layers visible in the cross-sectional sample; often more layers are visible in cross-section. Cross-sectional representations of colors often cannot represent hues accurately (though relative color differences can be compared between strata) and for communication purposes, exposures can be extremely valuable. It is possible to see very subtle structural differences using optical microscopy, identify differences between layers using ultraviolet light, and see temporal changes (e.g. dirt). Exposures reveal paint layers on a scale visible with the unaided eye and gather textural material property data not possible to gather with microscopy. There are advantages in each method, but using both techniques together is the most valuable system.

Procedural limitations

In many paint excavations, it can be nearly impossible to separate all interlayers because of the texture, bonding, or cleaving at layer interfaces, or the level of deterioration of the layers. For example, a very thin and brittle paint layer is often more difficult to reveal than a thick and tough paint layer because the brittle layer will likely fracture during removal of the upper paint layer. Similarly, two semi-soft layers can interact in such a way that their interface becomes joined and impossible to separate with standard excavation methods. In most cases the sheen cannot be accurately evaluated in an exposure window, because of abrasion to the surface and interactions between layers over time; this includes possible sanding between layers before repainting and damage to the paint layer during excavation with a scalpel. In some cases, paint layers cleave completely and cleanly because of poor adhesion, in these cases it is sometimes possible to accurately evaluate the sheen.

Sample ID	Building	Interior/Exterior/Arcade	Substrate	Notes
Sample K	Santa Teresa	Interior		Building dates to either 1779-1783 or 1898. Characterize the paint coating and provide a chromachronology.
Sample M	El Abanico	Exterior		Building dates to 1779- 1783 and finish may be original. Characterize the paint coating and provide a chromachronology.
Sample 2	North Casemate	Exterior	Stucco	Building dates to1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again. Characterize the paint layers and the earliest extant layers.
Sample 4	Officer's Quarters	Arcade	Brick	Building dates to1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the

Sample ID	Building	Interior/Exterior/Arcade	Substrate	Notes
				renovation. It is now an exterior arcade again. Characterize the paint layers and the earliest extant layers.
Sample 5	Officer's Quarters	Arcade	Brick	Building dates to1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again. Characterize the paint layers and the earliest extant layers.
Sample 6	Officer's Quarters	Arcade	Brick	Building dates to1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again. Characterize the paint layers and the earliest extant layers.
Sample 7	Officer's Quarters	Arcade	Brick	Building dates to1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again. Characterize the paint layers and the earliest extant layers.
Sample 8	Officer's Quarters	Arcade	Brick	Building dates to1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again. Characterize the paint layers and the earliest extant layers.
Sample 9	Officer's Quarters	Arcade	Brick	Building dates to1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again. Characterize the paint layers and the earliest extant layers.
Sample 11	Troop's Quarters	Interior	Wood	Building dates to 1773; however, the stairs appear to have been altered since then. Characterize the paint layers and the earliest extant layers.
Sample 12	Dungeon	Interior		This is a historic plaster that may date to 1770s. Possible coating on plaster or just a patina.
Sample 13	Plaza ramp wall	Exterior	Brick	Wall construction dates to 1785 but has been repaired and refinished

Sample ID	Building	Interior/Exterior/Arcade	Substrate	Notes
				several times. Characterize the paint layers and the earliest extant layers.
Sample 14	Officer's Quarters	Exterior	Stone	Building dates to1785 but was renovated between 1849-1858. The area had a faux stone finish with joint lines painted on. Characterize the paint layers and the earliest extant layers. There could be two; one for the faux finish and one for the faux joint lines.
Sample 15	Officer's Quarters	Exterior	Brick	Building dates to1785 but was renovated between 1849-1858. The area had a faux stone finish. Characterize the paint layers and the earliest extant layers.
Sample 16	El Abanico	Exterior	Stone	Building dates to 1779- 1783. The stucco had a faux finish with joint lines painted at the corners of the building. Characterize the paint layers and the earliest extant layers. There could be two; one for the faux finish and one for the faux joint lines.
Sample 17	El Abanico	Exterior	Stone	Building dates to1779- 1783. Characterize the paint layers and the earliest extant layers.
Sample 19	La Princesa	Interior	Plaster	Building dates 1897. Characterize the paint coating and indicate earliest extant layer.

Sample Locations

Detail photos provided by WJE.



K



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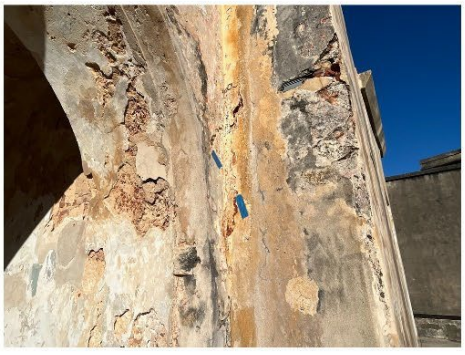
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Results

This section includes stratigraphic diagrams and chromachronology data tables for each sample.

Interpretation limitations

Because the Munsell color system sometimes lacks the exact color match, any Munsell colors listed are the nearest possible visual match. The structure has had a number of painting campaigns since its original construction. The painting history in one location may differ from another, and the small nature of the paint samples leaves room for misinterpretation because of the limited surface area that is revealed. Some areas may have been painted more frequently than others, and there is a possibility that some locations were stripped, sanded, or repaired. While the results of this research can give insight into the history of the location, more sampling and exposure windows are required to have an accurate understanding of the complete history.

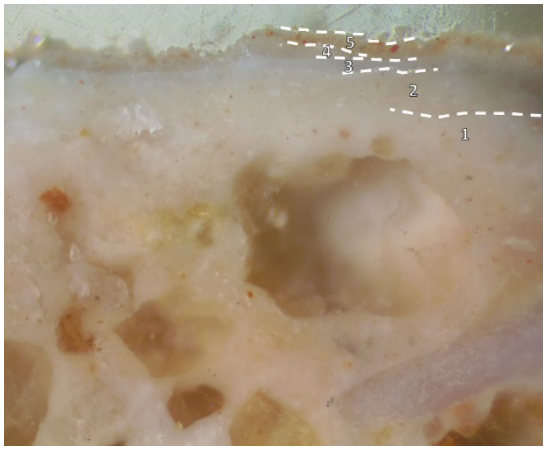
Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample K	Santa Teresa	Interior		Building dates to either 1779-1783 or 1898.

Discussion

Earliest estimated finish layer present: Layer 1-2, light orange-beige toned plaster or Layer 3, white paint

Munsell color code: Layers 1-2, 7.5YR 8/4 (when saturated) and 10YR 9/1 (when dry)

Note: The lower plaster layers are similar to light orange-beige plaster layers in other samples.



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
5	Translucent light orange	Paint or glaze. Orange and red particles. Possible limewash.	
4	Light orange-beige	Paint. Possible limewash.	
3	White	Paint. Possible limewash.	
2	Light orange-beige	Possibly part of Layer 1. Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (likely pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate.	7.5YR 8/4 (when saturated) and 10YR 9/1 (when dry)
1	Light orange-beige	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (likely pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate.	7.5YR 8/4 (when saturated) and 10YR 9/1 (when dry)

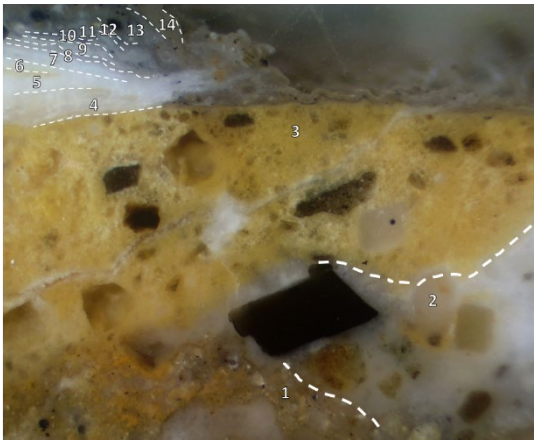
Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample M	El Abanico	Exterior		Building dates to 1779-1783 and finish may be original.

Discussion

Earliest estimated finish layer present: Layer 3, dark yellow toned plaster or modified fresco

Munsell color code: Between10YR 6/6 and 10YR 6/8

Note: The plaster layers are harder than most samples, have different particles, and the matrix is white.



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
14	Translucent brown	Toned coating or glaze. Possible shellac component.	
10-13	Translucent gray	Very hard; paint. Series of very thin layers.	
7-9	White	Very hard; paint. Series of very thin white layers.	
6	Light yellow	Very hard; paint.	
5	White	Very hard; paint. Series of very thin white layers.	
4	Light yellow	Very hard; paint.	
3	Dark yellow	Very hard; toned plaster. Possibly modified fresco. Black particles.	Between10YR 6/6 and 10YR 6/8
2	Light gray-beige	Very hard; plaster. Coarse light brown, dark brown, gray, and black particles (likely coarse sand), along with few dark red and orange particle aggregates (likely pigment clumps) in a white matrix.	
1	Brown	Plaster or concrete.	

Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 2	North Casemate	Exterior	Stucco	Building dates to 1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again.

Discussion

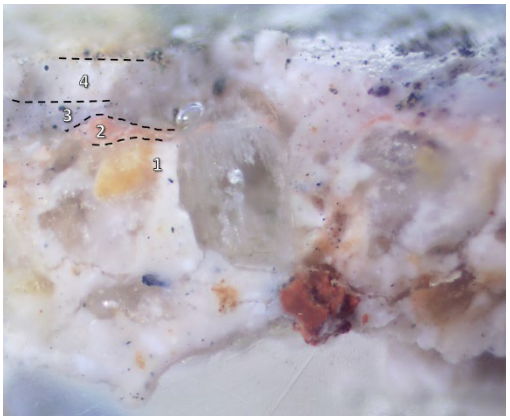
Earliest estimated finish layer present: Layer 2, dark red paint or Layer 2.1, dark yellow paint

Munsell color code:

Layer 2.1, 7.5YR 6/6

Layer 2, 10R 4/6

Note: The lower plaster layers are similar to light orange-beige plaster layers in other samples.



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
4	Light orange	Very fragile, powdery; paint.	
3	Gray	Hard; paint. Black particles.	
2.1	Dark yellow	Very hard; toned plaster or possibly modified fresco. Not visible in cross-section but observed during exposure.	7.5YR 6/6
2	Dark red	Paint. Possibly lime-based or fresco. The micrograph includes the lower interface of the layer; the entire layer was visible during exposure.	10R 4/6
1	Light orange-beige	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (likely pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate. Seashells observed.	

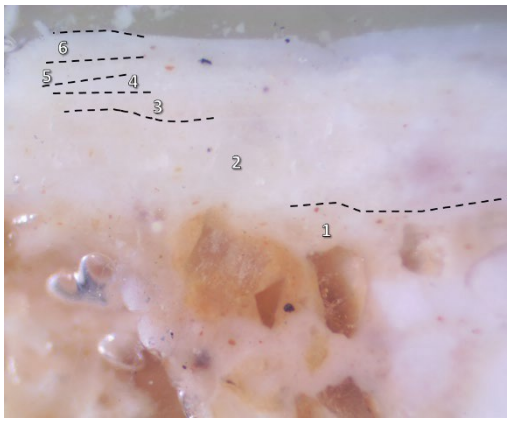
Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 4	Officer's Quarters	Arcade	Brick	Building dates to 1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again.

Discussion

Earliest estimated finish layer present: Layer 2 or 3, light orange paint

Munsell color code: 10YR 9/2

Note: The lower plaster layers are similar to light orange-beige plaster layers in other samples.



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
6	Light blue-gray	Very fragile, powdery; paint.	
5	Light orange	Very fragile, powdery; paint.	
4	Light orange	Very fragile, powdery; paint.	
3	Light orange	Very fragile, powdery; paint.	10YR 9/2
2	Light orange	Very fragile, powdery; paint. Possibly fine toned plaster or fresco.	10YR 9/2
1	Light orange-beige	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (likely pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate.	

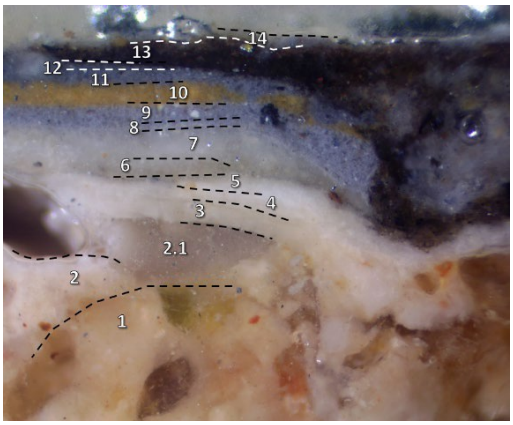
Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 5	Officer's Quarters	Arcade	Brick	Building dates to 1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again.

Discussion

Earliest estimated finish layer present: Layer 2, light orange paint

Munsell color code: 10YR 9/2

Note: The lower plaster layers are similar to light orange-beige plaster layers in other samples.



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
15	Black	Paint.	
14	Light beige	Paint. Not present in micrograph but observed during exposure.	
13	Dark brown	Paint.	
12	Gray-blue	Paint, glaze, or coating.	
11	Light gray-blue	Very fragile, powdery; paint.	
10	Yellow	Very fragile, powdery; paint.	
9	Light gray-blue	Very fragile, powdery; paint.	
8	Light gray	Very fragile, powdery; paint.	
7	White	Very fragile, powdery; paint.	
6	Gray	Very fragile, powdery; paint.	
4-5	White	Very fragile, powdery; paint.	
3	Light orange	Very fragile, powdery; paint.	
2.1	Gray	Very fragile, powdery; paint.	
2	Light orange	Very fragile, powdery; paint. Estimated to be lime-based or fresco.	10YR 9/2
1	Light orange-beige	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (likely pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate.	

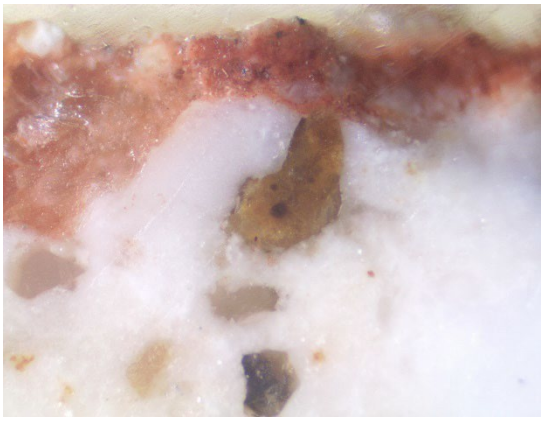
Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 6	Officer's Quarters	Arcade	Brick	Building dates to 1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again.

Discussion

Earliest estimated finish layer present: Layer 2, dark red paint

Munsell color code: 2.5YR 5/6

Note: The lower plaster layers are similar to light orange-beige plaster layers in other samples.



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
2	Dark red	Paint. Possibly lime-based or fresco.	2.5YR 5/6
1	Light orange-beige	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (possibly pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate.	10YR 9/1

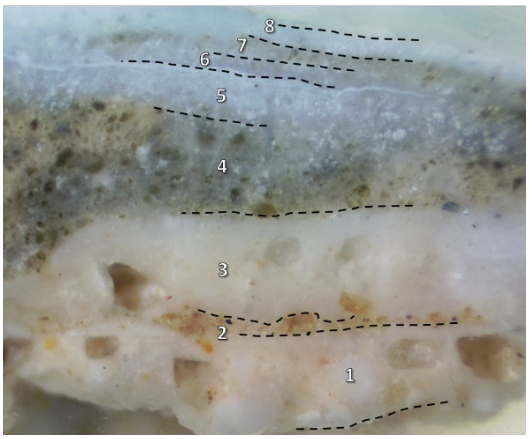
Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 7	Officer's Quarters	Arcade	Brick	Building dates to 1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again.

Discussion

Earliest estimated finish layer present: Layer 3, light beige toned plaster

Munsell color code: 10YR 9/1

Note: The lower plaster layers similar to light beige plaster layers in other samples. There is no coating over the toned plaster layer in the sample; it may have deteriorated or was mechanically removed before Layer 4 was applied, or Layer 3 was the finish layer.



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
8	White	Very fragile, powdery; paint.	
7	Light beige	Very fragile, powdery; paint.	
6	White	Very fragile, powdery; paint.	
5	White	Very fragile, powdery; paint.	
4	Gray	Very hard. Estimated to be concrete repair material.	
3	Light orange-beige	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (possibly pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate.	10YR 9/1
2	Translucent amber	Particles bound in translucent and strongly autofluorescent media. Not observed during exposure.	
1	Light orange-beige	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (possibly pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate.	10YR 9/1

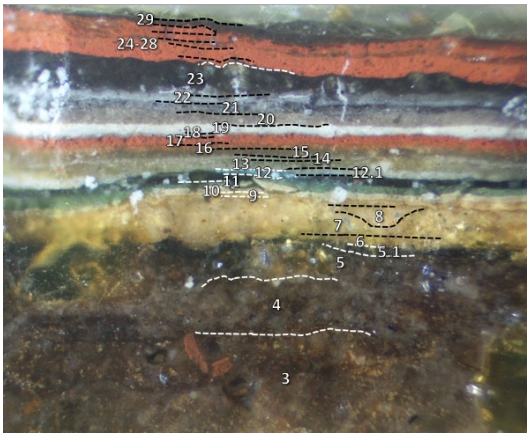
Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 8	Officer's Quarters	Arcade	Brick	Building dates to 1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again.

Discussion

Earliest estimated finish layer present: Layer 3, brown paint

Munsell color code: Between 10YR 4/4 and 10YR 5/4

Note: The lower plaster layers are similar to light orange-beige plaster layers in other samples.



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
29	Gray	Paint.	
24-28	Dark orange-red	Paint.	
23	Black	Paint.	
22	Light gray	Paint.	
21	Gray	Paint.	
20	Gray	Paint.	
19	Light gray	Paint.	
18	Gray	Paint.	
16-17	Dark orange-red	Paint.	
15	Green gray	Paint.	
14	Light gray	Paint.	
13	Green-gray	Paint.	
12.1	Light gray	Paint.	
12	Blue	Paint.	
11	Green	Paint.	
6-10	Beige	Paint.	
5.1	Black	Paint.	
5	Brown	Paint.	
4	Brown	Paint.	

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
3	Brown	Paint. Air bubbles.	Between 10YR 4/4 and 10YR 5/4
2	Light brown	Toned plaster; likely lower interface of brown layer above.	10YR 6/4
1	Light orange-beige	Crumbly; toned plaster. Coarse light brown, and dark brown particles (likely coarse sand), along with few dark red particle aggregates (likely pigment clumps) in a light beige matrix.	

Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 9	Officer's Quarters	Arcade	Brick	Building dates to 1785 but was renovated between 1849-1858. The space was on the exterior but became interior space after the renovation. It is now an exterior arcade again.

Discussion

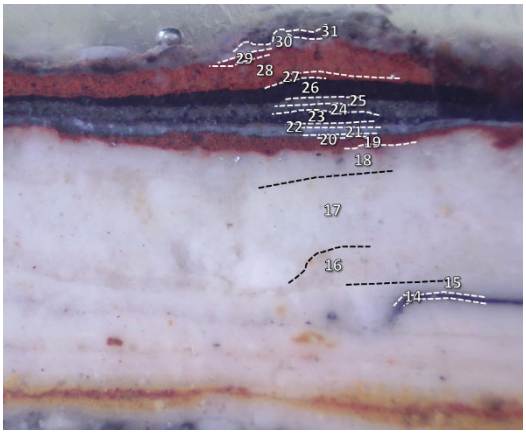
Earliest estimated finish layer present:

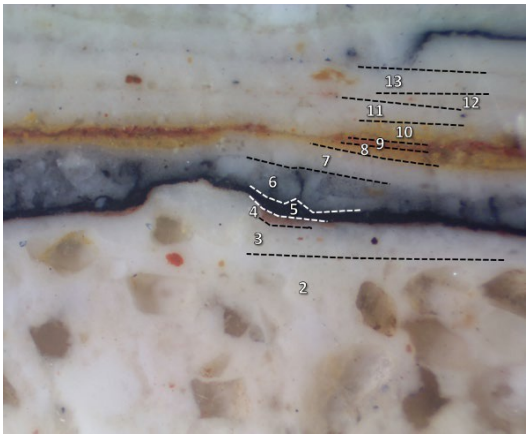
Layer 5, black paint
Munsell color code: N2

Layer 4, dark orange paint
Munsell color code: ~10R 4/6

Layer 3, light orange paint
Munsell color code: 10YR 9/2

Note: The lower plaster layers are similar to light orange-beige plaster layers in other samples.







Magnification: 40x

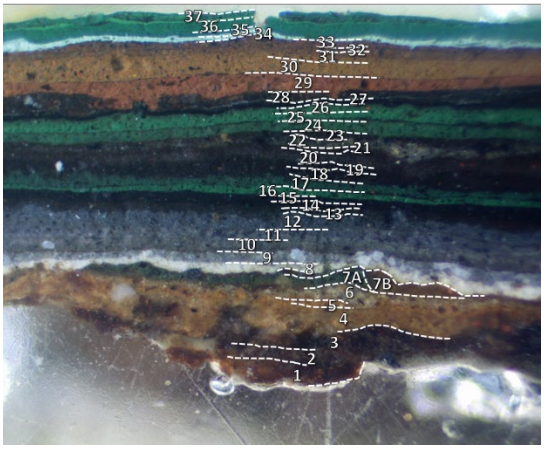
Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
31	Dark gray	Paint.	
30	Gray	Paint.	
29	Dark red	Paint.	
27-28	Dark orange	Paint.	
26	Dark gray	Paint.	
24-25	Gray	Paint.	
23	Dark gray	Paint.	
22	Brown	Paint.	
21	Gray	Paint.	
20	Dark gray	Paint.	
19	Dark red	Paint.	
18	White	Paint.	
15-17	Light orange	Paint.	
14	Dark gray	Paint.	
13	Light orange	Hard, paint.	
12	Light orange	Hard, paint.	
11	Beige	Very hard, paint.	
10	Dark yellow	Paint.	
9	Dark red-orange	Paint.	
8	Dark yellow	Paint.	
7	White	Paint.	
6	Gray	Paint.	
5	Black	Very thin, very hard, paint. Tenacious adhesion to layer below.	N2
4	Dark orange or red	Very thin, paint. Could not separate from layer above. Little available for color matching.	~10R 4/6
3	Light orange	Hard, paint.	10YR 9/2
1-2	Light orange-beige	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (likely pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate.	

Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 11	Troop's Quarters	Interior	Wood	Building dates to 1773; however, the stairs appear to have been altered since then.

Discussion

Earliest estimated finish layer present: Layer 1, brown paint

Munsell color code: 7.5YR 4/4



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
35-37	Green	Paint.	
34	Green	Paint.	
33	Brown	Paint.	
32	Brown	Paint.	
31	Brown	Paint.	
30	Light brown	Paint.	
29	Dark orange	Paint.	
28	Dark green	Paint.	
27	Black	Paint.	
25-26	Green	Paint.	
24	Green	Paint.	
23	Black	Paint.	
22	Gray	Paint.	
21	Gray	Paint.	
20	Gray	Paint.	
19	Black	Paint.	
18	Black	Paint.	
17	Green	Paint.	
16	Green	Paint.	

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
15	Black	Paint.	
14	Black	Paint.	
13	Black	Paint.	
12	Gray or blue	Paint.	
11	Gray	Paint.	
10	Gray	Paint.	
9	Gray	Paint. Dirt or soot layer above.	
8	Light gray	Paint.	
7B	Brown	Paint.	
7A	Dark green	Paint.	
6	Beige	Paint.	
5	Dark orange	Paint.	
4	Light brown	Paint.	
3	Brown	Paint.	
2	Brown	Paint.	
1	Brown	Paint. Possibly upper plaster layer.	7.5YR 4/4

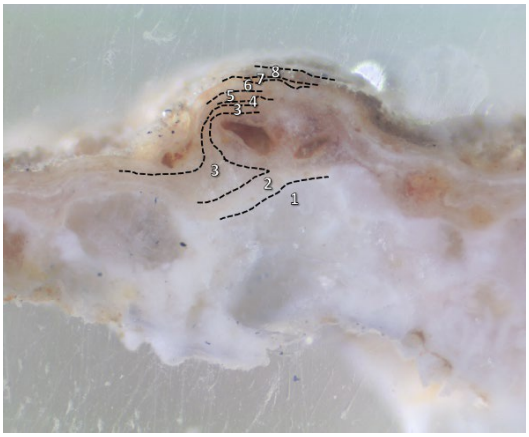
Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 12	Dungeon	Interior		This is a historic plaster that may date to 1770s.

Discussion

Earliest estimated finish layer present: Layer 2 - 3, light orange paint with transparent light orange glaze above

Munsell color code:
Layer 3, 7.5YR 7/4
Layer 2, 7.5YR 8/2

Note: The lower plaster layers are similar to light orange-beige plaster layers in other samples.



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
8	Beige	Paint.	
7	Transparent light orange	Paint or glaze.	
6	Light orange	Paint.	
5	Light orange	Paint.	
4	Semi-transparent light orange	Paint or glaze. Possible shellac component.	
3	Transparent light orange	Glaze.	7.5YR 7/4
2	Light orange	Paint; possibly lime-based or fresco.	7.5YR 8/2
1	White or light orange	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (likely pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate.	

Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 13	Plaza ramp wall	Exterior	Brick	Wall construction dates to 1785 but has been repaired and refinished several times.

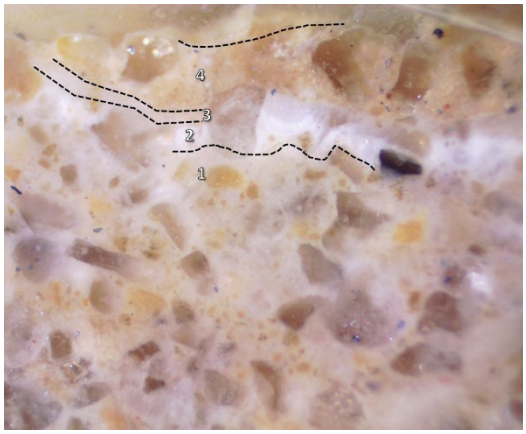
Discussion

Earliest estimated finish layer present: Layer 2, dark red paint

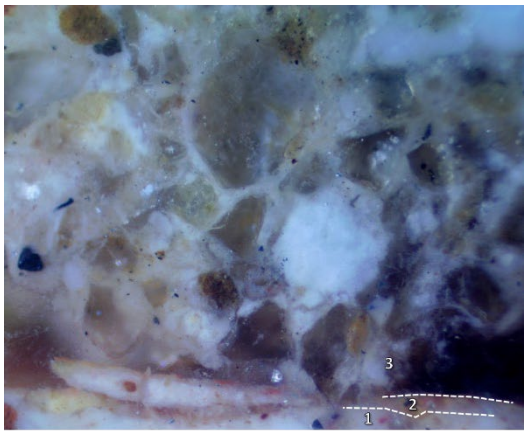
Munsell color code: 10R 4/6

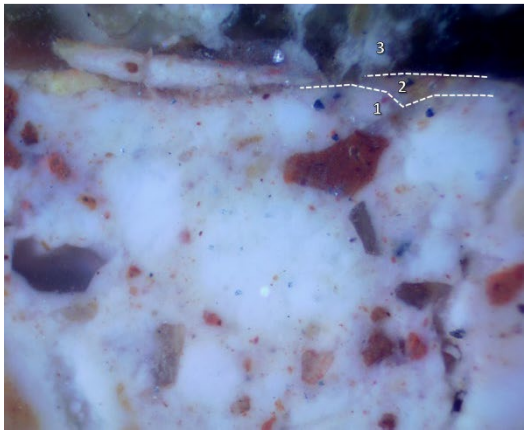
The samples are not contiguous; fragments from each bulk sublayer were mounted adjacent to one another to capture the estimated stratigraphy in one sample.

Note: The lower plaster layers are similar to light orange-beige plaster layers in other samples, but not exactly the same.



Upper layers Magnification: 40x





Lower layers Magnification: 40x

Upper layers

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
4	Beige	Estimated to be plaster.	
3	Beige	Estimated to be plaster.	
2	Light beige	Estimated to be plaster.	
1	Beige	Estimated to be plaster.	

Lower layers

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
3	Beige	Plaster.	
2	Dark red	Lime-based paint or fresco.	10R 4/6
1	Light orange	Toned plaster. Coarse light brown and dark brown particles (likely coarse sand), coarse red particles (possibly crushed brick), along with dark red and orange particle aggregates (likely pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate. Some evidence of possible shellac-based coating above.	

Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 14	Officer's Quarters	Exterior	Stone	Building dates to 1785 but was renovated between 1849-1858. The area had a faux stone finish with joint lines painted on. There could be two finishes: one for the faux finish and one for the faux joint lines.

Discussion

Earliest estimated finish layers present: Layer 2A, gray paint
Munsell color code: 10YR 4/1

Layer 2B, light orange (likely varnish or glaze)
Munsell color code: 10YR 9/2

Layer 2C, red paint
Munsell color code: 10R 4/6

Striped and relief design; three facets captured in one image. Gray, next to light orange, next to red lime-based paint or fresco over white plaster.

The sample fragment shows polished light orange plaster (very smooth with visible sand), an incised line painted gray, then the red was applied (and slightly overlaps the adjacent gray).



Magnification: 100x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
3	Gray	Paint.	
2C	Red	Paint. Possibly lime-based.	10R 4/6
2B	Light orange	Possible varnish or glaze. Some evidence of shellac-based material.	10YR 9/2
2A	Gray	Very thin, paint. Possibly lime-based.	10YR 4/1
1	White	Plaster. May not be original.	

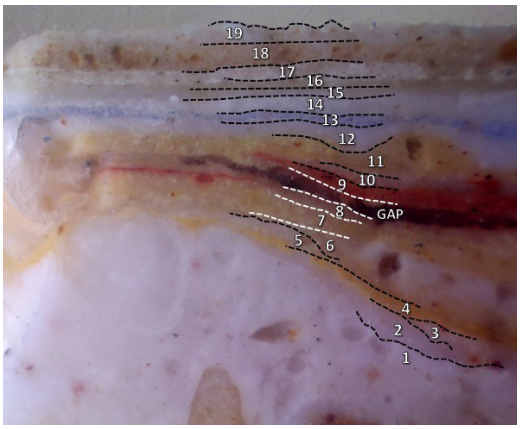
Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 15	Officer's Quarters	Exterior	Brick	Building dates to 1785 but was renovated between 1849-1858. The area had a faux stone finish.

Discussion

Earliest estimated finish layers present: Layer 4, dark yellow paint
Munsell color code: 10YR 6/6

Layer 3, translucent light orange paint
Munsell color code: Between 7.5YR 8/4 and 7.5YR 9/2

Layer 1, light orange-beige plaster
Munsell color code: 10YR 9/2



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
19	Yellow	Paint.	
18	Yellow	Paint.	
17	Light beige	Paint.	
16	Translucent beige	Paint.	
15	Translucent beige	Paint.	
14	White	Paint.	
13	Blue	Paint.	
12	White	Paint.	
11	Dark yellow	Paint.	
10	Light beige	Paint.	
9	Dark red	Paint.	
8	Light beige	Paint.	
7	Dark yellow	Paint.	
6	Light beige	Paint.	
5	Light beige	Paint.	
4	Dark yellow	Paint.	10YR 6/6
3	Translucent light orange	Paint. Possibly lime-based.	Between 7.5YR 8/4 and 7.5YR 9/2
2	White	Paint; likely lime-based	

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
1	Light orange-beige	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (likely pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate.	10YR 9/2

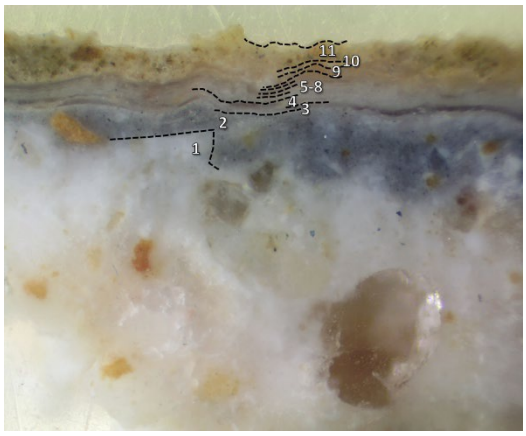
Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 16	El Abanico	Exterior	Stone	Building dates to 1779-1783. The stucco had a faux finish with joint lines painted at the corners of the building. There could be two finishes: one for the faux finish and one for the faux joint lines.

Discussion

Earliest estimated finish layer present: Layer 2 - 3, light gray toned plaster with translucent white paint layer above (possibly decorative)

Munsell color code:
Between N8.25 (lighter regions, translucent white over gray) and N7.25 (darker regions, gray)

Layers 5 - 8 (possibly layers 3 – 10) appear to be alternating layers of translucent gray and translucent white, with a strong indication of a shellac-based component. This may have been an area of decorative finishing; it could have incorporated the gray fresco layer as the base color. Shellac is not typically hard; therefore, it may have been a component in a varnish formulation.



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
11	Light brown	Very hard, paint.	
10	Brown	Very hard, paint.	
9	Translucent beige	Very hard, paint.	
8	Translucent gray	Very hard, paint.	
7	Translucent white	Very hard, paint.	
6	Translucent gray	Very hard, paint.	
5	Translucent white	Very hard, paint.	
4	Translucent gray	Possibly shellac-containing varnish or glaze.	

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
3	Translucent white	Paint, possible limewash. Could not separate from layer 2.	Between N8.25 (lighter regions) and N7.25 (darker regions) *Could not separate the layer.
2	Light gray	Estimated fresco layer. Could not separate from layer 3. Possible decorative finishing above and gray base layer.	
1	Light orange-beige	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (likely pigment clumps) in a light beige matrix with clumps of fine white powdery aggregate.	

Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 17	El Abanico	Exterior		Building dates to 1779-1783. We are interested in characterizing the paint layers and the earliest extant layers.

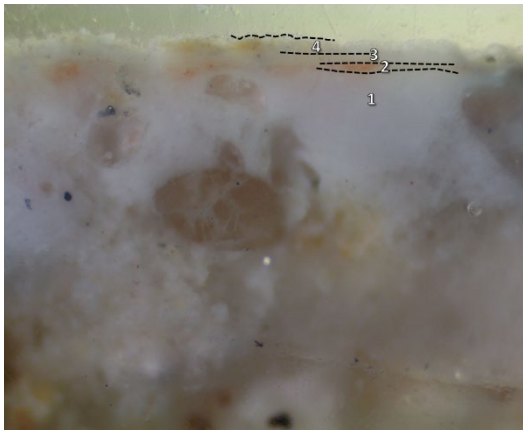
Discussion

Earliest estimated finish layer present: Layer 3, light orange paint

Munsell color code:
Between 7.5YR 8/2 and 7.5YR 8/4

Layer 2, dark orange paint
Munsell color code: 2.5YR 5/6

Layers 2 and 3 may have been components of decorative finishing. Estimated shellac layer over plaster.



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
4	Translucent light orange	Very hard, paint.	
3	Light orange	Paint, possible limewash. Could not separate from layer 2. Possible decorative finishing with layer 2.	Between 7.5YR 8/2 and 7.5YR 8/4
2	Dark orange	Very thin; paint. Possible lime-based or fresco.	2.5YR 5/6
1	Light orange-beige	Crumbly; toned plaster. Coarse colorless, light brown, and dark brown particles (likely coarse sand), along with dark red and orange particle aggregates (likely pigment clumps) in a light beige matrix with clumps	

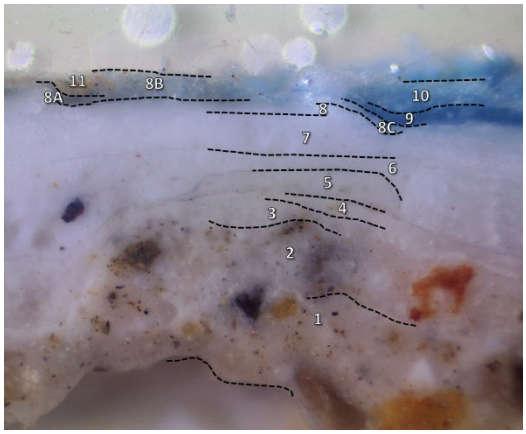
Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
		of fine white powdery aggregate. Estimated shellac layer above; possibly a sealant layer.	

Sample ID	Building	Interior/Exterior/ Arcade	Substrate	Notes
Sample 19	La Princesa	Interior	Plaster	Building dates 1897. Characterize the paint coating and indicate earliest extant layer.

Discussion

Earliest estimated finish layer present: Layer 2, light beige paint

Munsell color code: 10YR 9/2



Magnification: 40x

Layer	Description (Color)	Comments (Coarseness, texture, thickness, continuity; material. Notes)	Color matching (Munsell, commercial)
11	Orange	Paint.	
10	Blue	Paint.	
9	Blue	Paint.	
8C	Blue	Paint.	
8B	Gray-blue	Paint.	
8A	Gray	Paint.	
7	White	Paint.	
6	Beige	Paint.	
5	Beige	Paint.	
4	Beige	Paint.	
3	Beige	Paint.	
2	Light beige	Paint. Possibly lime-based or fresco.	10YR 9/2
1	Beige	Plaster. Slightly different than other samples: slightly darker, more brown particles, less binder, no or few white clumps.	

Conclusion

The goal of historic paint analysis for Castillo San Cristóbal, San Juan National Historic Site, was to discover the oldest existing paint colors and finishes, and complete chromachronology, of surfaces at the site. Longevity received 17 paint samples for analysis; the samples were prepared in cross-section, imaged, and interpreted. Microexposures were carried out on each layer of each sample; the client selected the earliest extant finish layer for Munsell color matching per sample however, more than one layer was matched because indications of possible decorative finishes were observed during exposure. From the analysis of this sample set and associated microexposure investigation, the plaster layers are largely similar and toned light orange, several samples included a likely shellac-based component in finish layers, and the earliest extant paint layers were likely lime-based or fresco. Dark red hues were frequently observed.

Recommendations

- Additional analysis of corresponding samples with intact original surfaces.
- Carry out large exposure windows in situ followed by Munsell color matching and colorimetry (in CIELAB) to accurately gauge and communicate the appearance of the original finishes.

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Appendix I: Analytical Techniques

Non-destructive macroscopic, microscopic, and spectroscopic techniques of examination and analysis were used as much as possible. The observations made through examination were recorded in writing, with digital photo documentation, and with digital mapping. To obtain information about the stratigraphy and of the paint layers, pigments, binders, and plant fibers, minimally destructive methods of analysis were employed.

Cross-sectional optical microscopy provides information about paint layer stratigraphy and characterization of binders and coatings, based on the morphology of layers and particles and autofluorescence of the layers under varying wavelengths. Samples were collected using a stereomicroscope and stainless-steel micro scalpel. The samples were cast into columns of clear acrylic resin and cured under an ultraviolet bulb. After curing, the columns were fine-sanded and dry- polished using Micro-Mesh silicon carbide sandpaper in grits ranging from 1,500-12,000. A Nikon Optiphot II epi-fluorescent microscope (Nikon 4X, 10X, 20X, 40X objectives; 10X oculars), was used to examine the samples under high-powered magnification using daylight-balanced (5000K) lamp for visible light analysis and imaging and a Nikon Super High-Pressure Mercury Lamp and a Nikon DM400 UV-2A cube for UV analysis and imaging. Digital images of the magnified samples were taken using the Amscope MU100 digital microscope camera in conjunction with the Amscope software for image capture.

Filter cubes for the Nikon Optiphot II Microscope and their parameters

Excitation	Cube	Excitation filter range (nm)	Longpass barrier filter (nm)	Dichroic mirror (nm)
Violet	UV-2A	330-380	420	Cut-on: 400 nm Reflects greater than 95% of UV between 330-390 nm

The colors of the original finishes were evaluated by eye using the Munsell Book of Color color system, matte edition, under daylight balanced lighting. Sunlight, measured in Kelvin (K), is generally accepted as follows: ~4000K for early morning and late afternoon, and ~5000K for midday. The following radiation sources were used for color matching: NextLED NT-1010UV, 4500K, CRI 95+ and Calibrite GrafiLite, 5000K, CRI: 95+.

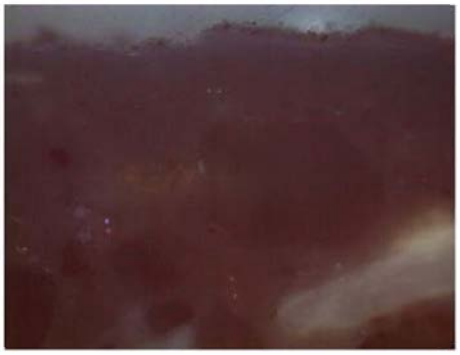
Commercial color matches were evaluated by eye using [TBD: Benjamin Moore and Tnemec color decks] under daylight balanced lighting, followed by natural daylight for final confirmation.

Appendix II: Photomicrographs

Image titles: Client_Project_Sample ID_Magnification_Radiation source_Sample region



WJE_SanC_K_40x_VIS



WJE_SanC_K_40x_UV



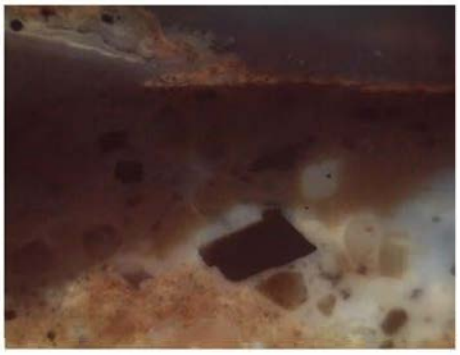
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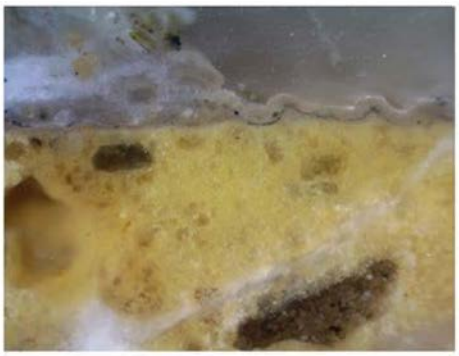
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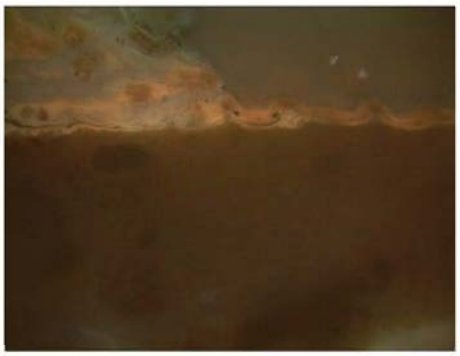
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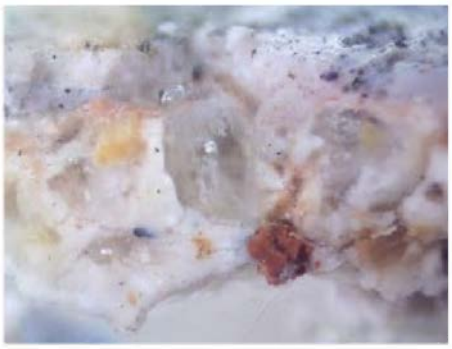
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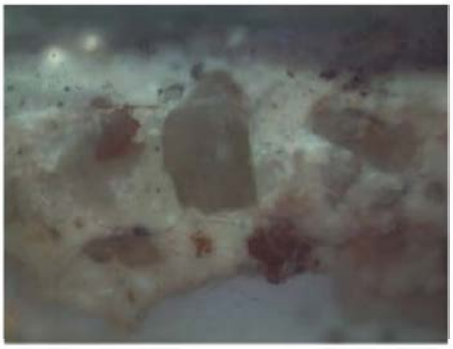
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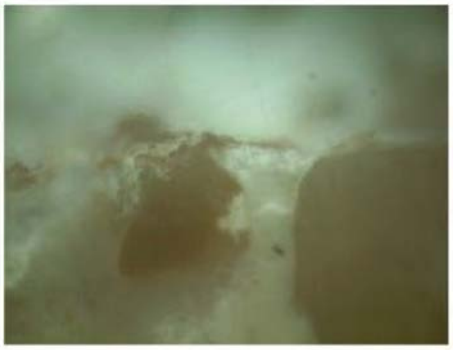
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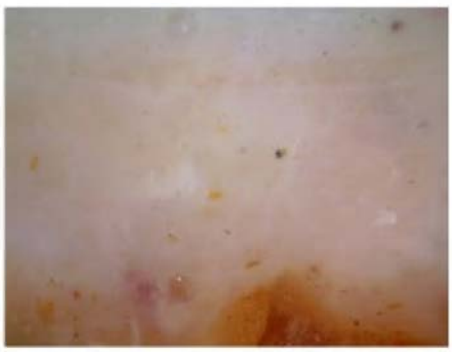
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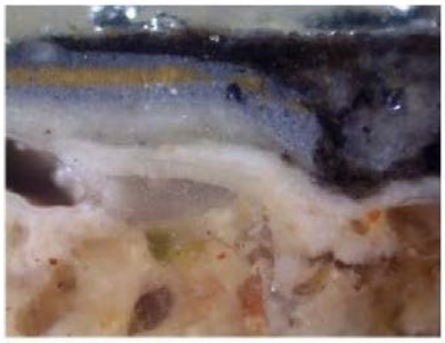
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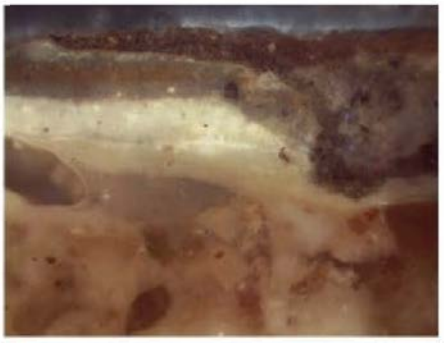
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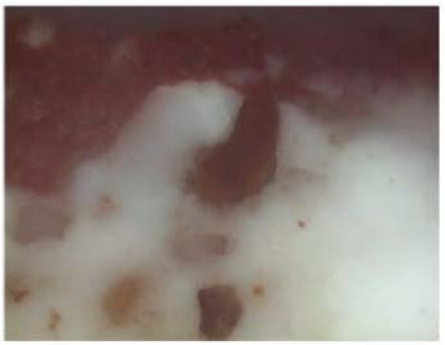
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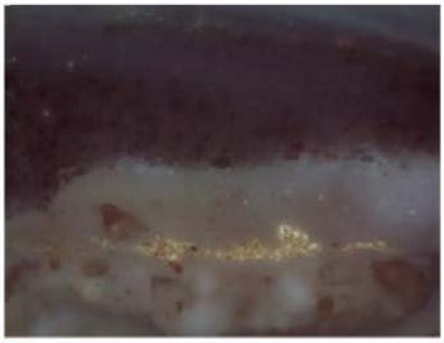
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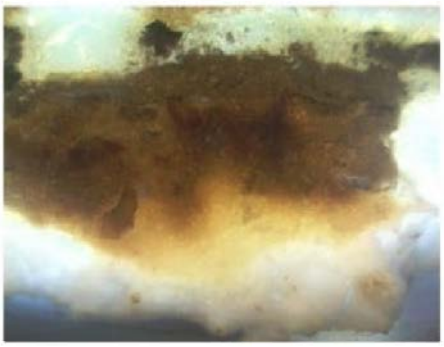
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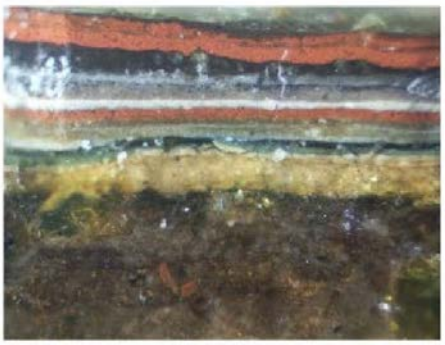
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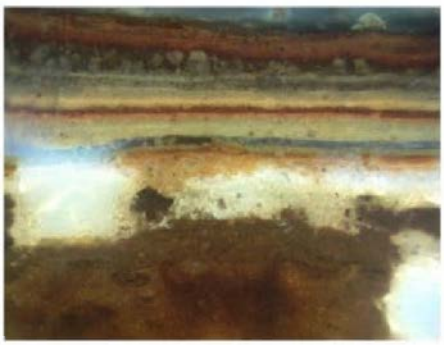
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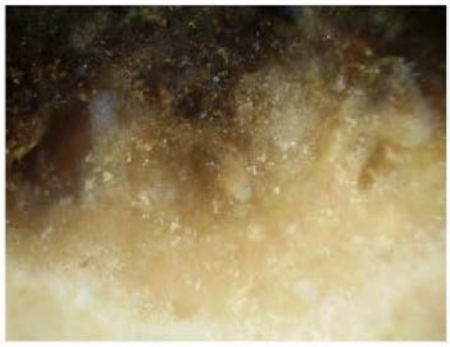
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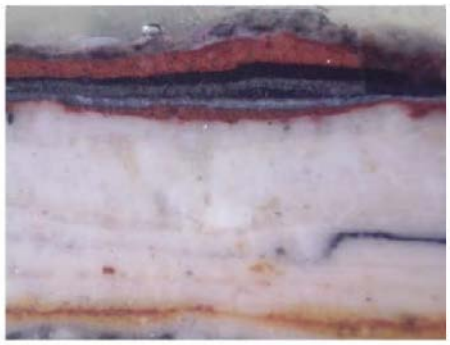
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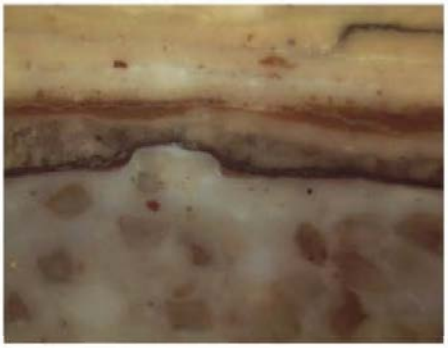
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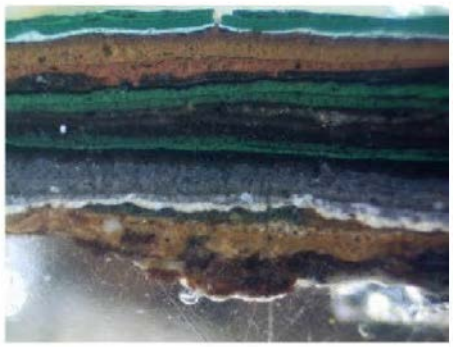
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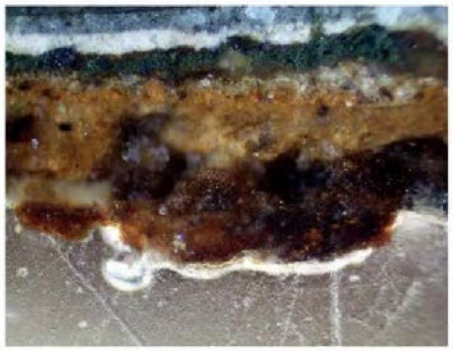
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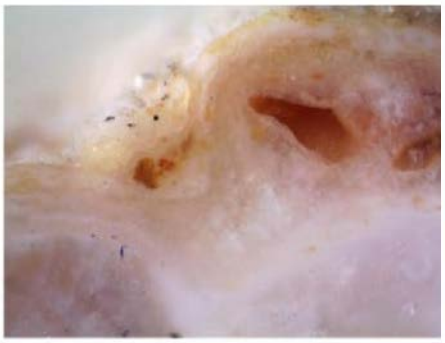
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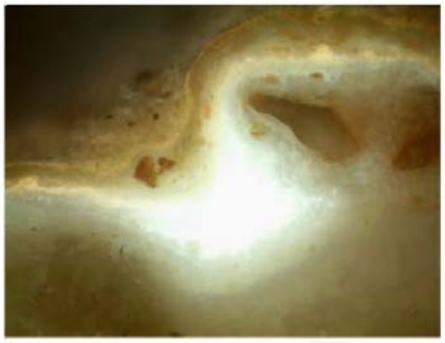
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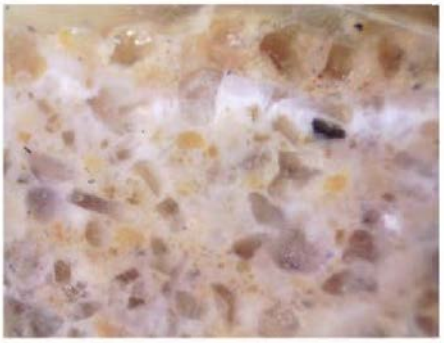
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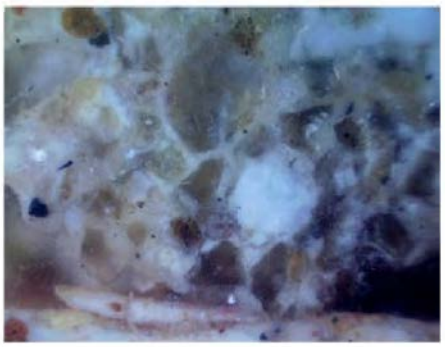
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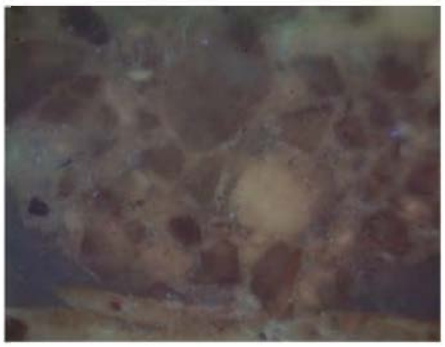
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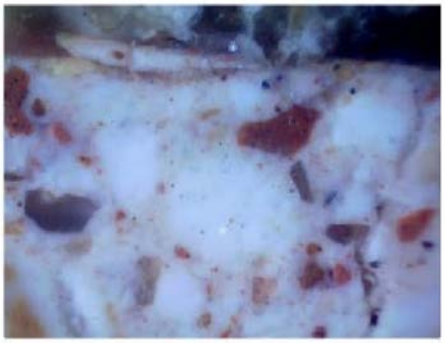
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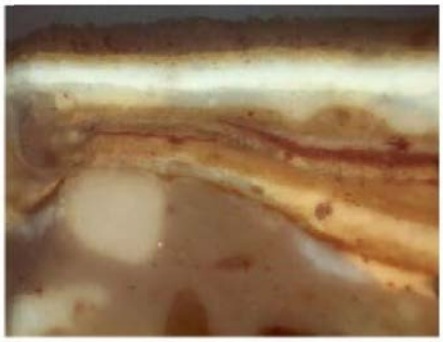
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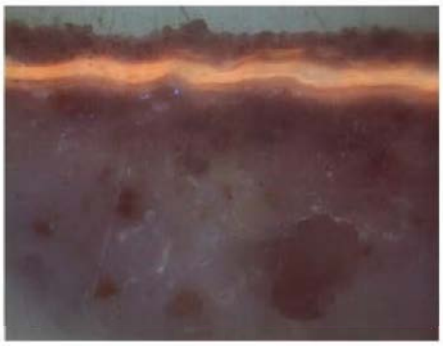
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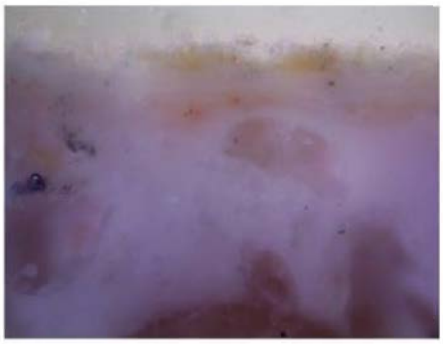
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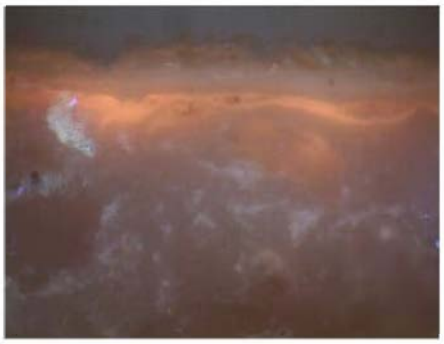
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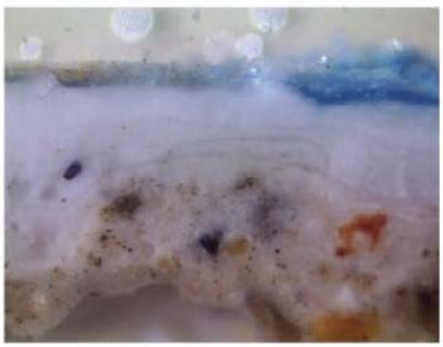
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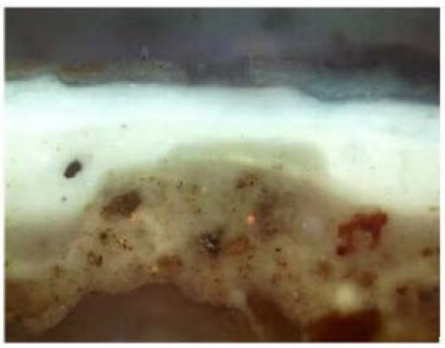
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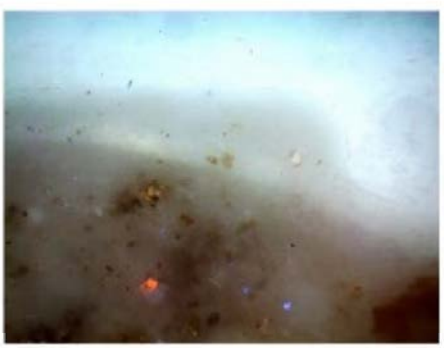
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National Park Service
U.S. Department of the Interior

Castillo San Cristóbal
San Juan National Historic Site
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San Juan, Puerto Rico 00901
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