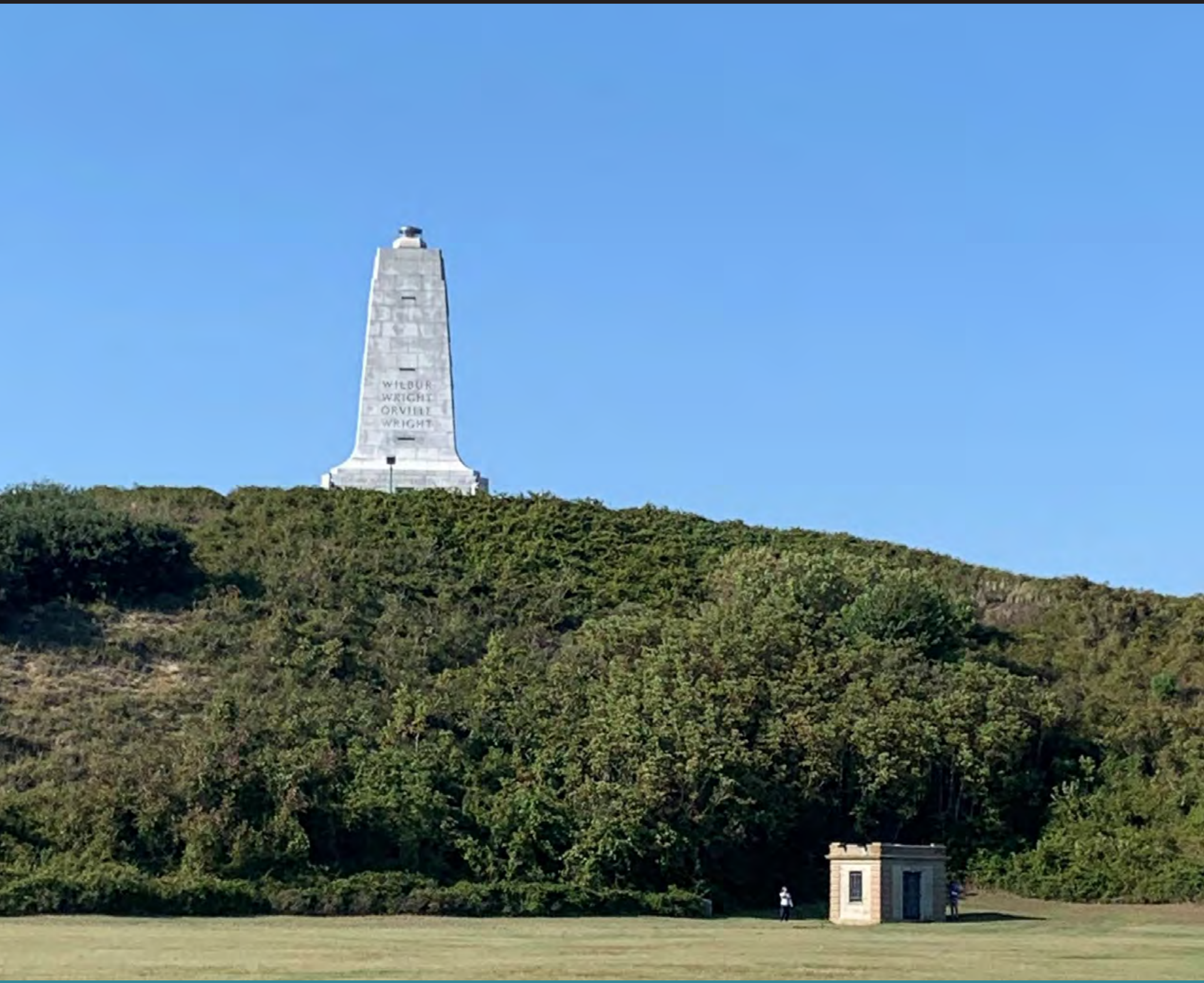
National Park Service
U.S. Department of the Interior

Wright Brothers National Memorial
Kill Devil Hills, North Carolina



Historic Structure Report

Wright Brothers Monument and Powerhouse

100% FINAL

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

Wright Brothers National Memorial

Wright Brothers Monument and Powerhouse

Historic Structure Report

October 2022

Quinn Evans

National Park Service

Interior Region 2: South Atlantic-Gulf

Cultural Resources, Partnerships, & Science

This historic structures report presented here exists in two formats. A traditional, printed version is available for study at the park, at the Southeast Regional Office of the National Park Service, and a variety of other depositories around the United States. For more widespread access, this historic structure report also exists in digital format through the website of the National Park Service. Please visit www.nps.gov for more information.

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Cover Image: Wright Brothers National Monument
(Quinn Evans 2021)

Wright Brothers National Memorial

Wright Brothers Monument and Powerhouse

Historic Structure Report

Approved by: ______________________________

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

Foreward

We are pleased to make available this Historic Structure Report of the Wright Brothers Monument and Powerhouse, part of the ongoing effort to provide comprehensive documentation for the historic structures and cultural landscapes associated with Wright Brothers National Memorial, one of three parks in the Outer Banks Group that also includes the Cape Hatteras National Seashore and Fort Raleigh National Historic Site.

A number of individuals and institutions contributed to the successful completion of this work. We would particularly like to thank the staff at Wright Brothers National Memorial and the Denver Service Center for their assistance throughout this project. Also, we thank the staff of the Southeast Regional Office of the National Park Service.

We hope that this study will provide valuable information to park management team in ongoing efforts to preserve these historic structures and to everyone in understanding and interpreting these unique resources.

David Hallac
Superintendent
Wright Brothers National Memorial
National Park Service

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Executive Summary

FIGURE 1–1. Wright Brothers Monument, 1956 (National Park Service (NPS): Wright Brothers National Memorial (WRBR) Collection).

The National Park Service requested that Quinn Evans, along with its consultant team Apogee Consulting Group, develop this Historic Structure Report (HSR) for the Wright Brothers Monument and Powerhouse, part of the Wright Brothers National Memorial in Kill Devil Hills, North Carolina. Maps depicting the location of the property are included at the end of the Executive Summary.

The Wright Brothers Monument and Powerhouse are historically significant as commemorative structures to the December 17, 1903 flight of Orville and Wilbur Wright, the first successful attempt of heavier-than-air power-driven flight in Kill Devil Hills, North Carolina.

This HSR documents the historical development, current conditions, and significance/integrity of the Wright Brothers Monument and Powerhouse, and recommends options for treatment and use to meet the National Park Service's management objectives. The HSR is divided into two sections. Part I: Developmental History documents the property's historical background and context and its chronology of development and use, describes and assesses its physical conditions, and evaluates its significance and integrity. Part II: Treatment and Use reviews requirements for treatment, presents an ultimate treatment and use, including evaluating alternatives for treatment, and provides recommendations for treatment, including resilience to natural hazards. The report also includes a bibliography and applicable appendices.

Historical Overview

For centuries, humans have been captivated by the idea of flight, though every attempt ended in failure. Greek mythology gives us the story of Daedalus, the father of Icarus, who fashioned a pair of wings fastened to himself and his son with wax. When Icarus flew too close to the sun, the wax melted, and he fell to the sea. Human fantasies of flight can be traced to the late fifteenth century and Leonardo da Vinci. A number of potential flight innovations were suggested by Leonardo da Vinci through his notebooks on devices for human powered flying machines with harnesses and movable bird-like wings to an early design for a helicopter and parachutes.

Louis XVI, King of France, and his Queen, Marie Antoinette, commissioned the brothers Joseph and Etienne Montgolfier to create a hot-air balloon and on September 19, 1783, the Montgolfier brothers' hot-air balloon lofted a duck, a sheep, and a rooster into the air for eight minutes. From 1783 to 1900, the world gradually became accustomed to the reality of hot-air balloons being lifted from the ground by gases. The public became thoroughly convinced that human flight was out of the realm of possibility, so much so that when it was actually accomplished, few people believed it had been done.

The Wright brothers began their experiments with flight in early 1899, employing a five-foot wide, double-foiled kite that would test their theories on lift and their "wing-warping" method of controlling the altitude and direction. After their kite tests, the Wright brothers proposed to build a full-size, human carrying glider to test their method of control and started thinking of a place in which to test it. To practice the operation of a glider, the Wright brothers took into consideration the components of kite flying including steady winds and flat open country, along with the conditions needed for gliding which included a sandy area for a soft landing and sandhill slopes free of trees and shrubs for the low-level flights. An area like this did not exist in the Wrights' hometown of Dayton but after some research the Wright brothers were convinced that Kitty Hawk, North Carolina was the ideal place.

Three seasons of glider experiments took place before the Wright brothers found success with the Flyer on December 17, 1903. The first flight lasted approximately 12 seconds and traveled about 100 feet from their launch site at the base of Kill Devil Hill[1].

Further innovations in heavier-than-air powered flight continued after the Wright brothers' achievements, paving the way for the flights of Louis Blériot, Walter Brookins, Lt. John A. Macready and Lt. Oakley G. Kelly, Commander Richard E. Byrd, Charles A. Lindbergh, Albert Hegenberger and Lester Maitland, Charles Kingsford Smith and Charles T. P. Ulm, and countless others.

With ever increasing flight activity during the 1920s, the public realized that the Wright brothers deserved public recognition for their role in the history of aviation. Legislation put forth by Representative Lindsay Warren of North Carolina and Senator Hiram Bingham of Connecticut was submitted in 1926 and led to President Calvin Coolidge's Act for the erection of a memorial in commemoration of the first successful attempt of a power-driven airplane flight. The legislation was signed into law on March 2, 1927.

Because various committee members could not decide on a design for the memorial, a design competition was held. The winning design by Rodgers and Poor Architects, selected in February 1930, led to the construction of the Kill Devil Hill Monument which was completed in 1932. The Monument, constructed of Mt. Airy, North Carolina granite, is a 60-foot-high Art Deco-inspired tower embellished with wings on its side and a five-pointed star serving as the base, symbolizing human conquest of the air. At the time of construction, the Monument was the only one ever built to honor someone who was still alive. At the foot of the Kill Devil Hill stands a Beaux Arts styled Powerhouse, built to house a generator for lighting the Monument's beacon. By the late 1930s, the introduction of commercial power sources outmoded the building's function and its equipment served as a source of auxiliary power until 1954.

The Kill Devil Hill Monument was transferred from the War Department to the National Park Service in August 1933, becoming Kill Devil Hill National Monument. During World War II when many park operations were suspended, the name changed once again to Kill Devil Hill National Monument Memorial. It wasn't until December 1, 1953, during the 50th anniversary year of the first flight, that NPS adopted the current name Wright Brothers National Memorial.

Originally open to the public, the Monument interior was closed in 1960 due to the construction of the visitor center, the condensation/moisture intrusion inside of the Monument interior, and

1 Kill Devil Hills in this report is in reference to the name of the municipality, while Kill Devil Hill is in reference to the actual hill or the original name of the site.

visitor safety issues.

Multiple small- and large-scale restorations occurred for the Monument in 1954, 1988, 1997, 2007-2008, and 2014-2015 with a stabilization of the Powerhouse in 2000.

Treatment & Use

The Wright Brothers Monument and Powerhouse were listed in the National Register of Historic Places in 1978 as contributing resources to the Wright Brothers National Memorial that is significant at the national level (NR66000071). The National Park Service has administratively determined the Management Category for the Wright Brothers Monument and Powerhouse as "Must Be Preserved and Maintained" and the latest Ultimate Treatment as Stabilization for the Monument and Rehabilitation for the Powerhouse. Consistent with Director's Order 28, the Historic Structure Report treatment section has assigned the Ultimate Treatment of "Stabilization" for the Monument and "Rehabilitation" for the Powerhouse, as characterized in The Secretary of the Interior's Standards for Treatment of Historic Properties. Additional treatments will be discussed in the Part 2 Treatment section, grouped under Preservation, Restoration, and/or Reconstruction based on the needs of the Monument and the Powerhouse as defined in discussions with the Park. Further explanation can be found in the *Treatment and Use* chapter, which begins on page 89.

Administrative Data

Locational Data

Building Names:	Wright Brothers National Monument and Powerhouse
Location:	Wright Brothers National Memorial Kill Devil Hills, North Carolina
UTM Coordinates:	18S 439816.28 m E 18S 3985740.46 m N
Latitude/Longitude Coordinates:	36.014297 N -75.667877 W
Monument CRIS Number:	007396
Powerhouse CRIS Number:	090077

Related Studies

Chapman, Bill. *Wright Brothers National Memorial (Additional Documentation) National Register of Historic Places Nomination*. Atlanta, GA: National Park Service, 1996.

Chapman, William R. and Jill K. Hanson. *Wright Brothers National Memorial Historic Resource Study*. Atlanta, GA: National Park Service Southeast Field Area, January 1997.

East, Omega G. *National Park Service Historical Handbook Series No. 34 Wright Brothers National Memorial*. Washington, D.C.: National Park Service, 1961.

Hewes, Andrew M. *Wright Brothers National Memorial An Administrative History*. National Park Service Division of History, Office of Archeology and Historic Preservation, December 1967.

Hitchcock S. *Wright Brothers National Memorial: Cultural Landscape Report*. Atlanta, GA: National Park Service Southeast Regional Office, 2003.

National Park Service. *Wright Brothers Monument Historic Structure Assessment Report*. United States Department of the Interior National Park Service, August 1996.

National Park Service. *Wright Brothers National Memorial Cultural Landscape Inventory*. Atlanta, GA: National Park Service Southeast Regional Office, 1998.

National Park Service. *Wright Brothers National Memorial Visitor Center Historic Structure Report*. Atlanta, GA: National Park Service Cultural Resources, Southeast Region, 2002.

Warfield, Ronald G. *National Register of Historic Places Nomination, Wright Brothers National Memorial*. Washington, DC: National Park

Service, 1978.

Cultural Resources Data

National Register (NR) Status: Contributing Resources to the Wright Brothers National Memorial (Listed 1978, NR# NR66000071).

Period of Significance:

NR: 1903 Wright Brothers Camp Buildings, 1932 Memorial Shaft, Twentieth Century

Cultural Landscape Report: 1900-1960 Wright Brothers National Memorial

Significance: The National Register nomination cites the December 17, 1903 flight of Orville and Wilbur Wright as the first successful attempt of heavier-than-air power-driven flight as a significant event in the history of aviation in Kill Devil Hills, North Carolina. The Wright Brothers Monument and Powerhouse, designed by Rodgers & Poor, Architects, is a commemoration of this flight and the nearby locations of the take-off and landing spots. During its time of construction, the Wright Brothers Monument was also the only Monument erected for persons still living.

Proposed Treatment: Stabilization/Preservation (Monument), Rehabilitation (Powerhouse)

Project Scope and Methodology

Purpose

This HSR documents the historical development, present condition, and significance/integrity of the Wright Brothers Monument and Powerhouse, and provides information to assist the NPS in planning for the preservation and maintenance of the Monument and Powerhouse in a way that preserves and interprets its historical significance in relation to the first heavier-than-air flight by Orville and Wilbur Wright. The NPS's Director's Order 28 states that "In no case should restoration, reconstruction, or extensive rehabilitation of any structure be undertaken without an approved HSR, Parts 1 and 2."[2] The purpose of this HSR is to provide a basis of information, including historical research, documentation of existing conditions, and treatment recommendations, that will guide the long-term stewardship of the building as part of Wright Brothers National Memorial.

Historical Research

The statement of work for the HSR required a limited primary research of readily available sources of documentation in the Park archives and the NPS's eTIC (electronic Technical Information Center) database.

Park archives and NPS eTIC database were supplemented by the archives located at the Outer Banks History Center, digital archives, including historic newspapers, Wright State University (WSU) Wright Brothers Photographs online collection, Library of Congress online collection, as well as relevant secondary sources, in order to develop the Historic Background and Context, and Chronology of Development and Use.

Condition Assessment

Physical investigation, including condition assessment, was conducted concurrently with historic research. Disciplines represented on the site survey team included architecture, structural, and building systems. Observations were documented with field notes, digital photographs, and annotation of sketch drawings prepared prior to field work. The condition assessment included the exterior, interior spaces, structure, systems, materials, and elements of the site relevant to building conditions. Field notes and measurements were taken to further develop measured drawings.

Contextual History, Chronology of Development, and Evaluation of Significance

The combined information from documentary research and physical investigations was analyzed, and a narrative context history and building specific chronology of development and use were written. The narrative physical description was prepared containing a systematic accounting of exterior and interior spaces, features, materials, and condition assessment. All narratives are supplemented by numerous photographs and drawings.

2 *NPS Director's Order 28: Cultural Resources Management Guideline,* chapter 8.

An evaluation of significance was prepared in accordance with the guidelines in the *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation.*[3] The seven aspects of historic integrity were assessed using the same guidelines. These evaluations of history, condition, significance, and integrity provided the basis for the development of recommended treatment alternatives.

Treatment Recommendations

The Secretary of the Interior's Standards for the Treatment of Historic Properties guided the development of treatment recommendations for the significant exterior and interior features of the buildings. Following the overall treatment approaches of Stabilization (Preservation) for the Monument and Rehabilitation for the Powerhouse, specific recommendations were developed to address the observed existing conditions as well as long term preservation objectives.[4]

Preparation of Historic Structure Report

Following completion of research, site work, and analysis, this report was prepared summarizing the results of the research and inspection and presenting the recommendations for treatment and future actions. It was compiled following the organizational guidelines of NPS *Preservation Brief 43: The Preparation and Use of Historic Structure Reports* and the NPS Scope of Work for this project.[5]

Selected Summary of Recommendations

The principal issues facing the Monument are related to moisture intrusion; therefore, the selected recommendations included here focus on these aspects. The principal issue facing the Powerhouse is related to its rehabilitation; therefore, the selected recommendations included here focus on this aspect. A complete listing of recommendations and guidelines for both the Monument and Powerhouse to maintain the buildings are fully described in the *Ultimate Treatment and Use* section, which begins on page 96.

Monument

Roofing System

- Remove existing roof materials from the observation deck. Install 90-mil EPDM roofing over sufficient insulation to provide for proper drainage. Tie roofing membrane to base terminations at perimeter, counterflash with new copper flashings that have fully soldered joints and seams and reset in existing reglets. Tie the roofing membrane into the existing drain sump and cover the entire roof surface with a walkway pad material.
- Clean and reseal or replace metal flashing at base of cupola plinth stone, Stone Course 'X'[6] (Figure 3–22)

Exterior Envelope System

- Pedestal walls: Reset displaced stone units and repoint existing joints in stone masonry. Repair spalled granite stones with specialized stone patching mortar and provide matching dutchman's at previous conduit locations. Repoint sky-facing stone joints with urethane sealant with a custom color matched to pointing mortar and rub sand into the face of the sealant joints. Clean ferrous staining at one drain outlet location. Excavate and regrade slightly at the southeast corner of terrace base to expose partially covered drain outlet.
- Conduct topographic survey of terrace level from base of pylon to perimeter drainage channels.
- Terrace surface: Assuming topographic survey confirms inadequate positive slope away from pylon base, consider possible solutions to address surface storm water by

3 *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation* (Washington, DC: National Park Service, National Register of Historic Places, 1990, revised 1997).

4 Anne E. Grimmer, *The Secretary of the Interior's Standards for Treatment of Historic Properties, with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings* (Washington, DC: National Park Service, Technical Preservation Services, rev. 2017).

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

6 Architectural Stone drawing scans provided by NPS, Wright Memorial Architectural Drawings, Robert Perry Rodgers & Alfred Easton Poor Architects, 1931, Sheet 30.

removing all existing mosaic stone pavers and excavate to depth sufficient to install a six-inch concrete slab. Demolish existing concrete slab (assuming that it exists). Pour a new six-inch thick, reinforced concrete slab at a depth of 3.5 inches below finish terrace grade. Set the slab with an adequate and continuous slope to encourage water drainage to the gutters at the perimeter. Provide for perimeter drainage of slab with lined perforated drain tile around base of pylon and connect to the existing terrace drain system. Reset mosaic pavers in a grout bed on the concrete slab and fill the gaps with buff colored pea gravel to match the existing condition. Provide a new expansion joint at the perimeter of pylon base, backed with closed-cell foam backing down to the concrete and concrete expansion joint.

- Exterior stone veneer of pylon: further investigative scope is pending on the exterior envelope system of the pylon. Preliminary primary recommendations are as follows:
  - Retain all granite veneer stone pieces in place. Drill into mortar joints to relieve all moisture build up in void spaces. Inject with non-expanding injection grout throughout existing voids.
  - Repoint fifty (50) percent of the joints, focusing at the top of the Monument, the joints in the flare (Stone Course ‘D’) and the base (Stone Course ‘A’).[7] Repoint stone joints, raking out to a minimum of 2.5 times the depth of the joint. Remove any sealant from non-sky facing joints and repoint with mortar. Install flexible tees into sky-facing joints at the top of Monument only.
  - NPS may consider pursuing repointing one hundred (100) percent of exterior stone joints instead of fifty (50) percent.
  - Repair exterior elevations spalled granite stone with specialized stone patching mortar.

Powerhouse

Interior Condition

- Maintain in place existing equipment and building utilities.

Openings: Windows & Doors, Exterior

Treatment recommendations for exterior windows and doors include:

- Remove security gate at entry door, replace with more accessible option to future program use. Repair concrete connection areas before reinstallation.
- Provide a fixed transparent door or panel to provide visual access to interior room and future programming.

Recommendations for Further Study

Recommendations for further study include:

Monument

- Removal of three exterior veneer stones for the purposes of assessing the condition of the in-wall components as listed above. Refer to Appendix G: “Technical Investigation 2022-2023” for further information regarding exterior envelope condition assessment.
- Investigation into the source of the seepage leak, causing paint flaking at Level B.
- A terrace-level test pit at the base of the pylon to confirm the presence and condition of a concrete slab underneath the plaza pavers and assess the viability of a sub-grade waterproofing installation to the depth of the ground level.
- Further testing of the soil characteristics below the terrace to assess soil type, saturation level, density, and percolation characteristics.
- Research is needed to confirm what components are in need of repair or replacement for the Monument’s dehumidification system.

7 Architectural Stone drawing scans provided by NPS, Wright Memorial Architectural Drawings, Robert Perry Rodgers & Alfred Easton Poor Architects, 1931, Sheet 30.

- Potential for installation of positively pressurizing interior of the Monument by the means of forced air to further discourage water vapor infiltration.

- Full storm drain scoping at terrace/grade level once obstructions and debris are removed.

Powerhouse

- Environmental impacts of the previous mechanical, electrical, plumbing (MEP) equipment.

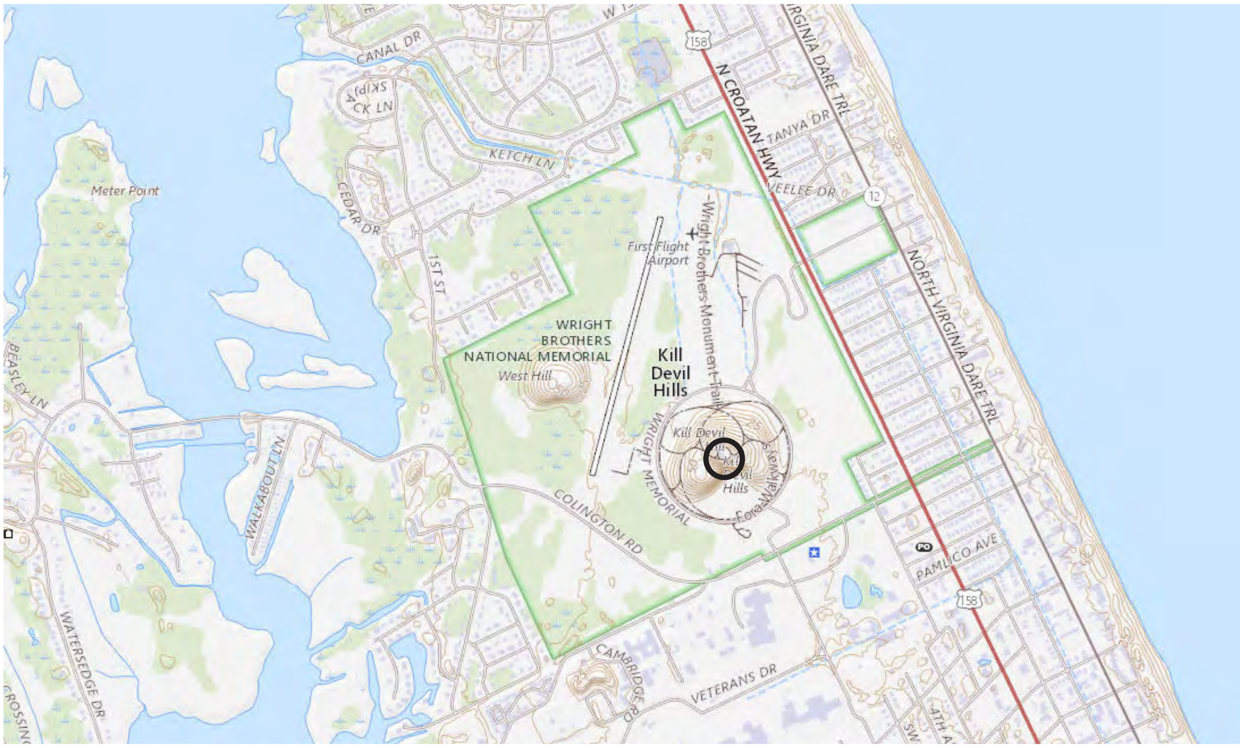

FIGURE 1–2. Map depicting the location of the Wright Brothers Monument and Powerhouse (circled) in relation to the Wright Brothers National Memorial (outlined in green) and surrounding area (USGS Topographic Map).

FIGURE 1–3. Aerial map depicting the relationship between the Wright Brothers Monument (circled) and the Powerhouse, noted by a rectangle (Google Maps).

Developmental History

FIGURE 2–1. A print portraying the mythological story of Icarus showing him falling from the sky over a large river. (Library of Congress)

Historical Background and Context

Aviation Prior to the Twentieth Century

For centuries, humans have been captivated by the idea of flight, though every attempt ended in failure. Greek mythology gives us the story of Daedalus, the father of Icarus, who fashioned a pair of wings fastened to himself and his son with wax. When Icarus flew too close to the sun, the wax melted and he fell to the sea (Figure 2–1). Human fantasies of flight can be traced to theoretical ideas developed during the late fifteenth century by Leonardo da Vinci. A number of potential flight innovations were suggested by da Vinci through his notebooks on devices for human powered flying machines from harnesses and movable bird-like wings to an early design for a helicopter and parachutes. Most of early flight theories fixated on the motion of a bird's flight; however, it wasn't until the fixed wing principle was accepted that human flight became possible.[1]

The concept of the fixed wing developed in the late-eighteenth to mid-nineteenth centuries in the form of primitive gliders in conjunction with the hot-air balloon and/or parachutes. One of the early experimenters of the fixed wing principle was Sir George Cayley, who is identified by historians "as the basic originator of the modern aeroplane" and was inspired by the balloon flights of Pilâtre de Rozier and the Marquis d'Arlandes in a craft designed by the French Montgolfier brothers in 1783.

Louis XVI, King of France, and his Queen, Marie Antoinette, commissioned the brothers Joseph and Etienne Montgolfier to create a hot-air balloon. On September 19, 1783, in front of the King and Queen and a large crowd of people, the Montgolfier brothers' hot-air balloon lofted a

1 Bill Chapman, *Wright Brothers National Memorial (Additional Information) National Register of Historic Places Nomination*, Atlanta, GA: National Park Service, 1996, 6.

duck, a sheep, and a rooster into the air for eight minutes. The hot-air balloon landed two miles away from the original take off location at the Versailles Palace, but the animals were unharmed upon landing.[2]

Between 1783 and 1785, four more hot-air balloon flights were accomplished. On November 21, 1783, Pilâtre de Rozier and the Marquis D'Arlandes were the first human beings to fly in an untethered balloon powered by burning straw, designed by the Montgolfier brothers, which lasted under 30 minutes. Shortly after de Rozier and D'Arlandes' flight, J.A.C. Charles and M.N. Robert Millbrook became the first people to fly in a gas balloon on December 1, 1783. Gas technology became the new means of hot-air production for balloons through the nineteenth and twentieth centuries. Elizabeth Thible was the first woman to fly in a hot-air balloon on June 4, 1784, while the first person on American soil to successfully fly in a hot-air balloon was Edward Warren, a thirteen-year-old boy from Baltimore, Maryland, on June 24, 1784. Roughly six-months after Warren's flight, Dr. John Jeffries, an American physician living in London, and Jean-Pierre Bianchard, a French aeronaut, were the first to fly across the English Channel.[3]

After years of research, in 1799, Cayley designed a fixed wing glider with a paddle-like mechanism for propulsion and a tail for stability. Cayley's design marked the first-time propulsion and lift were separated from each other, a vast difference from the ornithopter or movable wing principle. Until his death in 1857, Cayley was able to build a series of model gliders, one of which carried a small boy several yards. However, the problem faced by Cayley was the ability to sustain flight without a sufficient way to decrease air resistance on the craft.[4]

In 1857, a French naval officer named Felix du Temple experimented with powered heavier-than-air crafts through his construction of a monoplane design. His design contained a boiler similar to a locomotive and a smokestack, but he was unable to get the craft off the ground. By the 1870s, a British engineer, Thomas Moy, developed a steam-powered craft that was able to hover a few inches above the ground and in 1890, Clément Ader succeeded in leaving the ground with his aircraft but could not achieve sustained flight. The Wright Brothers National Memorial National Register nomination further describes influences of the Wright brothers,

> Another contribution to early flight was the continued work of model makers and kite designers, several of whom directly influenced the Wright brothers. The mid-nineteenth-century collaborative designs of the Englishmen Samuel Hensen and John Stringfellow prophetically anticipated later airplane design. The invention of the box kite in 1893 by Lawrence Hargrave in Australia similarly impacted the configuration of early aircraft, including the Wrights' biplane gliders and flyers. Miniature balsa models introduced by the Frenchman Alphonse Pénaud, with twisted elastic band propulsion, suggested an immediate prototype for the Wright brothers, down to the fixed tapered wings shaped in the form of a positive dihedral, and was later incorporated in the Wright design.[5]

From 1783 to 1900, the world gradually became accustomed to the reality of hot-air balloons being lifted from the ground by gases and flight experimentation during this time increasingly took place within the context of scientific societies, journals, publications, and correspondence between researchers. The public became thoroughly convinced that human flight was out of the realm of possibility, so much so that when it was actually accomplished, few people believed it had been done.[6]

The Wright Brothers

Wilbur Wright was born in Millville on a farm approximately eight miles east of New Castle, Indiana, on April 16, 1867 (Figure 2–2) to Reverend Milton Wright of the United Brethren Church and Susan Koerner Wright. Four years later, after the Wright family moved to Dayton, Ohio, Orville Wright was born on August 19, 1871 (Figure 2–3). Wilbur and Orville also had two older brothers named Reuchlin and Lorin, and a younger sister named Katharine. The Wright children were

2 Judy Baker et al., "Celebrating a Century of Flight," NASA Publications, 2002.

3 Judy Baker et al.

4 Chapman, 7.

5 Chapman, 7.

6 The United States of America, *World Heritage List Nomination Wright Brothers National Memorial*, National Park Service, 1980, 6-7.

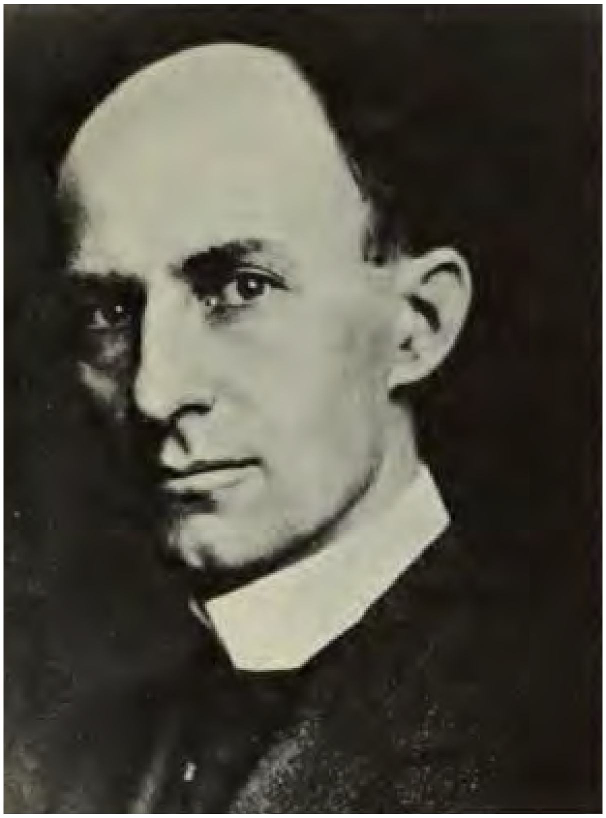

FIGURE 2–2. Wilbur Wright (1867-1912) taken about 1908. (*Wright Brothers National Memorial* by Omega G. East)

FIGURE 2–3. Orville Wright (1871-1948) taken about 1908. (*Wright Brothers National Memorial* by Omega G. East)

encouraged by their parents to pursue their intellectual interests and to follow their curiosities as both of their parents had been teachers. Both Wilbur and Orville were mechanically inclined, displayed the use of original thinking, and had an urge to be on the cutting edge of technology.[7] In 1878, the brothers' father gave Orville and Wilbur a toy rubber-band-powered helicopter, similar in design to the miniature balsa wood models introduced by Alphonse Pénaud.[8]

The brothers also shared a common interest in kite making. The same year in which Orville and Wilbur's mother died, 1889, they built a working printing press from parts found in junk yards and barns and began publishing a weekly neighborhood newspaper called *West Side News*. Both Orville and Wilbur attended high school full time but never formally graduated or attended college. After leaving school, the brothers continued to live with their father and younger sister at 7 Hawthorne Street, Dayton, Ohio, while their older brothers married and left to establish their own families.[9]

A bicycle shop was established in Dayton, Ohio, by Wilbur and Orville, named the Wright Cycling Company, in 1892. As the shop became more successful, the brothers found the need to add on a repair shop and through continued success, moved their business to other facilities that could accommodate their expansion. The Wright brothers' mechanical mind set, sharpened by their experience in the repair and manufacture of bicycles, became helpful in the development of their aviation experiments. The same tools used by the Wright brothers for repairing bicycles were used in the construction of their flying machines and many of their experiments. Additionally, many parts used in the construction of the gliders were produced in the back room of the Wright Cycling Company. Several hundred bicycles of the Wrights' own design were manufactured and sold before the Wright brothers closed the business to devote their full attention and time to aviation experiments.

7 Omega G. East, *Wright Brothers National Monument*, National Park Service Historical Handbook Series No. 34 (Washington, D.C., 1961), 1

8 Judy Baker et al.

9 East, 2.

Funding from the Wright Cycling Company provided the brothers the sole capital to work on their aviation experiments and they never sought additional financing. Each of the Wright children was given $1,000 from their father. Orville and Wilbur invested this money in stocks, and it was available if necessary, but was never used for their aviation work.[10]

Orville and Wilbur Wright originally became fascinated by the problems of flight around the mid-1890s. The Wright brothers, during the beginning of their research, corresponded with The Smithsonian Institute. Their work directly built on scientific and popular publications, such as the Smithsonian Institution's Secretary, Samuel P. Langley who published Experiments in Aerodynamics in 1891; as well as other writings from air flight pioneers like Octave Chanute, who published the Progress in Flying Machines in 1884; and James Means, whose journal, the Aeronautical Annual, was issued between 1895 and 1897.[11]

In addition to these studies, the Wright brothers are believed to have looked at the studies of Jules Marey, *Animal Mechanism: A Treatise on Aerial Locomotion* and the translation of Louise-Pierre Mouillard's *L'Empire de l'Air* in the Smithsonian Annual Reports. Based on the knowledge of these studies, the Wright brothers began making their own observations and conclusions.[12]

Direct influence on the Wright brothers came specifically from a German scientist and inventor, Otto Lilienthal, through his widely publicized successful glider experiments. Lilienthal made over 2000 successful glides, one of which carried him sixty-five feet in the air, but in 1896 Lilienthal died in a glider accident. When the Wright brothers wrote to the Smithsonian Institution in 1899 for information on flight, they were directed to Lilienthal's experiments. Lilienthal's principal innovation was the translation of the shape of a bird's wing into glider wings, creating a gentle parabolic curve on the upper surface of the wing and providing the necessary air lift. Through Lilienthal's work, the Wright brothers came to the realization that the short moveable wings in Lilienthal's gliders created instability and lack of control for the pilot.[13]

First Dayton, Ohio Experiments, 1899

The Wright brothers began working on the problem of how to control a flying machine through a method of restoring the machine's equilibrium both up and down as well as side to side. Experimentation prior to this relied on balancing a flying machine through human control, but the continual contortions and acrobatics required to maintain the flying machine's equilibrium were difficult and caused the deaths of both Lilienthal and Percy S. Pilcher in nose dive crashes.[14]

Convinced there was a better method to control the flying machine, the Wright brothers created a navigational pendulum akin to Elmer Abrose Sperry Sr.'s gyroscope, later patented as the "automatic" device. Their principle of lateral control of a flying machine was that movement of the airfoil about its longitudinal axis could be controlled by a pressure differential exerted on the opposing lateral extremities, which later became one of the fundamental principles of aeronautics known today as aileron control.[15] In order to prevent injuring themselves, the Wright brothers decided that their first tests of the control principle would be in a small model glider[16]

In early 1899, the Wright brothers conducted their first experiments through employing a five-foot, double-foiled kite that would test their theories on lift and their "wing-warping" method of controlling the altitude and direction. This method required differential twisting of the kite's curved wings in order to shift its direction, which was eventually called "helical twisting" by Orville and Wilbur. Combined with a rudder, the "wing-warping" or "helical twisting" allowed a pilot to lean into turns while maintaining aerial stability, becoming the Wright brothers' key to success.[17]

A final kite test during the summer of 1899 gave limited results towards the brothers' efforts to

10 East, 3-5.

11 Chapman, 7.

12 Chapman, 8.

13 Chapman, 8; East, 10

14 East, 10

15 East, 10-12.

16 East, 12.

17 Chapman, 10.

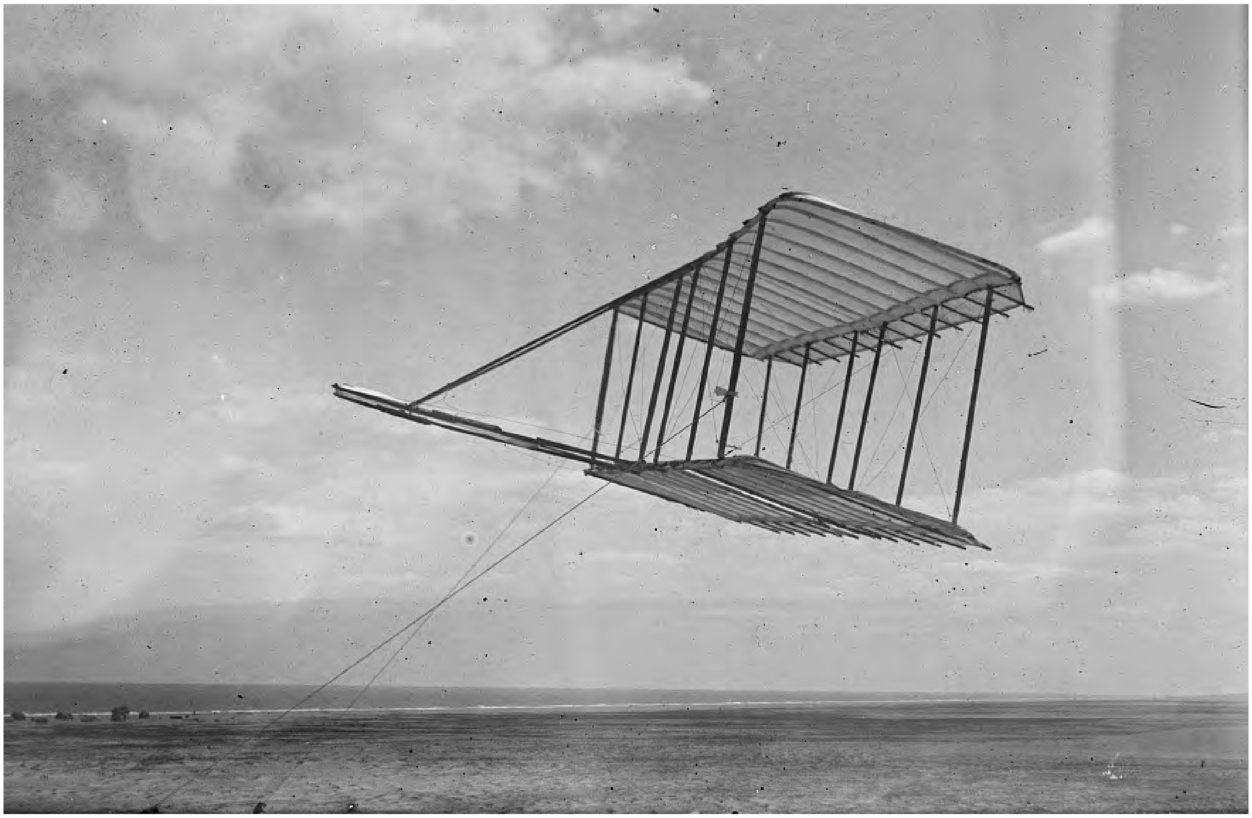

FIGURE 2–4. Left side view of the Wright glider before installation of forward horizontal control surface, flying as a kite and tipped forward, Kitty Hawk Lifesaving Station and Weather Bureau buildings in the background to the left, 1900. (Library of Congress)

create a glider capable of carrying a man's weight.[18]

After their kite tests, the Wright brothers proposed to build a full-size, man carrying glider to test their method of control and started thinking of a place in which to test it. To practice the operation of a glider, the Wright brothers took into consideration the components of kite flying including steady winds and flat open country, along with the conditions needed for gliding which included a sandy area for a soft landing and sandhill slopes free of trees and shrubs for the low-level flights. An area like this did not exist in the Wrights' hometown of Dayton but because of the bicycle shop's business demands, they needed a site that was fairly close to Dayton.[19]

On May 13, 1900, Wilbur and Orville wrote a letter to Octave Chanute, another flying machine experimenter, asking advice on a location for glider testing. Chanute suggested beach locations in California, Florida, Georgia, or South Carolina, but after researching wind records obtained from the Weather Bureau of Washington. DC, the Wrights decided that Kitty Hawk, NC, would meet their requirements better than other places within the same distance from their home. After writing to Joseph J. Dosher and William J. Tate of Kitty Hawk, the Wright brothers were convinced that Kitty Hawk was the ideal place to conduct their experiments and would start as soon as they could build the glider and travel to Kitty Hawk as their bicycle business would allow.[20]

First Season, 1900

The Wright brothers began their first experiments at Kitty Hawk in September 1900 (Figure 2–4). No bridge connected the Outer Banks to mainland North Carolina so the brothers needed to travel by boat to reach their destination, which at the time was an isolated fishing village with only a few hundred inhabitants. Wilbur Wright described the area as follows:

> In October my brother and myself spent a vacation of several weeks at Kitty Hawk,

18 National Park Service, *Wright Brothers National Memorial Historic Resource Study*, (Atlanta, GA: National Park Service Southeast Field Area, 1997), 19-20.

19 East, 13-14.

20 East, 14.

> North Carolina, experimenting with a soaring machine. We located on the bar which separates Albemarle Sound from the ocean. South of Kitty Hawk the bar is absolutely bare of vegetation and flat as a floor, from sound to ocean, for a distance of nearly five miles, except a sand hill (Kill Devil Hill) one hundred and five feet high which rises almost in its center. The main slope of the hill is to the northeast, which is facing the prevailing winds. The slope is one to six. To the north, northeast, east, and southeast there is nothing but flat plain and ocean for a thousand miles nearly. It is the ideal place for gliding experiments except for its inaccessibility.[21]

Prior to construction of the Wright brothers' camp, Orville and Wilbur stayed at the home of William J. Tate, the local postmaster, and his family in Kitty Hawk. The original camp was located approximately four miles north of the current National Memorial. During their first attempts, the Wright brothers focused on flying their glider like a kite with a guide rope attached and controlling it from the ground. On October 19, they moved their experiments approximately four miles south to Kill Devil Hills and commenced experiments with the manned glider, launching from the slopes of the large sand dunes that they referred to as Kill Devil Hill, West Hill, and Little Hill.

Staying in the area until late October, the brothers completed around a dozen manned glides from Kill Devil Hills. Upon their return to Dayton, Ohio, Orville and Wilbur began work on designing and constructing a second glider that was completed in early 1901.[22]

Second Season, 1901

Testing of the Wright brothers' second glider began in July 1901, where at this time, the brothers constructed a more permanent camp of a combined wood frame workshop and storage facility, approximately four miles south of their original camp and just northeast of the main sand dune Kill Devil Hill. A majority of the experiments

21 National Park Service, *Wright Brothers National Memorial Landscape Cultural Landscape Inventory,* Atlanta, GA: National Park Service Southeast Regional Office, 1998, 24-25.

22 National Park Service, *Cultural Landscape Inventory*, 26.

FIGURE 2–5. Start of a glide with Wilbur Wright in motion at the left holding one end of the glider, Orville Wright lying prone in the glider, and Dan Tate at the right in Kitty Hawk, October 10, 1902. (Library of Congress)

FIGURE 2–6. Orville and Wilbur Wright's heavier-than-air man-powered flight at Kill Devil Hill. (Library of Congress)

this season included manned glides from the top of Kill Devil Hill. With the new design of the glider having an increased wingspan and surface area, Orville and Wilbur broke their previous season's record for distance and time aloft for a manned glide. Upon completing their experiments in August, the brothers returned to Dayton to create another new design, after a series of wing configuration tests, that was incorporated into their new glider in 1902.[23]

Third Season, 1902

In August of 1902, the Wright brothers returned to Kill Devil Hills to begin their third season of experiments. Upon returning to their camp, the brothers found that a series of winter storms and shifting sands had left their wooden camp structures in disrepair. With the help of some locals, Orville and Wilbur were able to make some repairs to the camp and add approximately ten feet to the storage and workshop building that would be used as their living quarters. Remaining at Kill Devil Hill until October, Orville and Wilbur tested their new glider and completed over 700 glide tests from the sand dunes, surpassing the previous year's records for distance and loft time (Figure 2–5). Upon their return to Dayton, the brothers were happy with the success this season and began development of an engine for the aircraft over the winter of 1902 and the spring of 1903.[24]

Fourth Season and Powered Flight, 1903

Upon their return to the Outer Banks area in late September, the Wright brothers continued their experiments, initially with the 1902 glider until the 1903 aircraft (named the Flyer) was ready, and began repairs to their storage facility/workshop yet again. During this time the Wright brothers also constructed an additional building, the hangar, from a wood frame structure braced on two sides against the wind that measured approximately 44 feet by 16 feet.[25]

Approximately one month after arriving in the Outer Banks, the Flyer arrived but the Wright

23 National Park Service, *Cultural Landscape Inventory*, 26.

24 National Park Service, *Cultural Landscape Inventory*, 26.

25 National Park Service, *Cultural Landscape Inventory*, 27.

brothers took another month to assemble the aircraft before they could begin experiments. In order to better launch the Flyer, Orville and Wilbur built a 60-foot monorail type structure that consisted of four, 15-foot two-by-fours covered in a metal strip. Early on, engine difficulties resulted in a damaged propeller shaft that had to be sent back to Dayton for repair. Once the propeller shaft was returned on November 20, the brothers again had to delay further experiments due to extremely cold weather throughout the rest of November. The propeller shafts continued to crack as the experiments continued, and the brothers came to the conclusion that only solid steel shafts would withstand the vibration of the engine. Orville returned to Dayton himself to get the necessary parts.[26]

On December 12, 1903, the new solid steel propeller shafts were installed and on the following Monday, the Wright brothers tested the aircraft. Due to low wind velocities, the aircraft would only stay aloft for about three-and-a-half seconds before clipping the sand with the left wing. After making the necessary repairs, the Wright brothers commenced experiments with the aircraft on December 17, 1903 (Figure 2–6).[27] Orville Wright recorded the events that took place on this day in his diary.

> When we got up, a wind of between 20 and 25 miles was blowing from the north. We got the machine out early and put out the signal for the men at the station.
>
> Before we were quite ready, John T. Daniels, W.S. Dough, A.D. Etheridge, W.C. Brinkley of Manteo, and Johnny Moore of Nag's Head arrived. After running the engine and propellers for a few minutes to get them in working order, I got on the machine at 10:35 for the first trial. The wind according to our anemometer at this time was blowing a little over 20 miles (corrected) 27 miles according to the Government anemometer at Kitty Hawk. On slipping the rope the machine started off increasing in speed to probably seven or eight miles. The machine lifted from the truck just as it was entering on the fourth rail. Mr. Daniels took a picture just as it left the trucks.
>
> I found the control of the front rudder quite difficult on account of its being balanced too near the center and thus had a tendency to turn itself when started so that the rudder was turned too far on one side and then too far on the other.
>
> As a result, the machine would rise suddenly to about 10 feet and then as suddenly, on turning the rudder, dart for the ground. A sudden dart when out about 100 feet from the end of the track ended the flight. Time about 12 seconds (not known exactly as watch was not promptly stopped). The flight level for throwing off the engine was broken, and the skid under the rudder cracked.
>
> After repairs, at 20 minutes after 11 o'clock Will made the second trial. The course was about like mine, up and down but a little longer...over the ground through about the same in time. Distance not measured but about 175 feet. Wind speed not quite so strong.
>
> With the aid of the station men present, we picked the machine up and carried it back to the starting ways. At about 20 minutes till 12 o'clock I made the third trial. When out about the same distance as Will's I met with a strong gust from the left which raised the left wing and sidled the machine off to the right in lively manner. I immediately turned the rudder to bring the machine down and then worked the end control. Much to our surprise, on reaching the ground the left wing struck first, showing the lateral control of this machine much more effective than any of our former ones. At the time of its idling it had raised to a height of probably 12 to 14 feet.
>
> At just 12 o'clock Will started on the fourth and last trip. The machine started off with its up and downs as it had before, but by the time he had gone three or four hundred feet he had it under much better control, and was traveling on a fairly even course. It proceeded in this manner till it reached a small hammock out about 800 feet from the starting ways when it began its pitching again and suddenly darted into the ground. The front rudder frame was badly broken up, but the main frame suffered none all. The engine turns was 1,071, but this

26 National Park Service, *Cultural Landscape Inventory*, 27.

27 National Park Service, *Cultural Landscape Inventory*, 27.

> included several seconds while on the starting ways and probably about a half second after landing. The jar of landing had set the watch on the machine back, so that we have no exact record for the 1,071 turns. Will took a picture of my third flight just before the gust struck the machine. The machine left the ways successfully at every trial, and the track was never caught by the truck as we had feared.
>
> After removing the front rudder, we carried the machine back to camp. We set the machine down a few feet west of the building, and while standing about discussing the last flight, a sudden gust of wind struck the machine and started to turn it over. All rushed to stop it. Will, who was near the end, ran to the front, but too late to do any good. Mr. Daniels and myself seized spars at the rear, but to no purpose. The machine gradually turned over on us.
>
> Mr. Daniels, having no experience in handling a machine of this kind, hung on to it from the inside, and as a result he was knocked down and turned over and over with it as it went. His escape was miraculous, as he was in with the engine and chains. The engine legs were all broke off, the chain guides badly bent, a number of upright, and really all the rear ends of the ribs were broken. One spar only was broken.[28]

After dinner, Orville and Wilbur walked several miles to the Kitty Hawk Lifesaving Station to send a telegram to their father in Ohio stating:

> Success four flights Thursday morning all against twenty-one mile wind started from level with engine power alone average speed through air thirty-one miles longest 57 seconds inform press home Christmas. Orville Wright.[29]

During the transmission of the telegram, the time of 57 seconds was incorrectly given for the actual 59 second record flight along with the misspelling of Orville's name. This time was also leaked to a local newspaper, the *Virginia-Pilot* by the telegraph operator that resulted in multiple false reports pertaining to the length and duration of the flights.[30] After the brothers' successful heavier-than-air sustained flight, their success was printed in several other journals and newspapers. Recognition of their achievement was not immediate and took the public a few days to accept what they had done. On December 19, Wilbur and Orville broke camp and packed up the broken Flyer to be taken to Dayton.[31]

Wright Brothers Post 1903

The following section is taken from the Wright Brothers National Memorial Cultural Landscape Inventory:

> After successfully completing the first powered flights of 1903, Orville and Wilbur returned to Dayton to work on a sturdier flyer that would hold a more powerful engine. The brothers used a field located about eight miles from Dayton as a practice area for the two new planes that they designed and constructed in 1904 and 1905. Although they acknowledged that the practice area was not as favorable as the Kill Devil Hills site, they continued to set new records of time and distance aloft.
>
> Between 1905 and 1908, the brothers devoted their time to making improvements to the flyer and in negotiating the potential clients. In 1908, the brothers secured two contracts with the U.S. Army Signal Corps and a French client. Because the contracts were dependent on successful demonstrations of the flyer, the brothers decided to return to Kill Devil Hills where they could count on better winds, more open space, and privacy to regain their skills and further test the aircraft.

A fifth season began at Kill Devil Hills for the Wright brothers in April 1908 with Wilbur's arrival and then Orville followed a month later. Storms had yet again destroyed their camp buildings in their absence and a new building that would serve as both living quarters and hangar was constructed for the 1908 experiments. In May, the Wright brothers were confident that their aircraft would meet the needs of their contracts and on May 17, Wilbur left the Outer Banks headed for Europe to begin assembling the glider for a demonstration in LeMans, France. Orville left for Dayton a few days later to build a new flyer for the U.S. Signal Corps

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28 The United States of America, *World Heritage List Nomination*, 8-10.

29 East, 52.

30 East, 52.

31 National Park Service, *Historic Resource Study*, 28.

test at Fort Meyer, Virginia. Both the LeMans and Fort Meyer tests were successful and received wide acknowledgements.[32]

In 1911, Orville returned to the Outer Banks for a short time for more glider experiments.

The Wright brothers also had a number of competitors such as Glen Curtiss, who developed the ailerons, or flaps, that supplanted the Wrights' wing-warping mechanism. In 1912, Wilbur Wright died at the age of 45 of typhoid fever.[33]

Flights after the Wright Brothers

Further innovations in heavier-than-air powered flight continued after the Wright brothers' achievements in 1903 with the first flight over the English Channel by Louis Blériot on July 25, 1909, and Walter Brookins set a record in America for a 192-mile flight, with two stops, from Chicago to Springfield, Illinois, on September 29, 1911. The next year, Harriet Quimby became the first American female pilot to fly over the English Channel on April 16. By 1914, the world's first regularly scheduled airline went into service under the St. Petersburg-Tampa Airboat Line.[34]

With the beginning of World War I, the Wright brother's contributions to flight development were highlighted and by the end of the war, the British Flying Corps expanded from 1,800 men and officers to 300,000 men and 150 aircraft to 22,000 aircraft. Also during this time, "the U.S. Air Division, which started with Wright-supplied Signal Corps aircraft in 1917, grew to a force of 13,000 planes, with orders pending for 52,000 more."[35]

The mid- to late-1920s brought a period of renewed public interest in aircraft from multiple flight examples and the potential for what air flights could be in the future. In May 1923, the first nonstop American coast-to-coast airplane flight between Long Island, New York and San Diego, California took place with a travel time of 26 hours, 50 minutes by U.S. Army Air Service pilots Lt. John A. Macready and Lt. Oakley G. Kelly.[36] Three years

32 National Park Service, *Cultural Landscape Inventory*, 27-28.

33 National Park Service, *Cultural Landscape Inventory*, 30-31

34 Judy Baker et al.

35 National Park Service, *Cultural Landscape Inventory*, 31.

36 "The First Nonstop Transcontinental Flight," Smithsonian National Air and Space Museum, Barron Hilton Pioneers of Flight, accessed November 17, 2021, https://pioneersofflight.si.edu/content/first-nonstop-transcontinental-flight.

FIGURE 2–7. A photo of Charles Lindbergh next to the *Spirit of St. Louis* just before leaving San Diego. (Library of Congress)

later on May 9, 1926, Commander Richard E. Byrd and pilot Floyd Bennett announced the first flight over the North Pole.[37] Airplane flight made even further advancements in May 1927 when Charles A. Lindbergh made the first solo flight across the Atlantic Ocean from Long Island, New York to a landing spot seven miles northeast of Paris, France, in the Spirit of St. Louis, after approximately 33 hours, 30 minute in the air (Figure 2–7). Just a week prior to Lindbergh's transatlantic flight, he flew from San Diego to New York in the same aircraft and set the record for the fastest transcontinental flight at 21 hours, 40 minutes.[38] In June 1927, Albert Hegenberger and Lester Maitland made the first nonstop crossing of the Pacific Ocean from Oakland, California, to Oahu, Hawaii, on the Bird of Paradise. Hegenberger and Maitland's success was short lived for in May and June of 1928, Charles Kingsford Smith and Charles T. P. Ulm piloted the first trans-Pacific flight from Oakland, California, to Brisbane, Australia, stopping along the way in Hawaii and Fiji. The total air time of their trans-Pacific flight took almost 82 hours. In November 1929, Commander Richard E. Byrd again completed another successful first flight, this time over the South Pole.[39]

With ever increasing flight activity during the 1920s, the public realized that the Wright brothers deserved public recognition for their role in the history of aviation.

Chronology of Development and Use

Kill Devil Hill Monument Congressional Act

Construction of a national memorial to the Wright brothers' achievement at Kill Devil Hills, North Carolina, was advocated for in 1926-1927 by an editor of the Elizabeth City, NC, *Independent*, William O. Saunders. Saunders wanted to remind the world of the Wright brothers' achievements in North Carolina. The idea of a national memorial was then picked up by Lindsay C. Warren, a congressional representative of North Carolina and by Connecticut Senator Hiram Bingham.[40] In April 1926, Representative Warren drafted a bill for an aviation memorial but it wasn't until August of that year that the bill was made public. The hesitation in making the bill public stemmed from Representative Warren not wishing to have the Wright Memorial bill confused with a similar bill presented about Virginia Dare and the Lost Colony of Roanoke during this time, and wanting to have a symbolic introduction on December 17, 1926, the 23rd anniversary of the flight.[41]

Before submission of the Wright Memorial bill to Congress, Representative Warren wrote to the Commandant of the United States Coast Guard to inquire about the conditions of the Coast Guard Station near Kill Devil Hills. During the Wright brothers' flight attempts, the Kill Devil Hills Coast Guard Station played a key role in assisting the Wright brothers by transporting their gliders and other equipment to Kitty Hawk. The Commandant reported that conditions of the station were poor and Warren wanted to correct this through the bill. There were also concerns of a lack of roadways to the Outer Banks area which led Representative Warren to contact North Carolina Assemblyman E.R. Johnson stating,

> If Eastern North Carolina is to develop, then there must be additional communication afforded. If the members from the First District (Warren's) will consult... and stand as a unit for additional mileage, it would certainly exert a powerful influence. The Highway Commission has no right now to add one inch to the present map... but the State Highway Commission should be given the right to put them on.[42]

On December 17, 1926, the Wright Memorial bill was introduced in the House of Representatives and the bill was referred to the House Committee on the Library. The bill called for the construction of a memorial to Orville and Wilbur Wright, located at Kill Devil Hills, North Carolina, and asked for an appropriation of funding totaling

37 Judy Baker et al.

38 History.com Editors, "Charles Lindbergh completes the first solo, nonstop transatlantic flight," History, last modified May 19, 2020, https://www.history.com/this-day-in-history/lindbergh-lands-in-paris.

39 Judy Baker et al.

40 William Chapman and Cathleen Turner, "Wright Brothers National Memorial: A Short History,' *CRM* Volume 15 No.2 (1992), 4-5.

41 Andrew M. Hewes, *Wright Brothers National Memorial An Administrative History*, National Park Service Division of History Office of Archaeology and Historic Preservation, 1967, 5.

42 Hewes, 6.

FIGURE 2–8. Kill Devil Hill land donation prior to the construction of the Monument, late 1920s. (WRBR Collection)

$50,000, to be expended under the direction of the Secretary of War. The bill also called for the formation of a committee including the Secretaries of War and Navy and three U.S. citizens appointed by the President who would determine the type and form of the memorial.[43]

Unfortunately, Representative Warren's Wright Memorial bill never got out of committee but coincidentally, Senator Hiram Bingham also introduced a kindred bill on the same day. Senator Bingham's bill called for a commission of the Secretaries of War, Navy, and Commerce to carry out the Act and "to select a suitable location... which shall be as near as possible to the actual site of said flight; to acquire the land therefore; to superintend the erection of said Monument; and to make all necessary and appropriate arrangements for the unveiling and dedication of the same when it shall have been completed."[44] Senator Bingham's bill also didn't specify the amount of funding but left it open to the discretion of Congress.

Senator Bingham's bill passed unanimously on January 10, 1927, which consequently made Representative Warren not bring his bill before the House on its scheduled date of February 8. Instead, Warren suggested an amendment to Bingham's bill to include Wilbur Wright's name as Senator Bingham had omitted his name due to Orville being the brother who made the first flight.[45] An additional amendment to the bill stated, "the design and plans... shall be subject to the approval of the Commission of Fine Arts and the Joint Committee on the Library."[46] On February 21, 1926, Senator Bingham's bill with the two amendments went before the House and the vote carried. The following day, the Senate concurred with the House.[47] President Calvin Coolidge signed the Act "for the erection of a memorial in commemoration of the first successful attempt of a power-driven airplane flight" on March 2, 1927.[48] A land donation was secured by Frank Stick, a New Jersey-based real estate developer, for the memorial in 1928 (Figure 2–8). Frank Stick originally showed his interest in a land donation in January 1927 to Representative Warren stating in a

43 Hewes, 7.

44 Hewes, 7-8.

45 Hewes, 9.

46 69 Congress, 2 Session, S. 4876, 68-3003, (December 17, 1926).

47 Hewes, 11-12.

48 William Chapman and Cathleen Turner, 5.

telegram,

> My associates and myself greatly interested in your bill for Monument commemorating first aeroplane flight. We own Kill Devil Hills Tract and will gladly deed these hills and adjacent land required for Monument and reservation to the government without cost.[49]

Kill Devil Hill Monument Design Process and Competition

In March 1927, Secretary Hoover made an inspection tour of Kill Devil Hills accompanied by the Assistant Secretary of Commerce for Aeronautics, William P. MacCracken, Jr., and a few others. After their visit, MacCracken wrote to Representative Warren stating,

> It occurs to me that a marine light, which could also be used as an airways beacon, with a Coast Guard station at its base would be a very appropriate and useful memorial.[50]

Secretary Hoover agreed with MacCracken and thought the government should show its gratitude to the Kill Devil Hills Life-Saving Station, which at the time was in poor condition, for their assistance to the Wright brothers during their experiments. Secretary Hoover also made it clear that the government shouldn't spend a quarter of a million dollars for a memorial where only a few neighborhood people could see it as the Kitty Hawk and Kill Devil Hills area was not easily accessible except by the Point Harbor ferry service. To remedy the inaccessibility of the area, Representative Warren reassured the Committee for the Monument that a bill was pending for the construction of a bridge to replace the Point Harbor ferry service.[51] On September 27, 1930, after six months of construction, the Wright Memorial Bridge was completed and opened to traffic, connecting the North Carolina mainland to Kill Devil Hills on the Carolina banks with a three mile wooden span. [52]

49 Hewes, 10.

50 Hewes, 13.

51 Hewes, 14.

52 Arthur George Renstrom, Wilbur & Orville Wright: *A Reissue of A Chronology Commemorating the Hundredth Anniversary of the Birth of Orville Wright - August 19, 1871*, National Aeronautics and Space Administration and the U.S. Centennial of Flight Commission (Washington, D.C., 2003), 50.

In August 1927, William O. Saunders formed the Kill Devil Hills Memorial Association in Elizabeth City, North Carolina, which was renamed in 1966 to the First Flight Society (FSS), to attract attention to the Kill Devil Hills area and the effort to create a Monument to the Wright brothers.[53] The objective of the Association, taken from the First Flight Society bylaws, was

> to preserve and foster the memory of the historic achievements of Orville and Wilbur Wright, to sponsor, cosponsor, or otherwise arrange an appropriate observance each year at the site an on the anniversary date of man's first successful powered flight.[54]

The current mission of the First Flight Society is

> to memorialize Orville and Wilbur Wright, first in the world to successfully achieve powered flight in a heavier than air machine, on December 17, 1903 at Kitty Hawk, North Carolina. First Flight Society invites and promotes visits to the Wright Brothers National Memorial, so all may see the birthplace of powered flight. First Flight Society contributes to the advancement of aviation through programs, activities, education and the arts.[55]

With the help of Saunders, the Kill Devil Hills Memorial Association also pressured the State of North Carolina to build infrastructure in the area to provide motorists an opportunity to visit not only the proposed Monument but also Fort Raleigh. Additionally, the Association advocated for an airstrip to be located at the memorial site.[56]

Representative Warren was also in favor of the memorial being combined to include a Coast Guard station, tower, and beacon. The design and functionality of the memorial couldn't be agreed upon. Another member of the Committee, Representative Fiorella LaGuardia of New York said,

> The Monument at Kitty Hawk should compare favorably in artistic design and dimensions to that of the Statue of Liberty in New York

53 National Park Service, *Historic Structure Assessment,* 2.

54 Renstrom, 46.

55 "Our Mission, "*First Flight Society*, accessed February 10, 2022, https://firstflight.org/about/the-society/purpose/.

56 Hewes, 16.

> Harbor, to the Monument to Frederick the Great at Berlin, the Victor Emanuel Memorial in Rome, or the Waterloo Monument in Berlin, or even the pyramids in Egypt.[57]

Not only were members within the Committee in disagreement over the memorial but so were the two governing bodies for the Monument's design. The Memorial Commission favored a utilitarian design, and the Commission of Fine Arts, which was established by Congress to decide on matters concerning aesthetics and the fine arts, favored a purely commemorative structure.[58]

On January 31, 1928, the Memorial Commission submitted a recommendation for the memorial to President Coolidge that was returned within ten days because it was not approved by the Commission of Fine Arts and the Joint Committee on the Library. The plan submitted called for a combination of a Coast Guard station and a marine or aerial lighthouse constructed of native field stone with an appropriation of $100,000 and they attached a modest design proposal. The proposal was then sent to the Commission of Fine Arts but was rejected on March 10 as the Commission believed the proposal would not fulfill the requirements of the Act and was more of a utilitarian structure than a memorial. The Commission also noted that the Kill Devil Hills Memorial Association has submitted an idea to construct a memorial tower with a powerful light for air flyers and a landing place for planes, which better carried out the terms of the Act.[59]

The Memorial Commission submitted another proposal to the Commission of Fine Arts in March for a granite shaft with a bronze tablet and inscription at the site on Kill Devil Hill but distant from a memorial on the beach. This plan was also rejected as the Secretary of War wanted to see plans for a Coast Guard Station and light beacon. Both the Lighthouse Bureau and the Airways Division of the Department of Commerce issued statements that a lighthouse at the location was not seen as an advantage. The Airways Division believed the beacon was a worthy design element but the cost must be considered as there were no air routes nearby and it was standard practice for planes to stay away from coastlines at the time. The Memorial Commission then came to the decision that the memorial light tower and the Coast Guard station should be built separately.[60]

By June 1928, the Office of the Quartermaster General, responsible for supervision of construction of the memorial, realized the futility of a quick decision and announced a design competition.[61]

During an investigation of the site in October 1928, it was decided the memorial Monument should be constructed at the top of Kill Devil Hill, even though previously, it was thought impractical due to the shifting of the sand dune.[62] It is estimated that the sand hills had migrated west-southwest over 200 feet between 1900 and 1928 due to the ocean winds from the northeast.[63] But a few inches below the sand was a layer of moist and heavily compacted earth, meaning the area could be planted to secure the sands from shifting further. The higher ground also gave the advantage of further visibility of the Monument.[64]

On December 17, 1928, 200 delegates from the International Civil Aeronautics Conference along with more than 3,000 visitors dedicated a granite marker of the 1903 approximate liftoff location and placed the cornerstone for the Monument on Kill Devil Hill.[65]

The December 17 event took place in two parts, the first being the laying of the Monument cornerstone (Figure 2–9). F. Trubee Davison, Assistant Secretary of War, was the presiding officer of the event with Angus W. McLean, Governor of North Carolina, and Representative Warren, all of which addressed the crowd, speaking about the Monumental event and future possibilities. After the speeches, Secretary of War, Dwight F. Davis, laid the cornerstone of the Monument. A sealed copper box was placed in the cornerstone containing the following:

- A flag of the United States of America,

57 Hewes, 17.

58 National Park Service, *Cultural Landscape Inventory*, 33.

59 Hewes, 19.

60 Hewes, 19-23.

61 National Park Service, *Cultural Landscape Inventory*, 33.

62 Hewes, 23.

63 National Park Service, *Historic Structure Assessment*, 3.

64 Hewes, 24.

65 National Park Service, *Cultural Landscape Inventory*, 32.

- A photograph of Wilbur Wright,
- An autographed photograph of Orville Wright,
- A program of pilgrimage of delegates and guests of the International Civil Aeronautics Conference and of the National Aeronautic Association to Kill Devil Hills, NC, dated December 17, 1928,
- A brochure of the 25th Anniversary Celebration of the First Successful Airplane Flight,
- A copy of the *Independent*, Elizabeth City, NC, dated December 14, 1928 (a memorial edition to Kill Devil Hills),
- A Special United States two-cent postage stamp of the International Civil Aeronautics Conference, issued to commemorate the 25th anniversary of the first flight of an airplane,
- The badge of Orville Wright as official delegate of the United States at the International Civil Aeronautics Conference,
- A special aviation anniversary section from the *Dayton Daily News* dated Sunday, December 16, 1928.
- A special aviation anniversary section of the *New York Times* dated Sunday, December 16, 1928,
- A souvenir pamphlet of the International Civil Aeronautics Conference, and
- An original manuscript of first news dispatch reporting the first successful flight.[66]

The cornerstone event was concluded with a speech from Roy G. Fitzgerald, a representative from Ohio, and the presentation of flags. The unveiling of the granite marker denoting the approximate location of the 1903 liftoff took place an hour after (Figure 2–10).[67] Additional dignitaries in attendance at the cornerstone event included Orville Wright, Senator Bingham, aeronautical

66 The United States, *Twenty-Fifth Anniversary of the First Airplane Flight,* 70th Congress 2D Session House Documents No. 520, United States Government Printing Office, 1929, 1-13.

67 The United States*, Twenty-Fifth Anniversary,* 13-19.

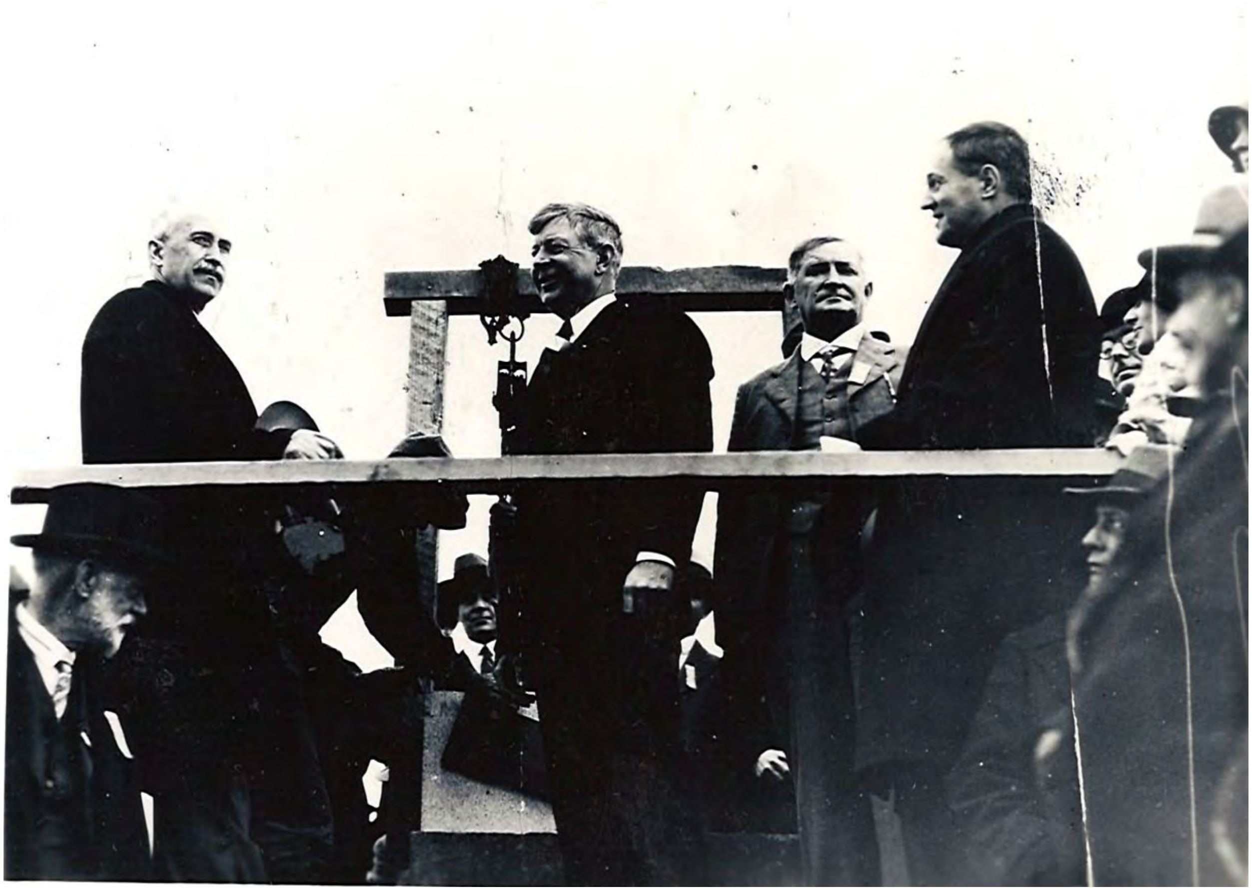

FIGURE 2–9. Secretary of War Davis (center) presents Orville Wright (left) with trowel used in laying the Cornerstone of the Wright Memorial Monument, December 17, 1928. (WRBR Collection)

engineer Igor I. Sikorskey, Italian airplane builder Giovanni B. Caproni, World War I flyer Reed G. Landis, and aviatrix Amelia Earhart.

Getting everyone to the Outer Banks of North Carolina for the event was quite a challenge:

> The party arrived at Old Point Comfort in Virginia on December 16 and toured Langley Field before heading to Norfolk, Virginia. The following morning, buses transported the group to Currituck Courthouse, North Carolina.... Automobiles replaced the buses at Currituck Courthouse because they were better suited to travel the forty miles over the main road, which was then under construction and included many detours to Point Harbor on Currituck Sound. The entourage then crossed the three-mile-wide shallow waters of Currituck Sound by ferry and proceeded the final six miles by automobile to Kitty Hawk. Visitors attending the ceremony from mainland North Carolina, ...were transported to the Outer Banks aboard the *USS Pamlico* and boats provided by the U.S. Coast Guard.[68]

After disembarking the ferries, visitors of the event had to wait for a car as only a few were available to transport the visitors the final length of the trip to the site. Tired of waiting, Amelia Earhart and Reed G. Landix commandeered a Coast Guard wagon and two horses to get to the site. They picked up passengers along the way and guided visitors from the dock to the site.[69]

December 17, 1928 also marked the 25th anniversary of the Wright brothers' achievement in heavier-than-air human-powered flight. The cornerstone laid during the ceremony was not used in the construction of the Monument as it would be moved to accommodate the design and construction and replaced with a larger stone

68 Steve Massengill, "Twenty-fifth Anniversary, December 17, 1928," *North Carolina Historical Review*, October 2003, 1-2.

69 Massengill, 2.

FIGURE 2–10. William J. Tate (center) speaking at the unveiling of the Wright Memorial Boulder with Orville Wright and Amelia Earhart (left), December 17, 1928. (WRBR Collection)

cut from Mt. Airy granite.[70] Additionally, the cornerstone was moved in order to anchor the shifting sands of the hill.[71]

On January 31, 1929, the memorial design competition was closed with thirty-six entries received. A jury established by the Memorial Commission through the Quartermaster General selected the winning design in accordance with principles established by the American Institute of Architects.[72] The design chosen by the Memorial Commission was then submitted to the Commission of Fine Arts who approved the design on February 18; even though Senator Bingham disapproved of the winning design due to it being akin to a lighthouse. Final approval of the design lay in the hands of the Joint Committee on the Library, of which Senator Bingham was a member, where he continued his opposition to the design.[73]

Disputes over the design continued throughout the year. A new Joint Committee on the Library met in January 1930, still with Senator Bingham fighting the design until finally a decision was made. On February 14, 1930, the architectural firm of Robert P. Rodgers and Alfred E. Poor was notified it had won the design competition along with the $10,000 award and employment as the memorial architects for construction (Figure 2–11 to Figure 2–13).[74] Four days later, the Secretary of War, Patrick Hurley, approved the findings of the Jury of Award of the American Institute of Architects and their victory was published in the *New York Times* the next day.[75] The Wright Brothers National Memorial Landscape Cultural Landscape Inventory describes the winning design:

> The winning Art Deco-inspired design was a masonry shaft and base of approximately sixty feet set on a star-shaped foundation. The foundation formed a terrace around the Monument base and shaft at a height of five to ten feet above grade. The triangular shaft was embellished with relief carvings symbolizing stylized sculpted wings on the east and west sides. The design implied ancient Egyptian motifs, an important source for Art Deco designs. The main entry to the Monument was from the terrace at the center of the base on the south side. Alfred Poor later remarked that the design and orientation of the Monument was influenced by thoughts of placing an airstrip south of the Monument. There were no provisions for pedestrian or auto circulation.[76]

FIGURE 2–11. Plan view of the Wright Memorial competition drawings submitted by Rodger and Poor Architects (Wright State University)

Modifications to the original design submission were made to deemphasize the beacon portion of the design and make the structure look more like a memorial with a beacon instead of a glorified beacon. Additionally, the original design intended the Monument to be constructed of concrete but Representative Warren urged the Monument to be built of North Carolina granite.[77]

The War Department Era: Construction of Kill Devil Hill National Monument

Captain William H. Kindervater, an engineer and later appointed the superintendent of construction for the Monument by the War Department,

70 G. B. Wills of Wills and Mafera Corporation to J. D. Sargent Granite Company, Memorandum, March 18, 1932.

71 Hewes, 25.

72 National Park Service, *Cultural Landscape Inventory*, 32.

73 Hewes, 28.

74 Hewes, 34.

75 Renstrom, 49.

76 National Park Service, *Cultural Landscape Inventory*, 32.

77 *The American Architect*, Vol. 137, No. 4 (April 1930), 55.

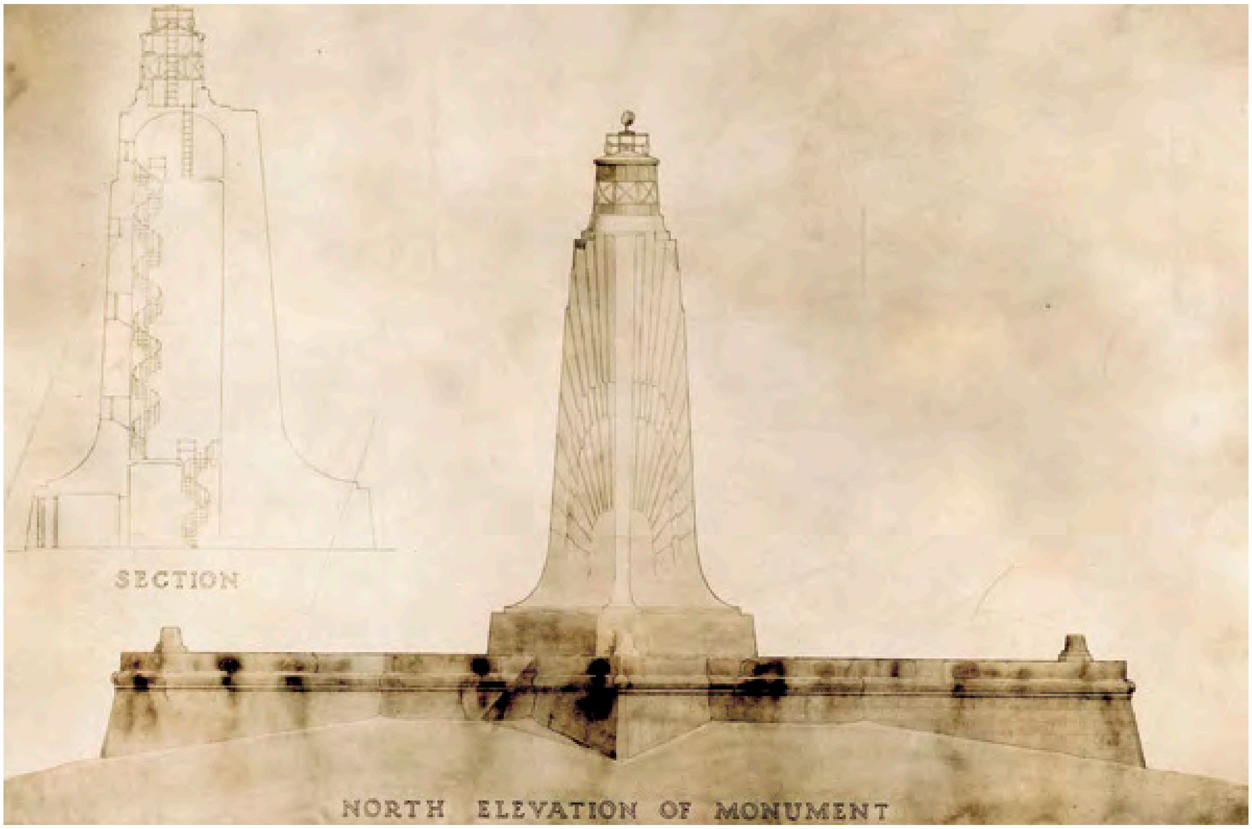

FIGURE 2–12. North Elevation drawing of the Wright Monument competition drawings submitted by Rodger and Poor Architects. (Wright State University)

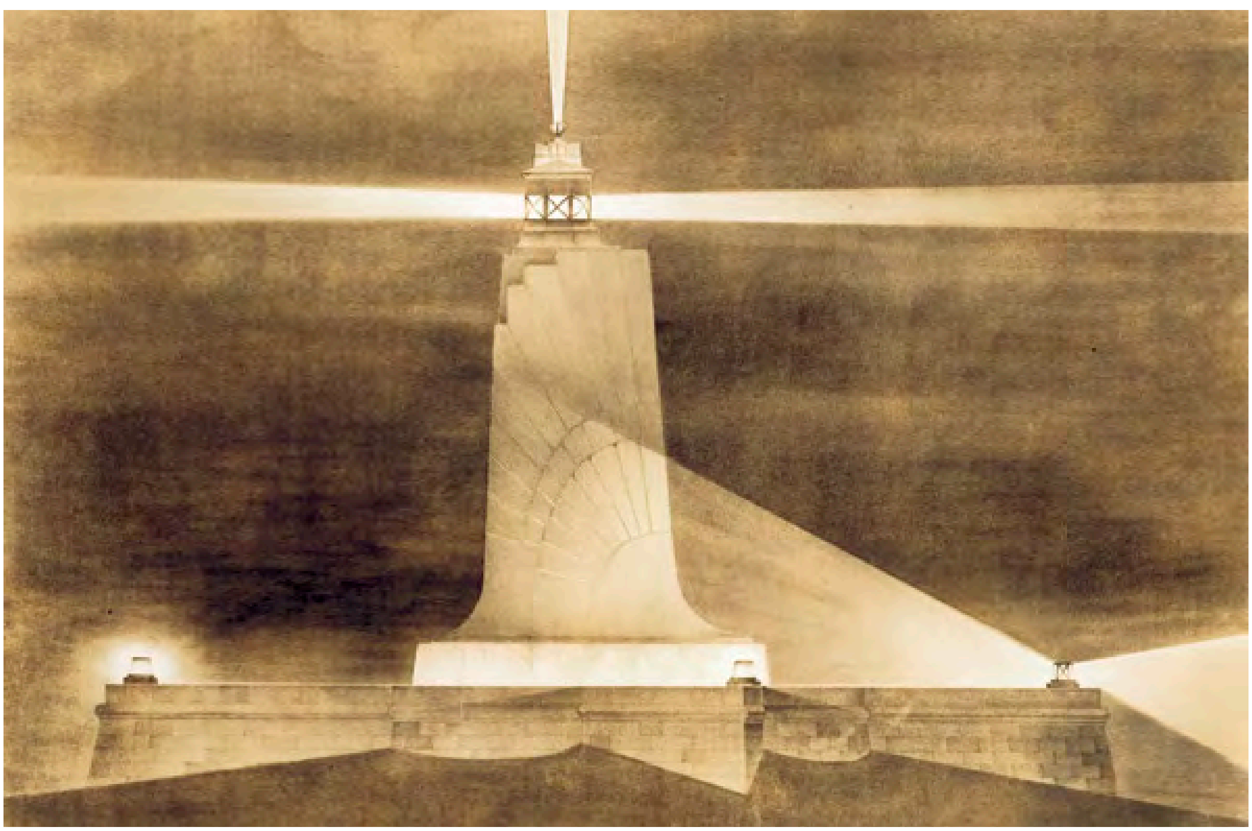

FIGURE 2–13. A drawing depicting the Wright Monument at night with the beacon and the floodlights lit for the Wright Monument competition submission by Rodger and Poor Architects. (Wright State University)

arrived at Kill Devil Hill in early 1929 and began the stabilization of the Monument site. This was achieved by applying a cover of woods mold over the sand hill, then bermuda grass (Cynodon dactylon), bitter panic grass (Panicum amarulum), and local vegetation, such as yaupon (Ilex vomitoria), myrtle (Myrica cerifera), pine (Pinus sp.), live oak (Quercus virginiana), and sumac (Rhus sp.) (Figure 2–14, Figure 2–15). The top of the hill was also leveled in preparation for construction of the Monument. The hill was further stabilized in the 1930s with the building of a dune system along the ocean front by the Civilian Conservation Corps to slow beach-sand migration and keep damaging salt spray from reaching Kill Devil Hill.[78]

On February 4, 1931, Major General John A. DeWitt, Quartermaster General, turned the first shovel of dirt to mark the beginning of excavation for the Wright Brothers Monument (Figure 2–16).[79] Once excavation commenced, a hole approximately 35 feet deep and 60 feet in diameter was dug for the Monument's foundation.[80]

To facilitate the construction of the Monument, access roads were constructed from North Carolina State Highway 158. Funding of $25,000 for the roads was authorized by the Secretary of War on January 13, 1931, with the understanding that Dare County would maintain the roads. The roads were completed on May 4.[81]

The Wills and Mafera Corporation of New York won the bid for general contractor with the low bid of $213,000 for the Monument and the substation in December 1930.[82]The work on the Monument was supervised by Construction Division of the Quartermaster Corps of the U.S. Army Engineers Captain John A. Gilman.[83] Construction specifications called for a granite pylon, 61 feet high, with a light beacon mounting

78 National Park Service, *Historic Structure Assessment*, 3.

79 Renstrom, 50.

80 National Park Service, *Historic Structure Assessment*, 3.

81 Hewes, 38.

82 The substation is referenced as the Powerhouse moving forward.

83 W.O. Saunders, *Two Historic Shrines The Wright Memorial and Fort Raleigh on Roanoke Island,* W. O. Saunders, 1937, 6.

FIGURE 2–14. Planting of Kill Devil Hill, 1930. (WRBR Collection)

(the beacon itself was not part of the contract) and the pylon at the bottom measured 36 feet by 43 feet on top of a star-shaped base. A change order from the J.D. Sargent Granite Company to Wills and Mafera Corporation, dated April 9, 1931, called for the star-shaped base to be paved with four-inch cobblestone blocks instead of a granite floor though construction of the star-shaped base didn't commence until December 1931[84](Figure 2–17 to Figure 2–22). Details specified stainless steel for metal fittings, except for waterproofing, roofing, flashing, and thresholds, which were to be copper and bronze. The entrance door would include stainless steel and a core of nickel with bronze engravings representing various parts of the story of human conquest of the air (Figure 2–23).[85] The Sargent Granite Company of Mount Airy, North Carolina, received the contract to supply the granite.[86] The Construction Quartermaster determined all granite should be faultless and the structure was guaranteed against leaks for twenty years according to the November 1930 construction specification. Moving large construction materials to the area required the construction of on-site rails. The stone was transported to the area, beginning in October 1931, by railroad via Norfolk and Elizabeth City and then by barge and truck. With the Wright Memorial Bridge opened to traffic in 1930, smaller materials were delivered by truck to the area.[87]

The interior first floor is a hexagonal room with a niche to either side of the entry door. These niches were planned to house busts of Orville and Wilbur Wright. An alcove is located directly across from the main entry. The original plan was to place a model of the Wright's 1903 Flyer that would hopefully be donated by a philanthropic individual.[88] An inscription is carved on the west wall that reads: "From a point near the base of this hill Wilbur and Orville Wright launched the first flight of a power driven airplane Dec. 17th, 1903." On the east wall, another inscription quotes Pindar: "The long toil of the brave is not quenched in darkness nor hath counting the cost fretted away the zeal of their hopes. O'er the fruitful earth and athwart the sea hath passed the light of noble deeds unquenchable forever."

Curving staircases to either side of the alcove lead to a platform and the second floor. On the second floor was a map prepared by Rand and McNally, well-known mapmakers, depicting the map of the world and all flights from 1902 to 1928. The map is,

> . . . titled the "First Twenty-Five Years of Aviation." Beginning with the first flight by the Wright Brothers on December 17, 1903, the legend of the map lists the flights of Farman, Bleriot, Paulhon, Curtiss, C.P. Rodgers, Garros, the N.C.-4, Alcock & Brown, Ross Smith, Sacduro & Courinho, the U.S. Army Around the World Flight, J. Rodgers, Byrd, Lindberg, De Pinedo, Maitland & Hegenberger, the "Bremen" and Kingsford Smith. The route of each of these epochal flights is traced out on the map.[89]

The beacon, specifically called a revolving airways beacon in the construction specifications, was detailed as a search-light drum with a 24-inch parabolic mirror and automatic lamp changer prepared by the Airways Division Lighthouse Service, Department of Commerce.[90] In a letter dated November 1, 1930, to Brigadier General L. H. Bash, Alfred Poor suggested using a different beacon type than the Standard Airways beacon. Instead, Poor thought it would be a better idea to use a "Neon" beacon or a dioptic lens as it was a more modern method of aviation lighting, though either option would work. It is unknown when the beacon was installed or by whom as it wasn't lit for the first time until sometime in 1937.[91] The light in the beacon was a 1000-watt light visible for 30 miles on a clear night. The beacon would be automatically lit 15 minutes after sunset and then shut off 15 minutes after sunrise.[92]

84 National Park Service, *Historic Structure Assessment*, 52

85 Hewes, 36.

86 National Park Service, *Cultural Landscape Inventory*, 34.

87 National Park Service, *Cultural Landscape Inventory*, 34-35; Hewes, 39.

88 W.O. Saunders, 6.

89 W.O. Saunders, 6.

90 Construction Division Office of the Quartermaster General, *Specifications for Construction of Wright Memorial and Sub Station Building for Wright Memorial and Utilities*, November 1, 1930, housed in the WRBR Collection, 60.

91 Molly Harrison, "An American Treasure," Outer Banks Explorer, housed in the WRBR Collection.

92 W.O. Saunders, 6.

FIGURE 2–15. Kill Devil Hill during planting, 1930. (WRBR Collection)

FIGURE 2–16. Major General John A. DeWitt, Quartermaster General turning the first shovel of dirt at Kill Devil Hill, marking the beginning of excavation for the Wright Monument, 1931. (WRBR Collection)

FIGURE 2–17. Formwork for the Monument concrete foundation, 1931. (WRBR Collection)

FIGURE 2–18. Construction formwork and scaffolding for the Monument, 1931. (WRBR Collection)

FIGURE 2–19. Construction of the concrete core of the Monument, 1931-32. (WRBR Collection)

FIGURE 2–20. Installation of the granite stone on the north exterior of the Monument, 1932. (WRBR Collection)

FIGURE 2–21. South face of the Monument and installation of the granite stone exterior, 1932. (WRBR Collection)

FIGURE 2–22. Construction of the Monument on Kill Devil Hill with the Powerhouse and materials waiting to be installed at the base of the hill, March 2, 1932. (WRBR Collection)

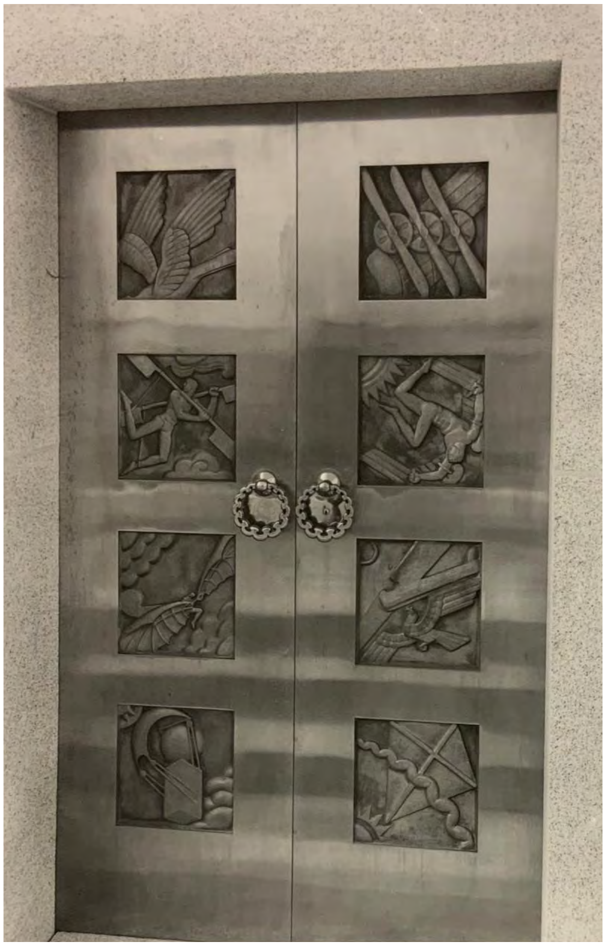

FIGURE 2–23. Main entry door of the Monument, 1956. (WRBR Collection)

The Powerhouse,[93] designed by the War Department in 1930,[94] was constructed at the foot of Kill Devil Hill with the intention of providing a constant supply of energy to the Monument interior lighting, floodlighting equipment, and to the revolving beacon during predetermined periods. Construction of the Powerhouse commenced between 1930 and 1932 and was completed in 1932. Inside the Powerhouse would be the necessary electrical equipment, including but not limited to transformers, gasoline engine, generator, distribution panel, transfer switch, etc (Figure 2–24) .[95]

Work on the star-shaped granite base began in December 1931. Granite blocks were lifted into place by a Caterpiller crane mounted on the hillside.[96] A total of 557 tons of granite were used to construct the base with an additional 640 tons of granite used for the Monument's pylon.[97]

Construction of the Monument was completed on October 15, 1932, and on November 19, 1932, a dedication was held (Figure 2–25). The day prior to the dedication, the area received heavy rain and high winds that continued until the morning of the ceremony. This reduced the number of people in attendance as well as prevented the planned airplanes, dirigible, and photography plane from attending the ceremony.[98] The Monument was unveiled by Ruth Nichols, noted aviatrix, and accepted by Secretary of War Patrick J. Hurley. Orville Wright was the guest of honor and accepted the Monument on behalf of himself and Wilbur Wright. Addresses were delivered by Representative Warren, J.C.B. Eringhaus, governor-elect of North Carolina, and Secretary of War Hurley. A letter of congratulations dated November 18 from President Herbert Hoover was also read by Acting Quartermaster General Louis H. Bash during the ceremony (Figure 2–26).[99]

Less than a month after the dedication, on December 12, 1932, the War Department Construction Quarter Master Robert Beard noted there was a considerable amount of leaking water through mortar joints into the memorial room when rain was accompanied by high winds out of the south. He also noted that the door was not as weather tight as it should be and some of the dampness occurring inside the Monument was due to condensation. [100]

The War Department additionally constructed an entrance feature that was sited to provide a visual link to the First Flight Marker, as well as provide a view to the Monument (Figure 2–27). Roughly following the form of truncated obelisks, the entrance posts used ancient Egyptian motifs similar to the Monument. Extending about nine feet above grade with approximately thirty-inch square, slightly projecting bases, the four obelisks

93 The Powerhouse is noted as an electrical substation in the original construction specifications.

94 National Park Service, *Wright Brothers National Memorial Statement of Work For The Stabilization of the Monument Powerhouse*, National Park Service, 2000.

95 Construction Division, 39.

96 National Park Service, *Cultural Landscape Inventory*, 34-35.

97 Hewes, 40.

98 Hewes, 44.

99 Renstrom, 51.

100 Jami Lanier, "WRBR Monument: Chronology of Physical Changes and Maintenance 1932-2016," Unpublished document, 2019.

FIGURE 2–24. South face of the Monument with the Powerhouse at the bottom right, May 1938. (WRBR Collection)

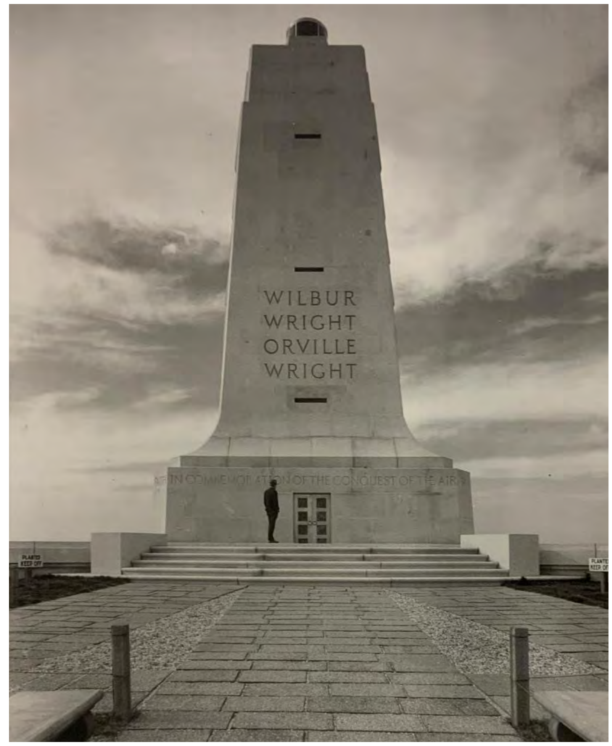

FIGURE 2–25. Finished construction of the Monument with historic plaza paving that has since been removed and replaced with current design, 1933. (WRBR Collection)

FIGURE 2–26. Ceremony and unveiling of the Monument with Orville Wright (fifth from left), Carrie Grumback - Wrights longtime housekeeper (sixth in from left), Lorin Wright (seventh from left), Mrs. Milton Wright, Sr (eighth from left), Milton Wright, Sr. - son of Lorin (right), and Milton Wright Sr.'s sons Wilkinson Wright and Milton Wright Jr. (kneeling front), November 19, 1932. (WRBR Collection)

FIGURE 2–27. Original entrance to the Kill Devil Hill Monument constructed by the War Department, ca. 1930. (WRBR Collection)

tapered to less than twenty-four inches at the top, terminating with a recessed, pyramidal cap. The two outer-most posts were fitted with bronze fence panels, and similarly designed moveable bronze gates, mounted on the two inner-most posts, guarded the entrance. The park built a small concrete contact station just to the west of the entrance, which served as a caretaker's office. The Quartermaster General Corps was responsible for the design and the oversight of construction, which was completed by L.R. Broyhill Company of Hampton, Virginia before the transfer to NPS on June 24, 1933.[101]

NPS Ownership of the Kill Devil Hill National Monument

In August 1933, two Executive Orders transferred the Kill Devil Hill National Monument from the War Department to the National Park Service (NPS), along with forty-seven other areas. Additionally, Congress voted for appropriations to be given to Kill Devil Hill National Monument for operational costs at a total of $2,200 and for improvements through the Public Works Administration for $90,500 that would be available from August 10, 1933, to June 30, 1934.[102] Once the Kill Devil Hill Monument was in the hands of NPS with appropriation funds available, the Kill Devil Hill Memorial Association began lobbying again for the construction of an airstrip. The expense required for the airstrip, including the additional land, construction, and operation, made the NPS hesitant and was not seen, at the time, to be within the NPS mission of maintaining the scenery and the natural and historic resources for the enjoyment of future generations.[103]

Through President Franklin D. Roosevelt's New Deal programs, specifically the Public Works Administration, NPS decided upon a different approach than the Kill Devil Hills Memorial Association proposed. The list of improvements determined by the park included road and trail construction and improvements, a

101 National Park Service, *Cultural Landscape Inventory*, 35; Hewes, 48.

102 Hewes, 50.

103 National Park Service, *Cultural Landscape Inventory*, 42.

superintendent's residence and office, a comfort station and shelter for visitors, additional fencing, electrical services, and plants for the road, trails, Monument, and planting the remaining 290 acres of the park. In July 1934, fencing was constructed to enclose the entire park and stabilization of the West Hill with Bermuda grass took place. Additionally in 1934, the existing footpath up the slope of Kill Devil Hill was removed and repurposed for walkways at the superintendent's residence. In its place, four symmetrical, curvilinear paths were constructed between 1934-1936 to ascend Kill Devil Hill.[104]

Between 1935 and 1936, the road around the east side of Kill Devil Hill constructed by the War Department was removed, and a new Monument road was constructed to encircle the base of the Monument with an exit spur that led to the village of Colington. The public also used part of the Monument road in order to reach Colington until a bypass road was constructed in the 1950s by North Carolina. Adjacent to this new road, the NPS constructed the superintendent's residence. Also constructed during this period was a comfort station for visitors, located at the south end of the park in order to protect views of the First Flight Marker while being on axis with the center line of the Monument.[105] The Monument began as the first visitor center for the Kill Devil Hill National Memorial (Figure 2–28) and became the site of the annual First Flight anniversaries prior to 1960.

In June 1934, the problem of condensation in the pylon arose again. Horace Dough, the caretaker of the Monument, noted on June 6 that the steel steps of the pylon needed to be painted but he was unable to because of the condensation on the interior. Dough also noted that the pylon seemed to have the least amount of condensation during the fall.[106]

Almost two months later, during a storm on July 30, 1934, lightning struck the metal framework of the beacon atop the pylon that resulted in damages to parts of the beacon switchboard and the on/off switch for the beacon.[107]

104 National Park Service, *Cultural Landscape Inventory*, 43.

105 National Park Service, *Cultural Landscape Inventory*, 43.

106 Lanier.

107 Lanier.

FIGURE 2–28. Historian Omega East in the Monument interior with visitors, 1959. (WRBR Collection)

FIGURE 2–29. Visitors on the walk and around the base of the Monument after the exterior rehabilitation, 1956. (WRBR Collection)

Beginning in 1936, the Monument's pylon was lit by floodlights in the evenings. Floodlighting of the Monument continued, but beginning in September 1937, floodlighting only took place during the tourist seasons. Also during this time, protection of the Monument had become a problem with Horace Dough reporting that the pylon door handles had been stolen in February 1936. Another guard was hired for the park, but not until the following year.[108]

Within the 1938 Master Plan for the park, the idea of an airstrip resurfaced and in July 1939, potential schematic layouts for the airstrip were drawn up for both north and south of the Monument. The location south of the Monument seemed to be problematic due to the necessity of moving a large amount of sand, but the onset of World War II brought a halt to development in the park and shelved the airstrip plans.[109] Another project proposed during the 1938 Master Plan included lightning protection for the Monument pylon. Appropriations were cut in 1938 and it is unknown if the lightning protection was ever installed.[110]

Commercial power from Roanoke Utilities became available at the Monument sometime in the mid- to late-1930s and the Powerhouse was used for auxiliary power only after this. As the commercial power became more reliable, the Powerhouse was used as an auxiliary power source. The equipment in the Powerhouse was connected and used as auxiliary power until 1954 but was found to be not operational for emergency power in February 1940 when commercial power in the area was interrupted for several days.[111]

In 1941, Paul Garber of the Smithsonian Institution offered to donate a scale model of the 1903 Wright Flyer to be placed in the center niche of the pylon first floor interior. The original intention of the center niche was to house a small scale replica, but had not been undertaken to this point. Horace

108 Hewes, 60-62.

109 National Park Service, *Cultural Landscape Inventory*, 44-45.

110 Hewes, 65-66.

111 William R. Chapman, *Wright Brothers National Memorial Historic Resource Study,* National Park Service, 1997, 58; Superintendent of Cape Hatteras Group, *Wright Brothers National Memorial 106 Compliance Statement Removal of Power House*, National Park Service, 1979.

Dough accepted the notation offer but nothing came of it until 1952, when the offer was made again.[112]

For a short time in 1942, the pylon at Kill Devil Hill National Monument aided in World War II defense operations. An ultra-high frequency monitoring system was installed at the top of the pylon in March 1942 to aid in monitoring and locating enemy submarines that patrolled the shipping lanes off the Outer Banks. The monitoring system was removed that spring, without damage to the pylon, but had helped to identify enemy submarines off the Outer Banks that April.[113]

A hurricane swept through the Kill Devil Hill National Monument in September 1944 that caused slight flooding in the Monument pylon and lifting of the roof material on the superintendent's residence.[114] By the end of World War II in 1945, the Monument pylon was showing rapid signs of deterioration due to water infiltration. Discoloration of the granite and mortar damage resulted from both rain and condensation on the pylon, and since the Monument was designed to be watertight and airtight, there was no ventilation. When the doors of the Monument were sealed shut, the difference in the exterior and interior air temperatures and humidity resulted in an accumulation of moisture as evidenced in damp walls and several inches of water accumulation on the first floor. Additionally, rainwater would enter the pylon interior in several locations.[115]

Maintenance on the Monument during 1946 was minimal and included resetting of cobblestones in concrete around the Monument base. On December 20 that same year, an inspection report completed by Roy Appleman, Regional Historian, noted the Monument to,

> show rapid signs of deterioration in the pointing of the stone work. Water is entering the Monument and working its way down between the stone veneer and the concrete floor. The water reaches the bottom of the shaft and frequently forces its way up through the floor. It is not uncommon, we were told, for several buckets full of water to be mopped up from the floor whenever there is any rain. The seeping of the water through the pointing joints between the stone blocks has resulted in the considerable discoloration inside the little rotunda and also on the exterior of the Monument.[116]

Maintenance and Monument improvements throughout 1947 included replacement of old broken toggle switches and switch boxes, electrical panel boxes were replaced, patching of pedestrian path shoulders, refinishing of the information desk in the memorial room, reworking of overhead indirect lighting, removal and replacement of lamps, installation of a telephone at the Monument information desk, and planting of shrubbery and grass on the hill. Plans were initiated for covering the interior steel and concrete steps with rubber treads as the steps became slippery from the water leaks when it rained but this was not completed.[117]

During World War II, the Monument floodlights and beacon were blacked out for security and economic reasons, but in December 1947, after receiving complaints, the Monument lights were turned back on.[118] In 1948, the Monument floodlights were removed, dismantled, and reconditioned with a list of parts needed sent to Westinghouse Electric Corporation. The hope was to light the Monument during the tourist season that started in April. The park received numerous complaints from visitors in 1949 that the floodlights were not turning on to illuminate the Monument. In March 1950 the lighting system was completely overhauled with the installation of six new 150-watt floodlights around the base of the Monument. Additionally, in December 1948 the concrete walls and the iron steps and railings inside the Monument were scraped and painted with aluminum paint. The process of scraping and painting was repeated two years later and again in November 1951.[119]

With the new floodlights installed, additional work to the lighting system was completed in April 1950 with the installation of a new switch panel board enclosed in a separate box that would prevent water seepage and condensation damage. The lighting system continued to be checked

112 Hewes, 70.

113 Hewes, 72.

114 Hewes, 74; Lanier.

115 Lanier.

116 Lanier.

117 Lanier.

118 Hewes, 79; Harrison, "An American Treasure.".

119 Lanier.

every year in March. In August 1950, the water infiltration persisted at the Monument and a test was completed on the drainage system in order to determine if broken pipes were the source of the water intrusion. No conclusive proof was found during the test that any drainpipes were broken, so the water was deemed to be coming from a different source.[120]

A debate over the local connotation of the park's name began in 1942. Superintendent Horace Dough suggested changing the name to Wright Brothers First Flight Memorial. Multiple other suggested names were put forth for the Monument and the area as a whole, but on December 1, 1953 (the 50th anniversary of the Wright Brothers successful flight), with pressure from individuals in the area and the chamber of commerce, the Park Service Director Conrad L. Wirth changed the name of the area to the Wright Brothers National Memorial. Formal legislation of the name change was not necessary as the original name was not established through legislation.[121]

Additionally, to mark the 50th anniversary of the Wright Brothers' achievement, the living quarters and hangar structures used by the Wrights during their time at Kill Devil Hills were rebuilt at the approximate original site and opened to the public on December 1, 1953.[122]

1954 Monument Rehabilitation

With a water infiltration problem still looming at the Monument, bids for preservation of the Monument were put out by NPS and on March 23, 1954, Guaranteed Waterproofing Company of Greensboro, North Carolina had the winning bid. The preservation work, which began April 22, 1954, consisted of cutting out and repointing joints in the stone and brickwork, caulking, and other related work in an effort to halt the water infiltration (Figure 2–29). By June, the preservation work was reported to be 95% complete and on June 8, the NPS Region One Architect Aschmann visited the Monument to see the work.

Mission 66

The National Park Service's Mission 66 initiative (1956-1966) modernized and reinvented the national park system after decades of decreased funding, deferred maintenance, and increased visitation. The main goals of the Mission 66 program at the Wright Brothers National Memorial were to preserve and interpret the site commemorating the first successful achievement of power-driven flight, and to provide the physical facilities and improvements necessary to accommodate the influx of increased visitation.[123] Circulation into and within the park was changed with the construction of a new entrance road and bypass road to Colington Road, next to the state highway that flanked the park to the east in 1957-58. A parking lot was also constructed during this time. With a new entrance completed, the original entrance at the south end of the park and Boulder Road adjacent to the superintendent's residence were closed to the public and removed in 1958-59. These improvements helped to differentiate the visitor and non-visitor traffic in the park. [124]

Accommodating a new influx of visitors required additional land and facilities for the park. In 1959, Congress authorized the formal acquisition of an additional 111 acres to the north and east that included the fourth landing site[125] and by the end of 1960, the Wright Brothers National Memorial Visitor Center, designed by Mitchell/Guirgola Architects of Philadelphia, Pennsylvania was constructed and opened to the public. The contractor for the Wright Brothers National Memorial Visitor Center was Hunt Construction Company of Norfolk, Virginia. Previously located in the Monument pylon first floor, the original visitor center was no longer large enough to accommodate the increasing number of visitors and when the Wright Brothers National Memorial Visitor Center was opened, the interior of the Monument was closed to the public on December 1, 1960.[126] Prior to closing the Monument interior, General Yoshitoshi Tokugawa, who made the first powered flight in Japan in 1910, visited the Monument along with Major General Benjamin D. Foulois, who learned to fly the first military planes purchased from the Wright brothers (Figure 2–30). Major General Foulois also flew

120 Lanier.

121 Hewes, 77.

122 Lanier.

123 National Park Service, *Master Plan for the Preservation and Use of Wright Brothers National Memorial Mission 66 Edition*, National Park Service, 1961.

124 National Park Service, *Mission 66 Edition;* Lanier.

125 Hewes, 82.

126 Hewes, 87; Acting Superintendent, Wright Brothers to Acting Regional Director, Region One, Memorandum, December 1960.

the Army Aeroplane Model 1, a Wright Model A, in March 1910.[127] Besides overcrowding of the Monument interior, other reasons for closing the structure included insufficient staff to provide adequate visitor services and proper protection of Monument exhibits.[128]

To further add to the interpretation of the park, a commemorative airstrip was added east of West Hill and the living quarters and hangar were reconstructed again after falling victim to termite damage.[129]

During 1960, a component of the original plan for the Monument came to fruition when sculptor Oskar Hansen created busts of Orville and Wilbur Wright that were planned for placement in the niches on the first floor of the Monument (Figure 2–31).[130] The busts were constructed of bronze and electroplated with grey cadmium to resist the salt air. They were originally commissioned in 1951 for the 50th Anniversary of the Wright brothers' achievements, but an automobile accident delayed Hansen's completion of the busts until 1960. Funding at the time for Hansen also became an issue as he originally wanted to fund the busts himself, but after his accident, he didn't have the funds. Hansen searched for an outside benefactor and the North Electric Company of Galion, Ohio donated $10,000. By the time the busts were ready for installation, the Monument interior had closed to the public so they were erected to either side of the steps at the exterior of the Monument base (Figure 2–32).[131]

Maintenance on the Monument and immediate area during this time included scraping and painting the interior walls and stairways in January 1956, filling in a washout area on the north side of the hill with fill dirt in May 1957, painting the pylon

127 "Major General Benjamin D. Foulis, Inducted in 1980: First United States Military Aviator," First Flight Society, accessed March 2, 2022, https://firstflight.org/major-general-benjamin-d-foulois/; "Yoshitoshi Tokugawa 1884-1963," Early Aviators, accessed March 2, 2022, https://www.earlyaviators.com/etokugaw.htm.

128 Hewes, 87; Acting Superintendent, Wright Brothers to Acting Regional Director, Region One, Memorandum, December 1960; Lanier.

129 Lanier.

130 Harrison, "An American Treasure."

131 Hewes, 97-98

FIGURE 2–30. Superintendent Gibbs greeting Generals Yoshitoshi Tokugawa and Major General Benjamin D. Foulois in the interior of the Monument, 1960. (WRBR Collection)

FIGURE 2–31. Bust of Orville Wright installed on the star-shaped Monument base, 1960s. (WRBR Collection)

interior by the park maintenance crew in February 1959, replacement of two broken floodlight covers due to vandalism in May 1959, repair of electrical wiring and painting the interior Monument stairs in December 1959, repair of three floodlights and other electrical fixtures in January 1960, and additional painting of the interior stairs and guardrails in January 1960 and February 1963.[132]

After the Monument rehabilitation in 1954, condensation in the interior of the Monument continued to be an issue. When the Monument interior was closed to the public on December 5, 1960, it is believed to have exacerbated the issue due to less ventilation than before. In July 1963, a fan and louvers were installed in the pylon in an attempt to reduce the condensation. The louvers were placed in the original three south facing windows on the pylon and the original glass was removed.[133] Sometime prior to 1964, vegetation had grown around most of the Powerhouse, partially hiding it from view of park visitors (Figure 2–33).

Post Mission 66 Era

In 1967, granite cobblestones at the Monument base were damaged from vandalism and required

132 Lanier.

133 Lanier,.

FIGURE 2–32. Busts of Orville and Wilbur Wright installed on pillars at the star-shaped Monument base, 1970s. (WRBR Collection)

replacement.[134] Improvements at the Monument didn't continue again until September 17, 1987. A ferrous metal restoration was undertaken by the Williamsport Preservation Training Center and the American Stripping Company of Norfolk, Virginia, that took approximately a week to complete.[135] Included in the restoration was removal, cleaning and repair of the beacon, cleaning and repair of the upper door and threshold, replacement of ferrous metal and stainless steel fasteners throughout the Monument, sandblasting the metal stairway and repainting, replacement of wood electrical panel covers with metal covers, installation of new exterior vent hoods and interior louver vents, removal of exfoliated rebar rods, and application of protectant to all stainless-steel, metal, and brass/bronze components. The extent of the corrosion on the metal elements of the Monument was attributed to the lack of ventilation and the salt air environment.[136]

The following year, a restoration of the pylon doors was undertaken by Billy Garrett, SER, and funded by the First Flight Society through money left over from the busts of Orville and Wilbur Wright. The pylon doors were subject to years of vandalism that caused their appearance to deteriorate.[137]

Further maintenance work at the Monument included the replacement of the floodlight timer with a solar light timer in 1995. The solar light timer allowed the floodlights to come on automatically at dark and go off shortly after sunrise.[138] During a NPS Denver Service Center Trip Report in 1995, it was noted that,

> The interior of the structure is extremely damp, especially at the lower level. It appears that the existing fan, located at the second floor level, is drawing the warm moist air from the upper levels and blowing it down onto the first floor so that the moisture levels reach rain forest like conditions. The existing fan unit is pulling warm moist air down from the top of the structure and may be creating more of a problem rather than solving the moisture issues. As it is natural for warm air to rise it would seem more logical to reverse the fan

134 National Park Service, *Historic Structure Assessment,* 5.

135 "Restoration Work To Begin On Wright Pylon Interior," The Coastland Times, Manteo, NC, September 13, 1987.

136 Barry T. Caldwell, *Ferrous Metal Restoration/ Replacement Wright Brothers National Memorial Pylon,* Williamsport Preservation Training Center, 1987.

137 Cape Hatteras National Seashore Cultural Resource Management Specialist, *Wright Brothers Pylon Doors Rehabilitation Project*, National Park Service, 1988.

138 Lanier.

FIGURE 2–33. Aerial view of the Monument and Powerhouse, 1964. (WRBR Collection)

FIGURE 2–34. Restoration work at the exterior of the Monument, 1997. (WRBR Collection)

FIGURE 2–35. Restoration work at the exterior of the Monument, 1997. (WRBR Collection)

FIGURE 2–36. Exterior of the Monument during the 1997 restoration. (WRBR Collection)

operation to pull the warm air up; this will require some modifications to the glazing at the roof level to allow a means for this air to escape.[139]

The comments from the DSC Trip Report led to a Historic Structure Assessment Report and a Condition Assessment Report that were completed in 1996. The Historic Structure Assessment Report, completed by the National Park Service, pointed out deficiencies and recommendations for the foundation structural stabilization, waterproofing and weatherproofing, electrical, mechanical, interior stabilization, associated walkways to the Monument, and accessibility. Specifically to water penetration, multiple sources where the water could be migrating from were noted including:

- The beacon canopy at the point where it sits on the granite top course,
- The beacon canopy structural integrity,
- The roof lead-coated copper flashing and lead-soldered joints around the beacon canopy,
- The tar and gravel roof surface and roof drain system,
- The top-level door system including the unsealed frame and failed threshold,
- Failed vertical and horizontal mortar seams between the granite block course that are allowing water staining and discoloration,
- Windows openings on the south face,
- The electrical panel box on the third floor and ceiling,
- Wall light fixture openings through the conduit channel,
- Lead-coated copper flashing in the mortar seam on top of the beveled granite block course and the vertical mortar seam on this course,
- Lead-coated copper gutter and drain system above the entrance door,
- The first-level entrance door frame and doors where the sealant has failed, and

139 Lanier.

- The tar border around the Monument between the granite border blocks and the first ground level granite course.

The recommendations to halt the water migration included using proper materials and correct procedures to help create a waterproof structure (without specific details on materials and procedures), cleaning the exterior granite surface using an acceptable sensitive system, removing the canopy and provide a temporary cover, replacing two broken stainless steel straps and a broken pane of glass, replacing and resealing all glass windows, cleaning, brushing, and recoating all interior painted surfaces, reinstalling the canopy with stainless steel lag bolts in lead anchors, cleaning the stainless steel handles in the granite ring, and resealing and monitoring the roof for leaks.[140]

The Condition Assessment Report listed the moisture problem as a critical need for the Monument. It was suggested to determine if a natural air ventilation system, an internal climate control system, or a combination of both along with waterproofing the exterior would correct moisture problems inside the Monument.[141]

1997 Monument Restoration

Based on the findings of the assessment reports the previous year and working in conjunction with NPS, the First Flight Centennial Foundation raised money for a restoration of the Monument in the spring of 1997. Plans for the restoration consisted of removing, cleaning, and repointing all mortar joints, cleaning the exterior and interior surfaces of the granite, replacement of the roof with an EPDM single-ply roofing membrane, updating the entire electrical system of the Monument, restoration of the rotating beacon, painting the interior stairs and rails, and installation of an HVAC system inside the Monument to aid in controlling the condensation issue (Figure 2–34 to Figure 2–36).[142] Additional work that took place during the restoration included replacing the exterior base floodlights, reworking all doors, and all other work necessary to make the structure watertight while protecting the historic fabric of the Monument.[143] After the restoration of the Monument, the beacon was brought back into service and was relit in 1998.[144]

2000 Powerhouse Stabilization

After sitting abandoned for decades, the Powerhouse was in dire need of stabilization efforts that took place in 2000 (Figure 2–37 to Figure 2–39). Stabilization at the exterior of the Powerhouse included removal of rust staining from the concrete door and window sills and the concrete slab of the building. Rust and copper residue was also removed from the concrete walls of the building. The original windows were removed during stabilization and two new steel-framed windows to match the original were fabricated and installed in the same manner as the original. A newly fabricated entry door to match the original was also installed. All hardware associated with the windows and doors was either reconditioned or replaced to match the existing. The metal grates used as covering for the windows and door were removed, sandblasted, galvanized and treated, painted with a rust protective coating, and then reinstalled. During the restoration of the metal grates, it was determined that several of the grate bars were completely rusted out and would have to be replaced. The copper metal roof drains were extended out away from the Powerhouse in order to prevent the aggregate from becoming stained again and so water would drain away from the structure. The Powerhouse roofing, specifically the soldered seams of the copper roof, was failing and stabilization efforts reconditioned and resoldered the roof where necessary. Additionally, the two air vents on the north wall were replaced and the entire exterior of the structure was cleaned to remove algae and mildew.

Interior work during the stabilization of the Powerhouse included repair of exfoliated and spalling concrete around door and window openings and on the ceiling with smooth finish Portland cement.[145] As part of a Historic Structure Report in 1998, it was noted that the interior electrical circuit box for the Powerhouse was

140 National Park Service, *Historic Structure Assessment*, 12-13.

141 Lanier.

142 Darrell Collins, "Wright Brothers Monument Restoration," CRM No. 7, 1997, 13.

143 Steven Harrison, *A Proposal to Restore the Wright Brothers Monument at Wright Brothers National Memorial*, National Park Service, 1996.

144 Harrison, "An American Treasure."

145 National Park Service, *Wright Brothers National Memorial Statement of Work For The Stabilization of the Monument Powerhouse*.

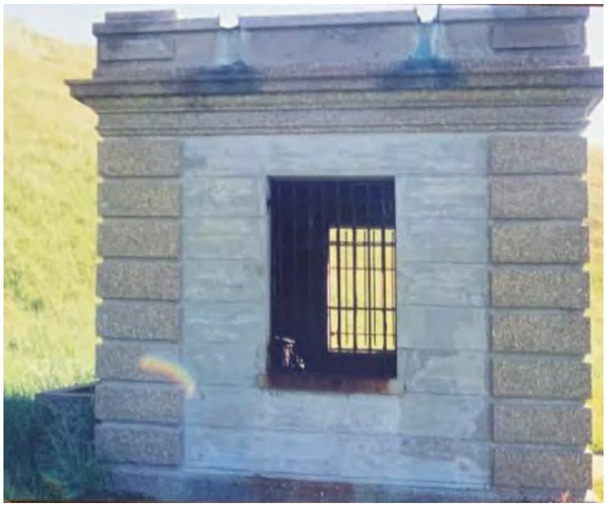

FIGURE 2–37. West elevation of the Powerhouse prior to the stabilization, 2000. (WRBR Collection)

FIGURE 2–38. Condition of the Powerhouse interior vent opening prior to the stabilization, 2000. (WRBR Collection)

FIGURE 2–39. South elevation of the Powerhouse prior to the stabilization, 2000. (WRBR Collection)

obsolete/inoperable and that the two transformers in the Powerhouse still contained oil. It was estimated that both the electrical circuit box and the transformers were removed sometime between 1998 and 2000 even though there was no description of electrical work performed during the 2000 stabilization.

First Flight Centennial Anniversary

Celebration of the First Flight Centennial consisted of events throughout the year of 2002-2003 in addition to a week-long celebration in December 2003 (Figure 2–41). The events included:

- December 17, 2002–December 1, 2003: The Experimental Aircraft Association's 50 Flags to Kitty Hawk,
- December 17, 2002: Presidential/Governor Proclamation for Centennial Year,
- December 2002: A commemorative coin released,
- December 2002: First Day Release,
- February 21-22, 2003: Celebration honouring the Tuskegee Airmen,
- March 14-16, 2003: Celebration in honor of Women in Aviation,
- April 16, 2003: Wilbur Wright's birthday,
- May 2003: The 50th Anniversary of Cape Hatteras National Seashore,
- May 10, 2003: The Pilot's Facility Opening,
- May 21, 2003: Ribbon cutting for the First Flight Centennial Pavilion,
- May 22, 2003: The First Flight Centennial Stamp (Figure 2–40)/First Day Issue,
- June 5, 2003: Concert with the North Carolina Symphony at Roanoke Island Festival Park,
- June 9, 2003: Concert by the U.S. Coast Guard Band,
- June 13 to July 27, 2003: A Smithsonian Exhibit of Women and Flight,
- June 14-15, 2003: The Wright Kite Festival,

- June 16-17, 2003: The Air Challenge,
- June 21-24, 2003: The 27th Annual Air Race Classic,
- July 2003: A Transcontinental Glider Race,
- July 4, 2003: The Soaring Society Finale Ceremony,
- July 6-9, 2003: The RE/MAX Balloon Celebration,
- August 16-17, 2003: The Things That Fly: Paper Airplane and Boomerang Contest,
- August 19, 2003: National Aviation Day and Orville Wright's Birthday,
- September 2003: National Air Tour and the unveiling of Icarus Monument,
- September 27, 2003: Presentations on Billy Mitchell, commonly known as the father of the United States Air Force, during Kitty Hawk Heritage Day, titled, Billy Mitchell on Hatteras Island and Billy Mitchell: American Hero, American legend,
- October 2003: A Commemoration of 1902 Gliders and Hang Gliders Festival, and
- November 2003: A Memorial Rededication.

FIGURE 2–40. The First Flight Commemorative stamp, honoring Orville and Wilbur Wright's first successful attempt of heavier-than-air power-driven flight, 2003. (WRBR Collection)

Centennial events culminated with a week-long celebration that took place December 12-17, 2003, and included exhibits, speakers, and performances related to the themes of Igniting the Imagination, Remember the Past and Imagine the Future, Protecting the Home of the Brave, In History's Footsteps, and 12 Seconds that Changed the World.[146] Multiple notable persons were in attendance of the First Flight Centennial Anniversary Celebration including North Carolina's Governor Michael F. Easley and North Carolina's First Lady Mary Easley, astronauts John

146 National Park Service, "First Flight Centennial Celebration Plan Wright Brothers National Memorial 2003,"Unpublished Report, 2003.

FIGURE 2–41. The Wright Brothers National Memorial during the First Flight Centennial Anniversary Celebration with people on Kill Devil Hill, 2003. (WRBR Collection)

Glenn, Buzz Aldrin, and Neil Armstrong, aviators Brigadier General Chuck Yeager and Harry B. Combs, former President George W. Bush, former Secretary of the Interior Gale Norton, actor John Travolta, and singing groups The Beach Boys and the Temptations to name a few.[147]

Monument Construction and Rehabilitation

A few years after the Powerhouse was stabilized, a concrete and granite paver plaza with a concrete bench was constructed at the Monument. Historically, a plaza was present at the southern portion of the Monument terrace, just outside the star-shape, but was removed at an unknown date.

In 2005, the Superintendent's Annual Report noted that water damage found in the pylon interior was reviewed with Mosier, Mayer, Phoenix, and Watson Electric. After review of the damage, a restoration on the Monument started December 2007 and during the SHPO review of the restoration project in August 2007, SHPO specifically mentioned "The serious and escalating moisture problem inside the Monument."[148]

Funded by the First Flight Foundation, the restoration of the Monument included cleaning both the interior and exterior of the granite pylon, repointing the exterior mortar, painting the stairs, polishing and coating the stainless-steel doors, replacing the ventilation system and the exterior lights, and renovating the electrical and mechanical systems. Additionally, the beacon at the top of the pylon was removed, cleaned, and reworked to have the unit working at maximum efficiency. A dehumidifier was also installed on the second floor of the pylon with the condensation from the dehumidifier pumped from a sump pump on the second story to a drain line embedded into the exterior wall.[149]

The goal of the restoration, besides halting the condensation problem, was to make the interior of the Monument accessible to the public again,[150] despite the advisement to keep the pylon interior closed from a safety inspection performed in June 1995. Elements noted in the safety inspection that wouldn't be corrected in the restoration included the steep narrow steps, a lack of guard rails at the top to prevent visitors from falling over the edge, and the extreme difficulty in emergency personnel reaching and removing an injured visitor in the event of an emergency.[151]

The continuing condensation problem at the interior of the Monument led to additional masonry cleaning and repair in 2014-2015. Through an inspection, it was revealed that the original weep holes throughout the Monument had been sealed during the last re-pointing. By opening the weep holes and repointing the exterior masonry joints, it was expected that the water would properly drain and not collect on the interior.[152] But after the masonry joint repairs were completed, the condensation issue still persisted.

After the 2014-2015 masonry cleaning and repair, Park Engineer, Nelson Pendleton noted,

> The first project in FY 15 reinstalled weep holes in the exterior walls, painted the interior and polished the front door. It was also to replace light fixtures, and install a protective devise for the beacon light. The project was 70% complete when we realized the weep holes only solved a portion of the water intrusion/moisture problems. The paint was not adhering to the interior and the new light fixtures were not installed.[153]

Additionally, in 2016, Nelson Pendleton noted,

> The second project in FY 16 conducted non-destructive tests to determine the sources of water intrusion and develop recommendations for treatment/repairs/etc. Multiple tests were conducted and we have the final report. The

147 "First Flight Centennial Celebration - Dec 12-17, 2003,"*First Flight Foundation*, accessed February 10, 2022, https://firstflightfoundation.org/first-flight-centennial-celebration-dec-12-17-2003/; "100 Years of Flight," *CBC News*, modified December 17, 2003, https://www.cbsnews.com/pictures/100-years-of-flight/15/.

148 Lanier.

149 Lanier.

150 Catherine Kozak, "Goal is to Reopen Interior to Public: Renovating flight Monument," The Charlotte Observer (Charlotte, North Carolina), 2007.

151 Robert Trick, Safety Committee Chairperson to Mary Collier, Assistant Superintendent, "Wright Brothers National Memorial Safety Inspection," Memorandum, 1995.

152 National Park Service, "Wright Brothers National Memorial Environmental Screening Form," PMIS Number: 206582, National Park Service, 2015.

153 Lanier.

> report has very good information and makes several recommendations to address moisture penetration, salt contamination, the HVAC system.... However, the report also suggests additional tests which were not included in this scope. The contractor also identified some unknown conditions which should be figured out before a final scope for repairs is created.[154]

A moisture intrusion investigation of the Monument was completed in February 2017 for Amidon, Inc., by Atkinson-Noland & Associates, Inc. and Masonry Solutions International, Inc., which included surface penetrating radar scanning, pachometer scanning, infrared thermography, water testing at the roof drain, pavement and foundation space investigations, videoscope investigations of a drainpipe, the wall, and conduit and access panels, and laboratory testing of a series of mortar joint and stone surface samples. The investigation concluded that the moisture intrusion is well-documented (Figure 2–42). Water was observed to be running from mortar joints at the interior and exterior and to be pooling at the lobby floor during and after a rainstorm in significant amounts. It was noted that originally flashing was installed to collect moisture and water was observed to be running out of the joint at the flashing level after minor precipitation. The effectiveness of weep holes installed during the previous mortar reporting effort were also called into question on their functionality. Exterior mortar joints were noted to be delaminated and providing multiple points for moisture entry. Mortar joint samples that were tested showed very high chloride levels which can lead to the potential for corrosion of embedded metals such as anchors or rebar along with the potential for damage resulting from salt crystallization and salt hydration. As the concrete structure of the Monument is reinforced, combined with the high chloride levels of the mortar, the report suggested there is a high potential for reinforcement corrosion though the interior paint coating may be minimizing oxygen diffusion and corrosion activity.[155]

Radar scans of the exterior suggested there may be internal voids behind select stones that could serve to collect and transport moisture to the interior and appear as leaks in the interior. Conduits were observed to be moderately to severely corroded for both in-service and abandoned lines. The report hypothesized that the significant moisture intrusion was being transported and concentrated in the conduits due to water collecting behind stones. Blotchy and uneven appearances of the interior and exterior stone surface was noted to be related to salt hydration rather than localized moisture leaks.[156]

Recommendations in the report were given pertaining to moisture penetration, salt contamination, and heating, ventilation, and air conditioning (HVAC) systems. For moisture penetration, the report recommended addressing all open and delaminated mortar joints as well as sealing other point sources for moisture entry such as skyward facing joints. Embedded conduit was recommended to be removed or filled with non-shrink injection grout. Additional investigation of the grout fill between facing stones and the underlying concrete structures through core sampling and testing for alkali-aggregate reactions and chloride concentrations was also recommended. To remedy void spaces within

154 Lanier.

155 Atkinson-Noland & Associates, Inc. and Masonry Solutions International, Inc., *Evaluation and Testing Wright Brothers National Memorial Monument*, Amidon, Inc., February 2017, 19-21.

156 Atkinson-Noland & Associates, Inc. et al, 19-21.

FIGURE 2–42. View of moisture at the exterior of the Monument during the moisture intrusion investigation, 2017. (Evaluation and Testing Report Wright Brothers National Memorial Monument prepared for Amidon, Inc.)

FIGURE 2–43. The Wright Brothers Monument showing signs of moisture penetration, three to four years after the 2014-15 masonry cleaning, 2018. (https://ncseagrant.ncsu.edu/coastwatch/previous-issues/2018-2/winter-2018/bundle-up-and-explore-coastal-winter-adventures/)

the masonry walls, fluid grout injection was recommended with points of entry through the mortar joints from both the interior and exterior.[157]

Salt contamination recommendations focused on poultice applications (at regular intervals of three to five years) to the interior lobby stones or the use of electro-osmosis. Due to the high chloride concentrations, checking the structure for any damage or deterioration was recommended along with preventative measures of installing an impressed current cathodic protection system to halt the corrosion process. Routine maintenance of the dehumidification system and joint sealing louvres associated with the dehumidifier makeup and exhaust air to ensure proper operation was recommended. It was also noted that the negative internal pressure could be exacerbating moisture intrusion by drawing moisture through the mortar joints into the interior spaces.[158]

Between 2018 and 2020, no new information was been gleaned into the moisture intrusion of the Monument (Figure 2–43). In 2022, after a torrential downpour event on the night of July 13, park staff noticed 0.5” of water had accumulated on the interior floor of the Monument with signs of water intrusion from the mortar joints and near the electrical panels. Park staff came to the conclusion that the interior gutter system may be leaking with substantial water intrusion near the electrical panel. The dehumidification system was also non-functional during at this time as there was now water in the condensate line and the pea trap leading to the condensate pump was dry and appeared to be dry for quite some time. Although the dehumidification system was non-functional, there were no signs of condensation on the granite walls, painted concrete walls, or metal handrails.

During the time this report was completed, Pre-Design and Schematic Designs were being developed for the National Park Service to address the continued moisture intrusion of the Memorial’s Monument.

157 Atkinson-Noland & Associates, Inc. et al, 21-22.

158 Atkinson-Noland & Associates, Inc. et al, 22-23.

Timeline

March 2, 1927	President Calvin Coolidge signs an Act "for the erection of a memorial in commemoration of the first successful attempt of a power-driven airplane flight."
June 1928	Design competition for the Monument is announced.
Dec. 17, 1928	Ceremonial corner stone laid and dedication ceremony held.
January 1929	Monument design competition closes.
Feb. 14, 1930	The winning entry of the design competition is chosen, awarded to the New York Firm of Rodgers and Poor.
1930	The Powerhouse is designed by the War Department to house the electrical equipment for the Monument.
1928-1931	Stabilization efforts of Kill Devil Hill by Captains Gilman and Kindervater of the War Department using a variety of beach grasses.
1930-1932	Construction of the Powerhouse commences.
Feb. 4, 1931	Major General John A. DeWitt, Quartermaster General, turned the first shovel of dirt to mark the beginning of excavation and construction for the Wright Brothers Monument foundation.
Dec. 1931	Construction on the star-shaped base of the Monument begins.
1932	Construction of the Powerhouse is completed in 1932.
Oct. 15, 1932	Construction of the Monument is completed.
Nov. 19, 1932	Dedication of the Monument is held.
Dec. 12, 1932	Comments from Robert Beard, War Dept. Constructing Quartermaster: *The granite work as it now stands is very pleasing to the War Department, however, there has been considerable trouble with leakage of water into the memorial room when rains are accompanied by high southerly winds. The door construction is not as weather tight as it should be and, undoubtedly, some of the dampness of the walls is due to condensation, but a material amount of it is evidently due to leakage through the mortar joints. Possibly this may have to be corrected at some future date by raking out the face of the joint and filling them with Pecora cement or in some other matter.*
August 1933	The Kill Devil Hill Monument is transferred to the National Park Service, with Horace Dough as the superintendent, from the War Department, becoming the Kill Devil Hill National Monument.
1934-1936	A curvilinear circulation pattern is introduced to substitute for the original direct concrete pathways to the Monument built by the War Department. The original entrance road built by the War Department is also removed and a new circular road constructed.
June 6, 1934	Horace Dough comments that steel steps need painting but that he is unable to paint due to condensation on the inside of the Monument. Notes that Monument shows least condensation during the fall season.
July 30, 1934	Lightning strikes the metal framework of the beacon dome, damaging parts of the switchboard and the on/off beacon switch.
1935-1936	Comfort Station constructed.
1936	Superintendent's residence is constructed in a modernistic style

	compatible with the Monument.
February 1936	Monument pylon door handles are stolen.
Spring 1942	An ultra-high frequency monitoring system is installed atop the Monument's pylon to monitor and locate enemy submarine ships during World War II. The monitoring system is removed sometime that spring without damage to the pylon.
Sept. 1944	The memorial shaft suffers slight flooding from hurricane rains, but no damage.
1945	At the end of World War II, the Monument shaft is showing rapid signs of deterioration as a result of water accumulations. Granite discoloration and mortar damage result from both rain and condensation. The Monument has been designed to be water and airtight, and there is no ventilation. When sealed shut, the differences in exterior and interior air temperature and humidity result in an accumulation of moisture, from damp walls to several inches of water on the main floor. In addition, rainwater enters the Monument in several places.
July 7, 1946	Floodlights illuminate the Monument from dusk to midnight; no mention is made of the beacon.
Sept. 1946	Loose cobblestones in concrete around the Monument base are reset.
Dec. 20, 1946	Inspection Report from Roy Appleman, Regional Historian: *The Kill Devil Hill Monument is beginning to show rapid signs of deterioration in the pointing of the to stonework. Water is entering the Monument and working its way down between the stone veneer and the concrete floor. The water reaches the bottom of the shaft and frequently forces its way up through the floor. Is it not uncommon, we were told, for several buckets full of water to be mopped up from the floor whenever there is any rain. The seeping of the water through the pointing joints between the stone blocks has resulted in the considerable discoloration inside the little rotunda and also on the exterior of the Monument.*
January 1947	Old broken toggle switches and switch boxes are replaced. A few light fixtures are still needed but the lighting system is much improved.
March 5, 1947	Electrical panel box replaced.
May 5, 1947	Pedestrian path shoulders are patched, the information desk in the memorial room is refinished, the overhead indirect lighting unit is reworked, and old lamps are replaced with new ones. Plans are initiated to cover steel and concrete steps with rubber treads (the steps were slippery due to leaks from normal rain).
June 1947	A telephone is installed at the desk in the Monument; shrubbery and grass are planted on the hill.
February 1948	Floodlights are dismantled and reconditioned; a list of needed parts is sent to Westinghouse Electric Corporation. This is done in the hope that some arrangement could be made to light the Monument during part of the year.
October 1948	Additional work is completed on floodlights that were previously dismounted.
Dec. 1948	The concrete walls and the iron steps and railings in the Monument are given another coat of aluminum paint.
July 1949	Numerous complaints are

	registered by visitors because the floodlights are not turned on to illuminate the Monument.
March 1950	The lighting system is given a complete overhaul; six new 150-watt floodlights are installed around the base of the Monument in an attempt to eliminate all dark spots in preparation for floodlighting of the Monument on April 1, 1950.
April 1950	A new switch panel board is enclosed in separate box to prevent water seepage or condensation from damaging the switches and fuse blocks. The switch panel board that controls the lighting system is installed without interruption of floodlighting the Monument.
August 1950	A test is made on the Monument drainage system to try and determine if the leak inside the Monument is caused by a broken drainpipe. There is no conclusive proof that a drainpipe is broken, so water is coming from some other source. Leaks are noted.
Dec. 1950	Steel stairs and floors in the Monument are scraped and painted.
March 1951	Floodlights are checked and thoroughly tested in preparation for the beginning of the floodlighting season on April 1.
Nov. 1951	The handrail on the steel stairs is cleaned and repainted.
Dec. 1, 1953	The Kill Devil Hill National Monument is renamed the Wright Brothers National Memorial. To mark the 50th anniversary of the Wright Brother's achievement, the two structures (living quarters and hangar) used by the Wrights are rebuilt on their approximate original site.
1954	The Powerhouse is no longer used.
March 23, 1954	Rehabilitation bids are opened, and Guaranteed Waterproofing Company, Greensboro, NC, is the winning bidder. Work is to consist of cutting out and repointing joints in stone and brickwork, caulking, and other related work. No completion report or documentation can be located.
April 22, 1954	Rehabilitation work on the Monument begins.
June 1954	Rehabilitation work on Monument is 95% complete.
June 8, 1954	Architect Aschmann from NPS Region One visits the Monument to go over rehabilitation work.
January 1956	The walls and stairways at the Monument are scraped and repainted, and unpainted interior sections are cleaned.
1957-1958	Construction on a new entrance road and bypass road to Colington, next to the state highway flanking the site to the east, commences in 1957 and is completed in 1958.
May 1957	Fill is hauled to the north side of the hill to fill a washout.
1958-1959	The original entrance road and Boulder Road, adjacent to the superintendent's residence, are removed.
1959	Congress authorizes the formal acquisition of an additional 111 acres to the north and east.
1959-1960	The Wright Brothers National Memorial Visitor Center, designed by Mitchell/Guirgola Architects of Philadelphia, PA with the contractor of Hunt Construction Company of Norfolk, Virginia, is constructed.

February 1959 — The interior of the shaft is painted by the maintenance crew.

May 1959 — Two floodlight covers are broken by vandals.

Dec. 1959 — The stairs in the shaft are painted by the maintenance crew, and the electrical wiring is repaired.

January 1960 — The stairs and guardrails of the pylon are repainted, and three floodlights and other electrical fixtures are repaired.

Dec. 1960 — The Monument is closed to the public; the new visitor center is opened. Closing the Monument might contribute to more water and seepage problems; there is less ventilation than before the closing.

1963 — Commemorative airstrip added to the Wright Brothers National Memorial east of West Hill. The reconstructed hangar and living quarters are reconstructed again.

February 1963 — The purchase order is prepared for painting the interior of the structure.

July 1963 — A fan and louver are installed in the shaft in an attempt to reduce condensation (reference to the louver is probably to the three windows originally built on the south face). The original glass is removed and vents are installed; no completion report was located.

Dec. 1967 — Granite cobblestones are replaced around the Monument base, evidently because of vandalism.

Sept. 1987 — Ferrous metal restoration includes removal, cleaning and repair of beacon; cleaning and repair of upper door and threshold; replacement of ferrous metal and stainless-steel fasteners throughout; sandblasting metal stairway and repainting; replacement of wood electrical panel covers with metal covers; installation of new exterior vent hoods and interior louver vents; removal of exfoliated rebar rods; and application of protectant to all stainless steel, metal, brass/bronze components. Reports attributes corrosion to lack of ventilation and salt air environment. All work is done either by Williamsport Preservation Center or supervised by that office.

1995 — The timer is replaced with a solar light timer so that the floodlights come on automatically at dark and go off at daybreak.

August 1, 1995 — From the DSC Trip Report: *The interior of the structure is extremely damp, especially at the lower level. It appears that the existing fan, located at the second floor level, is drawing the warm moist air from the upper levels and blowing it down onto the first floor so that the moisture levels reach rain forest like conditions. The existing fan unit is pulling warm moist air down from the top of the structure and may be creating more of a problem rather than solving the moisture issues. As it is natural for warm air to rise it would seem more logical to reverse the fan operation to pull the warm air up; this will require some modifications to the glazing at the roof level to allow a means for this air to escape.*

1996 — Condition Assessment Report lists critical need: Determine if a natural air ventilation system versus an internal climate control system or a combination of both along with waterproofing the exterior will correct moisture problems inside the Monument.

2000 — Stabilization of the Powerhouse takes place.

Dec. 2007-June 2008 — Monument restoration funded by First Flight Foundation. The

	project includes cleaning both the interior and exterior of the granite pylon, repointing the exterior mortar, painting the stairs, polishing and coating the stainless-steel doors, replacing the ventilation system and the exterior lights, and renovating the electrical and mechanical systems. The beacon atop the pylon is removed, cleaned, and reworked for maximum efficiency. A dehumidifier is installed on the second floor. Condensation from the dehumidifier is pumped from a sump on the second story floor to a drain line which is embedded in the exterior wall of the pylon.
2015	Note from Nelson Pendleton, Park Engineer: *The first project in FY 15 reinstalled weep holes in the exterior walls, painted the interior and polished the front door. It was also to replace light fixtures, and install a protective devise for the beacon light. The project was 70% complete when we realized the weep holes only solved a portion of the water intrusion/moisture problems. The paint was not adhering to the interior and the new light fixtures were not installed.*
2016	Note from Nelson Pendleton, Park Engineer: *The second project in FY 16 conducted non-destructive tests to determine the sources of water intrusion and develop recommendations for treatment/repairs/etc. Multiple tests were conducted and we have the final report. The report has very good information and makes several recommendations to address moisture penetration, salt contamination, the HVAC system.... However, the report also suggests additional tests which were not included in this scope. The contractor also identified some unknown conditions which should be figured out before a final scope for repairs is created.*
Feb. 2017	Evaluation and Testing report done for Amidon, Inc., by Atkinson-Noland & Associates, Inc. and Masonry Solutions International, Inc., which included surface penetrating radar scanning, pachometer scanning, infrared thermography, water testing at the roof drain, pavement and foundation space investigations, videoscope investigations of a drainpipe, the wall, and conduit and access panels, and laboratory testing of a series of mortar joint and stone surface samples.
July 2022	After a torrential downpour event on the night of July 13, park staff noticed 0.5” of water had accumulated on the interior floor of the Monument with signs of water intrusion from the mortar joints and near the electrical panels. The dehumidification system was also non-functional during at this time.

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Physical Description and Condition Assessment

FIGURE 3–1. Wright Brothers Monument, view from the southwest. (QE 09/2021 - Typical all photos this section.)

General Description: Wright Brothers Monument

Site

The Wright Brothers Monument is located at Wright Brothers National Memorial in Kill Devil Hills, North Carolina, part of the Outer Banks Group.

The Wright Brothers Monument, hereafter referred to as “the Monument”, is located in the center of the Wright Brothers National Memorial. (Figure 3–1). The Monument consists of specific parts. The plaza in front, the star shaped pedestal,

FIGURE 3–2. View from the rear park entrance facing south.

FIGURE 3–3. View from the visitor center parking lot facing north.

FIGURE 3–4. Drone footage of Monument site. (NPS 2022)

terrace surface and the pylon building. The pylon refers to the entire building that consists of a base,

FIGURE 3–5. View from the Monument, facing southeast.

FIGURE 3–6. View from the Monument, facing east.

FIGURE 3–7. View from the Monument, facing north.

FIGURE 3–8. Site lighting fixture, facing north.

tower and observation deck. Other buildings on the site include the entrance gate and kiosks, the visitor center, reconstructed camp buildings, centennial facilities, air strip, a sculpture, and administrative buildings.

The Wright Brothers National Memorial is located west of US Highway 158, north of Colington Road and east of the Colington Creek. The main entrance was previously located to the south along Colington Road before the US Highway 158 was constructed. (Figure 3–2, Figure 3–3) There are four concrete gateposts that indicate the historic entrance. (Figure 3–11).

The Monument sits on top of a 90-foot tall vegetated sand dune located in the center of the park. The dune is surrounded by a paved road with parking locations. The remainder of the site is a mix of wooded areas, short shrub vegetation and mown grass. The stabilized sand dune has a medium slope on the north, east and west sides with a steep slope at the rear (south) face. (Figure 3–5 to Figure 3–7) At the base of this slope is the Powerhouse building described below.

Multiple curvilinear concrete paved paths direct visitors up the sides of the dune to the Monument at the top. These paths encircle the base of the Monument with a small paved plaza with concrete benches at the south side of the Monument. This plaza replaced the previous design and was added in the early 2000s and is not original to the site. The vegetation of the dune has changed over the years and has more wooded vegetation on the south end with shorter scrub vegetation on the north, east and west sides. The vegetation is mown on the north, east and west sides. Drone footage shows the curve of the hill and the border of the various vegetations. (Figure 3–4). Historically site lighting was intended to be along the points of the pedestal but were installed on the ground.

FIGURE 3–9. View of the paved paths, facing east.

FIGURE 3–10. View of the Monument from the paved path, facing southeast.

Currently there are modern pole lights directed towards the Monument around the concrete paths. These lights replaced previous multiple versions and were installed in the 1997 restoration project. (Figure 3–8)

More information on the site can be found in the 1998 Cultural Landscapes Inventory and the 2002 Cultural Landscape Report.

Condition

The site is in fair to good condition. Maintenance over the years has decreased the amount of mowing needed on the hill but vegetation still needs to be cleared for sight lines and views. The hill vegetation is now maintained more frequently and is in good condition. The road and paths leading to the Monument are in good condition.

FIGURE 3–11. View of historic gateposts, facing north.

TABLE 3-1: SITE

Features	Evaluation	Date of Origin (if known)	Date of Alteration (if known)
Hill	C	1931	
Curved Paths	C	1934	2000's
Light posts/ Floodlights	NC	1997	
Plaza	NC		2002

** Contributing (C), Noncontributing (NC)*

Around the terrace at the exterior there is wearing down of the grass with natural worn footpaths having been utilized by visitors. Surface erosion of the mown grass has occurred by visitor traffic off the paved paths and close-cut mowing. (Figure 3–9 and Figure 3–10).

Exterior Description and Conditions

The pylon is a 60-foot-tall Mount Airy granite tower constructed atop a star-shaped pedestal. The pylon is designed with a flared base, a characteristic wing motif carved into relief in the sides of the pylon and is crowned with a metal and glass cupola which houses a rotating beacon. Decorative carving on the east and west side of the pylon gives the indication of wings, while an inscription encircles the base of the building, "In

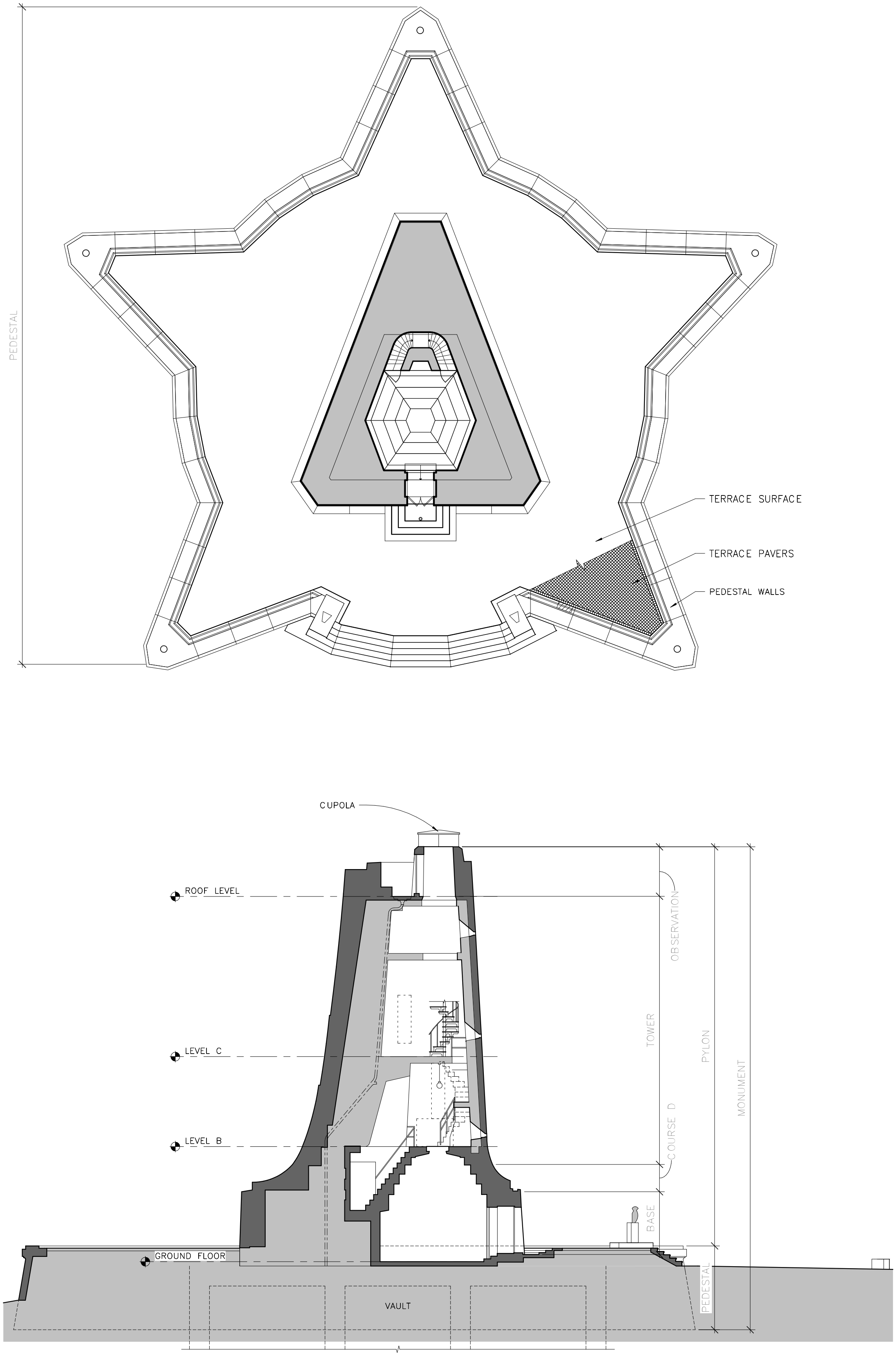

FIGURE 3–12. Diagram section of the Monument.

commemoration of the conquest of the air by the brothers Wilbur and Orville Wright conceived by genius achieved by dauntless resolution and unconquerable faith." (Figure 3–17 to Figure 3–18)

The pylon sits on a star shaped pedestal, whose perimeter walls are clad and capped in granite and at the interior is a terrace surface composed of square granite pavers. The terrace level is approximately 6-8' higher than the ground of the site.

The pylon and terrace are clad with granite, from Mount Airy which is light grey and white in coloring. The base of the pylon is made up of three courses of smooth granite blocks, then two concave curved profile courses, and then the rest of the tower is clad with tapering courses of granite that have been carved with relief patterning depicting wings in flight. The top of the pylon steps in to form the roof that supports the lantern. For more information see Figure 3–12.

Foundation

The pylon is set on cast-in-place concrete foundations that are approximately 34 feet deep. With the pylon constructed over a concrete vault. The 2017 evaluation and testing report by Atkinson-Noland & Associate Inc and Masonry Solutions International, Inc, note that the vault is approximately 33 feet deep with a concrete slab below the memorial room. The video scoping observed a few inches of standing water at the base of this vault.

Condition

The foundations were not inspected. Visual observation of the pylon and terrace does not indicate any concerns with the condition or performance of the foundation. The vault was also not observed.

Structure

The pylon's primary structure is a cast-in-place concrete tripod. The entirety of this structure is enclosed with granite cladding on the exterior, as well as on the interior of the ground floor. The concrete structure is exposed on the second level of the pylon interior and above. The exposed concrete wall, ceiling, and floor surfaces are all painted. At the top of the tower, approximately the last four feet of the interior, the structure changes

FIGURE 3–13. Interior of the pylon, showing bubbling paint and surface pockets.

from concrete to granite cap stones that form the top of the tower. Radar readings taken as part of the 2017 report suggest that the reinforcing rods nearest the interior surface are between 1-1/2 and 3 inches deep, depending on location.

Condition

Where the concrete structure could be observed, it is in good condition overall. Acute surface pockets were observed in the interior faces of the concrete on the second level. These pockets appear to be due to disintegrating surface material rather than concrete which has been physically forced from the body of the structure (a typical spalling condition). (Figure 3–13). In one location, an area of bubbling paint was probed, revealing similar disintegrated concrete material underneath. No reinforcing or other potential proximate causes for these pockets were observed, leading the team to conclude that the deterioration is likely caused by moisture entrapment underneath painted surfaces.

Adjacent to the stairway leading up to the second level from the first floor, there is a distinct area of missing paint on the concrete wall surface, coupled with significant efflorescence. The concrete itself seems intact. This efflorescence suggests concentrated water infiltration in this area. The area is in close proximity to the path of the interior

FIGURE 3–14. Close up view of the base courses, showing typical open joints and deterioration.

FIGURE 3–15. Close up view of a previous mortar and patch repair.

rain leader which extends from the observation level above, suggesting that the primary water source affecting this condition may be leakage from the existing rain leader.

Portions of the concrete floors exhibit worn, peeled or displaced paint coatings. The concrete surfaces are in good condition. Paint wear was observed on or near stairways and is most likely due to wear from foot traffic. In less trafficked areas, the peeling appears to be a result of moisture drive forcing the paint film to delaminate from the concrete.

Exterior Elevations

The exterior of the pylon is clad with Mount Airy granite. Units measure approximately 30 by 60 inches and vary in depth depending on their location on the pylon. The granite blocks are jointed with 1/4-inch mortar joints. According to original construction drawings these stone units are anchored with brass anchors hooked into kerfs in the stone and set in dovetails in the concrete

FIGURE 3–16. Close up view of the curved profile stone (Course D), with non matching sealant in joints.

FIGURE 3–17. View of the Monument, south elevation.

substructure. According to original construction documents, these stone units were designed to be fully backbuttered with grout or mortar.

Condition:

The exterior of the pylon is in good condition with minimal damage to the granite. Mortar joints are generally weathered on the pylon exterior, with more significant weathering in the flared Course D section. The base plinth also exhibits substantive open or deteriorated joints. (Figure 3–14) Sealant appears to have been installed over the joints in the flared section, where original drawings note that a flashing or waterproof membrane is present. (Figure 3–16) The sealant was applied to the surface of the existing mortar joints rather than bedded into the joints themselves, and is mostly displaced. Evidence of a prior repointing campaign is present in non-matching, newer-looking mortar joints. (Figure 3–15) Many of these repointed joints, similar to the sealant-treated joints, were not raked properly prior to application of new mortar and consequently the new mortar has not held up.

Spalls were noted in the granite cladding in discrete locations. These do not appear to be related to any deterioration in subsurface metals or anchorages and are likely caused by water infiltration into faults in the stone edges.

Elevation South

The south or front elevation faces Colington Road as well as the gathering plaza. (Figure 3–17) At the ground level of the south elevation the terrace steps down three times to form the small alcove for the entry door to the interior memorial room. The memorial room is three feet lower than the ground floor level.

The south elevation has a flat face with the inscription “Wilbur Wright Orville Wright” halfway up the tower surface. Three equally-spaced openings on the south face were historically glazed with fixed windows, but were replaced with louvers for the mechanical system added in 2008. At the

FIGURE 3–18. View of the Monument, east elevation.

top of the elevation is a solid stone cap with a metal and glass lantern which is illuminated at night.

Condition

The front (south) elevation is in good condition. There are typical areas of open and deteriorated joints, the majority of which are located along the

FIGURE 3–19. View of the Monument, west elevation.

FIGURE 3–20. View of the Monument, north elevation.

bottom three courses of stone. Additional open joints occur near the top of the tower as well as around the three louver openings. There are some spalls at various locations on the south elevation face.

Elevation East

The east elevation faces US Highway 158. (Figure 3–18) It has a flat face that is carved upward forming a wing pattern. The east elevation has a shallow curved pitch at the south end and a steep curve at the north end. At the top of the elevation the stones step back near the lantern, emphasizing the wing shape. The base is composed of three courses, with an inscription that encircles the pylon at the top course.

Condition

The side (east) elevation is in good condition. There are open and deteriorated joints along the entire elevation, not just the bottom three courses. There are some spalls at various locations on the elevation face. At Course D the joints have been filled with sealant.

Elevation West

The west elevation faces the airplane landing strip and the wooded side of the park. (Figure 3–19) The east and west elevations on the pylon are identical mirrored opposites except for the words of the inscription at the base.

Condition

The side (west) elevation is in good condition with similar conditions to the east. There are typical areas of open and deteriorated joints, the majority along the bottom three courses of stone. There are some spalls at various locations on the elevation face. At Course D, the joints have been filled with sealant.

Elevation North

The north elevation faces the entrance of the park and the first flight marker. It is the thinnest elevation at the point of the pylon's wedge-shaped floor plan geometry. It follows the same pattern of stone profiles as the three other elevations except it has a steeper curve profile. Along the base course is an inscription as well as a keystone.

Condition

The rear (north) elevation (Figure 3–20) is in good condition and has typical conditions as the other three elevations. This elevation is the smallest with areas of open and deteriorated joints at the bottom and the top courses. There also areas of non-matching mortar.

Roofing

Roofing on the pylon is limited to a small patch of flat area in the base of the observation deck. (Figure 3–21) This roof area appears to have been originally constructed of lead-coated copper and provided with a single roof drain, connected to a 3-inch rain leader that extends down the pylon and discharges through a scupper on the east side of the pedestal retaining wall. The sheet metal assembly is flashed to the granite surrounding the observation deck and set in reglets approximately 3 inches above the roof surface. (Figure 3–22) The roof surface was subsequently covered in a rubberized roof patching material.

The actual pathway of the roof drain conductor pipe is not clear. Based on observations in the field as well as through study of the original construction documents and the 1954 documents, the roof conductor is routed through a cavity or chase located directly behind the north-facing

FIGURE 3–21. Observation deck level, flat roof with drain and rubber flat roofing.

corner of the pylon. It appears that this roof conductor turns to the east at the second level, where the access door is located, and that there is a cleanout at this bend. The condensate drain line for the dehumidifier is run into this access door, and it is believed that it was connected to the roof drain conductor at this cleanout.

It is believed that the roof conductor once again turns down and runs down to below the terrace level, where it connects with one of the perimeter gutter drains, then daylights out on the east-northeast face of the perimeter plinth wall. It was observed on site that the rain conductor leader turns immediately north at the roof sump. It is indicated to be covered with plaster, but there is no evidence of joints or a change in materials anywhere in this area of pylon. It is believed that the drain pipe may have been cast into the concrete, making access for repair or replacement in-kind impossible.

Condition

The existing flashings and the patching material appear to be in fair condition. The roof drain body is intact and shows no direct sign of wear, damage or leakage. The rain leader and conductor are discussed in the mechanical system sections below. The granite stones around the observation level have open joints on the exterior and at the interior face.

Cupola

The cupola atop the pylon is constructed from stainless steel and glass. The cupola houses a motorized rotating light beacon consisting of a triangular light housing fitted on each side with a circular solid-cast glass Fresnel bullseye lens

FIGURE 3–22. Metal flashing around granite cupola base at observation deck level, facing south.

FIGURE 3–23. Interior of metal and glass cupola, rotating beacon light.

FIGURE 3–24. Beacon attachment and light below, surface staining and rust at metal.

FIGURE 3–25. Exterior of beacon with failed sealant joints and surface rust.

illuminated by what appears to be a mercury-vapor lamp. (Figure 3–23) The equipment is operated by a photosensor with an override switch.

At the interior of the cupola is the rotating light beacon. The metal base sits on a metal beam that is attached into the granite at the top of the pylon. There are light fixtures as well as conduit lines around the area as well. (Figure 3–24)

Condition

The cupola is in fair condition. A broken pane was noted on the northeast quadrant and the broken portion appears to have been covered with clear tape. Glazing materials are cracked and dry but generally intact. The metal work at the interior shows no sign of water staining or other infiltration. On the exterior there is surface rust and the sealant joints at the base of the cupola are deteriorating and cracking. (Figure 3–25)

The beacon appears to be fully operational, although the motor assembly, when activated, is quite noisy, suggesting that there is more mechanical contact and resistance in the assembly than would normally be expected. The metal beam connection to the granite is highly corroded and has produced ferrous staining at the stone face.

There are previous treatment options present including a clear silicone sealant. (Figure 3–24)

Doors

The entry doors to the pylon are polished stainless steel over nickel, with bronze reliefs in each panel depicting flight-related allegories and historical flying machine concepts and fantasies. The panel descriptions starting on the left door from top to bottom are: birds wings and man's inspiration for flight, attempt to fly by threshing the air with paddles, Leonardo da Vinci's innovation of a harness and movable bird wings and the first balloon flight. The panel descriptions at the right

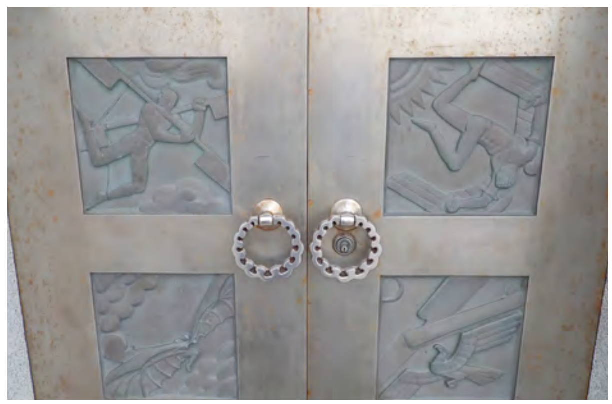

FIGURE 3–27. Close up of entry doors showing reliefs and decorative door pulls.

FIGURE 3–26. Front entry doors with steps going down to the memorial room level.

FIGURE 3–28. Metal doors to roof access.

door from top to bottom are: powered flight, the fall of Icarus, and kite flying. (Figure 3–26)

These doors are set in pivots, with water diverters at the sill rails, a modern changeable-cylinder deadlock on the active leaf with replacement circular doorknobs. (Figure 3–27)

Similar to the entry doors, the observation deck doors are stainless steel paneled doors, with no decorative reliefs in the panels. (Figure 3–28) The active leaf has a lever operating trim which is loose but still generally functional, and a deadbolt cylinder which is missing its changeable core. The inactive leaf is fitted with flush bolts, one of which appears to be original and the other a replacement.

Condition

The entry doors are in fair condition. The hardware is stiff but functional, with major surface corrosion at the hinges. One hinge pin was completely corroded through and broke after the initial survey trip. The door pulls are in good condition and were replaced in 1978. The polished stainless steel surfaces exhibit minor corrosion.

The observation deck doors are also in good condition. The flush bolts appear to be out of alignment and do not extend properly into their mortises, and are difficult to operate. Because of this, the door cannot be properly secured and has been wedged shut with a piece of lumber. Like the entry doors, these doors exhibit minor corrosion.

Terrace/Pedestal

The pedestal walls are also Mount Airy granite, of the same type used on the pylon. The walls consist of a lower retaining wall with a top cap that has

FIGURE 3–30. Gutter drains and previous conduit box location.

FIGURE 3–31. Typical condition of open top joints at terrace wall.

FIGURE 3–29. Terrace wall, gutter and granite pavers.

FIGURE 3–32. Typical condition of spalls at underneath of terrace cap.

a built in gutter that meets the terrace surface. (Figure 3–29) At the end point corners there are circular holes that previously housed conduit. (Figure 3–30) Below the star points and at the centers of the lower portion of the wall are exterior drains and granite splashblocks. (Figure 3–33) At the front (south) of the pedestal are five steps that have curved nose profiles. Two large granite blocks flank the stairs with two non historic granite pillars on top. The metal busts of Orville and Wilbur Wright, originally intended for the interior memorial room niches, are set atop the pillars. (Figure 3–35)

The terrace surface is a loose mosaic pattern of approximately 3-inch cubes of Mount Airy granite, arranged in a concentric pattern. The joints between these pavers are about 1/2 inch wide and filled with buff pea gravel. (Figure 3–34) The original documentation indicates that these terrace pavers should be grout-set on a concrete slab.

The base of the pylon is met by 12-inch-wide granite pavers, creating a border for the mosaic paver stones. The joint between these wide pavers and the stone tower pylon wall is fitted with a flexible expansion joint. (Figure 3–34)

Condition

The pedestal walls are in good condition, with some isolated areas of spall primarily below the drip edge at the exterior face. (Figure 3–32) There are open mortar joints in the copings and some face stones. (Figure 3–31) There is acute displacement of stone units on the easternmost point of the pedestal, exposing the joint filler material used between stones.

The terrace surface pavers are in good condition; however, they can be easily removed by hand, with one missing during the time of the site visit. The surface as a whole is undulating, indicating settlement in the substrates. This also has resulted in inadequate surface drainage restricting some

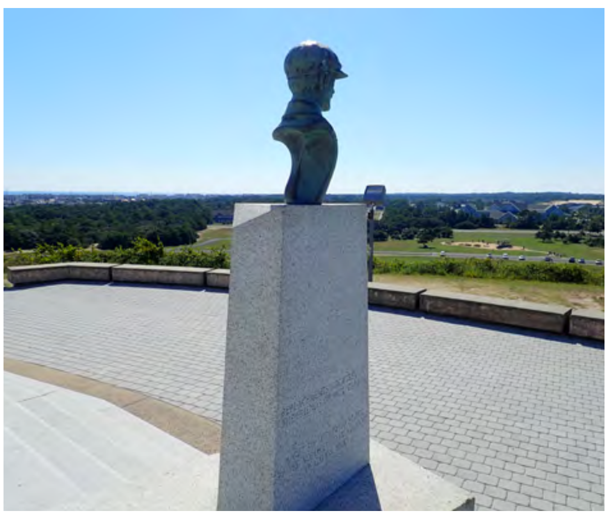

FIGURE 3–35. Close up of bust and granite pillar.

FIGURE 3–33. Exterior pedestal wall drain, appears to be the single one in use.

FIGURE 3–34. Missing terrace granite paver and broken sealant joint at base of the Monument.

TABLE 3-2: EXTERIOR FEATURES			
Features	Evaluation	Date of Origin (if known)	Date of Alteration (if known)
Pedestal Walls	C	1931	
Granite Pavers	C	1931	
Pylon	C	1931	
Cupola	C	1931	
1st Floor Doors	C	1931	
Busts	C	1960's	

** Contributing (C), Noncontributing (NC)* storm water from properly draining to the perimeter gutters. The joint between the wide flat pavers and the base of the tower appears to have no backing and is torn or failed in several locations.

Interiors

Memorial Room (Ground Floor)

Granite Wall and Ceiling Cladding

The memorial room in the pylon interior is clad

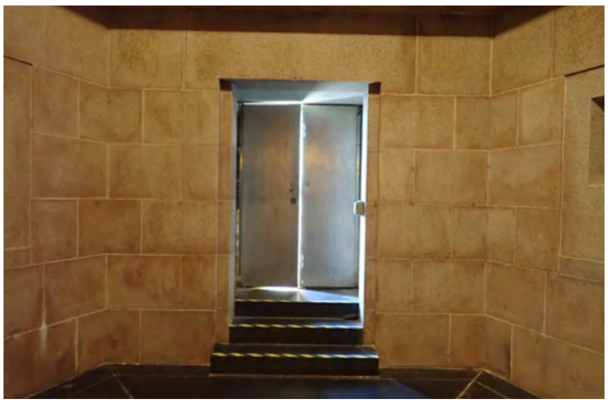

FIGURE 3–36. Interior of Memorial Room, south wall.

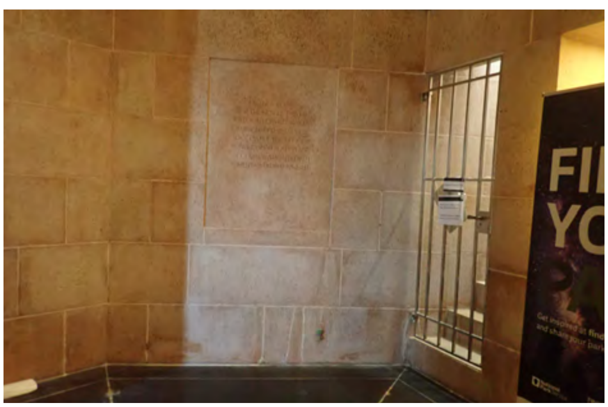

FIGURE 3–37. Interior of Memorial Room, west wall.

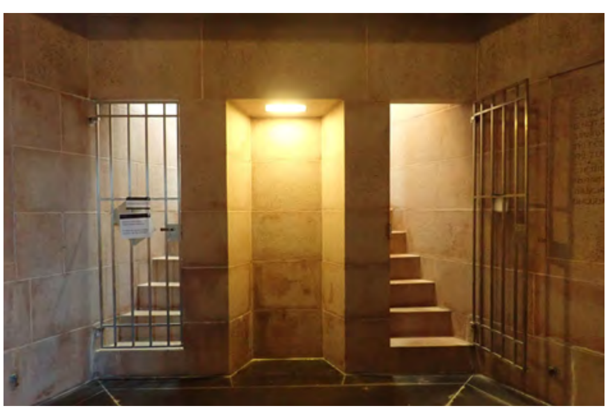

FIGURE 3–38. Interior Memorial Room, rear (north) wall with niche and staircases leading up to the top of the pylon.

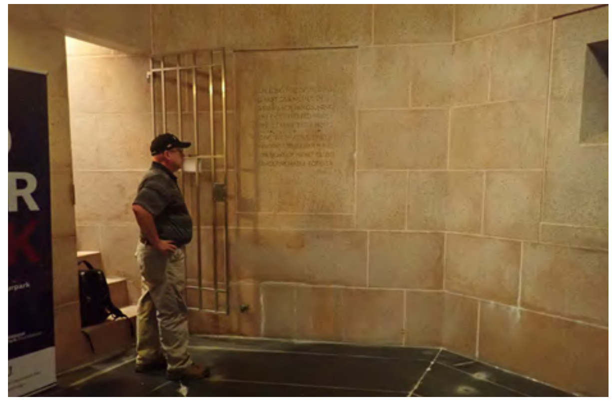

FIGURE 3–39. Interior of Memorial Room, east wall.

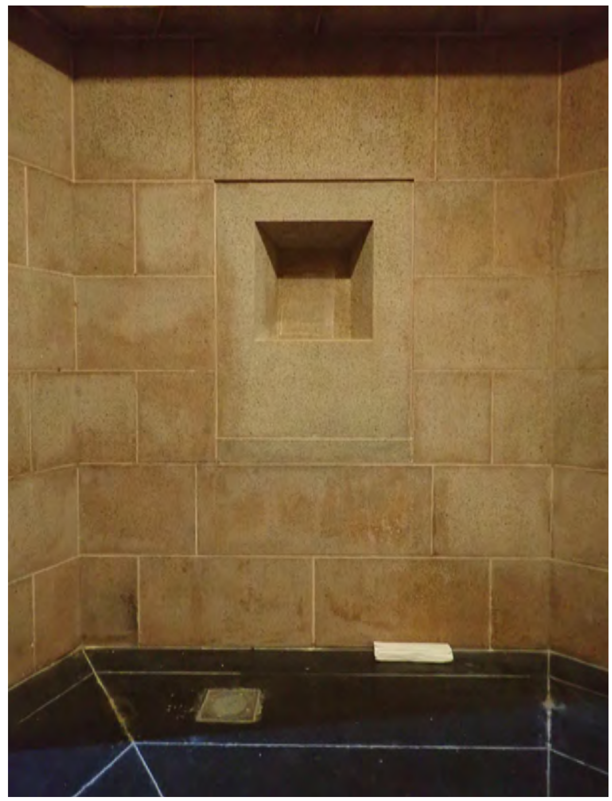

FIGURE 3–40. Interior of Memorial Room, niche for metal busts.

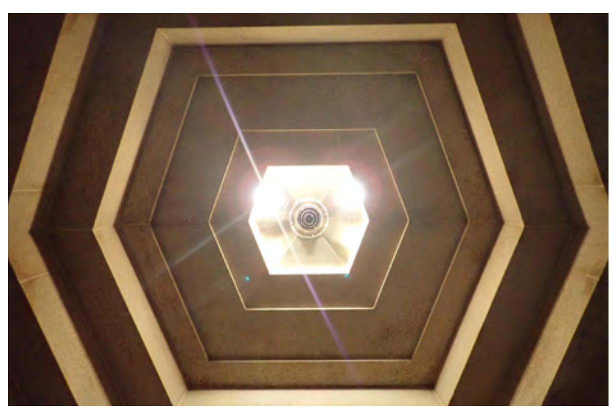

FIGURE 3–41. Hexagonal, corbeling pattern of stone at ceiling of the Memorial Room.

with pink granite blocks jointed in tan mortar, set in a running bond on the walls and corbeled in the ceiling. The room is hexagonal in shape with the two side walls mirroring each other. It is approximately 15’-0” by 16-7” in size with a ceiling height of 15’-9”. (Figure 3–36, Figure 3–37)

There are two existing niches approximately 1’-4” wide by 2’-0” tall and 9 1/2” deep, built into either wall adjacent to the entry door. These niches were originally designed to hold the busts of Orville and Wilbur Wright that are located on piers at the exterior terrace; however, the busts were not completed until the Monument was closed to the public. (Figure 3–40) Adjacent to the two niches, are two large stone panels, 3’-4” wide by 4’-9” tall, with inscriptions. (Figure 3–39) In the center of the rear (north) wall is another niche that is approximately 3’-4” at its widest point by 8’-3” tall and 1’-5” deep. It was originally designed to house a model of an airplane on a pedestal base but is currently not used. (Figure 3–38) At the center of the ceiling is a non historic light with no fixture and a mechanical diffuser. (Figure 3–41)

Condition

At the memorial room interior, the stone work is in good condition overall, exhibiting minor efflorescence in both the stone and mortar joints. At the corbeled ceiling there is efflorescence coming through the joints, the majority along the lower three courses. (Figure 3–43) There is evidence of substantive water infiltration through the wall joints, creating stalactites and mineral stains on the floor below. Occasional holes in mortar joints were observed, either at locations of removed anchorages or holes drilled in the mortar joints as part of investigations related to the 2017 report.

Granite Flooring

The floor of the memorial room is uniform black granite jointed in white mortar. (Figure 3–42) The historic drawings indicated a decorative floor panel at the center of the room that was never built. The joints along the floor follow the same hexagonal pattern as the ceiling.

Condition

The granite flooring is in fair condition, with minor joint deterioration and staining caused by the water-damaged mortar as noted above. There is a

FIGURE 3–42. Typical joint conditions at Memorial Room floor.

FIGURE 3–43. Water staining at joints in ceiling.

FIGURE 3–44. Lights at upper corbeling.

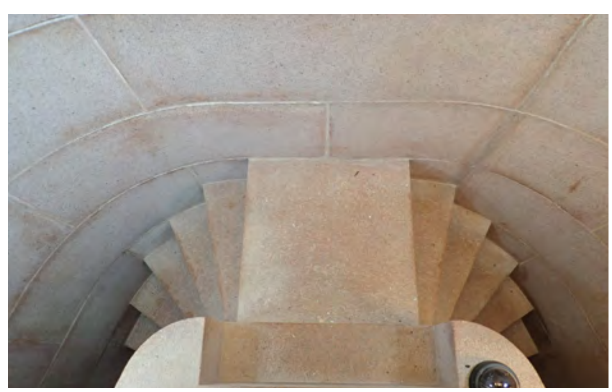

FIGURE 3–45. Landing at double staircase.

surface crack and deteriorated mortar joints .

Staircase

At the memorial room level there are two matching granite stairs that curve around the center of the room at the rear and meet in the middle at a landing, then continue up to Level B as a single stair. These curved stairs are accessed by metal gate doors. The interior gates are stainless steel, with a ward lock and lever trim. There are horizontal lights at each of the granite corbeling above the stairs. These lights appear to be original but were adapted in the 2000 restoration project. (Figure 3–44)

Condition:

The granite staircases are in good condition showing similar signs of damage as the interior walls. There is minor efflorescence in both the stone and mortar joints. (Figure 3–45) There is evidence of substantive water infiltration through the joints, with salt deposit on the wall that is leeching from the stone.

Handrails

Polished stainless-steel metal railings are installed on the granite stairways from the memorial room up to Level B. There are two railings on the interior wall of the two curved stairs that stop at the shared center landing. (Figure 3–47). Then there is another polished stainless-steel metal handrail that continues up to Level B at the straight stair. (Figure 3–46) At the top of level B stair is a small portion of guardrail.

Condition

The handrails are in good condition with no surface rust or deterioration of the brackets. The handrails do not connect between the curved stairs

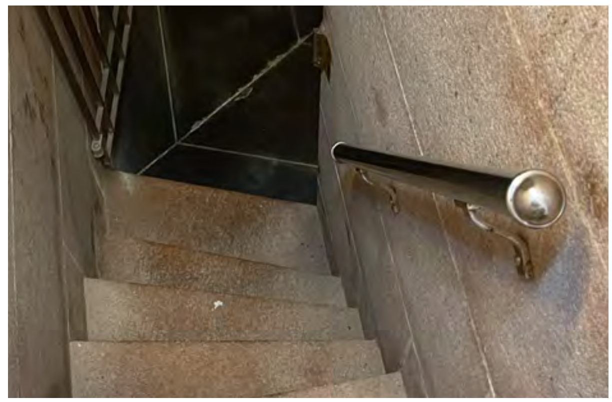

FIGURE 3–47. Granite staircase and metal handrail, going down to the Memorial Room.

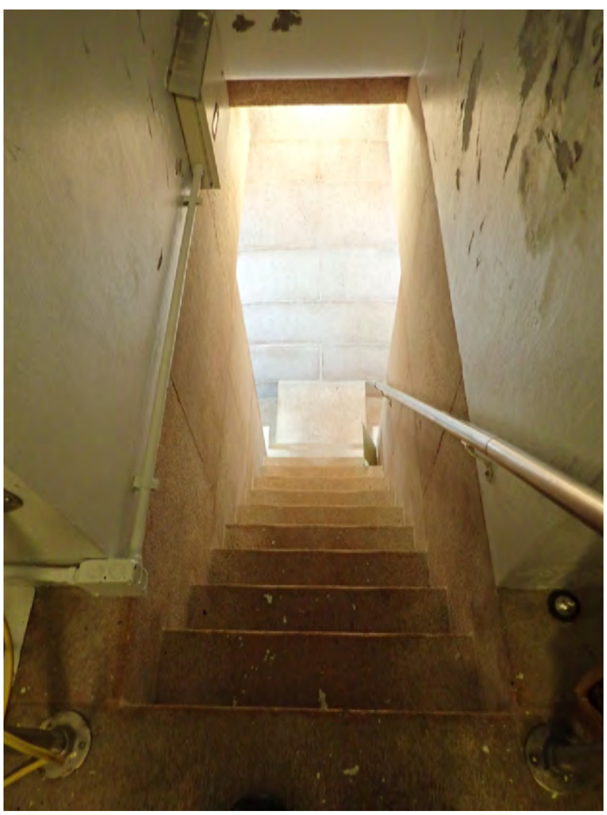

FIGURE 3–46. View from Level B down to the stair landing.

FIGURE 3–48. Center of Level B containing MEP equipment.

and the landing.

Level B

Walls and Ceiling

At the interior of the pylon on Level B, the walls and ceiling transition from pink granite cladding to exposed concrete structure. The concrete surfaces have been painted white.

At the inner stairwell there is an access panel that leads to the condensate line. This was inaccessible at the time of the survey. At the ceiling is a metal light fixture with a globe lantern. It is unknown if this is the original fixture; however, it does match the historic style based on the drawings. (Figure 3–49)

Condition

The concrete at Level B is in good condition with some previous surface spalls. In the stairwell area, the paint is peeling and coming off the surface. (Figure 3–50) There is also a small spall at the

FIGURE 3–49. Typical Art Deco inspired light fixture in both Level B and Level C.

FIGURE 3–50. Paint peeling and popping off at stairwell, below access hatch.

FIGURE 3–51. Surface wear and rust at risers, typical.

FIGURE 3–52. Metal light and mechanical diffuser at center of the floor in Level B.

transition line from granite to concrete at the top of the stairs.

Floor

The floor of Level B is smooth concrete that has also been painted white. Historically in the center of the floor was a metal table platform that held a map which is now stored at the Museum Resource Center at Fort Raleigh NHS on Roanoke Island. This was located directly above the light fixture below. The table and map have been removed to give room to the mechanical system that was installed in 2008. Currently the metal casing and diffuser is visible. (Figure 3–52)

Condition

The concrete at the floor is in good condition. The paint is worn in areas of high traffic.

Staircase

A concrete spiral staircase extends from the second level (Level B) to the third level (Level C). (Figure 3–55) It is cast-in-place concrete with steel anti-slip half treads on the front edge of the risers. At the underside of the stairs the concrete has a rubbed finish. Both the concrete and the metal treads are painted white and were painted originally in the 1950s.

FIGURE 3–55. Concrete stair and metal handrail at Level B to Level C.

Condition

The concrete spiral staircase is in good condition. There is paint wear on the risers due to the traffic going up and down the stairs. (Figure 3–51). The metal treads are showing signs of surface rust that is coming through the paint and staining the surface. There are no surface cracks or spalling of the concrete.

Handrails

There is a polished stainless-steel metal handrail

FIGURE 3–53. Bubbling paint at Level C.

FIGURE 3–54. Peeling and worn paint at intermediate landing in the pylon.

that goes from Level B to Level C at the spiral staircase. The handrails are attached to the face of the interior side of the staircase with metal brackets. As the handrail follows the curve of the stair, it has a angular bend in the path. It is similar in style to the ground floor railings. (Figure 3–55)

Condition

The handrails are in good condition with minimal surface rust or deterioration of the brackets.

Level C

Walls and Ceiling

The walls and ceiling at the intermediate landing of the interior of the pylon (Level C) are all smooth face concrete that have been painted white. At the wall is an existing electrical box that has been retrofitted to house a smaller newer panel. At the ceiling, there is a metal light fixture with a white globe similar to the fixture at Level B.

Condition

The concrete at Level C is in good condition with some previous surface spalls. There are areas at the side wall near the electrical panel that has bubbling and peeling paint. (Figure 3–53) The electrical equipment will be discussed in the section below.

FIGURE 3–56. Steel spiral staircase from Level C to roof.

Floor

The floor of Level C is smooth concrete that has also been painted white.

FIGURE 3–57. View from top of cupola, showing metal spiral staircase, interior joints at top cupola stones.

TABLE 3-3: INTERIORS			
Features	Evaluation	Date of Origin (if known)	Date of Alteration (if known)
Memorial Room	C	1931	
Inscriptions	C	1931	
Light Fixture (Ground)	NC	2000's	
Metal Gates	C	1931	
Curved Stairs	C	1931	
Handrails	NC (Design) C (Material)	1931	2000's
Light Fixtures (Stairs)	C	1931	2000's
Concrete Stair	C	1931	1950's
Stair Handrail	NC (Design) C (Material)	1931	
Light Fixture Level B & C	C	1931	2000's
Steel spiral stair	C	1931	1950's
Spiral stair railing	NC (Design) C (Material)	1931	1950's
Roof Doors	C	1931	2000's

** Contributing (C), Noncontributing (NC)*

Condition

The concrete at Level C is in good condition with areas of worn paint in high traffic locations. The paint is peeling up at the edge of the floor along the rear wall. (Figure 3–54)

Staircase

A steel spiral staircase starts at Level C and continues up to the observation level access landing. The staircase is painted white and was painted originally in the 1950s. (Figure 3–56)

Condition

The steel staircase is in fair condition with surface rust at the treads, landings and anchor connections. The metal support pole at the middle also has surface rust. (Figure 3–57)

Handrails

There is a simple metal handrail with round balusters that is attached to the spiral staircase at the exterior edge of the risers. It follows the curve of the staircase up to the observation level.

Condition

The handrail is in fair condition with surface rust at the top rail. There is no deterioration of the attachment brackets.

Building Systems

Mechanical

The lower level of the pylon, which was the previous visitor center and is open to the public as staffing allows, is served by a dehumidification air conditioning unit which recirculates air inside the pylon as well as brings in fresh outside air from an existing intake louver slot on the southern face of the pylon. (Figure 3–58) The unit was manufactured in 2008, meaning that it is more than halfway through its expected life. It is controlled by a wall-mounted Carell controller. Park Service maintenance staff indicated that they make repairs to the unit as required, but there have not been any major issues with it. Condensate from the dehumidification unit is piped into a small condensate pump on the floor of the mechanical level (referred to as “Level B” on the original drawings), which pumps the condensate overhead

FIGURE 3–58. Existing dehumidification unit.

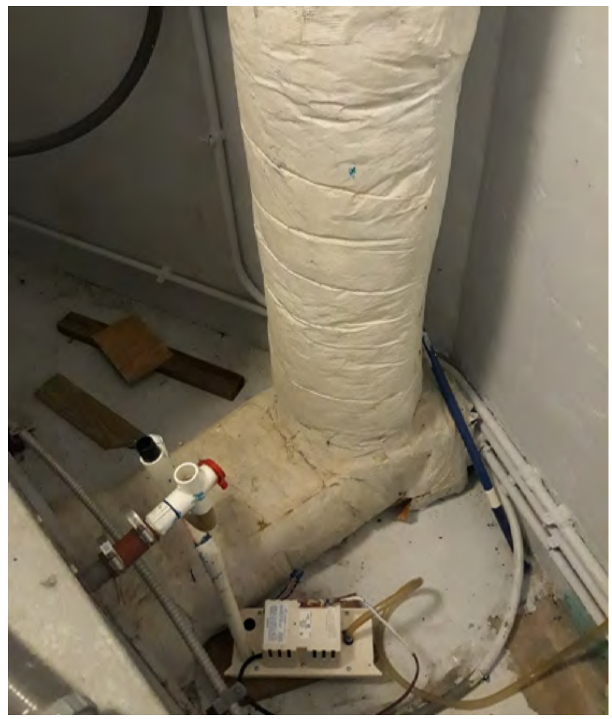

FIGURE 3–59. Dehumidification unit condensate pump and duct work.

FIGURE 3–60. Main Service.

and through an access door. (Figure 3–59)

Condition

The engineer observed that while the supply fan in the dehumidification unit was constantly running, the compressor in the unit did not turn on despite the inside condition of the space being noticeably humid.

Electrical

The main 200-amp service panel is located at ground level in the southeast corner of the platform within a stainless-steel enclosure. (Figure 3–60, Figure 3–61) This panel provides power to the flood lights for the Monument and to the interior 100-amp panel by way of an underground raceway or conduit.

The feeder to the interior panel runs underground and comes up behind, or encased in, the interior walls of the pylon and enters a 24” x 24” junction box located on the third level of the pylon. (Figure 3–62) The feeder then enters a flexible conduit that has been inserted into the original conduit located in the wall and terminates in the panel.

FIGURE 3–61. Opening in Main Service Enclosure.

FIGURE 3–62. 24” x 24” Junction Box.

FIGURE 3–63. Electrical box and repairs at Level C.

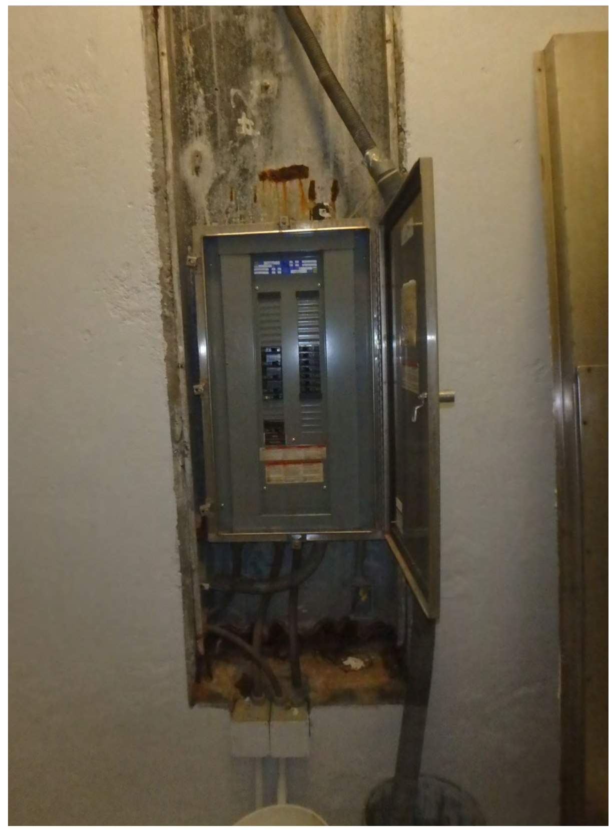

FIGURE 3–64. Old panel metal box, panel rust.

FIGURE 3–65. Panel rust.

The panel was installed within the wall opening for the previous electrical panel. The previous panel enclosure is not contributing to the interior of the Monument. An abandoned conduit located at the top of the opening is providing a path for water from above to enter the conduit leak into the opening. This water is being diverted into 5-gallon buckets by way of a flexible hose to prevent the electrical panel from getting wet. (Figure 3–63, Figure 3–64)

The branch circuits from the third level panel, serving lights and receptacles, are routed within the existing walls to the upper and lower levels through the junction box with the exception of some surface mounted conduit serving new equipment that has been installed to help control the humidity within the pylon. (Figure 3–66) There is also a conductor running from the metal portion of the globe located at the top of the pylon housing the beacon down to the junction box. This is assumed to be a lightning grounding conductor. (Figure 3–67, Figure 3–68, Figure 3–69)

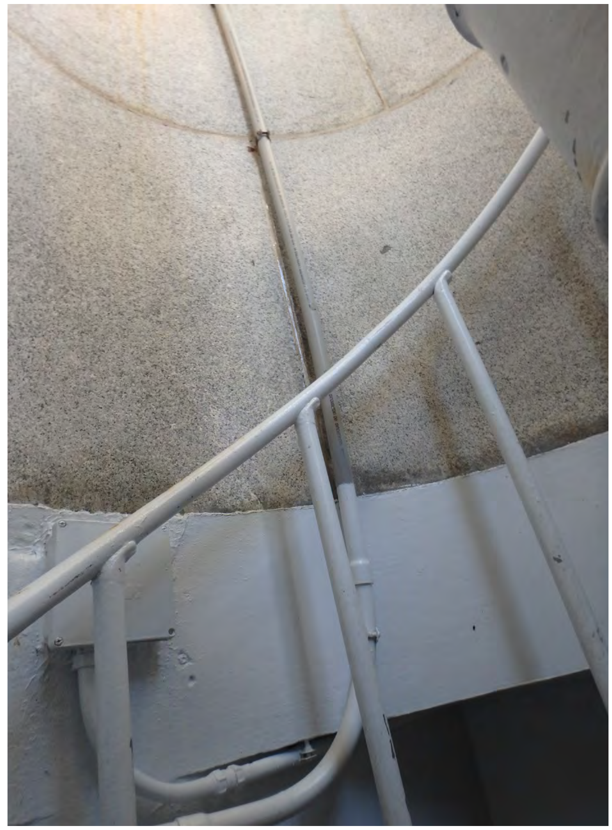

FIGURE 3–67. Lightning grounding conductor.

FIGURE 3–68. Lightning grounding conductor.

Condition

The outdoor enclosure has an empty conduit opening that should be closed or covered with a screen to prevent wildlife and insects from getting into the enclosure.

The panel that sits in an opening of an earlier panel is showing some signs of rust. (Figure 3–65) The walls of this opening are lined with what appears to be the metal box of an earlier panel and is showing signs of decay. An abandoned conduit located at the top of the opening is providing a path for water from above to enter the conduit leak into the opening. This water is being diverted into 5-gallon buckets by way of a flexible hose to

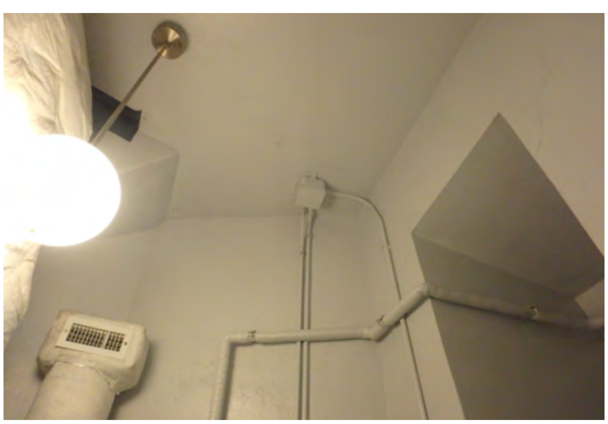

FIGURE 3–66. Branch circuit conduits.

FIGURE 3–69. Lightning grounding conductor.

prevent the electrical panel from getting wet. It has been reported that the lower light switch located at the left stairwell had water pour out of it when the cover was removed. This was most likely due to water entering through this opening and entering the old panel and then following the conduit down to the lower level.

The electrical system seems to be in working order and does not appear to be the source of water entering the structure.

Plumbing

Plumbing systems are limited to area drains on the site terrace and the rain leader serving the observation deck roof. (Figure 3–70) The roof rain conductor is a 3 inch pipe, indicated as brass on original drawings.

Terrace drains are located in gutters along the perimeter of the pedestal, and directly discharge to scuppers through the pedestal retaining walls.

The drain outlet serving the roof rain conductor is located on the east side of the pedestal retaining wall.

Condition

Some of the plumbing outlets at the ground appear to be clogged by landscaping. (Figure 3–72, Figure 3–73)The terrace surface drains along the gutter do not appear to be used with the slope of the surface. (Figure 3–71) There is one storm drain that shows consistent use at the pedestal walls.

FIGURE 3–70. Roof drain and grate at top of pylon.

FIGURE 3–71. Area drain in drain trench at perimeter of deck.

FIGURE 3–72. PVC storm outlet on southwest side.

FIGURE 3–73. Clogged storm outlet at southeast corner.

General Description: Powerhouse

Site

The Powerhouse is located at Wright Brothers National Memorial in Kill Devil Hills, North Carolina, part of the Outer Banks Group of parks. The Powerhouse is located in the rear of the Wright Brothers National Memorial, at the base of the hill below the Monument. It is at a southeast angle to the north/south axis of the Monument but will be referred to in directions and in the drawings at the same axis.

The Powerhouse sits on a flat mown lawn adjacent to the vegetative hill at the south end of the park. (Figure 3–74, Figure 3–75). There are no direct paths leading to the Powerhouse and it is set back far into the lawn. The site extends at the south and west side of the Powerhouse until it reaches the paved parking areas and the circular loop road. To the rear (north) and east of the building is a more wooded portion of the Monument hill. The hill rises from the Powerhouse in a steep slope. (Figure 3–76)

There is a modern electric transformer to the north of the building at the base of the hill. (Figure 3–77). There are also two PVC pipes at the northwest corner of the building that have been enclosed in a wooden box for protection.

Condition

The site at the Powerhouse is in good condition. It consists of primarily mown lawn and vegetated trees. There are areas of worn grass around the Powerhouse due to low mowing, however in general this site is not as highly trafficked as other locations in the park.

Exterior Description and Conditions

The Powerhouse is approximately 11'-9" tall by 12'-0" wide and 12'-0" long. The square-shaped building is constructed of a smooth concrete body with exposed aggregate concrete quoining at the corners. Its appearance is similar in style to that of a small mausoleum, which often can confuse

FIGURE 3–74. Powerhouse site, facing west.

FIGURE 3–75. Powerhouse site, facing southeast.

FIGURE 3–76. Powerhouse and Monument site, (NPS).

FIGURE 3–77. Current electric transformer.

visitors as to its purpose. (Figure 3–78, Figure 3–79)

The body has joint lines that mimic stone while the corners have a rough texture, mimicking hewn stone. There is a concrete cornice and then a parapet with a flat roof on top. At the corners of the parapet are rectangular panels that match the shape of the quoining below.

Foundation

The Powerhouse is built on a concrete foundation that is approximately 4 feet deep set on a concrete footing. Refer to Appendix B.

Condition

The foundation was not visible but is assumed to be in good condition.

Structure

The Powerhouse's primary structure consists of concrete walls, slab floor and foundation. According to the historic drawings the concrete is reinforced with steel rebar throughout the structure.

Condition

The structure appears to be in good condition with no visible signs of deterioration.

Exterior Elevations

The exterior of the Powerhouse is constructed of two types of concrete. There are two windows, one entry door, and two metal vents at the exterior. There are also metal scuppers extending from the flat metal roof.

Elevation South

The south or front elevation faces Colington Road, the parking lot/circle loop road and the December 17th 1903 Sculpture. (Figure 3–80) The south elevation has the entry door that is an eight panel metal door with a metal security gate in front. Above the door is a concrete arch, with pronounced blocks mimicking stone. There is a keystone concrete block at the middle.

Condition

The front (south) elevation is in good condition. There are no visible signs of concrete deterioration and the joints are in good condition with one open joint at the top of the wall above the door. There is some biological growth at the top of the parapet wall.

Elevation East

The east elevation faces the side of the Monument hill and beyond is Highway 158. (Figure 3–81) It has a smooth concrete face with formed joint lines and rough aggregate concrete quoining at the corners. There is a 3'-1 1/2 wide by 4'-6 1/2" tall window centered on the face of the wall that has

FIGURE 3–78. Powerhouse, view from northeast corner.

FIGURE 3–79. Powerhouse, view from southwest corner.

FIGURE 3–80. Powerhouse, front (south) elevation.

FIGURE 3–81. Powerhouse, side (east) elevation.

FIGURE 3–82. Powerhouse, rear (north) elevation.

FIGURE 3–83. Powerhouse, side (west) elevation.

FIGURE 3–84. Powerhouse, close-up of cornice, parapet and quoining.

a concrete sill. There are metal security bars at the window similar to the entry door.

Condition

The side (east) elevation is in good condition. The concrete is in good condition with some superficial surface cracks near the window. There is biological growth and staining along the top of the parapet. (Figure 3–84)

Elevation West

The west elevation faces the open area of lawn and beyond is the airplane landing strip and the wooded side of the park. (Figure 3–83) The east and west elevations on the Powerhouse are identical except for the top of the west elevation where two metal scuppers extend from the flat roof beyond the cornice line.

Condition

The side (west) elevation is in good condition. The concrete is in good condition with some surface cracking near the bottom of the wall and spreading from the window sill. There is ferrous staining from the metal scuppers at the top of the parapet as well as the base of the wall.

Elevation North

The north (rear) elevation faces the back of the hill and the vegetation. It has a smooth concrete face with formed joint lines and rough aggregate concrete quoining at the corners. There are no windows or doors on this elevation but two small louver openings, one in the parapet and the other at the base of the wall, both are centered on the elevation. At the base of the north elevation is a concrete bumpout that housed the generator equipment. At the west end of the bumpout is an earth filled planter and at the east is a man-hole cover. Remnants of abandoned utilities are still attached to the elevation. In front of the bumpout is a modern PVC pipe that appears to be capped. (Figure 3–82, Figure 3–85)

Condition

The rear (north) elevation is in good condition. The concrete is in good condition with one surface crack leading from the lower louver opening. There is atmospheric and biological staining along the lower base, below the cornice and at the

FIGURE 3–85. Powerhouse, rear concrete bump out.

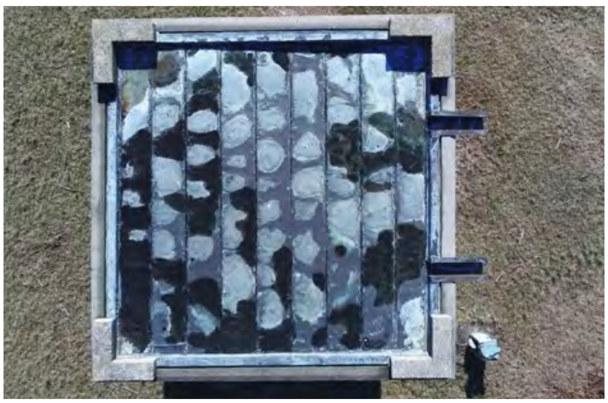

FIGURE 3–86. Powerhouse, view of the roof (NPS).

FIGURE 3–87. Powerhouse, view of front entry door.

parapet. There is some surface spall and cracks at the concrete bumpout. There is grass growing at the earth filled planter.

Roofing

Roofing on the Powerhouse is a concrete deck overlaid with a copper roof membrane. While intensive survey was not possible, drone photography show that there are copper layers and flashing at the top of the roof. (Figure 3–86)

Condition

While there was limited visibility of the roof, it appears to be in fair condition. There is water ponding in the corner locations and staining at areas. The parapet wall is in good condition. The roof and drainage system was repaired and the roof scuppers were replaced in 2000.

Doors

There is one entry door to the Powerhouse on the front (south) elevation. (Figure 3–87) It is approximately 3'-5" wide by 7'-0" tall. The door is metal with eight inset panels and a modern doorknob and deadbolt hardware. On the exterior face of the door is a secondary metal gate door that has hinges set into the concrete surround and is secured by a padlock.

Condition

The entry door is not original and was replaced in 2000. It is in fair condition. There is surface rust along the frame of the door, on multiple of the panels as well as at the base of the door. At the base the metal is deteriorating and sloughing from the surface.

The security bars at the entry door are in fair condition. The metal is in good condition however the black paint has worn off in a majority of the locations. There is some surface rust at the concrete where the security gate hinges are embedded.

Windows

There are two windows at the Powerhouse, one on the east and one on the west elevation. (Figure 3–88) These windows are approximately 3'-1 1/2 wide by 4'-6 1/2" tall and 3'-0" off the ground.

FIGURE 3–88. Powerhouse, view of windows.

FIGURE 3–89. Powerhouse, view of interior (NPS).

They are metal windows with flat muntins and nine panes of glass that are 12" by 16" in size. Both windows have a concrete sill. There are security bars over the windows that match the style of the entry door gate. These security bars are attached to the concrete surround in four locations.

At the rear (north) elevation are two metal louvers. According to the historic drawings the top louver was for outgoing air while the bottom louver was for intake air.

Condition

The windows are not original and they were replaced in 2000. The windows at the Powerhouse are in good condition. The metal frames and glass panes are in good condition with no breakage or surface rust. The metal security bars show similar signs of wear with the black paint having worn off and some of the bottom bars are bent.

Interior

The interior of the Powerhouse was inaccessible to survey; however, NPS provided recent interior photos.

The interior of the Powerhouse is constructed of concrete with a concrete floor, walls and ceiling.

FIGURE 3–90. Powerhouse, view of interior (NPS).

There are existing MEP equipment including plumbing and electrical panels within the space. A large tank is in the corner. (Figure 3–89 to Figure 3–92)

Condition

The interior of the Powerhouse was inaccessible; however, visual inspection from recent photos show that it is in fair condition. The concrete walls have biological growth as well as environmental staining along the walls and floor. The exterior cracks are also visible on the interior along the rear (north) elevation. There is water intrusion present at the floor and along the wall.

FIGURE 3–91. Powerhouse, view of interior (NPS).

FIGURE 3–92. Powerhouse, view of interior (NPS).

Building Systems

Mechanical

There are no current mechanical systems at the Powerhouse. The previous systems have been abandoned and elements of these systems remain in place.

Electrical

There are no current electrical systems at the Powerhouse. The previous systems have been abandoned and elements of these systems remain in place.

Plumbing

There are no current plumbing systems at the Powerhouse. The previous systems have been abandoned and elements of these systems remain in place.

Condition

It is unknown the working condition of the building systems that remain in the Powerhouse building but the physical conditions are fair with surface rust and deterioration.

TABLE 3-4: POWERHOUSE			
Features	Evaluation	Date of Origin (if known)	Date of Alteration (if known)
Exterior Walls	C	1931	
Concrete Quoining	C	1931	
Copper Roof	C	1931	2000’s
Metal Scuppers	C	1931	2000’s
Concrete Bumpout	C	1931	
Door	C	1931	2000’s
Windows	C	1931	2000’s
Security Bars	C	1931	

* *Contributing (C), Noncontributing (NC)*

Significance & Integrity

National Register of Historic Places

The National Register of Historic Places is the official list of the nation's historic places worthy of preservation. Authorized by the National Historic Preservation Act of 1966, the National 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.[1]

To be eligible for inclusion in the National Register, a property must possess significance under at least one of four criteria. The criteria apply to properties

> 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.[2]

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 50 years shall not be 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 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.[3]

1 National Park Service, "National Register of Historic Places," https://www.nps.gov/subjects/nationalregister/index.htm, accessed June 2021.

2 Code of Federal Regulations, Title 36, Part 60, "The National Register Criteria for Evaluation" (36 CFR Part 60).

3 Code of Federal Regulations, Title 36, Part 60, "The National Register Criteria for Evaluation" (36 CFR Part 60).

Status of the Wright Brothers Monument and Powerhouse

The Wright Brothers National Memorial was listed in the National Register of Historic Places in 1978 with additional documentation for the Visitor Center added in 1996-1998 (NR66000071). The nomination notes,

> The commemorative structure, circulation around the Monument, and the important axial relationship between the marker and the Monument were all established before 1941. They represent the realization of the intended commemorative purpose of the park through a formal design under War Department and NPS management. Subsequent development focused on the interpretation of the Wrights' innovations and visitor access through the construction of a new visitor center, circulation system, airstrip, and reconstructed hangar and quarters building in the 1950s and 1960s.

The areas of significance cited in the NRHP nomination are Invention, Architecture, Landscape Architecture, Conservation, and Transportation with a period of significance as 1900-1941, with specific dates of 1900-1903, 1928, 1931-32, 1933, and 1936. Significant people associated with the Wright Brothers National Memorial are listed as Orville Wright and Wilbur Wright. The Wright Brothers National Memorial is also listed as significant under Criteria A, B, and C and Criteria Consideration F with the Wright Brothers Monument and the Monument Powerhouse as contributing resources. The National Register nomination statement of significance states,

> "At Kitty Hawk, North Carolina, on December 17, 1903, Orville and Wilbur Wright changed the technical complexion of the 20th Century. As Orville Wright said, his 12 second, 120 foot flight was the first in which "a machine carrying a man had raised itself by its own power in to the air in full flight and sailed forward without reduction of speed, and finally landed at a point as high as that from which it started."
>
> The Wright brothers needed a place with fairly constant winds in which to carry out their experiments. According to weather bureau records, Kitty Hawk provided their needed winds. The Wright brothers made more than a thousand glider flights from Kill Devil Hill in 1900, 1901, and 1902, improving each model until they were ready to try powered heavier-than-air flight in 1903.
>
> The Wright Memorial Shaft on Kill Devil Hill commemorates the flight, and markers nearby indicate the take-off and landing spots.... The proposals for a memorial to the Wright brothers were introduced by Representative Lindsay C. Warren (NC) and Senator Hiram Bingham (CN) on December 17, 1926. On March 2, 1927, President Calvin Coolidge signed the act "For the erection of a memorial in commemoration of the first successful attempt of a power-driven airplane flight." On December 17, 1928, the 25th anniversary of the first flight, the cornerstone of the memorial shaft was laid. The memorial was completed in mid October 1932 and dedicated on November 19, 1932. The memorial now stands as a token of America's gratitude to the brothers from an airplane-conscious nation."

The 1996-1998 update to the National Register nomination also states that the Monument and the Powerhouse retain their overall integrity of location, design, setting, materials, workmanship, feeling, and association.

A Historic Structure Assessment of the Wright Brothers Monument was completed in August 1996. The Wright Brothers Monument period of significance is not stated in this report but the significance of the Monument is assessed stating,

> The Monument was built in 1931-32 and designed by the New York architectural firm of Rodgers and Poor in the Art Deco style. It is one of two projects explicitly designed with the Art Deco influence that were sanctioned and funded by the federal government. The property is significant because it recognizes and commemorates Orville and Wilbur Wright for their achievements on the site between 1900 and 1911 and the role of the United States in the

development of powered flight and modern aeronautics.[4]

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.[5]

The following list identifies existing character-defining features of the Monument and Powerhouse site.

- Kill Devil Hill
- Curved Paths

The following list identifies existing character-defining features of the Wright Brothers Monument. The list below indicates which features are original, reconstructed using in-kind materials, and/or a mixture of both.

- Star-shaped terrace with granite cobblestones on which the Monument sits including the walls and pavers**
- Art Deco Style with three-sided obelisk form of the pylon*
- Egyptian styled bas-relief pattern of the granite exterior*
- Exterior engravings of "WILBUR WRIGHT ORVILLE WRIGHT" and "IN COMMEMORATION OF THE CONQUEST OF THE AIR BY THE BROTHERS WILBUR AND ORVILLE WRIGHT CONCEIVED BY GENIUS AND ACHIEVED BY DAUNTLESS RESOLUTION AND UNCONQUERABLE FAITH."*
- The busts of Orville and Wilbur Wright.**

4 National Park Service, *Wright Brothers Monument Historic Structure Assessment Report*, United States Department of the Interior National Park, August 1996.

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

- Segmented arched stairs leading to the terrace**
- Double-entry doors constructed of metal with four relief carved panels, depicting scenes related to aviation or flight through an Egyptian style, and decorative metal ring handles.**
- Sunken entry into the Monument with three additional steps down in the interior*
- Cylindrical metal cupola and beacon at the top of the pylon**
- The first floor Memorial Room*
- Black and pink granite interior finishes of the first floor*
- Double-arched staircases leading to a single platform between the first and second floors*
- First floor corbelled ceiling*
- Two inscribed panels in the interior located on the first floor walls*
- Two metal gates at the entrance to the curved stairs.**
- Stairway light fixtures*
- Level B and C light fixtures*
- Concrete and Spiral staircases*
- Roof doors*
- Material of the polished stainless-steel and white metal handrails*

The following list identifies existing character-defining features of the Powerhouse.

- Concrete slab-on-grade foundation*
- Beaux Arts style*
- Concrete quoins of the same dimension at all four corners with sunken fillets between each quoin*
- Two nine-light fixed windows on the east and west elevations***
- Wrought iron bars and gate on the windows

and entry door**

- Recessed eight-panel metal entry door***
- Accentuated cornice*
- Flat roof with solid parapet and sunken fillet quoins*
- Flat arch above the entry door with a projecting keystone*
- Concrete exterior scored to resemble ashlar stonework*
- Metal rectangular vents at the rear, one of which in the elevation and one of which in the parapet***
- Metal scuppers***
- Concrete bump out at rear with a manhole cover to provide access to components of the original generator*

* indicates original materials.

** indicates both original and reconstructed materials.

*** indicates wholly reconstructed materials.

Assessment of Integrity

Assessment of integrity is based on an evaluation of the existence and condition of the physical features that 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 were 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.[6]

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."[7]

The historic integrity of the Wright Brothers Monument has been assessed as follows:

Integrity of Location. The Wright Brothers Monument and Powerhouse maintain their integrity of location, as they remain in the place of original construction in 1931-1932.

Integrity of Design. The Monument and Powerhouse maintain integrity of design. Character-defining features of the Monument and Powerhouses design, such as the star-shaped terrace, Art Deco and Beaux Arts styles and detailing, massing, granite stone and concrete, inscriptions, Monument entry components, and Monument interior finishes remain as originally designed and constructed. The remainder of the character-defining features are either a mix of original and reconstructed or newly reconstructed to match the original design, and as such, still retain their integrity of design.

Integrity of Setting. Integrity of setting of the Wright Brothers Monument and Powerhouse as a part of the Wright Brothers National Memorial

6 National Park Service, *National Register Bulletin: How to Apply the National Register Criteria for Evaluation*, 44-45.

7 National Park Service, *National Register Bulletin: How to Apply the National Register Criteria for Evaluation*, 44-45..

(originally named Kill Devil Hill Monument) has been altered from the original configuration constructed by the War Department. The changes to setting made by the National Park Service in the 1940s including the curvilinear walkways, outer paths leading to the Monument, and the change of the park entrance location have acquired their own historic significance to the Monument and Powerhouse setting over the last approximately 80 years. Although the setting has changed from the original design and construction, the integrity of setting for the Monument and Powerhouse are still maintained.

Integrity of Material and Workmanship. The Wright Brothers Monument and Powerhouse maintain integrity of materials and workmanship as the original Art Deco and Beaux Arts designs and original Mt. Airy granite used in the construction of Monument are still extant. Maintenance repairs, stabilization, and rehabilitations of the Monument and Powerhouse have taken place over the years but have not altered the integrity of the structures. The Powerhouse has slightly diminished interior material integrity due to the removal of generating equipment but still retains exterior and interior finish material integrity.

Integrity of Feeling. The Wright Brothers Monument and Powerhouse maintain their integrity of feeling. The Monument was originally built as a commemorative structure and continues to be used as such. The Powerhouse was originally built to power the beacon atop the Monument, but was decommissioned in 1954. Even though the Powerhouse is no longer used for its original intended purpose, the floor plan and relation of the exterior to the interior space is still extant. The buildings convey the historic character and contribute to the sense of place as a commemorative structure to the Wright Brothers National Memorial.

Integrity of Association. The Wright Brothers Monument and Powerhouse retain integrity of association as an example of commemorative structure built in the Art Deco and Beaux Art styles.

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Treatment and Use

Requirements for Treatment

The treatment and use of the Wright Brothers Monument and Powerhouse must be considered within a framework of applicable laws, agreements, and policies. These mandates govern a wide range of management issues beyond the preservation, protection, and interpretation of the Wright Brothers National Memorial's cultural resources. They extend to issues of visitor and staff use, agricultural lease safety, and universal accessibility, among others. Additionally, the Wright Brothers National Memorial Foundation Document is discussed below.

Wright Brothers National Memorial Foundation Document

A foundation document is a park's core mission "to provide basic guidance for all planning and management decisions—a foundation for planning and management." The document includes the definition of the park purpose, the park significance statements, primary interpretive themes, fundamental resources and values, and special mandates.[1]

Park Purpose:

The purpose of the Wright Brothers National Memorial is to commemorate the first successful power-driven airplane flight, which was made by Wilbur and Orville Wright at Kitty Hawk, North Carolina, on December 17, 1903.[2]

Park Significance: This section identifies three reasons why the park's resources are significant enough to warrant national park designation. The three significance statements are as follows:

- Wright Brothers National Memorial is the site of the first-ever powered, controlled, heavier-than-air flights, made on December 17, 1903, by Wilbur and Orville Wright.
- The presence of steady wind, massive dunes, unobstructed open space, isolation, and soft sand were instrumental in the selection of the site where the Wright brothers tested, perfected, and implemented the basic principles of flight, launching an era of aeronautical development that revolutionized human transportation.
- The Wright Brothers Monument and associated commemorative landscape, including the take-off point and path of the four powered flights of December 17, 1903, perpetuate the memorialization of Orville and Wilbur Wright for their conquest of the air and the significance of their dream, vision, and achievement.[3]

Primary Interpretive Themes: This section is based on the stated park purpose and significance.

Topic: The Wright Brothers of Dayton – The Wright brothers' extraordinary accomplishments were made possible by a unique combination of factors, including problem-solving, ingenuity, intellectual tenacity, discipline, conviction, and perseverance that continues to offer perspective and inspiration today, and to invite reflection on the characteristics that lead to the achievement of success.

Topic: Why Kitty Hawk? – The human and geographic advantages of Kitty Hawk combined to make this the ideal site for the Wright brothers' experiments, reminding us of the ways that physical and cultural geography shapes human events.

Topic: Achieving Flight – By methodical research, a deliberate engineering approach, and years of experimentation, the Wright brothers discovered

1 National Park Service, *Foundation Document Wright Brothers National Memorial, North Carolina,* United States Department of the Interior, July 2017, 2.

2 National Park Service, *Foundation Document Wright Brothers National Memorial, North Carolina*, 5

3 National Park Service, *Foundation Document Wright Brothers National Memorial, North Carolina*, 6.

the fundamental principles of powered flight, ushering in an era of technological development that broke mankind's bonds to earth.

Topic: Commemorating the Wrights – Wright Brothers National Memorial commemorates the inaugural flights made by Wilbur and Orville Wright on December 17, 1903, after years of hard work and scientific research—a tenacious process of invention that inspired continuing global achievement in flight technology and celebration of the power of human achievement.

Topic: Global Impact – The Wright brothers' invention of powered flight fundamentally affected the evolution of world civilization.

Topic: Changing the Outer Banks – The local grassroots effort to honor the Wright brothers' achievements at Kitty Hawk demonstrates the strength and impact of citizens working together to achieve dreams. The effort fundamentally changed the community in ways that continue to have an impact today.

Topic: Preservation and Stewardship – Preservation and stewardship of Wright Brothers National Memorial's natural and cultural resources is critical so that future generations can access, enjoy, value, and learn from these valued resources.[4]

Fundamental Resources and Values: This section identifies attributes which "warrant primary consideration during planning and management processes because they are essential to achieving the purpose of the park and maintaining its significance." The Wright Brothers Monument is identified as a fundamental resource.[5]

Outer Banks Group Climate Action Plan

On September 29, 2015, the Climate Action Plan for Cape Hatteras National Seashore and the other parks of the Outer Banks Group was finalized.[6] The plan acknowledges that climate change threatens the cultural and natural resources which the NPS strives to preserve. Directives and guidelines provide information on how to take action through adaptation and mitigation to climate changes. These directives and guidelines include the following, among others:

- Executive Order No. 13693: "Planning for Federal Sustainability in the Next Decade"
- Green Park Plan (NPS)
- 2012-2014 Climate Change Action Plan (NPS)
- Climate Change Response Strategy (NPS)

The plan further defines strategies that CAHA enact to meet required mitigation and adaptation goals. These include:

1. Reduce greenhouse gas emissions resulting from activation by operations
2. Increase climate change education and outreach
3. Actions for adapting cultural and natural resources to a changing climate

Strategy 3 most directly affects the Wright Brothers Monument and Powerhouse. It further states:

> Climate change threatens the cultural and natural resources that the Outer Banks Group is known for and so the Outer Banks Group has considered actions to take to adapt to climate change. In the context of climate change, adaptation is an adjustment in natural or human systems that moderates harm or seeks out beneficial opportunities in response to change. Adaptation may include a variety of social, economic, or ecological responses such as adapting the location, structure, or function of Outer Banks Group facilities in anticipation of climate change. Given the potential impact from climate change, it is important to closely monitor cultural and natural resources and identify those that are most at risk. From this identification, the Outer Banks Group can work towards reducing the risk or documenting the resources to try and keep a record of them.

A Coastal Hazards & Sea-Level Rise Asset Vulnerability Assessment was completed in May

4 National Park Service, *Foundation Document Wright Brothers National Memorial, North Carolina*, 9.

5 National Park Service, *Foundation Document Wright Brothers National Memorial, North Carolina*, 7.

6 National Park Service, U.S. Department of the Interior, *Cape Hatteras National Seashore, Wright Brothers National Memorial, & Fort Raleigh National Historic Site, Climate Action Plan,* Signed September 29, 2015, accessed on February 25, 2022. https://www.nps.gov/subjects/climatechange/upload/CAHA-CFP-Action-Plan-508Compliant.pdf.

2018 for Cape Hatteras National Seashore, Wright Brothers National Memorial, and Fort Raleigh National Historic Site by the National Park Service and Western Carolina University. This assessment analyzed a total of 226 structures (buildings, shelters, Monuments, and amphitheaters) along with 202 transportation assets (roads, road segments, parking lots, piers, docks, access ramps, road turnouts, boardwalks/platforms, etc.) for a timeframe of approximately 35 years (to the year 2050). The Wright Brothers Monument and Powerhouse are shown in this study to have minimal exposure risk to coastal hazards and sea-level rise based on flooding potential, extreme event flooding, sea-level rise inundation, shoreline change, and reported coastal hazards.[7]

Adaptation

1. Incorporate climate adaptation into all levels of NPS planning
    - Monitor resources for climate impacts
    - Develop management strategies to increase the adaptive capability of park resources and facilities
    - Identify species and resources most at risk
    - Conduct climate science within parks

Evaluate Progress and Identify Areas for Improvement

By taking the actions established in the goals above, the Outer Banks Group plans to reduce its emissions to the specified goals. Achieving these goals will require an ongoing commitment by the Outer Banks Group, which may include subsequent emission inventories, additional mitigation and adaptation actions, and reevaluation of goals. Presented below are the actions that the Outer Banks Group will pursue.

Monitoring - Planning Actions

1. Monitor progress with respect to reducing emissions and use this to drive continual performance
    - Track progress on climate friendly actions through the environmental management system

National Historic Preservation Act

The 1966 National Historic Preservation Act (NHPA), as amended, established programs for the preservation of historic and cultural properties, including buildings, landscapes, and archeological sites. Its implementation has established laws and authorities that are binding on the NPS.

Section 106 and 110

Section 106 of the NHPA requires a consultative process prior to any federal agency undertaking, or federal involvement in an undertaking, that might affect historic properties listed or eligible for listing in the National Register of Historic Places. The regulations are codified at 36 CFR Part 800, "Protection of Historic Properties." The agency must initiate consultation; identify and evaluate historic properties; assess effects to historic properties; take steps to avoid, minimize, or mitigate adverse effects; and give the Advisory Council on Historic Preservation "a reasonable opportunity to comment with regard to such undertaking."

Section 106 strives to ensure that all interested parties have a voice in the preservation of our nation's cultural heritage. The published regulations require, among other things, consultation with State Historic Preservation Officers (SHPOs) and other appropriate parties, which may include local governments, government or nongovernment applicants, Tribal Historic Preservation Officers (THPOS) and tribal leaders, other parties, the general public, and the Advisory Council.

The regulations establish criteria under which the Advisory Council may comment, but the vast majority of federal undertakings do not involve Advisory Council review.

A programmatic agreement among the Advisory Council for Historic Preservation, the National Conference of State Historic Preservation Officers, and the NPS expedites the Section 106 review process. With certain conditions, routine repairs and maintenance that does not alter the appearance of the historic structure or involve

7 National Park Service, *Outer Banks (PBX) Group Coastal Hazards & Sea-Level Rise Asset Vulnerability Assessment*, United States Department of the Interior, May 2018, 9-15.

widespread or total replacement of historic features or materials are not subject to review outside the NPS.

Section 110 of the NHPA clarifies the broad historic preservation responsibilities of Federal agencies with the intention of ensuring that historic preservation is fully integrated into the ongoing programs of all Federal agencies by identifying, protecting, and avoiding unnecessary damage to historic properties. Additionally, each agency is required to use historic properties available to it and when managing these properties, must consider preservation of their historic, archeological, architectural, and cultural values.

Executive Order No. 11593

Executive Order No. 11593: Protection and Enhancement of the Cultural Environment (1971) mandates that "the Federal Government shall provide leadership in preserving, restoring, and maintaining the historic and cultural environment of the Nation."[8] Responsibilities of federal agencies include:

- Nominating "…to the Secretary of the Interior all sites, buildings, districts, and objects under their jurisdiction of the control that appear to qualify for listing on the National Register of Historic Places."
- Exert caution "…during the interim period until inventories and evaluation…are completed to assure that any federally owned property that might qualify for nomination is not inadvertently transferred, sold, demolished, or substantially altered."
- "Initiate measures to assure that where as a result of Federal action or assistance of a property listed on the National Register of Historic Places is to be substantially altered or demolished, timely steps be taken to make or have made records, including measured drawings, photographs, and maps, of the property, and that copies of such records then be deposited in the Library of Congress ad part of the Historic American Buildings Survey or Historic American Engineering Record for future use and reference."
- "Initiate measures and procedures to provide for the maintenance, through preservation, rehabilitation, or restoration, of federally owned and registered sites professional standards prescribed by the Secretary of the Interior."

Executive Order No. 13006

Executive Order No. 13006: Locating Federal Facilities on Historic Properties (1996) mandates that "the Federal Government shall utilize and maintain, wherever operationally appropriate and economically prudent, historic properties and districts…." Furthermore, "any rehabilitation or construction that is undertaken pursuant to this order must be architecturally compatible with the character of the surrounding historic district or properties."[9]

Secretary of the Interior's Standards

The Secretary of the Interior's Standards for the Treatment of Historic Properties articulate best practices for protecting a wide range of historic properties. They provide a philosophical rationale for historic preservation that is almost universally accepted in the United States and applies to a wide variety of resource types, including buildings, sites, structures, objects, and district. Revised in 2017, the Standards are codified at 36 CFR Part 68.

Treatment of the Wright Brothers Monument and Powerhouse is to be guided by The Secretary of the Interior's Standards for Historic Preservation Projects.[10] The Standards describe four broad approaches to the treatment of historic properties: Preservation, Rehabilitation, Restoration, and Reconstruction. Descriptions of the four standards 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

8 A copy of this E.O. can be found on the NPS's website at (http://www.nps.gov/history/history/online_books/anps/anps_7b.htm).

9 A copy of this agreement is located on the ACHP's website at (http://www.achp.gov/EO13006.html).

10 Kay D. Weeks and Anne E. Grimmer, *The Secretary of the Interior's Standards for the Treatment of Historic Properties, with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings* (Washington, DC: National Park Service, Technical Preservation Services, rev. 2017).

of historic materials and features rather than extensive replacement and new construction. New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project.[11]

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.[12]

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.[13]

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.[14]

Because the Wright Brothers Monument and Powerhouse stand intact, reconstruction is not a treatment consideration.

Director's Order 28

Director's Order 28 is the NPS Cultural Resources Management Guideline, which requires planning for the protection of cultural resources on park property.

11 Preservation Treatment Standards, www.nps.gov/tps/standards/four-treatments/treatment-preservation.htm.

12 Rehabilitation Treatment Standards, www.nps.gov/tps/standards/four-treatments/treatment-rehabilitation.htm.

13 Restoration Treatment Standards, www.nps.gov/tps/standards/four-treatments/treatment-restoration.htm.

14 Reconstruction Treatment Standards, www.nps.gov/tps/standards/four-treatments/treatment-reconstruction.htm.

Americans with Disabilities Act of 1990 and Architectural Barriers Act of 1968

The 1990 Americans with Disabilities Act (ADA) established comprehensive civil rights protection for disabled Americans, both in employment and in their right to free, unaided access to public buildings.

In 1968 Architectural Barriers Act (ABA) applies to facilities designed, built, altered or leased with certain federal funds. The law is intended to provide unaided access to federal buildings. While people with restricted mobility have most benefited, the protections of ADA and ABA extend to those with impaired vision, hearing, or other disabilities.

Requirements for full compliance with ADA and ABA regulations are extensive and easiest to apply to new construction. Full compliance for historic buildings is more difficult. When a project would require significant alterations to their historic character, the regulations authorize a process for arriving at alternatives that can preserve historic character while maximizing disabled visitors' access.

Further exploration of implications for the Wright Brothers Monument and Powerhouse site and facilities accessibility will be developed in the sections to follow.

Director's Order 42

Director's Order 42 concerns the NPS goal to ensure that all people have the highest reasonable level of accessibility to NPS programs, facilities, and services in conformance with relevant regulations and standards. The level of accessibility to be provided will be consistent with the obligation to conserve park resources and preserve the quality of the park's experience. A fundamental principal of the order is to "seek to provide the highest level of accessibility that is reasonable, and not simply provide the minimum level that is required by law. Consequently, managers are encouraged to exceed the requirement for visitor accessibility through innovative techniques and partnerships whenever possible and reasonable."

The five objectives of the Director's Order are:

- Incorporate the long-range goal of providing the highest level of accessibility that is reasonable for people of all abilities in all facilities, programs, and services, instead of providing "separate" or "special" programs;

- Implement this goal with the daily operation of the NPS, its policies, organizational relationships, and implementation strategies;
- Provide further guidance and direction regarding the NPS interpretation of laws and policies;
- Establish a framework for the effective implementation of actions necessary to achieve the highest level of accessibility that is reasonable; and,
- Ensure the implementation of "universal design" principles within the national park system.

International Building Code

According to the 1988 Amendment to the Public Building Act, any building constructed or altered by a Federal agency must, "to the maximum extent feasible, be in compliance with one of the nationally recognized model building codes and with other applicable nationally recognized codes." The International Building Code (IBC) is one of the allowable recognized model building codes.[15]

Treatments of the structure and its site may be guided by the following codes:

- International Building Code (IBC), 2018
- International Existing Building Code (IEBC), 2018
- International Energy Conservation Code (IECC), 2018
- International Plumbing Code (IPC)
- National Electrical Safety Code (NESC)
- National Fire Protection Association (NFPA) Code 914
- NPS Guiding Principles of Sustainable Design

The NPS is not legally bound to local or state building codes. The 2018 IBC and its appendices, as well as the 2018 IEBC with appendices and Resource A, are currently referenced by the NPS Denver Service Center for design and construction.

The National Fire Protection Association (NFPA) has promulgated codes for historic buildings, most notably NFPA 909, "Code for the Protection of Cultural Resources Properties – Museums, Libraries, and Places of Worship," and NFPA 914, "Code for Fire Protection of Historic Structures." As a matter of policy, NPS provides a reasonable level of fire protection for all historic buildings and structures.[16]

Threats to public health and safety must be eliminated, but alternative ways to prevent them are always sought when full code compliance would needlessly compromise the integrity of the historic building.

Consulting with the NPS Branch Chief of Structure Fire located at the National Interagency Fire Center (NIFC) in Boise, Idaho regarding the requirements of fire protection for the historic structures is recommended. NPS Regional Structural Fire Managers (RSFMs) are also responsible for NPS structural fire program management within their regions and should also be consulted.

NPS Management Policies

NPS General Management Policies (2006), especially chapter 5, "Cultural Resource Management," guide its oversight of historic properties. Based on the authority of some nineteen Acts of Congress and many more Executive Orders and regulations, these policies require planning to ensure that decision-making and priority-setting processes integrate information about cultural resources and consultation and collaboration with outside entities. These also support good stewardship to ensure that cultural resources are preserved and protected, receive appropriate treatments (including maintenance), and are made available for public understanding and enjoyment.

Section 5.3.5, Treatment of Cultural Resources

This section of NPS General Management Policies

15 The General Services Administration has more information on this amendment and other accepted building codes at (http://www.gsa.gov/portal/content/101288).

16 NPS Structural Fire Reference Manual 58, 2015, https://www.nps.gov/subjects/fire/upliad/reference-manual-58.pdf.

provides specific directives, including a stipulation that "the preservation of cultural resources in their existing states will always receive first consideration."

It also states:

> ... treatments entailing greater interventions will not proceed without the consideration of interpretive alterations.... Pending treatment decisions reached through the planning process, all resources will be protected and preserved in their existing states. Except for emergencies that threaten irreparable loss without immediate action, no treatment project will be undertaken unless supported by an approved planning document appropriate to the proposed action. (p.50)

The park's *Long Range Interpretive Plan* (LRIP) is an example of an approved planning document. HSRs and CLRs are intended to inform the planning process.

Park Planning Documents Addressing Treatment of the Wright Brothers Monument and Powerhouse

1997 Historic Resource Study (HRS)

A historic resource study was prepared by the NPS Southeast Regional Office in 1997. About the Wright Brothers Monument, Powerhouse and adjacent site, the report says:

> No structures from the 1900 to 1903 Wright Brothers site remain. Most of the resources from the commemorative period, 1926 to 1941, including the Wright Brothers Monument and the First Flight Marker, have been protected and should be included in the visitor experience at the park.
>
> The area defined by the location of Kill Devil Hill, the Monument, the marker, the Powerhouse, the Monument's curving trails and circular road, and the spatial relationship between the Monument and the marker represents the historic commemorative zone of the park. Every effort should be made to protect and interpret these resources as the remaining elements of the first commemoration of the Wright brothers' work. No alterations or additions should be made in this area that detract from the commemorative core. Especially significant is the vista along the axis from the Wright Brothers Monument to the First Flight Marker. The existing vegetation adjacent to the commemorative zone is not historically significant and can be manipulated in order to reinforce the memorial space or to screen out undesirable views to adjacent development. Refocusing the visitor experience on the Monument and marker should include reopening the Monument to visitor access and utilizing the series of curving trails on the Monument hill. Traffic on the circular drive may be restricted, but removable bollards or chains are preferable to the construction of more permanent gates. Every effort should be made to use the historic material for resurfacing the roads and materials.[17]

2002 Cultural Landscape Report (CLR)

A CLR was prepared by the NPS Southeast Regional Office in 2002. About the Wright Brothers Monument, Powerhouse, and surrounding site of Kill Devil Hill, the report recommends to:

- Establish a path on the east side of the Monument (the NE secondary connecting path) to match the path added on the west side, keeping the design symmetrical.
- Improve the Monument plaza, which is currently a wide asphalt landing at the base of the Monument steps. The new work would begin at a place on the existing path near the Monument flood-lights. The path will incorporate materials used on the Monument terrace, including granite pavers, stone, and/or concrete. An 18-inch seat wall may define the outside edge of the plaza in order to provide seating and definition to an area with a steep topographic change.[18]

Since the CLR was published, the Wright Brothers National Memorial has completed the recommendations of the additional NE path in ca. 2005 and improved the Monument plaza in 2008.

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17 William R. Chapman and Jill K. Hanson, *Wright Brothers National Memorial Historic Resource Study,* National Park Service Southeast Field Area (Atlanta, GA: January 1997), 71.

18 Susan L. Hitchcock, Wright Brothers National Memorial Cultural Landscape Report, National Park Service Southeast Regional Office (Atlanta, GA:2002), 79.

Ultimate Treatment and Use

Guidelines for Treatment

The National Park Service has administratively determined the Management Category for Ultimate Treatment as ***Preservation*** (Stabilization) for the Monument, and ***Rehabilitation*** for the Powerhouse. Preservation was selected for the Monument to preserve the character defining features of the nationally significant structure. Preservation additionally establishes the framework for necessary improvements to prevent intrusion of bulk water into the structure while meeting the long-range interpretive and use goals of the facility which is to remain as a monument and open to visitors. Rehabilitation was selected for the Powerhouse to provide flexibility for the development of a compatible use function.

Standards and Guidelines for the Preservation Management Category are as follows:

Standards for Preservation[19]

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

Guidelines for Preservation[20]

Guidelines for ***Preservation*** treatment are enumerated in the Secretary of the Interior's Standards for the Treatment of Historic Properties. The guidelines are sequential in terms of hierarchy of import and logical order of operation and are given thusly:

- Identify, retain, and preserve historic materials and features
- Stabilize deteriorated historic materials and features as a preliminary measure
- Protect and maintain historic materials and features
- Repair (stabilize, consolidate, and conserve) historic materials and features
- Limited replacement in-kind of extensively deteriorated portions of historic features

19 The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, & Reconstructing Historic Buildings, U.S. Department of the Interior, National Park Service, Technical Preservation Services, 2017, 28.

20 The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, & Reconstructing Historic Buildings, U.S. Department of the Interior, National Park Service, Technical Preservation Services, 2017, 29-30.

- Code-related work: Accessibility and Life Safety
- Resilience to natural hazards
- Sustainability (codified as part of Rehabilitation treatment guidelines, but can help guide Preservation treatment)

Standards and Guidelines for the Rehabilitation Management Category are as follows:

Standards for Rehabilitation[21]

1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces and spatial relationships.
2. The historic character of a property will be retained and preserved. The removal of distinctive 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. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.
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. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.
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.
9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work will be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.
10. New additions and adjacent or related new construction will be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Guidelines for Rehabilitation[22]

Guidelines for ***Rehabilitation*** treatment are enumerated in the Secretary of the Interior's Standards for the Treatment of Historic Properties. The guidelines are sequential in terms of hierarchy of import and logical order of operation and are given thusly:

- Identify, retain, and preserve historic materials and features
- Protect and maintain historic materials and features
- Repair (stabilize, consolidate, and conserve) historic materials and features
- Replace deteriorated historic materials and features
- Design for the replacement of missing historic features
- Alterations (in order to ensure continued use, without radically altering character-defining

21 The Secretary of the Interior's Standards for the Treatment of Historic Properties, 76.

22 The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, & Reconstructing Historic Buildings, U.S. Department of the Interior, National Park Service, Technical Preservation Services, 2017, 77-79.

materials and features)

- Code-related work: Accessibility and Life Safety
- Resilience to natural hazards
- Sustainability
- New exterior additions and related new construction

National Park Service, Technical Preservation Service Guidelines

All treatment recommendations shall follow the preservation standards[23] set by the National Park Service including, but not limited to, the following briefs:

- Preservation Brief #1 – Cleaning and Water-Repellent Treatments for Historic Masonry Buildings
- Preservation Brief #2 – Repointing Mortar Joints in Historic Masonry Buildings
- Preservation Brief #4 – Roofing for Historic Buildings
- Preservation Brief #15 – Preservation of Historic Concrete
- Preservation Brief #32 – Making Historic Properties Accessible

Treatment Recommendations

Monument Recommendations: Preservation (Stabilization)

Introduction and Goals

For the Monument, the NPS administratively determined Management Category is "Must Be Preserved and Maintained" and the Ultimate Treatment is ***Preservation*** (Stabilization). This treatment allows for the efforts necessary to preserve, maintain, and repair historic materials and features; permits minor modifications as needed to address new information regarding historic integrity, and to meet the needs of contemporary interpretation. The Preservation treatment retains historic features, and allows selective restoration of character-defining elements where missing or altered, when appropriate archival or physical documentation is available. Thus, the goals of Monument's treatment recommendations are to abide by and reinforce the standards set forth in its assigned Management Category.

Rehabilitation focuses on work towards a compatible use for a property, and is likely not a viable designation for the Wright Brothers Monument since the intent of the Park is to return the Monument to its original full public ground level access and not introduce a compatible, though ultimately different, use.

Restoration would return the Monument to its appearance during the period of significance. Though multiple maintenance restoration projects have been undertaken periodically since the Monument's completion in 1932, to address various masonry degradations and moisture infiltrations, the character-defining physical appearance of the Monument's period of significance has remained intact. Therefore, Restoration treatment is not applicable.

Reconstruction treatment designation does not apply as the Monument remains in place, and no parts of the work have been demolished or removed.

Treatment Recommendations

It is recommended for a maintenance plan to be developed or commissioned for the Monument. This would specifically provide recommendations for systems, materials and finishes.

Site, Setting & Cultural Landscape

Site recommendations are limited to the maintenance of the current vegetation, paved pathways, and plaza area in front of the Monument. Previous site projects included replacing the curvilinear paths with six-foot-wide path over an improved base and updating the plaza from asphalt to stone paving and low wall seating. Overall site recommendations are based on findings from the 2002 Cultural Landscape Report and 1998 Cultural Landscape Inventory. Site treatment recommendations include:

23 Preservation Briefs as published by the National Park Service located at https://www.nps.gov/tps/how-to-preserve/briefs.htm.

- Improve turf management around the exterior of the pedestal where heavy visitor traffic has caused surface erosion and the wearing of current vegetation.
- Reduce tall vegetation along the hill to improve historic site lines and viewsheds from other areas of the park. Maintain current mowing regimen.
- Preserve and retain the concrete paved curvilinear paths
- Update outdated site and pylon up-lighting. Replace with less intrusive and more energy efficient options.
- Preserve and retain the plaza's stone paving and low wall seating
- Research long term visitor traffic control methods to help mitigate the amount of erosion caused by visitors surrounding the Monument.
- Accessible route: refer to Use section for comments on site access.

Roofing System

Roofing system treatment recommendations include:

- Remove existing roof materials from the observation deck. Install 90-mil EPDM roofing over sufficient insulation to provide for proper drainage. Tie roofing membrane to base terminations at perimeter, counterflash with new copper flashings that have fully soldered joints and seams and reset in existing reglets. Tie the roofing membrane into the existing drain sump and cover the entire roof surface with a walkway pad material.
- For roof drain and leader system treatment recommendations, refer to "Building Systems" narrative below
- Replace one pane of damaged glass at the beacon cupola housing. Not recommended to be restoration glass due to its location, but must match optic qualities of existing glass.
- Clean rust staining at beacon attachment points, replace rusted or corroded fastener and anchorage components (Figure 3-18).
- Clean and reseal or replace metal flashing at base of cupola plinth stone, Stone Course 'X'[24] (Figure 3–22).
- Clean and reseal or replace metal flashing at base of cupola plinth stone, Stone Course 'X'[25] (Figure 3–22).

FIGURE 5–1. Typical spall condition at pedestal walls (QE 2021).

Exterior Envelope System

Exterior envelope system treatment recommendations include:

- Pedestal walls: Reset displaced stone units and repoint existing joints in stone masonry. Repair spalled granite stone locations with specialized stone patching mortar specifically engineered for patching granite (Figure 5-1). Provide matching dutchmans to be quarried from similar stone, at previous conduit locations. Repoint sky-facing stone joints with urethane sealant with a custom color matched to pointing mortar and rub sand into the face of the sealant joints. Clean ferrous staining at one drain outlet location. Excavate and regrade slightly at the southeast corner of terrace base to expose partially covered drain outlet.

24 Architectural Stone drawing scans provided by NPS, Wright Memorial Architectural Drawings, Robert Perry Rodgers & Alfred Easton Poor Architects, 1931, Sheet 30.

25 Architectural Stone drawing scans provided by NPS, Wright Memorial Architectural Drawings, Robert Perry Rodgers & Alfred Easton Poor Architects, 1931, Sheet 30.

FIGURE 5–2. Typical condition of mortar joints at Monument, rake out and repoint (QE 2021).

- Conduct topographic survey of terrace level from base of pylon to perimeter drainage channels.

- Terrace surface: Assuming topographic survey confirms inadequate positive slope away from pylon base, consider possible solutions to address surface storm water by remove all existing mosaic stone pavers and excavate to depth sufficient to install a six-inch concrete slab. Demolish existing concrete slab (assuming that it exists). Pour a new six-inch thick, reinforced concrete slab at a depth of 3.5 inches below finish terrace grade. Set the slab with an adequate and continuous slope to encourage positive water drainage to the gutters at the perimeter. Verify that positive drainage is achieved. Provide for perimeter drainage of slab with lined perforated drain tile around base of pylon and connect to the existing terrace drain system. Reset mosaic pavers in a grout bed on the concrete slab and fill the gaps with buff colored pea gravel to match the existing condition. Provide a new expansion joint at the perimeter of pylon base, backed with closed-cell foam backing down to the concrete and concrete expansion joint.

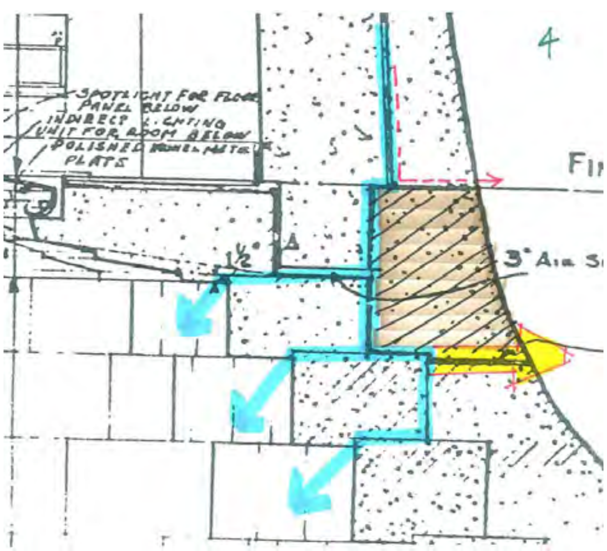

FIGURE 5–3. Moisture infiltration diagram (Moser Mayer Associates, Inc., 2009).

- Exterior stone veneer of pylon: further investigative scope is pending on the exterior envelope system of the pylon. See Table 5-1 for previous observed moisture events. Preliminary primary recommendations are as follows:

  - These treatment recommendations fully meet the Secretary of Interior's Standards for Treatment of Historic Properties and likely to greatly reduce leaks through the building envelop, while still requiring regular maintenance. It is estimated that limiting above-grade envelope treatments to repointing of masonry joints will require annual inspections of sealant joints, inspections of vulnerable mortar joints

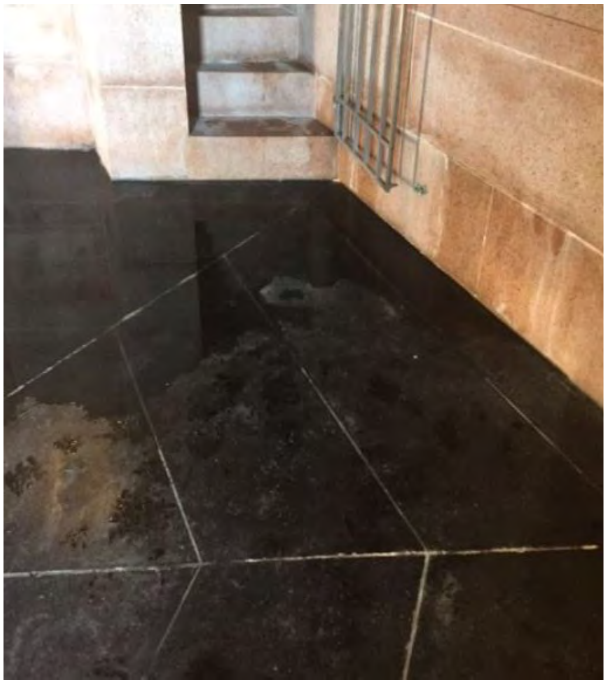

FIGURE 5–4. Moisture staining on the ground level floor (Atkinson-Noland & Associates, Inc. et al, 2017).

FIGURE 5–5. Moisture staining on the ground level walls (Atkinson-Noland & Associates, Inc. et al, 2017).

every five years, and overall inspections of mortar joints every ten years, followed up with maintenance or repairs on an ongoing basis, to maintain weather-tightness.

- Retain all granite veneer stone pieces in place. Drill into mortar joints to relieve all moisture build up in void spaces. Inject with non-expanding injection grout throughout existing voids. Grout injection is proposed to eliminate void spaces created by water infiltration into the interior of the building cladding assembly over time. Injection must be performed carefully to avoid creating unnecessary

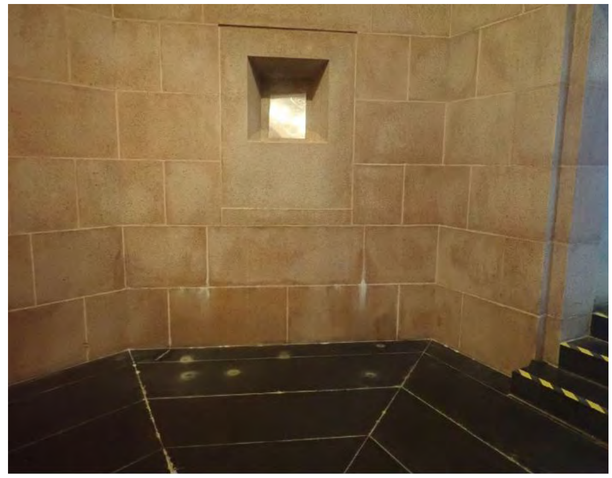

FIGURE 5–6. Ground level deposits (Atkinson-Noland & Associates, Inc. et al, 2017).

pressure between and behind the stone units. Provision of weeps to allow relief of accumulated moisture was considered as a treatment approach. However, this approach does not address the issue of voids within the wall assembly providing a pathway for water infiltration to make its way throughout the exterior cladding assembly, from which water is currently making its way into the building interior.

- Repoint fifty (50) percent of the joints, focusing at the top of the Monument, the joints in the flare (Stone Course ‘D’) and the base (Stone Course ‘A’).[26] Repoint stone joints, raking out to a minimum of 2.5 times the depth of the joint (Figure 5–2). Remove any sealant from non-sky facing joints and repoint with mortar. Install flexible tees into sky-facing joints at the top of Monument only.

- Repair exterior elevations spalled granite stone with specialized stone patching mortar.

- Preserve and retain the two metal busts set atop the nonhistoric granite pillars.

26 Architectural Stone drawing scans provided by NPS, Wright Memorial Architectural Drawings, Robert Perry Rodgers & Alfred Easton Poor Architects, 1931, Sheet 30.

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Table 5-1: Observed Moisture Events at Wright Brothers Monument						
Event	Location	Moisture Type	Observation Source	Notes on Suspected Source	Further Exploration	Image Reference
Water seepage observed on interior	Interior, ground level: walls & ceilings	Seepage after storm event	Field observation	Observed after rain events. Several delaminations of mortar joints observed across face of Monument. Cross section of Monument suggests natural path for bulk water infiltration behind the stone veneer if flashing and weeps have failed. 2009 report and supplemental diagrams support this diagnosis.[1] 2017 Report findings suggest void (cavity) space between exterior veneer stone and interior stone and concrete walls which would transport water to all areas of the building if the setting mortar (backbuttering) material has eroded and failed.[2] According to the report the other cause of the memorial room water seepage may be from the roof drain line as suspected damage occurs at 52' which is in the boundary of the memorial room.	Invasive investigative testing recommended by stone veneer removal.	Figure 5–2, Figure 5–3, Figure 5–4, Figure 5–5
Water spilling out of conduit	Ground level and Level C	Bulk water during storm event	Park staff observation, Investigative scoping observation	Observed after rain events, and reported in 2009 post-restoration follow up memo.[3] It is assumed that the volume of water large enough to generate this event is owing to an infiltration condition beyond the capillary action of the veneer stone and mortar. Therefore a possible source may include the observation deck and/or roof leader. Based on the learnings and clarification from the 2017 report the suspected damaged is at 52' - 56' from the drain rim.	Consideration in base scope of PreDesign is to abandon conduits and inject with grout. Alternate treatment aims to address infiltration upstream.	Figure 5–7, Figure 5–8, Figure 5–10
Bubbling/ peeling paint on concrete	Interior, Level B: wall	Condensation		High levels of interior relative humidity reported in 2009 memo in excess of 60% RH.[4]		N/A
Bubbling/ peeling paint on concrete	Interior, Level B: wall	Seepage	AE Field observation	Condensate line from dehumidification equipment appears to connect into roof storm leader, appears to be leaking into the void behind the wall.	Confirm condensate line routing and tie-in location.	Figure 3–50
Spotting on stone and concrete	Interior	Evaporation and Efflorescence	Field observation[5]	Salt deposit residue from atmospheric moisture absorption, moisture held within hydrating salts. Seawater atmosphere source likely.	Electro-osmosis system suggested for mitigation , but not recommended without proof of concept demonstrated. These systems are typically deployed in underground concrete structures. Furthermore, successful water infiltration mitigation efforts upstream should prove to have ameliorative effect on interior moisture levels. Poultice application treatment could address any residual salt deposit spotting.	Figure 5–6
Humidity levels within Monument	Interior	Airborne vapor	Field observation	Mechanical Engineer field observation notes dehumidification system appeared to be semi-functional. The circulating fan was operating, yet the compressor was not operating, despite the elevated humidity levels. Design documents note dehumidification mode is to begin when RH levels exceed 60%.	Confirmation the compressor is functional. Develop recommendation for addressing moisture and temperature stratification.	N/A
Infiltration at ground level	Interior, ground level: floor perimeter	Seepage	Park staff observation	Infiltration may be owing to limited/inadequate positive slope away from base of Monument.	Test pit at Monument base investigative scope recommended.	Figure 5–4
Storm leader leakage	Terrace subsurface	Bulk water during storm event	Investigative scoping observation	Suspected break/leak in storm leader under the plaza was suggested having observed the ballooning test on the main roof leader.	Clear drainage pipe of debris, rescope to assess as needed.	Figure 5–11
Infiltration at sub-surface	Interior of vault foundation	Standing water	Park staff observation	Standing water has been reported at the base of the vault foundation, likely from ground water seepage.	Likely no action needed, impact to Monument is negligible.	N/A

1 Moser Mayer Phoenix Associates, PA, *Report and Recommendations, Interior Water Leakage Post-Construction*, May 2009, 1.

2 Atkinson-Noland & Associates, Inc. et al, 2-3.

3 Moser Mayer Phoenix Associates, PA, 1.

4 Moser Mayer Phoenix Associates, PA, 1.

5 Atkinson-Noland & Associates. Inc. et al. 20.

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Interior Condition

Interior treatment recommendations include:

- Ground level: Clean the granite flooring to remove mineral stains and repoint the grout joints, approximately twenty (20) percent of total (Figure 5–6). Preserve and retain the two large stone panels with inscriptions found within the Memorial Room.
- Level B: Prime areas of exposed concrete where paint has failed, and paint all exposed concrete. Use a traffic-grade primer and paint. Maintain painted finish.
- Level C: Prime areas of exposed concrete where paint has failed, and paint all exposed concrete. Use a traffic-grade primer and paint. Maintain painted finish.
- Observation Deck (Roof): Refer to roofing system and spiral staircase notes.
- Granite stairs between ground level and Level B: Clean efflorescence and staining from the existing granite and mortar joints. Prep, prime, and paint metal handrails.
- Concrete stairs between Level B and Level C: Prime areas of exposed concrete where paint has failed, and paint all exposed concrete. Use a traffic-grade primer and paint (Figure 3–55). Prep, prime, and paint metal handrails.
- Spiral staircase from Level C up to observation deck: prep, prime, and paint existing steel spiral stair assembly. Paint with a high-performance coating (epoxy or urethane base) and apply grit in paint for treads and landings to improve slip resistance (Figure 3–57). No work recommended at the handrail elements.

Openings: Windows & Doors, Exterior & Interior

Treatment recommendations for window and door openings, both exterior and interior, include:

- Primary entrance doors at ground level: polish the existing stainless steel to remove corrosion. Inspect existing hinges and replace the existing pins with new. Adjust and repair the operating hardware, if necessary replace the hardware to match in kind. Replace the perimeter sealant joint. Replace entrance door lockset to match in kind.
- Interior gates at ground level: current hardware is difficult to key, consider first to repair the hardware and alternatively replace keying mechanism to match in kind.
- Roof access door: polish the existing stainless steel to remove corrosion. Adjust and lubricate the operating hardware. Adjust hardware to achieve a properly latching and secure door closure. Repair the loose operating trim and provide a blank core for the cylinder.
- Louver vent, intake, and exhaust at south elevation: no work recommended provided potential new dehumidification system is able to reuse existing ducted connections.

Ceilings & Walls

Treatment recommendations for the interior walls and ceilings include:

- Ground level: Clean efflorescence and staining from the existing granite and mortar joints at the wall and ceilings (Figure 5–4). Fill the openings in the existing mortar joints. Remove any unused anchors in the granite wall and patch the holes.
- Level B: Remove flaking paint, prime and repaint to match surrounding.
- Level C: Remove flaking paint, prime and repaint to match surrounding.
- Observation deck: Refer to roofing system and spiral staircase notes.
- Stairs between ground and Level B: Clean efflorescence and staining from the existing granite and mortar joints.

Building Systems

Plumbing treatment recommendations include:

- Remove obstruction in storm drainage line under terrace leading from entrance steps drain adjacent to Monument entrance. Clean drain line of dirt residue buildup. Complete water testing at door gutter and floor drain location.

- There are a number of potential areas of water intrusion within the existing roof drain pipe. The areas include; at the cleanout, the condensate line connection, a bolt intrusion within the roof drain pipe and a crack located within the pipe underneath the plaza. While on site the hatch at the cleanout was not accessible and could not be studied further. According to the 2017 Atkinson-Noland Report[27], the approximate location of the bolt intrusion within the roof drain pipe is at 52', shown in the section diagram in Appendix E and Figure 5–9.

  The recommendation for treatment is to investigate and confirm the leaks, do further testing of the roof drain pipe with water and concurrently observe what water events if any are occurring in the areas of concern. This investigation would be conducted with a camera scope with live feed. After the investigation occurs there are two options for treatment, however both treatment recommendations depend on further evaluation of the roof drain pipe.

  - The first is a targeted repair of the pipe. This would involve replacing the broken section under the plaza so it is fully functional and the drain is daylighting appropriately. If the areas of damaged pipe are reachable inside of the monument then those repairs will also be conducted.

  - The second option is to abandon and re-route a new leader all the way down the monument and out at the plaza.

Mechanical treatment recommendations include:

- Per SHPO recommendations, it is recommended to consult multiple mechanical engineering firms to evaluate and recommend treatments for long-term moisture and interior humidity issues.

- As the dehumidification equipment is at the end of its life-span it should be repaired or replaced. Since the monument will remain open to the public at limited levels, stratification of air is problematic. Adjust (or add) controls and ducting accordingly to ensure all levels of the interior of the Monument are adequately served.

- With the redesign of the ventilation system there should conduct testing, evaluation, etc in order to determine the functional heating,

27 Atkinson-Noland & Associates, Inc. et al, 2017.

FIGURE 5–7. Ground level conduit scope (Atkinson-Noland & Associates, Inc. et al, 2017).

FIGURE 5–8. Level C conduit scope (Atkinson-Noland & Associates, Inc. et al, 2017).

FIGURE 5–9. Bolt intrusion in roof drain pipe (Atkinson-Noland & Associates, Inc. et al, 2017).

ventilation, and/or conditioning of the air to allow for the ground floor to be opened to the public and the upper floors to be closed while housing mechanical equipment.

- If dehumidification system is upgraded and replaced, consider a comprehensive moisture management and ventilation strategy for dealing with interior humidity levels. Treatment selection will affect the mechanical approach.

FIGURE 5–10. Conduit drain bucket (QE, 2021).

FIGURE 5–11. Drain line blockage (Atkinson-Noland & Associates, Inc. et al, 2017).

Electrical treatment recommendations include:

- Complete further camera or borescope inspection to provide additional information on the existing electrical equipment.
- Replace the existing interior panel, conduit, wiring, switches, lights, etc. with surface mounted equipment. Remove the original abandoned panel box, existing wiring and seal conduits with injection grout. Paint surface beneath abandoned panel box but leave opening as is. The condition of the existing underground raceway containing the 100-amp feeder to the panel is unknown so this feeder would remain and be reworked to the new surface mounted panel as required.
- Replace lighting sources with new LED fixtures (if available to retain historically significant fixtures) and surface mounted switches.
- All exposed conduit and boxes would be schedule 80 PVC eliminating any chance of corrosion in the future. Remove abandoned metallic conduit from interior wall faces and from within chase spaces if at all possible. Where conduit is bedded into concrete, fill solid with non-shrinking, non-metallic grout. Remove any temporary water control measures that were installed in existing panel boxes and conduit. Drill cores between the levels to provide a pathway for new conduits. This approach would not have any impact to the upper levels since these areas would most likely not be seen by the public. Where finished stone interiors are present, re-use existing concealed pathways if possible. If not possible, carefully remove interior stone and create new concealed pathways to route conduits.
- Establish electrical panel labeling system, label accordingly to the typical National Electric Code naming conventions. Prepare a one-line diagram of the electrical system, using the labels and designations of panels, equipment and circuits, as part of design for electrical system overhaul. Maintain final construction record copy for maintenance and reference

purposes.

Use Narrative

The recommended ultimate use of the Monument assumes that adaptation of the structure to a new use is not planned at this time. Information regarding the Park's interpretive goals has been derived from the Wright Brothers National Memorial Long-Range Interpretive Plan, November 2010 by Wright Brothers National Memorial and Harpers Ferry Center Interpretive Planning and Interpretive Solutions, Inc.

Visitor Use

Due to the opening of the new Visitor Center and ongoing levels of moisture intrusion into the Monument the ground level was closed to the public in 1960 (Refer to Developmental History, starting on page 9). NPS has expressed the goal of reopening the ground level room to the public, and relocating some artifacts within the vaulted granite room including a metal relief map of historic flight paths originally housed in the Monument.

Park Administration Use

The monument will retain its use as a monument with visitors only at the exterior and the Memorial Room level. NPS staff will be able to access the upper floors as needed for maintenance and servicing the equipment.

Visitor Safety and Accessibility

A site accessibility assessment was not included in the scope of work for this project, therefore accessibility treatment options were not included. The long-term goal of the park is to provide more accessibility to the site. The most appropriate response will take into account scoping and technical design requirements of the Architecture Barrier Act Accessibility Standards. Refer to NPS Preservation Brief #32: "Making Historic Properties Accessible" for more information.

Existing conditions that appear to limit accessibility and present conflicts with accessibility improvements due to their contributing significance to the Wright Brothers Monument site include:

- Remoteness of handicapped accessible parking
- Steepness of curvilinear paved paths leading up to the Monument
- Stone steps leading up to terrace level
- Terrace level paver joint spacing and unevenness
- Stone steps leading down to entrance doors from terrace
- Stone steps leading down to ground level from entrance doors

Appropriate Activities and Uses

Appropriate activities and uses of the Monument include retaining the current use as a memorial with interpretive displays and signage. Consideration should be given to the means necessary to reopen ground level room for public access.

Powerhouse Recommendations: Rehabilitation

Introduction and Goals

For the Powerhouse, the NPS administratively determined Management Category is "Must Be Preserved and Maintained" and the Ultimate Treatment is ***Rehabilitation***. This treatment provides flexibility for the development of a compatible use function for the facility, while maintaining its current use as a reminder of the Monument's function as both a memorial and aviation beacon.

- ***Preservation*** would use the Powerhouse as it was historically. The equipment and use of the Powerhouse have been removed and bringing it back to its previous function is not desired for its future use.
- ***Restoration*** would return the Powerhouse to its appearance during the period of significance. Though the Powerhouse is no longer functioning as it did historically, the character-defining features and exterior of the Powerhouse have not changed. Therefore, Restoration treatment is not applicable.
- ***Reconstruction*** treatment designation does not apply as the Powerhouse remains in place, and the only parts of the building that were

removed was the previous equipment although the base and some parts remain.

Treatment Recommendations

Site, Setting & Cultural Landscape

Site recommendations are limited to the maintenance of the current mown lawn and the tree-line border at the rear (north) of the Powerhouse. Over-all site recommendations are based on findings from the 2002 Cultural Landscape Report and 1998 Cultural Landscape Inventory. Site treatment recommendations include:

- Maintain mown lawn.
- Cut-back and maintain wooded vegetation.
- Provide more permanent cover at utility equipment in grass.
- Provide more adequate drainage trench at west elevation.

Roofing System

Roofing system treatment recommendations for the Powerhouse include the repair of the copper roofing system at failed joints and seams and to improve the roof slope to relieve ponding. Preserve and retain the metal scuppers.

Exterior Envelope System

Exterior envelope system treatment recommendations include:

- Repair cracked concrete at exterior walls.
- Clean biological, ferrous and environmental staining at parapet and at the base of the walls.
- Maintain earthen planter at rear concrete bump out. Remove biological growth from metal louvers and wall (Figure 3–82).
- Remove abandoned conduit at rear elevation.

Interior Condition

Interior treatment recommendations for the ceiling, walls, and floors include:

- Clean and repair interior face of concrete walls.
- Clean and repair interior ceiling and floor.
- Maintain in place existing equipment and building utilities.

Openings: Windows & Doors, Exterior

Treatment recommendations for exterior windows and doors include:

- Repair and repaint metal security bars.
- Repair bent security bars.
- Repair and recoat hinge locations to prevent rust, cracking and spalls at concrete attachments.
- Repair and repaint metal exterior door and frame.
- Provide a fixed transparent door or panel to provide visual access to interior room and future programming.

Building Systems

Building system treatment recommendations include the investigation into the condition of the abandoned and obsolete equipment. Remove equipment as necessary and provide new minimal building utility to allow power and lighting to the Powerhouse.

Use Narrative

The recommended ultimate use of the Powerhouse assumes that adaptation of the structure to a new use is not planned at this time, yet with consideration to its Management Category of ***Rehabilitation***, notes regarding its potential use are explored. Information regarding the Park's interpretive goals has been derived from the Wright Brothers National Memorial Long-Range Interpretive Plan.

Visitor Use

The long-term goal for the Powerhouse is to rehabilitate it for a future use. An example of a future use could be creating an exhibit or artifact enclosure of previous use, to tell the history of the site and connection to the Monument. The exhibit or artifact enclosure would focus on the importance of the Powerhouse in providing power to the Monument as an aviation beacon.

Park Administration Use

A park administrative use for the Powerhouse could be as a storage facility or other administrative programming to help with staffing away from the visitor center and closer to the Monument.

Visitor Safety and Accessibility

In order to provide visitor safety and accessibility, physical access to paved parking areas and other paved paths along the site will need to be provided to connect to the Powerhouse.

Appropriate Activities and Uses

Appropriate activities and use for the Powerhouse include creation of a small permanent exhibit with replica generator equipment and signage. Interactions with the exhibit would provide a connection between the Powerhouse, the Monument, and the remainder of the site and other buildings.

Recommendations for Further Research

Monument

Additional investigation is needed to confirm the condition of the collar joint mortar, the extents and condition of the waterproofing, the extents and condition of the in-wall moisture control componentry including waterproofing membrane(s), flashing membranes, weeping devices/embeds. Previous studies suggest this be accomplished by way of core drilling from the interior of Monument.[28] This approach is limited in effectiveness in two ways:

1. The equipment needed to core drill through concrete walls of the thicknesses present at the Monument present problems for staging and performing the work with the limited interior space available, and
2. The scoping will only confirm the back of stone condition at the core location, and further assumptions would still be needed as to the surrounding conditions of the collar joint mortar.

Instead, recommendations have been made to NPS for the removal of three exterior veneer stones for the purposes of assessing the condition of the in-wall components as listed above.

Further investigation is recommended in the location of paint loss and efflorescence adjacent to the concrete stairway at Level B. The condensate line for the dehumidification unit is believed to be connected to the roof drain conductor pipe via a cleanout concealed behind an access door above the stairway. The roof conductor is the suspected source of water which is causing this deterioration. Camera inspection of the conductor piping, conducted from the cleanout or the condensate line connection, should readily confirm whether the storm conductor is the source of the water.

Recommendation was made by NPS for a terrace-level test pit at the base of the pylon to confirm the presence and condition of a concrete slab underneath the plaza pavers and assess the viability of a sub-grade waterproofing installation to the depth of the ground level.

Further testing of the soil characteristics below the terrace have been suggested by the park to assess soil type, saturation level, density, and percolation characteristics. Refer to the treatment recommendations for the plaza for further exploration of remedial water control recommendations.

The Monument's dehumidification system is nearing 15 years of service and though the course of the mechanical engineer's site observations it is suspected that the compressor componentry is nonfunctional, though the recirculation fan was functioning. Further research is needed to confirm what components are in need of repair or replacement.

Further study of moisture migration through the Monument's enclosure and structural assemblies is recommended to fully diagnose and address suspected causes of moisture infiltration causing interior paint detachment, mineral leeching, and efflorescence. Studies should be modeled based on unconditioned interiors, interiors under positive pressure, dehumidified interiors, and dehumidified and heated interiors to assess whether the dehumidification system is contributing to moisture migration, and whether other conditioning or ventilation strategies may prove more effective in managing moisture infiltration. Modeling should include study of the wall assemblies in a fully-repaired state as well

28 Atkinson-Noland & Associates, Inc. et al, 22.

as with the alternative to introduce a waterproof membrane behind the stone cladding throughout. Research and testing of low-tech environmental control methods to manage humidity levels within the Monument is also recommended.

Perform full storm drain scoping at terrace/grade level once obstructions and debris are removed.

Further investigation and study will be required if NPS desires to replace electrical work as part of the preservation work. Effects on the Monument's historical significance contributing elements due to the installation of new electrical service will need to be better understood. Access to an existing 24" x 24" interior junction box is recommended in the investigative scope.

Powerhouse

Further research is needed on the environmental impacts of the previous mechanical, electrical, plumbing (MEP) equipment. If hazardous materials are found, then the removal of the equipment and remediation at the interior of the Powerhouse will need to be provided and completed.

Site Connecting Monument and Powerhouse

A Civil/Environmental Engineering QA Review checklist should be completed.

Site Accessibility

Refer to the Visitor Safety and Accessibility section for further information on site accessibility.

Resilience to Natural Hazards and Climate Variability

The NPS has developed both national and region-specific resources for the treatment, upgrade, and considerations given to historic structures in view of natural hazard resilience goals. Acknowledgement of potentially conflicting goals of resilience and preservation is noted:

> Hazard mitigation measures for historic assets (or the functions within) will be designed and installed to least affect the features that contribute to its significance. However, if it is determined that modification of particular features would impair a property's integrity and character in terms of the Advisory Council's regulations at 36 CFR (Code of Federal Regulations) 800.0 such modifications

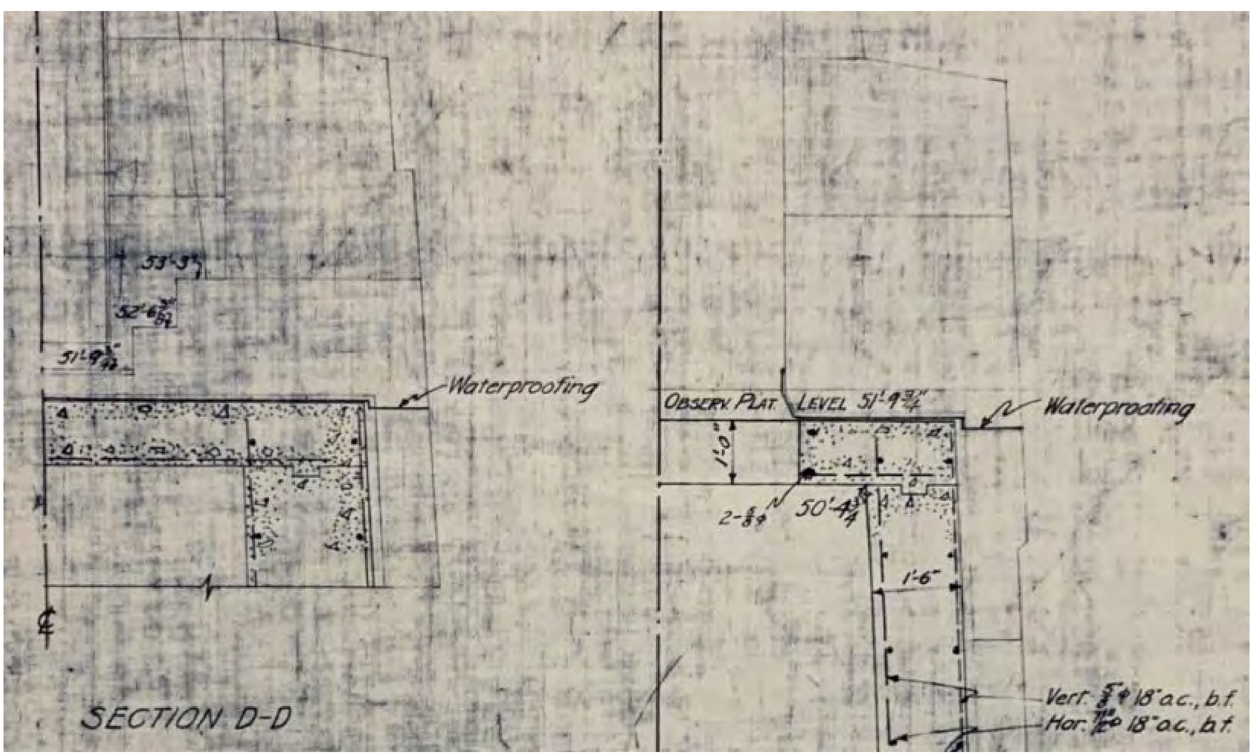

FIGURE 5–12. Section detail of waterproofing at observation deck, Wright Memorial Architectural Drawing Scans (Robert Perry Rodgers & Alfred Easton Poor Architects, 1931).

will not be made.[29]

The Coastal Hazards & Sea-Level Rise Asset Vulnerability Assessment report has noted that the Wright Brothers Monument and Powerhouse are assigned minimal risk exposure to coastal hazards and sea-level rise based on flooding potential, extreme event flooding, sea-level rise inundation, shoreline change, and reported coastal hazards.[30] Though the Monument and Powerhouse have been given this classification relative to specific sea-level flooding risk, there are appropriate categories of action to combat more general climate-related concerns. Strategies to combat adverse effect of natural hazards on cultural resources are divided into three categories: **Adaptation** is the process of adjustments to actual natural hazards and the environment and its effects; human intervention may facilitate adjustment to expected climate. **Mitigation** is the lessening of the potential adverse impacts of natural hazards through actions that reduce hazards, exposure, and vulnerability. **Resilience** is the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic features, structures, or function.

Refer to the “Requirements for Treatment” section for further information on the specific measures being undertaken by the park relative to more general climate-related concerns.

Though flood risk has been deemed to be of minimal risk, other natural hazards such as hurricanes, high winds, increasingly severe rain events, increasingly warming temperatures, and lightning strikes present a distinct threat to the Wright Brothers National Memorial site. For example, at least one Category 3 Hurricane should be expected to travel up to the Wright Brothers National Memorial by the year 2100.[31]

Yet it is important to note that the effects of climate variability are not just forecasted into the future but are being experienced at present. This is demonstrated in the “mean warmest quarter temperature” and “mean annual temperature” data results for Wright Brothers National Memorial that are designated “extreme warm” relative to historic tracking records over the last century.[32]

Relative to the preservation treatment of the Monument and Powerhouse buildings, the following considerations are offered for the overarching preservation goals of the resources:

Adaptation: The Monument and Powerhouse have performed well during hurricane events including in 1933, 1944, 1954, 1993, 1996, 1999, and 2019. The Monument reportedly suffered slight flooding from hurricane rains in 1944. The structures are constructed solidly, and have thus far withstood the hurricane events without permanent damage. The persistent water infiltration is not necessarily owing to natural hazard-related events and preservation measures to counteract these infiltration events are not reasonably classified as adaptation strategies.

Mitigation: Refer to the Alternate Treatment section for discussion related to introduction of an air and water vapor retarding membrane and pressure-equalized air cavity within the wall assembly of the Monument. This strategy offers an option for passively mitigating the increasingly disruptive and progressively damaging effects of moisture intrusion into the Monument.

A lightning protection system has been passively mitigating the risk of damage due to lightning strikes on the top of the Monument. It is recommended that the system be examined by a certified lightning protection design specialist in order to judge if the system is due for an upgrade or retrofit to comply with NFPA 780.

Resilience: Both the Monument and Powerhouse have proven reasonably resilient to the challenges presented by natural hazards. Despite natural weathering and slow erosive effects of wind and rain, the two structures have been able to absorb the effects of natural hazards due to the sturdiness of their frames and hardiness of their materials.

29 National Park Service, *Addressing Climate Change and Natural Hazards, Facility Planning and Design Considerations*, U.S. Department of the Interior, January 2015, 3.

30 National Park Service, *Outer Banks (PBX) Group Coastal Hazards & Sea-Level Rise Asset Vulnerability Assessment*.

31 Maria Caffrey and Rebecca Beavers, *Sea Level and Storm Trends, Wright Brothers National Memorial*, Boulder, CO: University of Colorado, 2015.

32 National Park Service, *Recent Climate Exposure of Wright Brothers National Memorial*, Climate Change Resource Brief, National Park Service, 2014.

FIGURE 5–13. Wright Brothers National Memorial Site Map (NPS, 2010).

Yet, given the worsening Atlantic hurricane and the trends of intensifying storm events, NPS should be prepared to monitor the impact of storm events on the softer, more malleable, less resilient materials of the building enclosures subject to degradation due to exposure. This includes the mortar joint material between the granite veneer stone, which should be monitored annually by means of visual inspection through drone photography. The condition of the mortar joints should be monitored for any losses that may impact the building's ability to reject bulk water infiltration. This is particularly critical for any skyward-facing joints that have been repointed with sealant and flexible tees. Roofing membrane termination bar joints and those locations where dissimilar material assemblies meet (such as where the cupola housing meets the stone plinth) shall also be closely monitored for delamination or detachment from surrounding material. This is particularly critical at the top of the Monument given exposures to high wind velocities and uplift forces that would impact the integrity of the roofing joints. Observations should be made after high windstorm events to ensure the material and enclosure assembly integrity remain intact.

In addition to intensifying storm events and impact on building enclosure condition, NPS park management will also likely be facing increasing temperatures over the coming decades. Increased temperatures are expected to impact the interior thermal comfort of both the Monument and Powerhouse, which may limit the long-term viability of use for the public. The park should continue to monitor interior environmental data such as temperature and relative humidity levels, and make appropriate plans for the dehumidification of the interior of the structures in anticipation of public visitation. Further treatment recommendations for the Monument's dehumidification equipment can be found in the report above.

It is also expected that visitation to the Wright Brothers National Memorial will increase in the coming years given the strong model and predicted relationship between temperature and visitation at the park. An 11%-36% increase in annual park visitation has been predicted should the increasing temperature and Representative Concentration pathway modeling prove accurate.[33] The increased visitation predicted is expected to have a degrading impact on the park, particularly on the grounds. The Monument plaza paver stones should be monitored for damage or loss due to

33 National Park Service, *Wright Brothers National Memorial: How might future warming alter visitation?*. Park Visitation and Climate Change Park-specific Brief. National Park Service. 2015.

wear and tampering from the public. The grounds surrounding the Monument and Powerhouse should be monitored for wearing pathways that occur from natural occupant foot traffic patterns. Consideration should be given to providing visual cues or physical barriers to prevent such wear and potential eroding effects of pedestrians on site impact can be found in the Wright Brothers Memorial Cultural Landscape Report.

Refer to the Alternate Treatment section for consideration for improving the resiliency of the Monument to ongoing water infiltration events.

Alternatives for Treatment

Monument

Exterior

As an alternative exterior treatment, NPS may consider pursuing repointing one hundred (100) percent of exterior stone joints instead of fifty (50) percent.

Repointing 100% of the joints would provide multiple benefits including

- Ensuring a consistent appearance across the face of the monument, ameliorating the effects of multiple previous repointing campaigns,
- Providing mortar consistent in type, age and wear, and reducing the possibility of further water intrusion at intersections of mortars of dissimilar type and age.

The areas that this alternate would affect are limited to the exterior envelope. While the proposed treatment option calls for repointing key areas, this alternate would affect all of the exterior envelope. These changes would create a more cohesive and seamless exterior look with matching mortar versus the current facade that has multiple types and conditions.

The other area affected would be the site. Items such as staging equipment, scaffolding would need to be coordinated since the entire tower would be implicated under this alternate. Site access for machinery and equipment is also a concern as well as staging locations. All construction work would need to be coordinated with NPS to consider how to schedule within visitor seasons.

Powerhouse

Currently, the Powerhouse is not represented on the Wright Brothers National Memorial site map, suggesting its prominence and significance is underemphasized, perhaps due to its inaccessibility and condition (Figure 5–13).[34] Depending on the park's interpretive intentions for the Powerhouse, an alternative treatment and use for the Powerhouse might include the following:

Small Display or Interpretive Center Option

- Consider developing the structure into a small display or interpretive center with simulated reconstructed artifacts and interpretive signage highlighting the former purpose of the Powerhouse to power the beacon light. "[The Powerhouse] is a great reminder that no place on the Outer Banks was yet wired for electricity at that time."[35]
- Treatment recommendations would generally follow the primary recommendations above.

Site

- Consider making Powerhouse accessible to the rest of the site. Depending on future planning and programming of the Powerhouse, the site would be connected to the other ring structure and sidewalks.

34 National Park Service, *Wright Brothers National Memorial Long-Range Interpretive Plan*, United States Department of the Interior, November 2010,, i.

35 National Park Service, *Wright Brothers National Memorial Long-Range Interpretive Plan*, 45.

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Appendices

Drawings

Appendix A: 1930 Construction Drawings, Pylon Monument

Appendix B: 1930 Construction Drawings, Powerhouse

Appendix C: 1954 Rehabilitation Drawings, Pylon Monument

Appendix D: Existing Drawings, Pylon Monument and Powerhouse

Appendix E Treatment Drawings: Surrounding Site, Pylon Monument, and Powerhouse

Reports

Appendix F: "Evaluation and Testing, Wright Brothers National Monument, 2017"

Appendix G: "Technical Investigation, 2022-2023"

Appendix H: Alternative Treatment

Appendix A

1930 Construction Drawings, Pylon Monument

Sheet 1: Platform Plan, Elevation, Section

Sheet 2: Memorial Room First Floor Plan, Reflected Ceiling Plan, Section

Sheet 3: Plan at Lantern , Level B Plan, Level C Plan

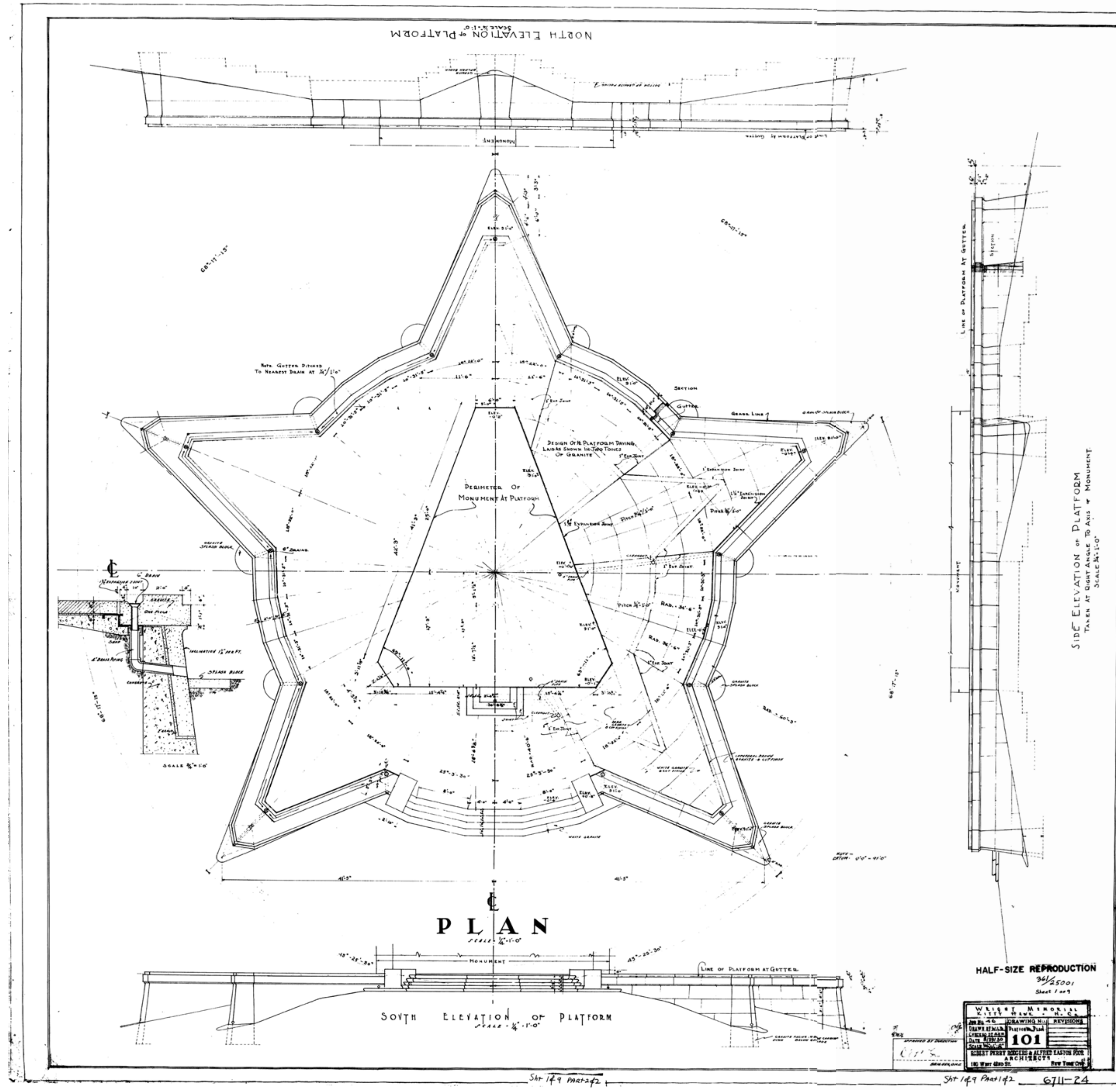
Sheet 4: Rear Elevation, Lighting Details

Sheet 5: Side Elevation

Sheet 6: Front Elevation

Sheet 7: Longitudinal Section

Sheet 8: Transverse Sections


North Elevation of Platform
Plan
South Elevation of Platform
Side Elevation of Platform
Taken at Right Angle to Axis of Monument
Perimeter of Monument at Platform
Design of N. Platform Paving, Laid as Shown in Two Tones of Granite
Line of Platform at Gutter
Half-Size Reproduction
Wright Memorial
Kitty Hawk - N.C.
101
Robert Perry Rodgers & Alfred Easton Poor Architects
6711-24

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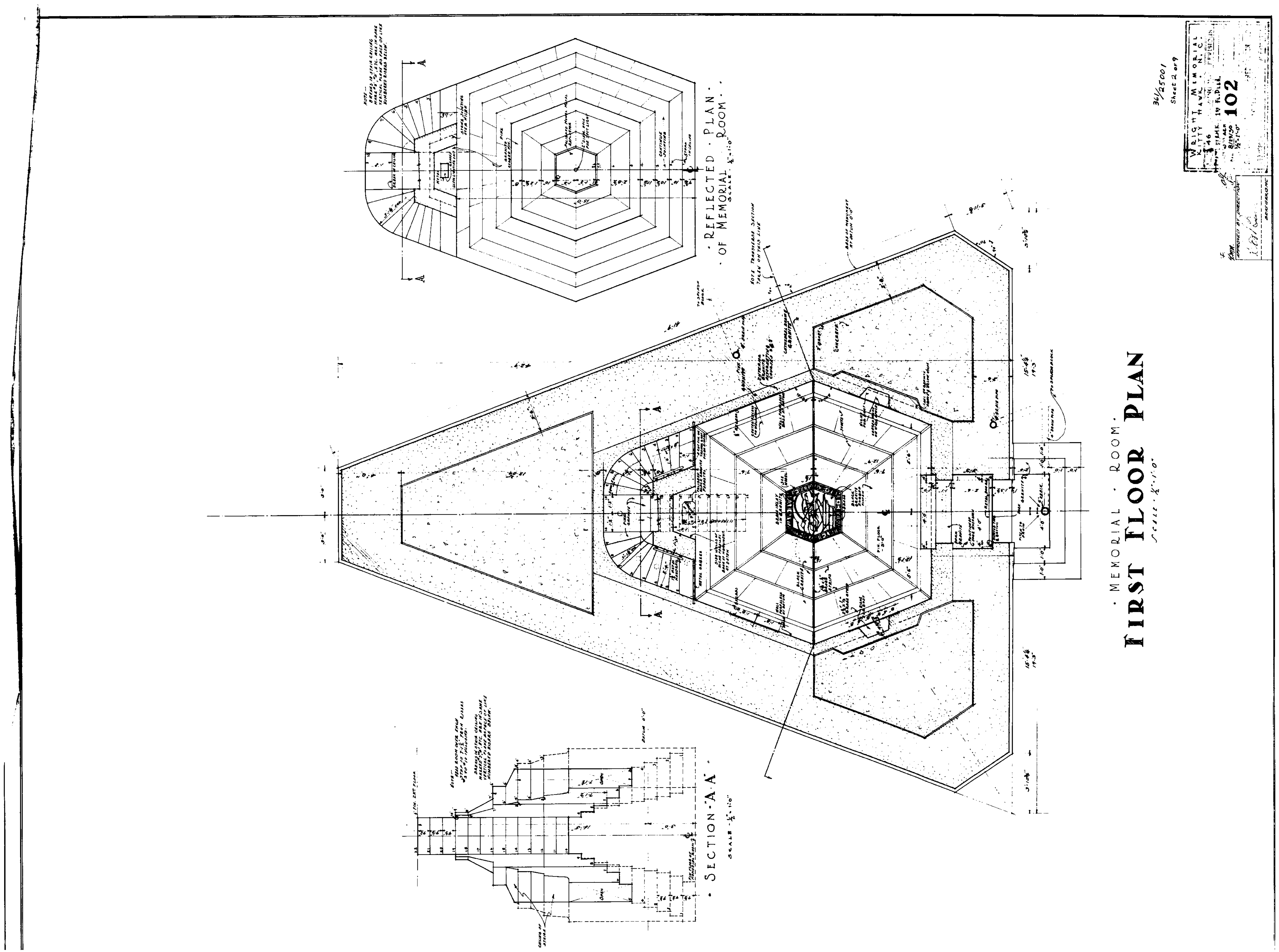
REFLECTED PLAN OF MEMORIAL ROOM
MEMORIAL ROOM
FIRST FLOOR PLAN
SECTION AA
WRIGHT MEMORIAL
KITTY HAWK N.C.
102
6711-25

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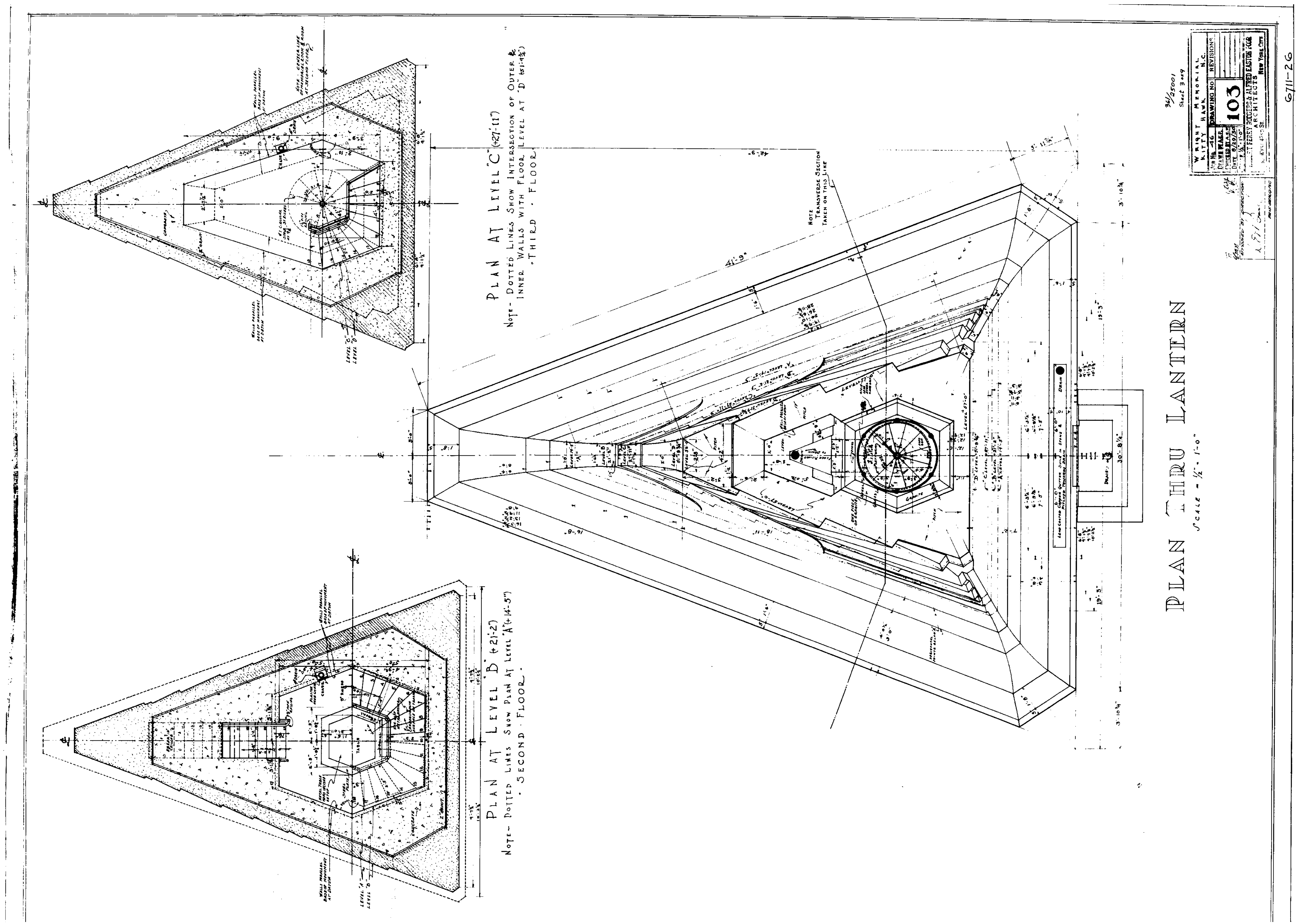
Plan Thru Lantern
Scale = 1/2" = 1'-0"
Plan at Level "C" (+27'-11")
Note - Dotted Lines Show Intersection of Outer & Inner Walls with Floor Level at "D" (+31'-4 3/4")
· Third · Floor
Plan at Level "D" (+21'-2")
Note - Dotted Lines Show Plan at Level "A" (+14'-5")
· Second · Floor ·
Note
Transverse Section
Taken on this Line
Wright Memorial
Kitty Hawk N.C.
Drawing No.
103
Revisions
Architects
New York City
6/11-26
41'-9"
30'-8 1/2"

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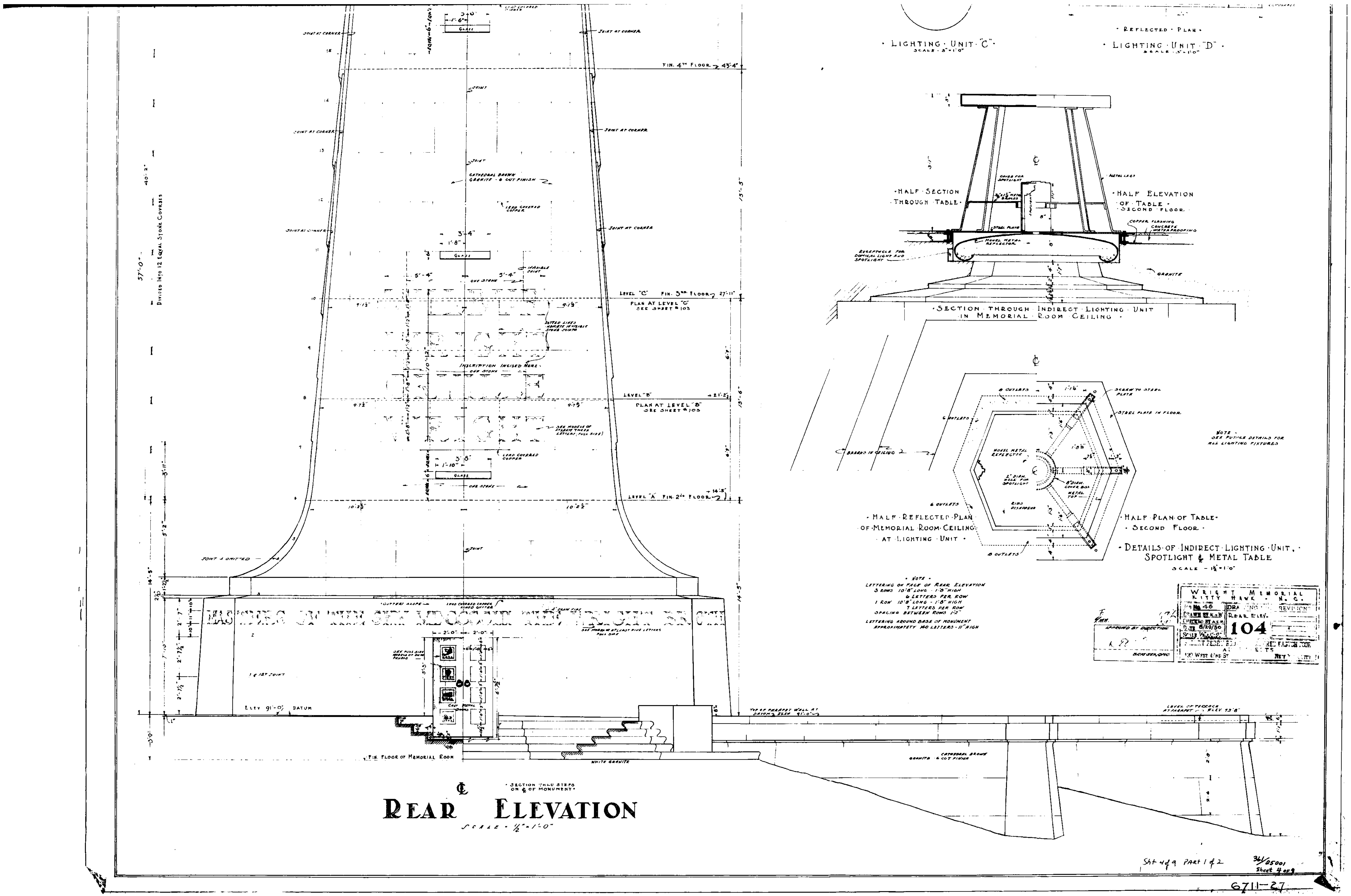
Rear Elevation
Scale ½" = 1'-0"
Section thru steps on ℄ of monument
Lighting Unit "C"
Reflected Plan
Lighting Unit "D"
Half Section Through Table
Half Elevation of Table Second Floor
Section Through Indirect Lighting Unit in Memorial Room Ceiling
Half Reflected Plan of Memorial Room Ceiling at Lighting Unit
Half Plan of Table Second Floor
Details of Indirect Lighting Unit, Spotlight & Metal Table
Fin. 4th Floor
Level "C" Fin. 3rd Floor
Level "B"
Level "A" Fin. 2nd Floor
Inscription Incised Here
Cathedral Brown Granite & Cut Finish
Fin. Floor of Memorial Room
White Granite
Wright Memorial Kitty Hawk N.C.
104
6711-27

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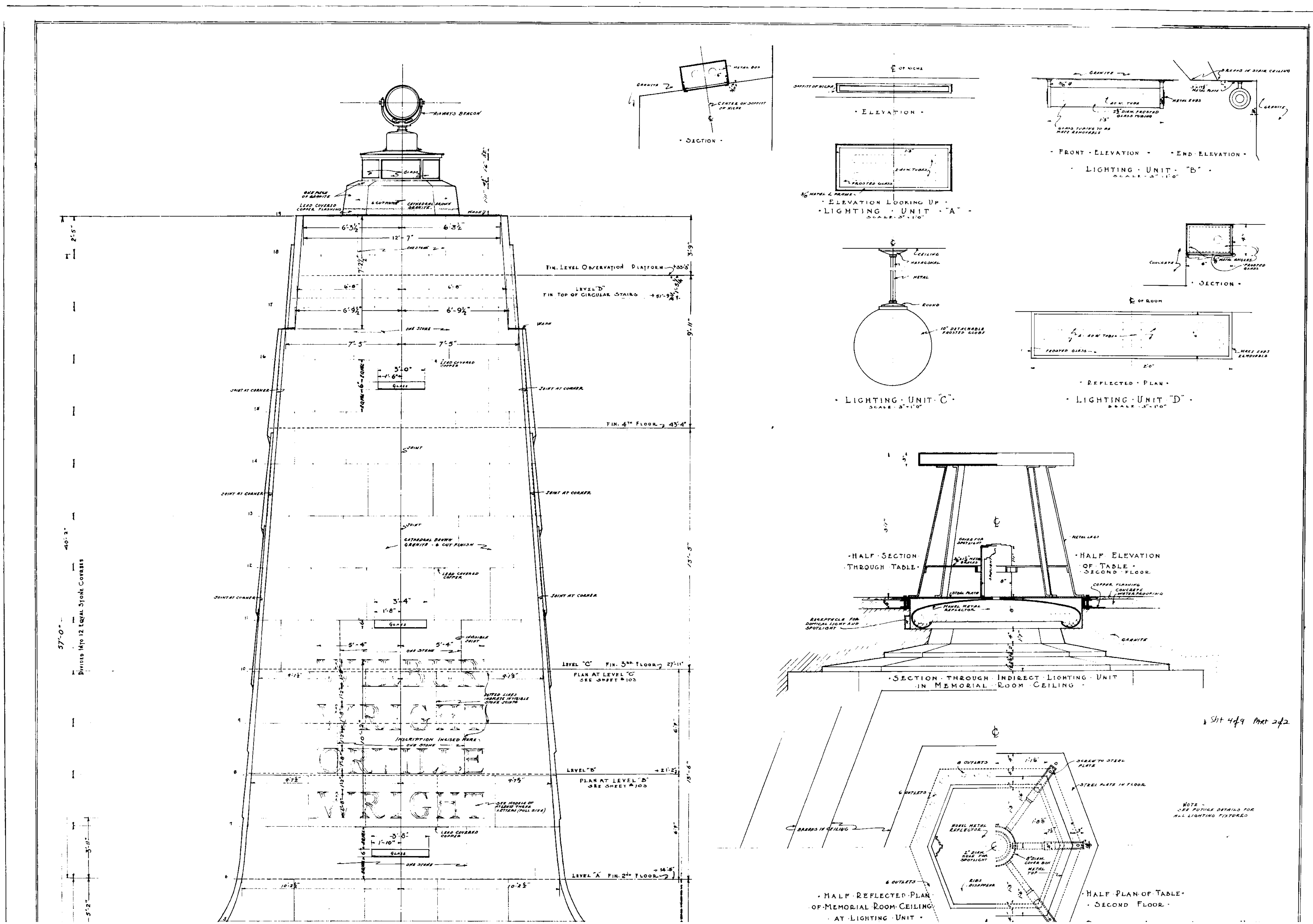

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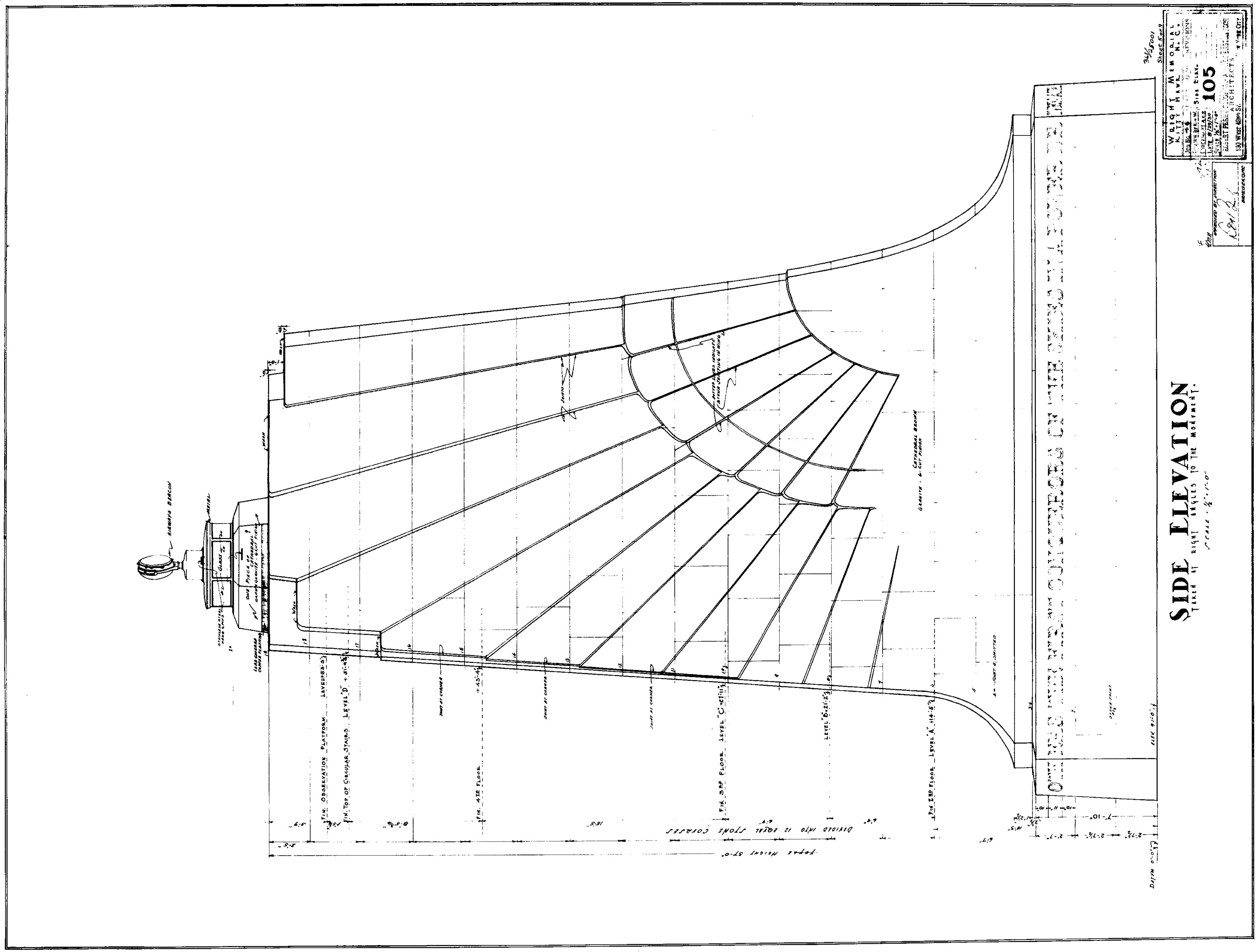
SIDE ELEVATION
TAKEN AT RIGHT ANGLES TO THE MONUMENT.
WRIGHT MEMORIAL
KITTY HAWK N.C.
105
6711-28

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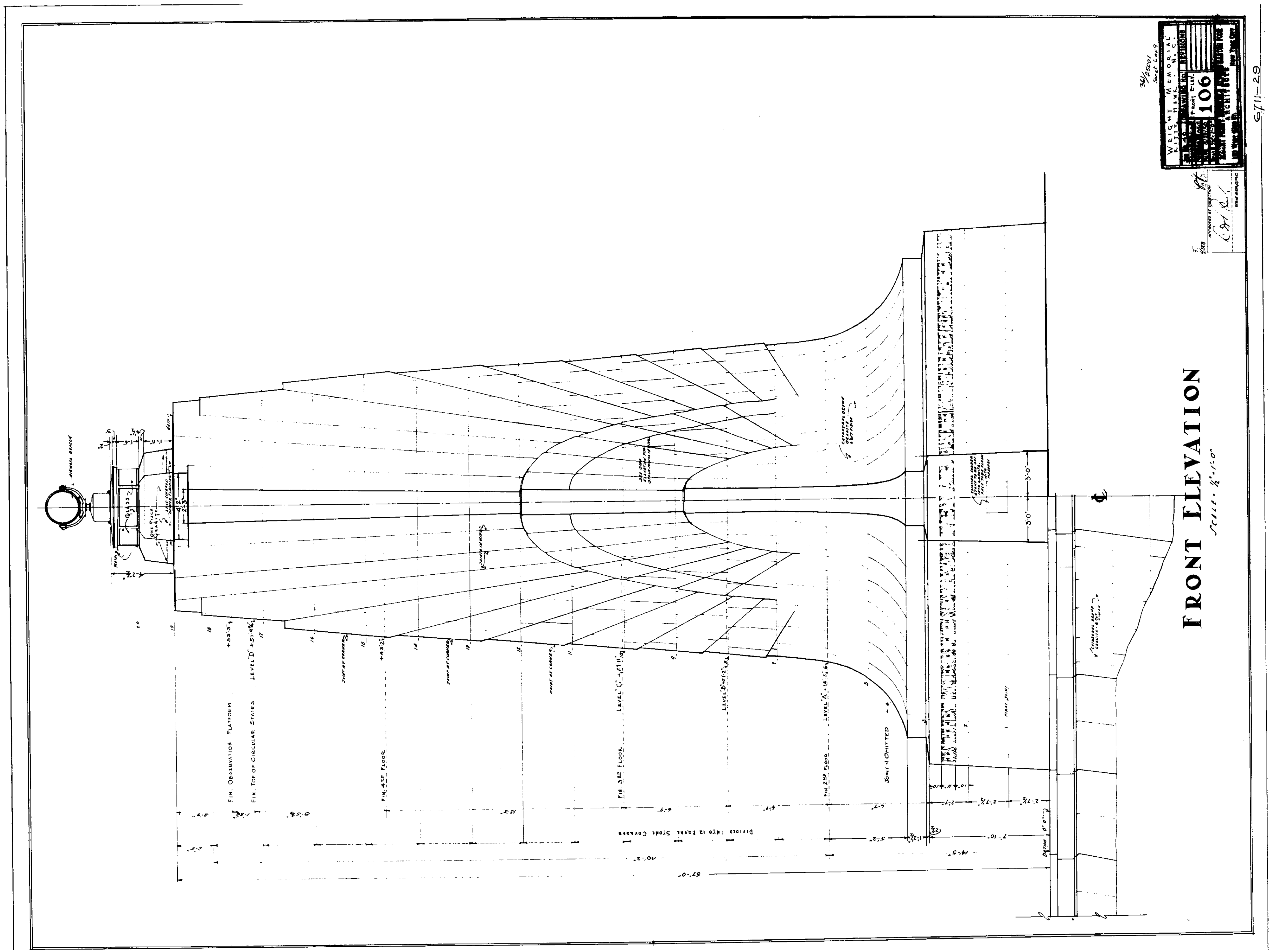
Wright Memorial
Kitty Hawk N.C.
106
Front Elevation
Fin. Observation Platform
Fin. Top of Circular Stairs
Fin. 4th Floor
Fin. 3rd Floor
Fin. 2nd Floor
Joint 4 Omitted
Divided into 12 Equal Stone Courses

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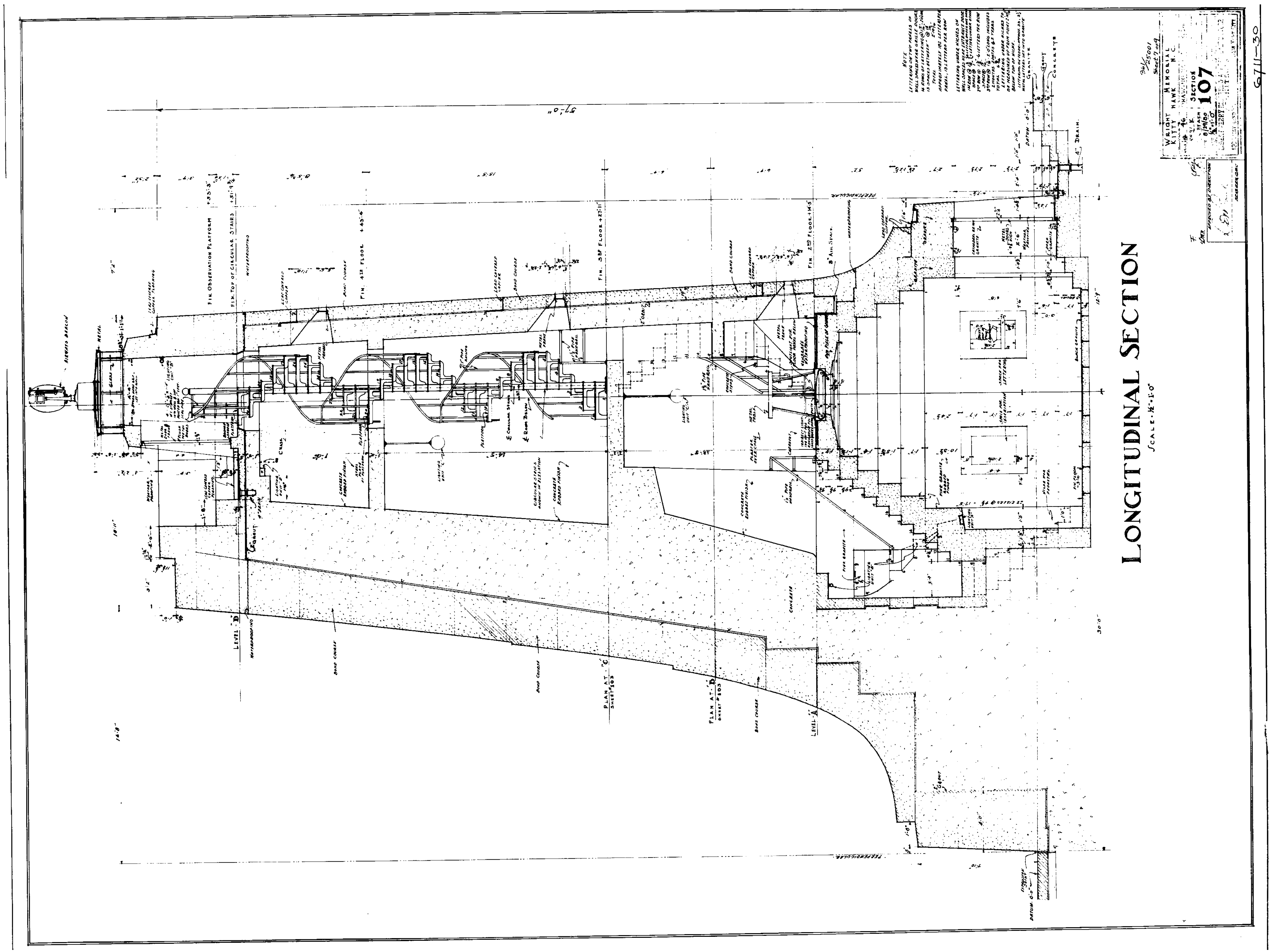
Longitudinal Section
Wright Memorial
Kitty Hawk N.C.
Section
107
6711-30

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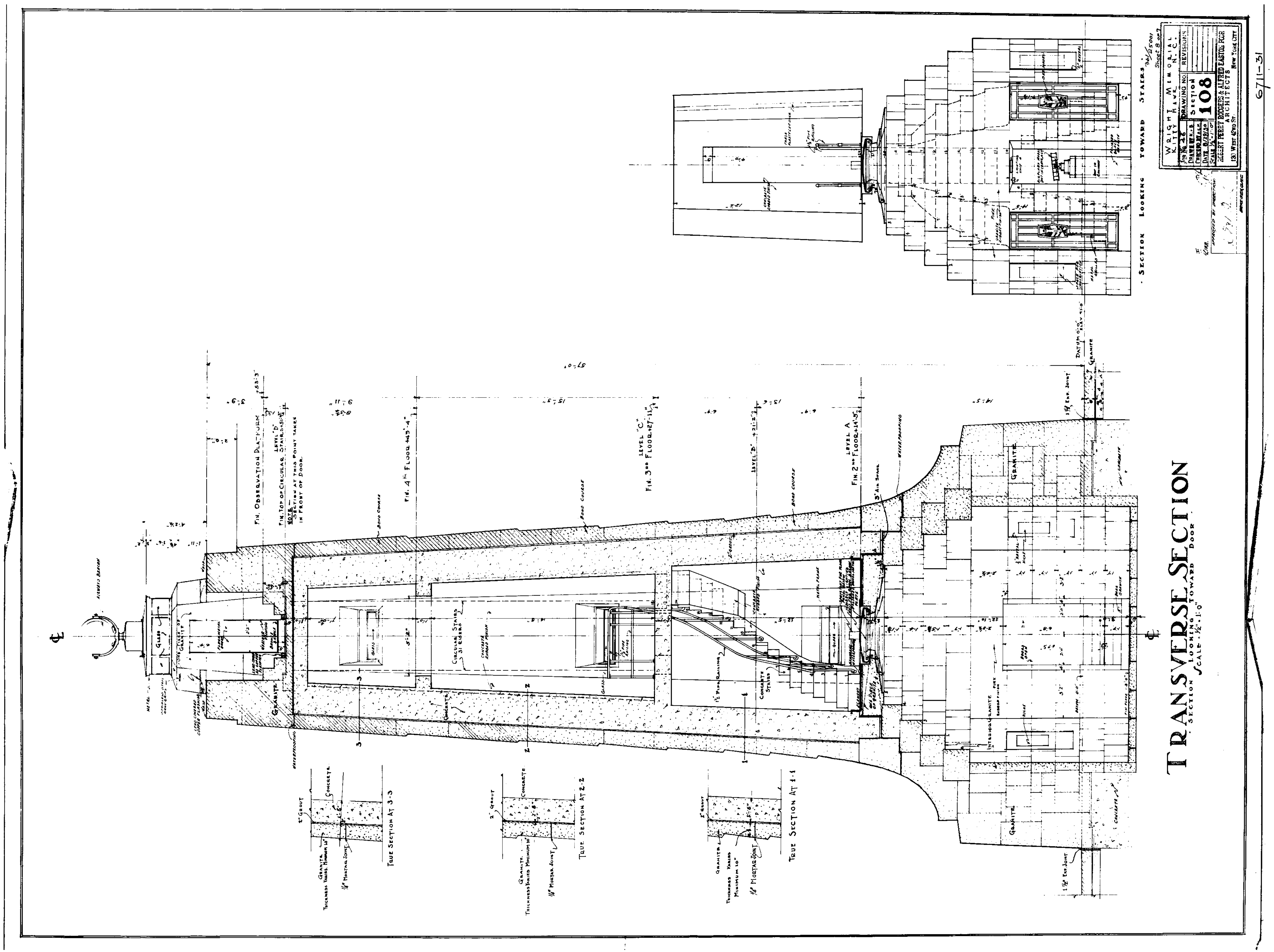
TRANSVERSE SECTION
SECTION LOOKING TOWARD DOOR
SCALE ½" = 1'-0"
SECTION LOOKING TOWARD STAIRS
TRUE SECTION AT 1-1
TRUE SECTION AT 2-2
TRUE SECTION AT 3-3
108
6711-31

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Appendix B

1930 Construction Drawings, Powerhouse

Sheet 1: Outside Electrical Distribution

Sheet 2: Sub Station Building Sections, Plan, Wiring Diagram

Sheet 3: Sub Station Building Plans, Elevations, Sections, Details

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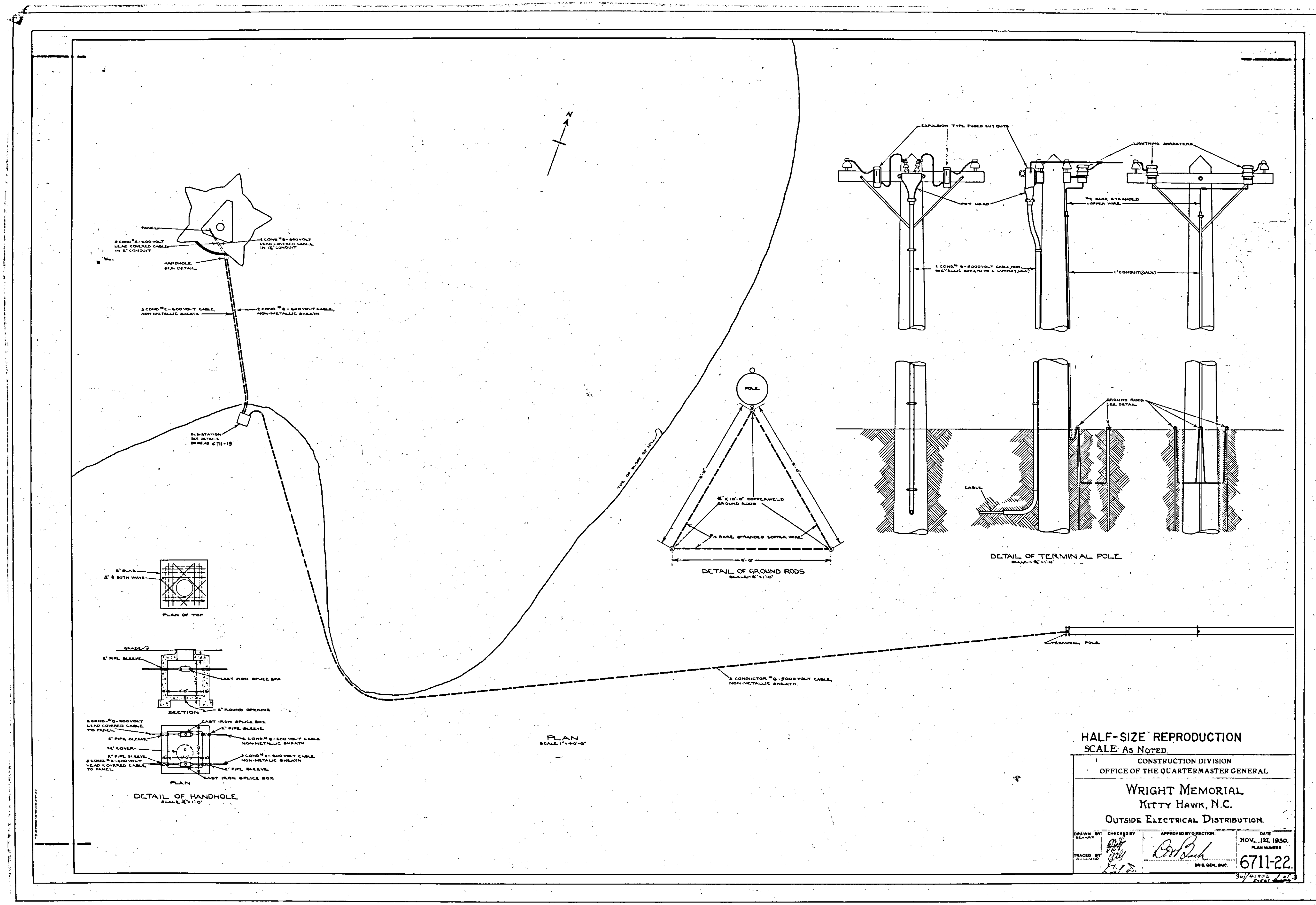
EXPULSION TYPE FUSED CUT OUTS
LIGHTNING ARRESTERS
POT HEAD
#4 BARE STRANDED COPPER WIRE
1" CONDUIT (GALV.)
POLE
GROUND RODS SEE DETAIL
CABLE
#4 BARE STRANDED COPPER WIRE
TOE OF SLOPE OF HILL
DETAIL OF GROUND RODS
DETAIL OF TERMINAL POLE
TERMINAL POLE
PLAN OF TOP
SECTION
PLAN
DETAIL OF HANDHOLE
PLAN
HALF-SIZE REPRODUCTION
SCALE: As Noted.
CONSTRUCTION DIVISION
OFFICE OF THE QUARTERMASTER GENERAL
Wright Memorial
Kitty Hawk, N.C.
Outside Electrical Distribution.
DRAWN BY
CHECKED BY
APPROVED BY DIRECTION:
BRIG. GEN., QMC.
TRACED BY
DATE
Nov. 1st, 1930.
PLAN NUMBER
6711-22.

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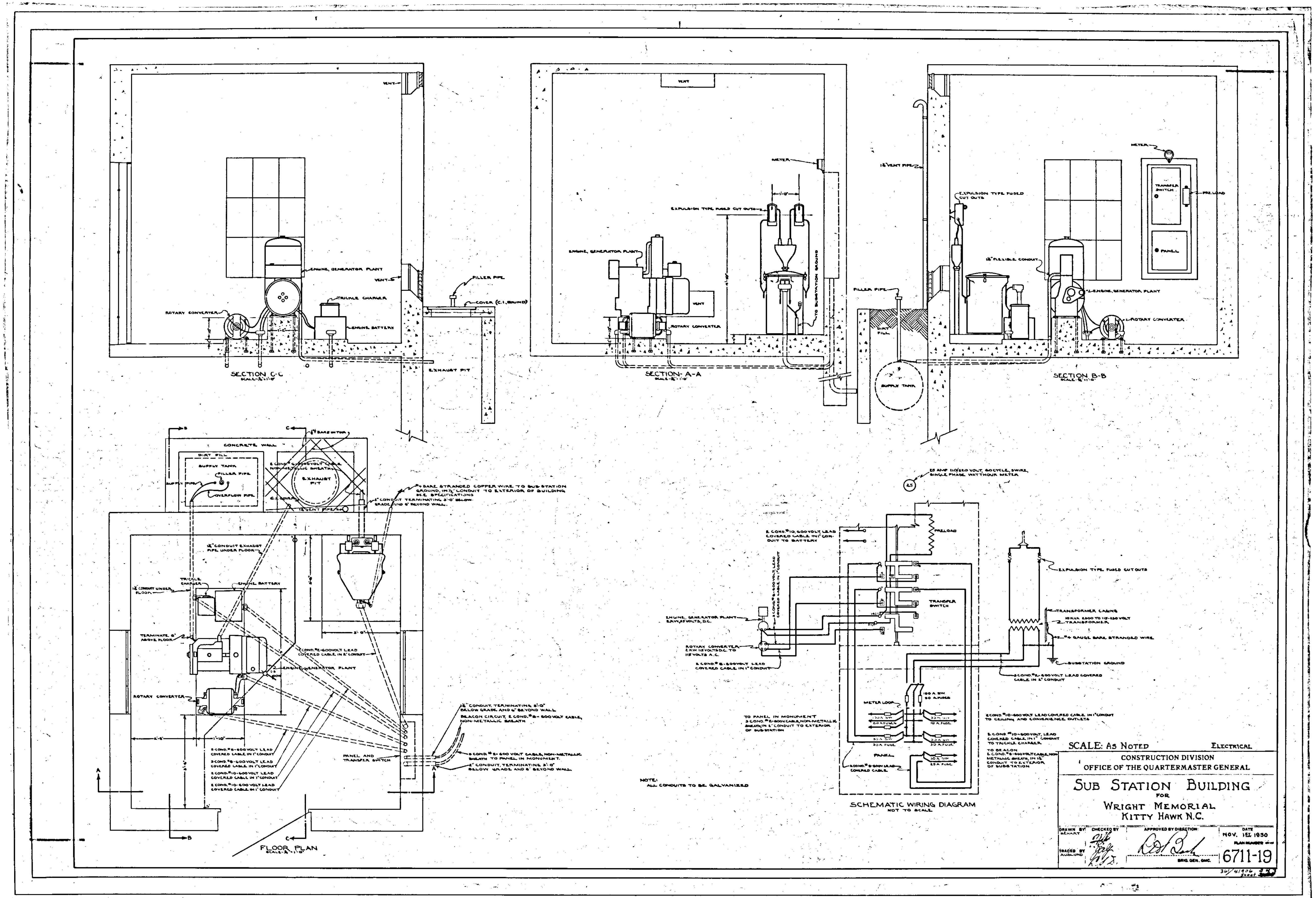
SECTION C-C
SECTION A-A
SECTION B-B
FLOOR PLAN
SCHEMATIC WIRING DIAGRAM
NOT TO SCALE
NOTE:
ALL CONDUITS TO BE GALVANIZED
SCALE: AS NOTED
ELECTRICAL
CONSTRUCTION DIVISION
OFFICE OF THE QUARTERMASTER GENERAL
SUB STATION BUILDING
FOR
WRIGHT MEMORIAL
KITTY HAWK N.C.
6711-19

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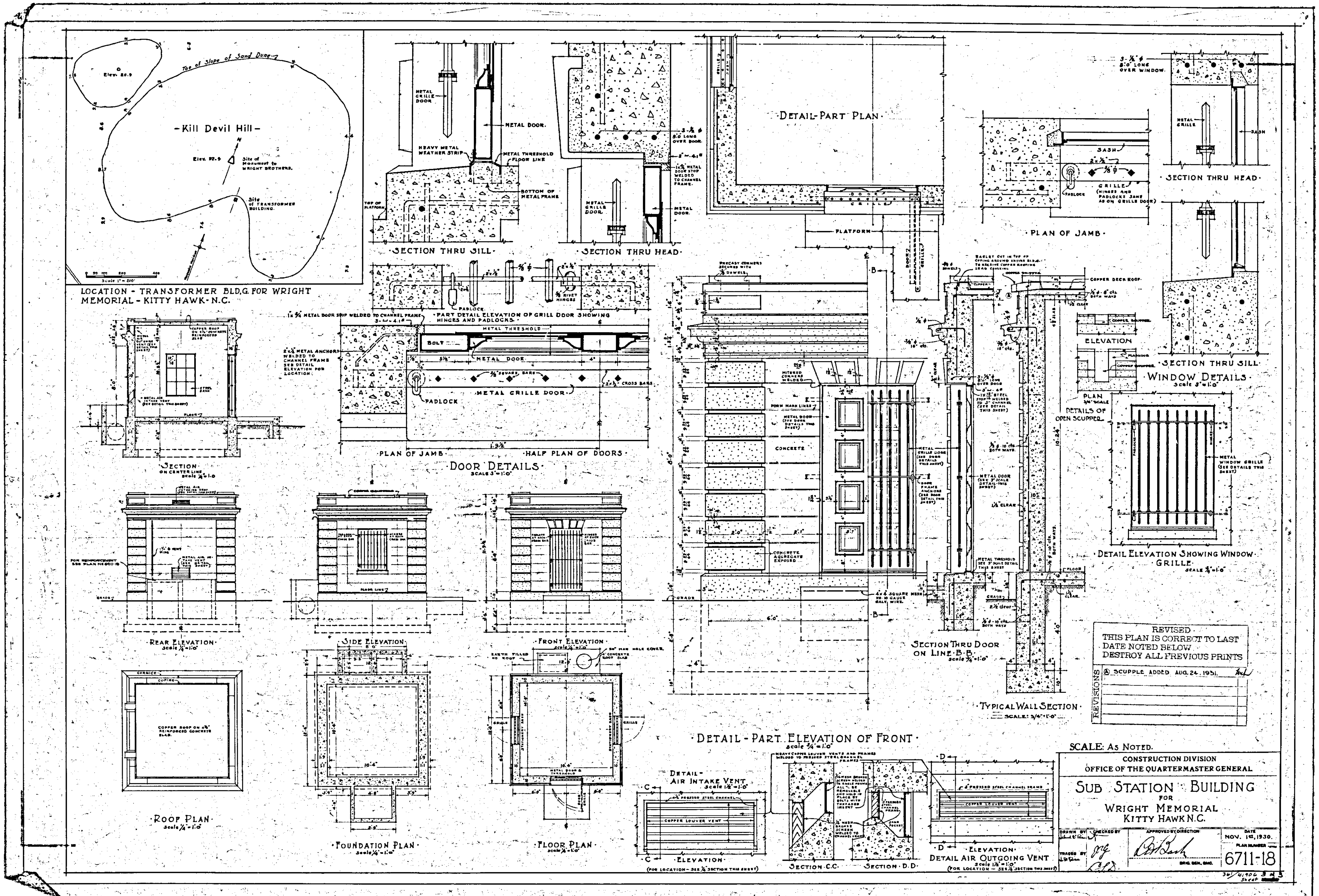

Kill Devil Hill
LOCATION - TRANSFORMER BLD.G. FOR WRIGHT MEMORIAL - KITTY HAWK - N.C.
SECTION THRU SILL
SECTION THRU HEAD
DETAIL-PART PLAN
PLAN OF JAMB
SECTION THRU HEAD
SECTION THRU SILL
WINDOW DETAILS
PART DETAIL ELEVATION OF GRILL DOOR SHOWING HINGES AND PADLOCKS
PLAN OF JAMB
HALF PLAN OF DOORS
DOOR DETAILS
SECTION ON CENTER LINE
DETAIL ELEVATION SHOWING WINDOW GRILLE
SECTION THRU DOOR ON LINE B-B
TYPICAL WALL SECTION
REAR ELEVATION
SIDE ELEVATION
FRONT ELEVATION
REVISED
THIS PLAN IS CORRECT TO LAST DATE NOTED BELOW
DESTROY ALL PREVIOUS PRINTS
SCUPPLE ADDED AUG. 24, 1931.
REVISIONS
ROOF PLAN
FOUNDATION PLAN
FLOOR PLAN
DETAIL - PART ELEVATION OF FRONT
DETAIL - AIR INTAKE VENT
ELEVATION
SECTION C-C
SECTION D-D
ELEVATION
DETAIL AIR OUTGOING VENT
SCALE: AS NOTED.
CONSTRUCTION DIVISION
OFFICE OF THE QUARTERMASTER GENERAL
SUB STATION BUILDING
FOR
WRIGHT MEMORIAL
KITTY HAWK N.C.
NOV. 1st, 1930.
6711-18

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Appendix C

1954 Rehabilitation Drawings, Pylon Monument

Sheet 1: Plan of Pylon and Terrace

Sheet 2: South Elevation of Pylon

Sheet 3: East Elevation of Pylon

Sheet 4: Longitudinal Section of Pylon

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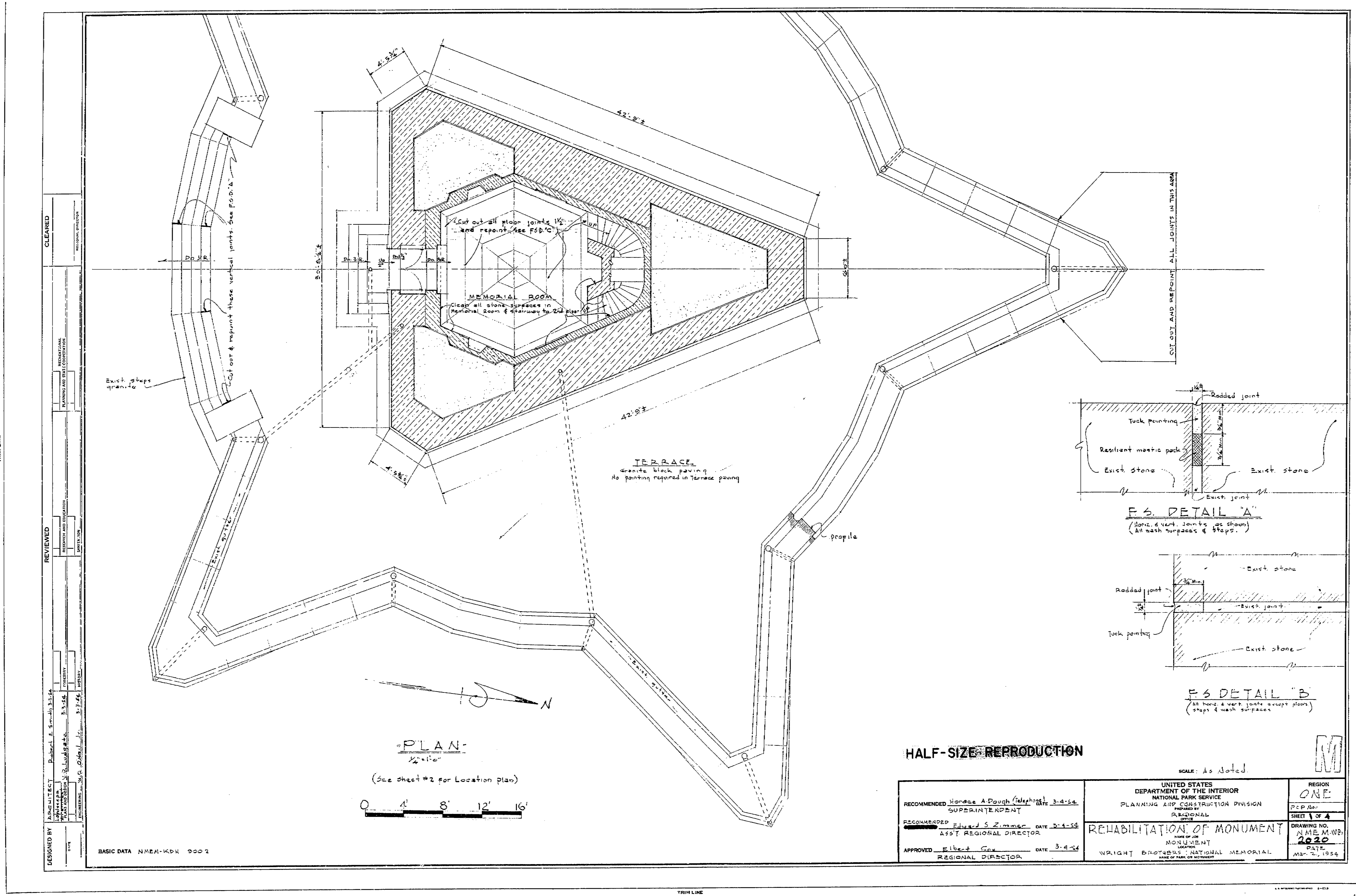

PLAN
(See sheet #2 for Location plan)
0 4' 8' 12' 16'
N
MEMORIAL ROOM
Cut out all floor joints 1½" and repoint. See FSD"C"
Clean all stone surfaces in Memorial Room & Stairway to 2nd floor
TERRACE
Granite block paving
No pointing required in Terrace paving
Cut out & repoint these vertical joints. See F.S.D."A"
Exist. steps granite
Exist. gutter
Profile
42' 9¾"
CUT OUT AND REPOINT ALL JOINTS IN THIS AREA
Rodded joint
Tuck pointing
Resilient mastic pack
Exist. stone
Exist. joint
F.S. DETAIL "A"
(Horiz. & vert. joints as shown)
(All wash surfaces & steps.)
Exist. stone
Rodded joint
Tuck pointing
F.S. DETAIL "B"
HALF-SIZE REPRODUCTION
SCALE: As Noted
RECOMMENDED Horace A. Dough SUPERINTENDENT DATE 3-4-54
RECOMMENDED Edward S. Zimmer ASS'T REGIONAL DIRECTOR DATE 3-4-54
APPROVED Elbert Cox REGIONAL DIRECTOR DATE 3-4-54
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
PLANNING AND CONSTRUCTION DIVISION
REGIONAL
REHABILITATION OF MONUMENT
MONUMENT
WRIGHT BROTHERS NATIONAL MEMORIAL
REGION ONE
SHEET 1 OF 4
DRAWING NO. NME M-WB 2020
Mar. 2, 1954
BASIC DATA NMEM-KDH 9002
DESIGNED BY
REVIEWED
CLEARED
TRIM LINE

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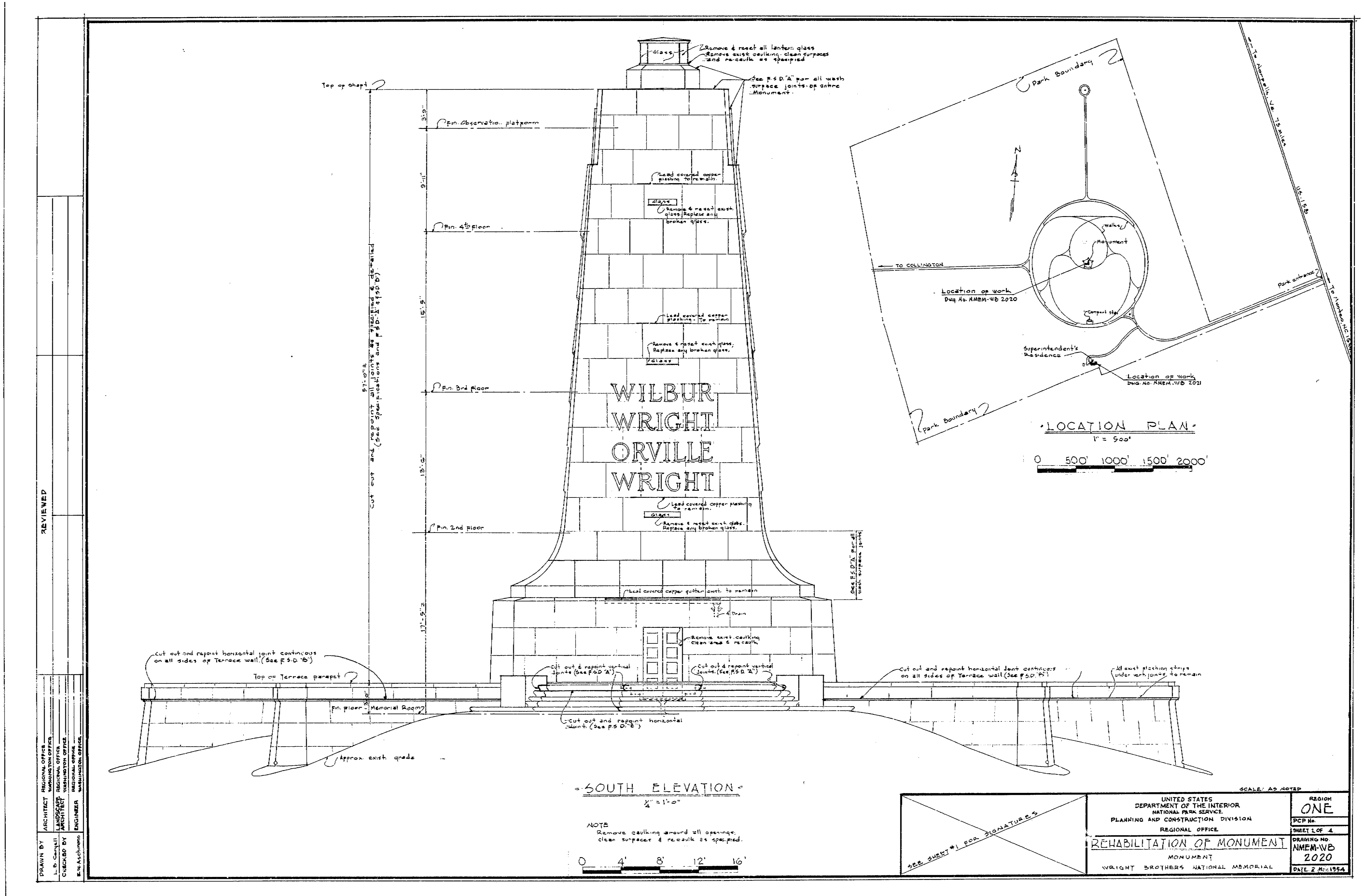
SOUTH ELEVATION
1/4" = 1'-0"
NOTE
Remove caulking around all openings, clean surfaces & recaulk as specified.
WILBUR WRIGHT ORVILLE WRIGHT
LOCATION PLAN
1" = 500'
Park Boundary
TO COLLINGTON
Location of work Dwg. No. NMEM-WB 2020
Superintendent's Residence
Location of work Dwg. No. NMEM-WB 2021
Park entrance
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
PLANNING AND CONSTRUCTION DIVISION
REGIONAL OFFICE
REHABILITATION OF MONUMENT
MONUMENT
WRIGHT BROTHERS NATIONAL MEMORIAL
REGION ONE
SHEET 2 OF 4
DRAWING NO. NMEM-WB 2020
SCALE: AS NOTED
SEE SHEET #1 FOR SIGNATURES
REVIEWED
DRAWN BY
CHECKED BY
ARCHITECT
LANDSCAPE ARCHITECT
ENGINEER

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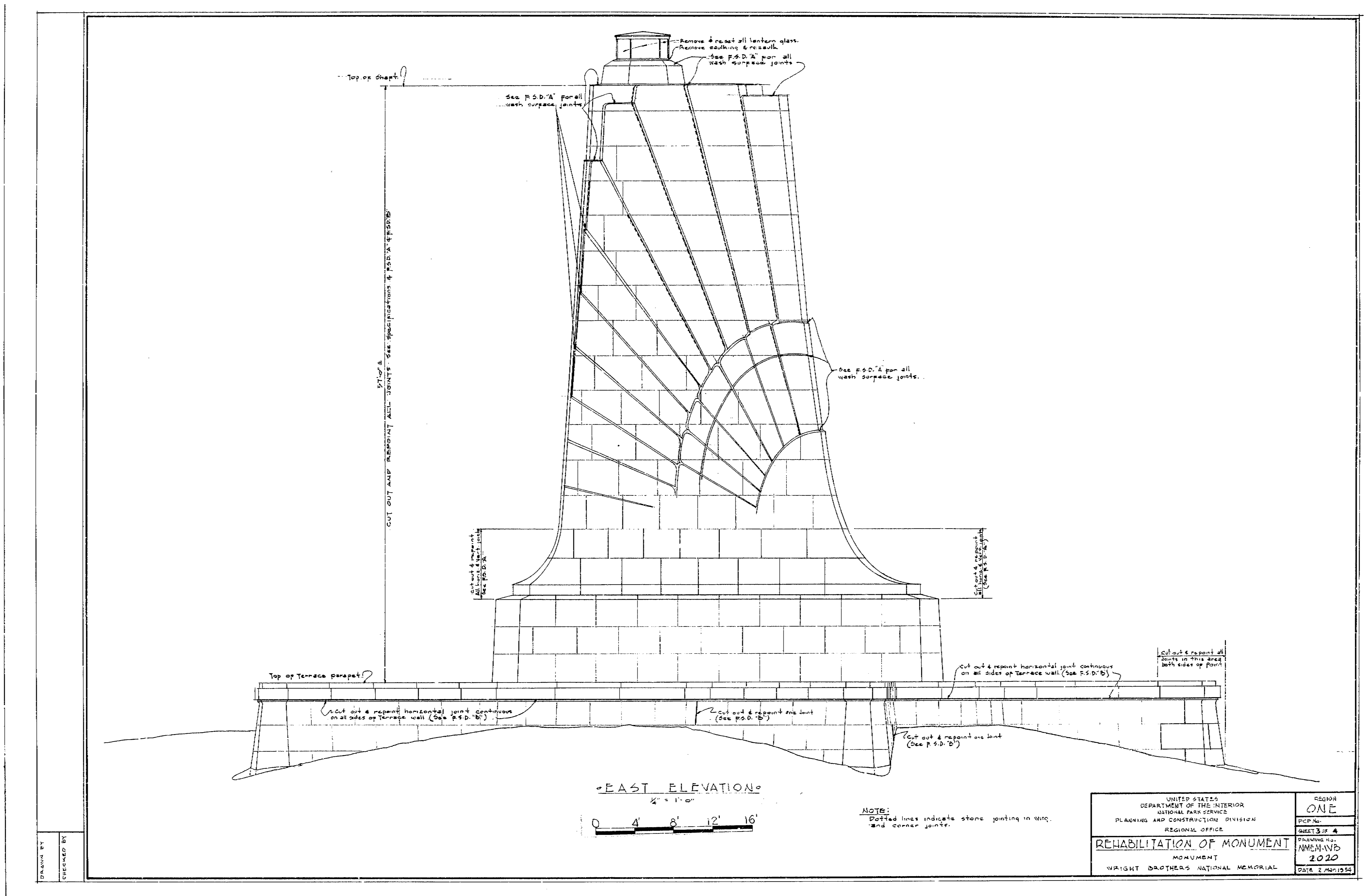
Remove & reset all lantern glass.
Remove caulking & recaulk
See F.S.D. "A" for all wash surface joints
Top of Shaft
See F.S.D. "A" for all wash surface joints
57'-0" ± CUT OUT AND REPOINT ALL JOINTS. See Specifications & F.S.D. "A" & F.S.D. "B"
See F.S.D. "A" for all wash surface joints.
Top of Terrace parapet
Cut out & repoint horizontal joint continuous on all sides of Terrace wall. (See F.S.D. "B")
Cut out & repoint all joints in this area both sides of point
Cut out & repoint horizontal joint continuous on all sides of Terrace wall (See F.S.D. "B")
Cut out & repoint one joint (See F.S.D. "B")
Cut out & repoint one joint (See F.S.D. "B")
EAST ELEVATION
¼" = 1'-0"
0 4' 8' 12' 16'
NOTE:
Dotted lines indicate stone jointing in wing and corner joints.
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
PLANNING AND CONSTRUCTION DIVISION
REGIONAL OFFICE
REHABILITATION OF MONUMENT
MONUMENT
WRIGHT BROTHERS NATIONAL MEMORIAL
REGION
ONE
PCP No.
SHEET 3 OF 4
DRAWING No.
NMEM-IVB
2020
DATE 2 Mar. 1954
DRAWN BY
CHECKED BY

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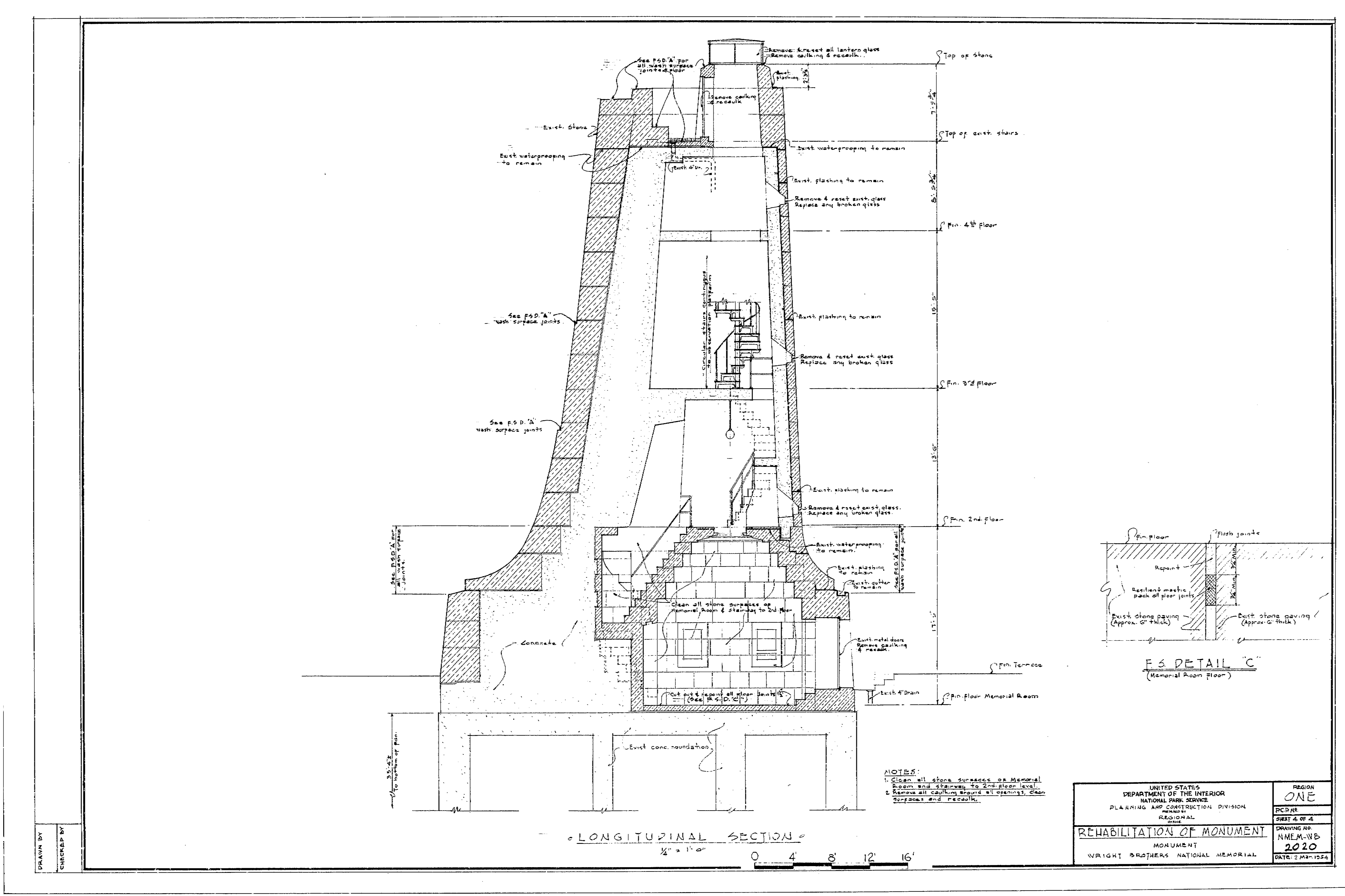
Remove & reset all lantern glass
Remove caulking & recaulk.
Top of Stone
See F.S.D. "A" for all wash surface joints & floor
Remove caulking & recaulk
Exist. Stone
Top of exist. stairs
Exist. waterproofing to remain
Exist. waterproofing to remain
Exist. flashing to remain
Remove & reset exist. glass
Replace any broken glass
Fin. 4th Floor
Circular stairs continue to observation platform
See F.S.D. "A" wash surface joints
Exist. flashing to remain
Remove & reset exist. glass
Replace any broken glass
Fin. 3rd Floor
See F.S.D. "A" wash surface joints
15'-5"
13'-6"
Exist. flashing to remain
Remove & reset exist. glass.
Replace any broken glass.
Fin. 2nd Floor
See F.S.D. "A" for all wash surface joints
Exist. waterproofing to remain.
Exist. flashing to remain
Exist. gutter to remain
Clean all stone surfaces of Memorial Room & stairway to 2nd floor
Concrete
Exist. metal doors
Remove caulking & recaulk
Fin. Terrace
Exist. 4" Drain
Fin. floor Memorial Room
Cut out & repoint all floor joints (See F.S.D. "C")
Exist. conc. foundation
35'-4" to bottom of fdn.
Fin. floor
Flush joints
Repoint
Resilient mastic pack all floor joints
Exist. stone paving (Approx. 6" thick)
Exist. stone paving (Approx. 6" thick)
F.S. DETAIL "C"
(Memorial Room Floor)
NOTES:
1. Clean all stone surfaces of Memorial Room and stairway to 2nd floor level.
2. Remove all caulking around all openings, clean surfaces and recaulk.
LONGITUDINAL SECTION
1/4" = 1'-0"
0 4' 8' 12' 16'
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
PLANNING AND CONSTRUCTION DIVISION
REGIONAL OFFICE
REHABILITATION OF MONUMENT
MONUMENT
WRIGHT BROTHERS NATIONAL MEMORIAL
REGION
ONE
SHEET 4 OF 4
DRAWING NO.
NMEM-WB
2020
DATE: 2 Mar. 1954
DRAWN BY
CHECKED BY

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Appendix D

Existing Drawings, Monument and Powerhouse

Sheet 1: Site Plan

Sheet 2: Monument Floor Plans

Sheet 3: Monument South Elevation

Sheet 4: Monument North Elevation

Sheet 5: Monument West and 1B Elevations

Sheet 6: Monument East and 1A Elevations

Sheet 7: Powerhouse Plan

Sheet 8: Powerhouse Elevations

Sheet 9: Powerhouse Elevations

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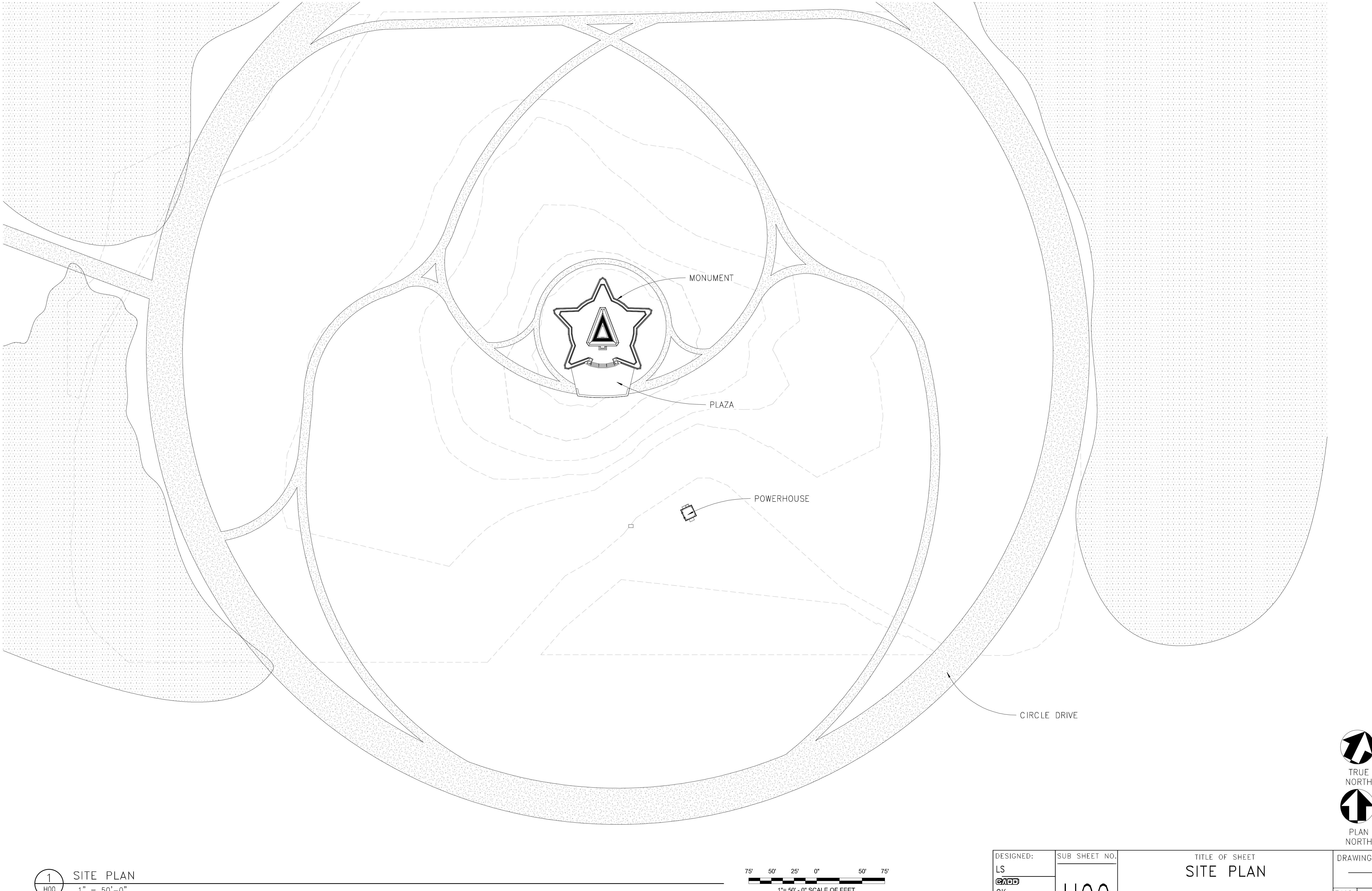

1 H00 SITE PLAN
1" = 50'-0"

DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
LS	H00	SITE PLAN	
CADD GK		HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE	PKG. NO. / SHEET 1 OF 9
TECH. REVIEW: PR		WRIGHT BROTHERS NATIONAL MEMORIAL	
DATE: 01/13/2023			

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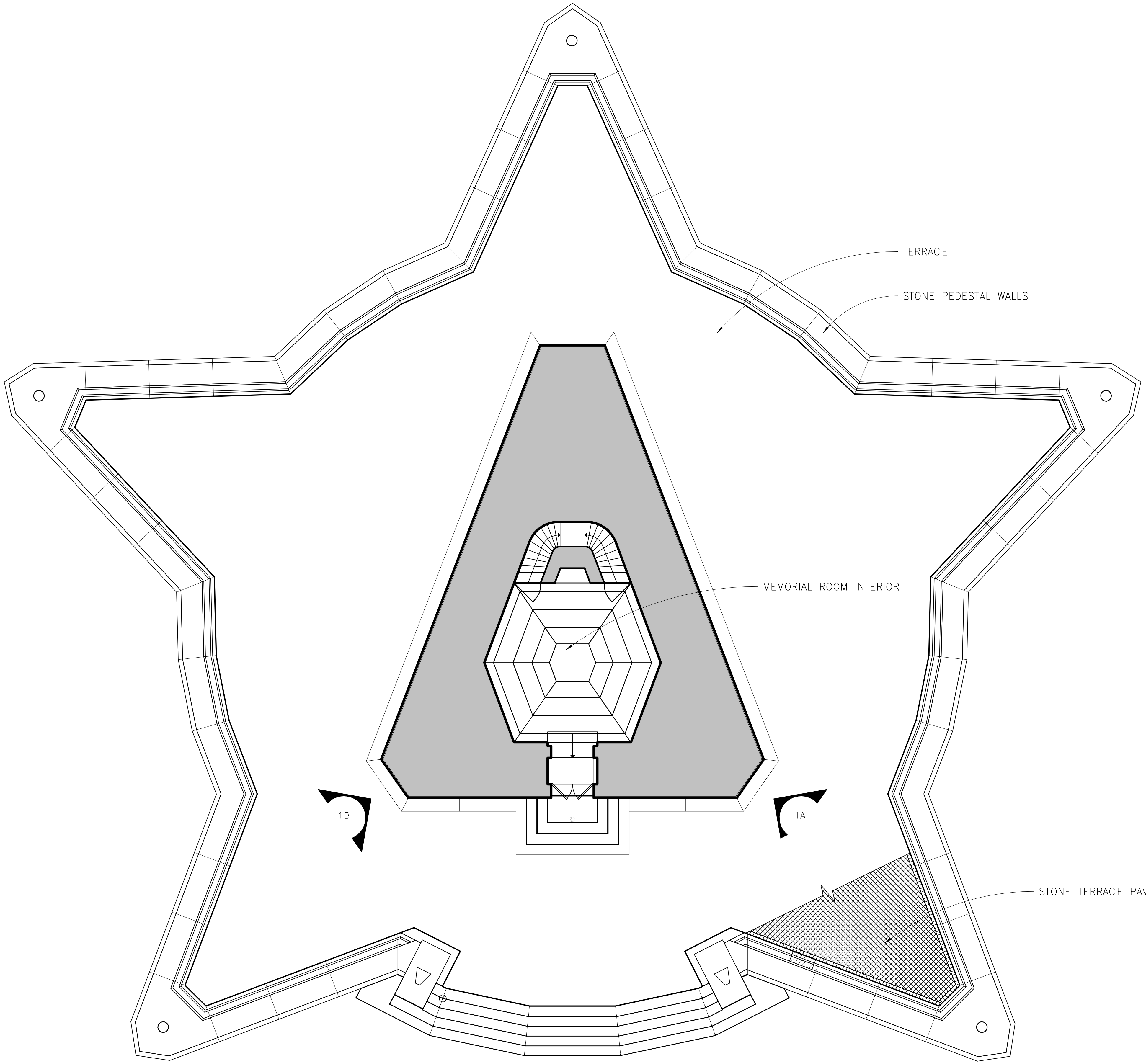
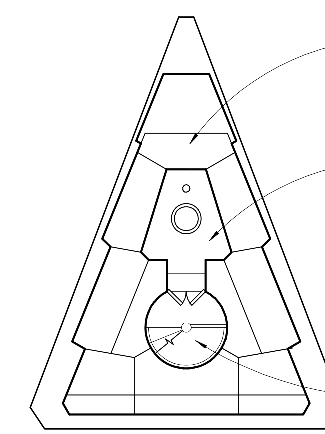
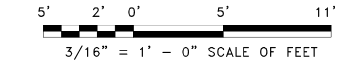
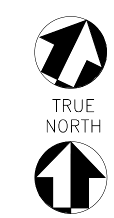


1 H01 EXISTING GROUND FLOOR PLAN
3/16" = 1'-0"



2 H01 EXISTING OBSERVATION PLATFORM
3/16" = 1'-0"





DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
LS CADD GK TECH. REVIEW: PR DATE: 01/13/2023	H01	MONUMENT FLOOR PLANS HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE WRIGHT BROTHERS NATIONAL MEMORIAL	PKG. NO. SHEET 2 OF 9

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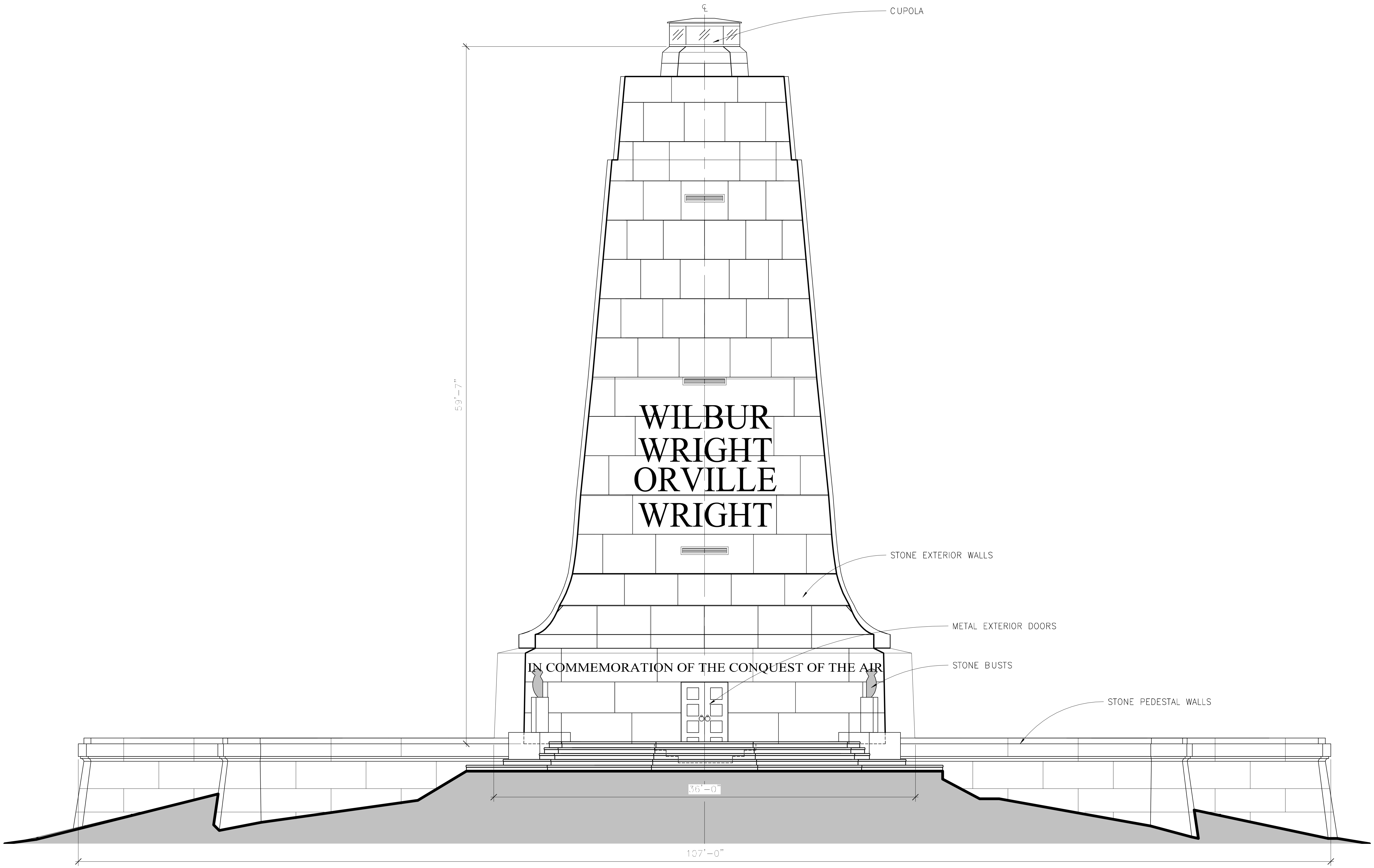

1 H02 EXISTING SOUTH ELEVATION
1/4" = 1'-0"

4' 2' 0 4' 8'
1/4" = 1'-0" SCALE OF FEET

DESIGNED: LS CADD GK TECH. REVIEW: PR DATE: 01/13/2023	SUB SHEET NO. H02	TITLE OF SHEET MONUMENT SOUTH ELEVATION HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE WRIGHT BROTHERS NATIONAL MEMORIAL	DRAWING NO. PKG. NO.	SHEET 3 OF 9

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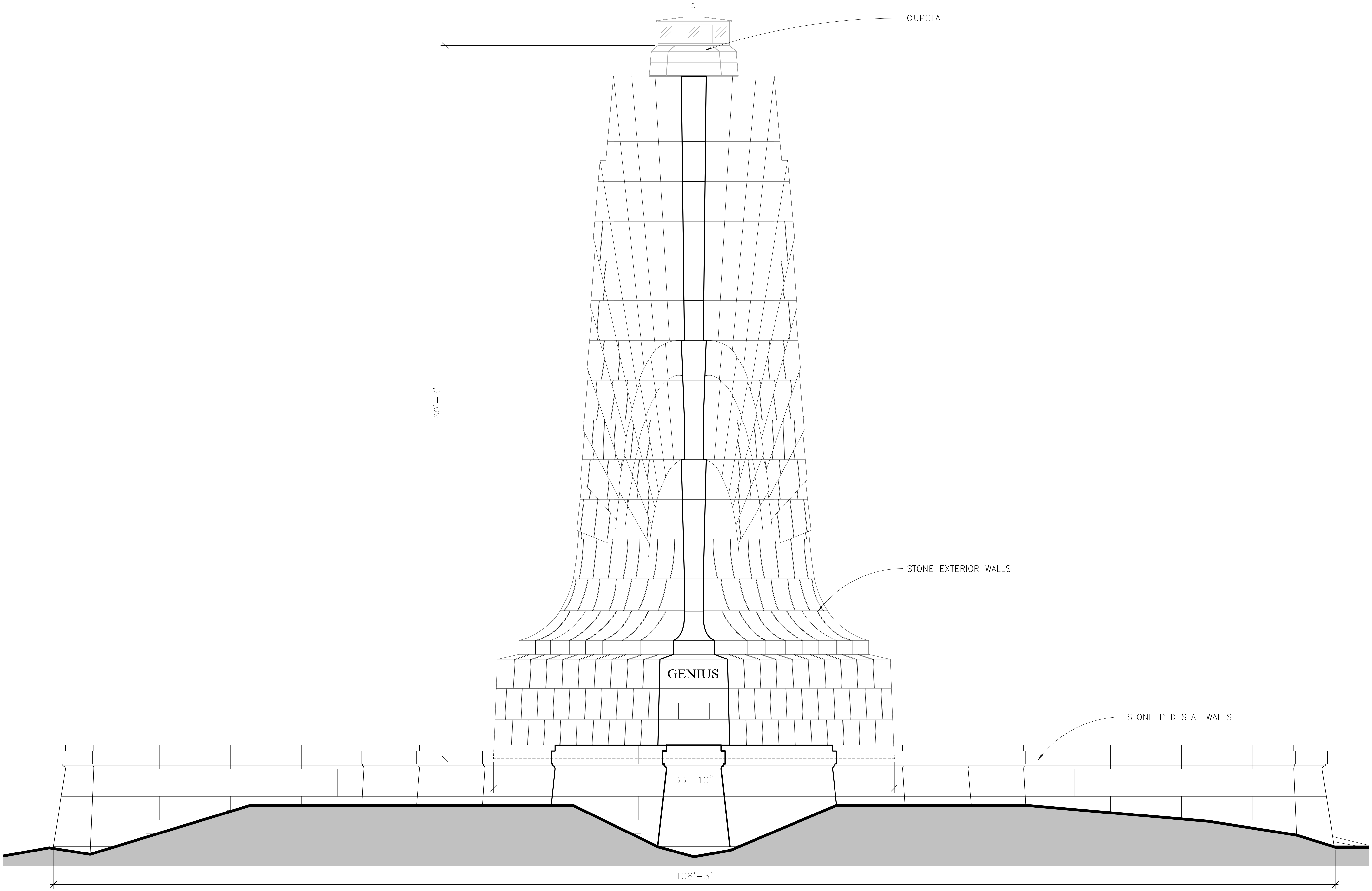

1 H03 EXISTING NORTH ELEVATION
1/4" = 1'-0"

4' 2' 0 4' 8'
1/4" = 1' - 0" SCALE OF FEET

DESIGNED: LS CADD GK TECH. REVIEW: PR DATE: 01/13/2023	SUB SHEET NO. H03	TITLE OF SHEET MONUMENT NORTH ELEVATION HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE WRIGHT BROTHERS NATIONAL MEMORIAL	DRAWING NO. PKG. NO. SHEET 4 OF 9

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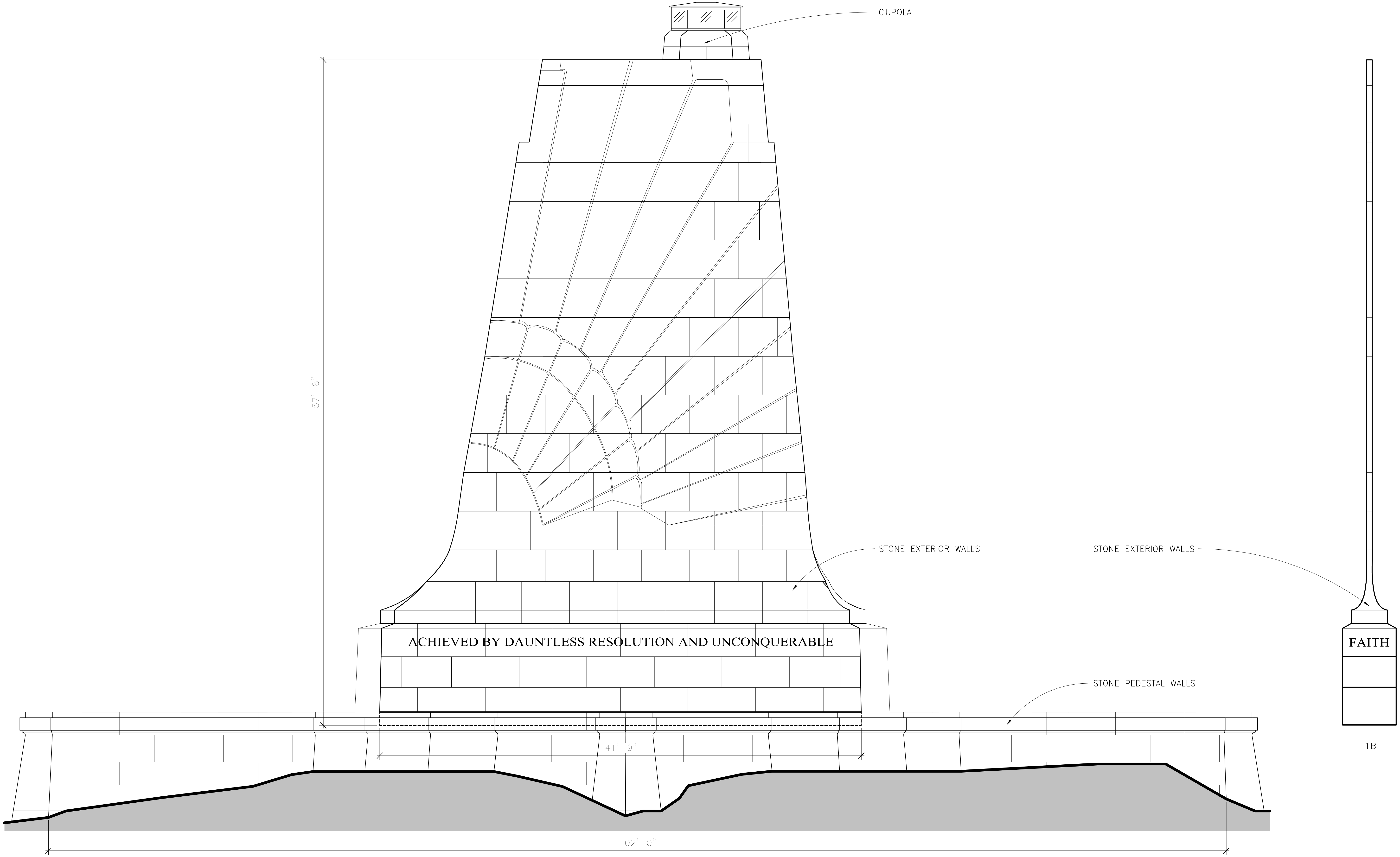

1 / H04 EXISTING WEST ELEVATION
1/4" = 1'-0"

4' 2' 0 4' 8'
1/4" = 1'-0" SCALE OF FEET

DESIGNED: LS CADD GK TECH. REVIEW: PR DATE: 01/13/2023	SUB SHEET NO. H04	TITLE OF SHEET MONUMENT WEST AND 1B ELEVATIONS HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE WRIGHT BROTHERS NATIONAL MEMORIAL	DRAWING NO. PKG. NO. SHEET 5 OF 9

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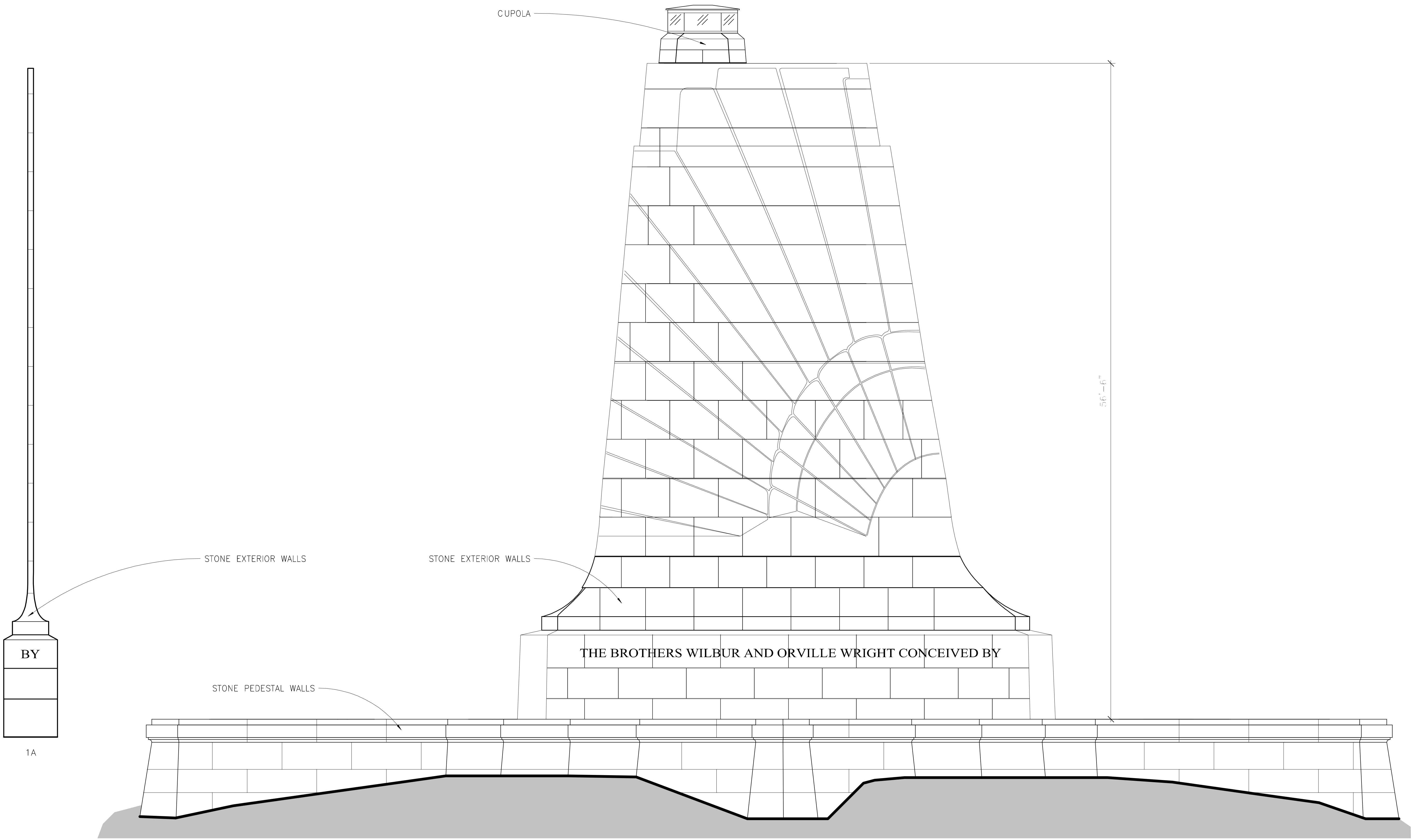

1 H05 EXISTING EAST ELEVATION

1/4" = 1'-0"

4' 2' 0 4' 8'

1/4" = 1' - 0" SCALE OF FEET

DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
LS	H05	MONUMENT EAST AND 1A ELEVATIONS	
CADD GK		HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE	PKG. NO.
TECH. REVIEW: PR		WRIGHT BROTHERS NATIONAL MEMORIAL	SHEET 6 OF 9
DATE: 01/13/2023			

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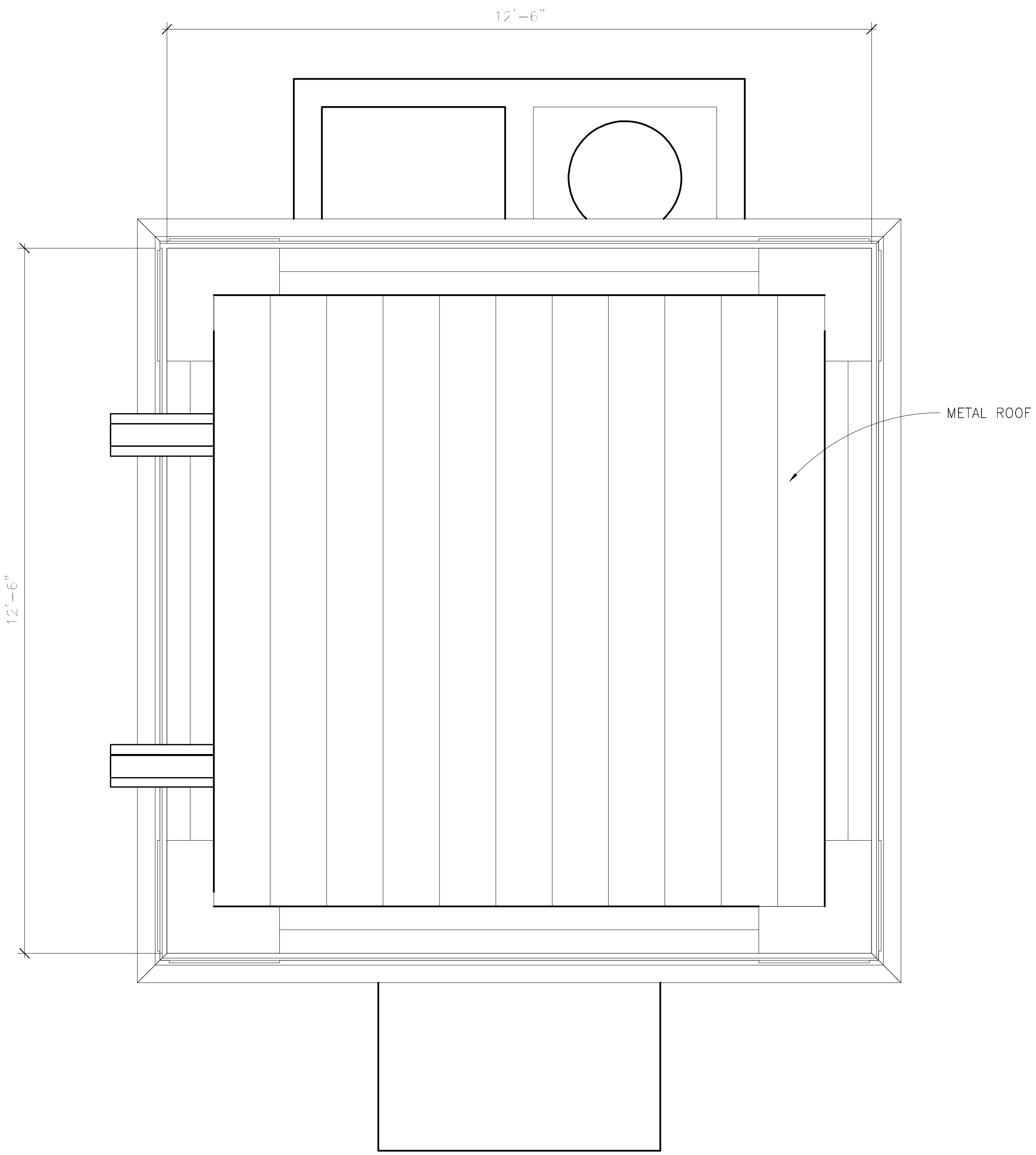
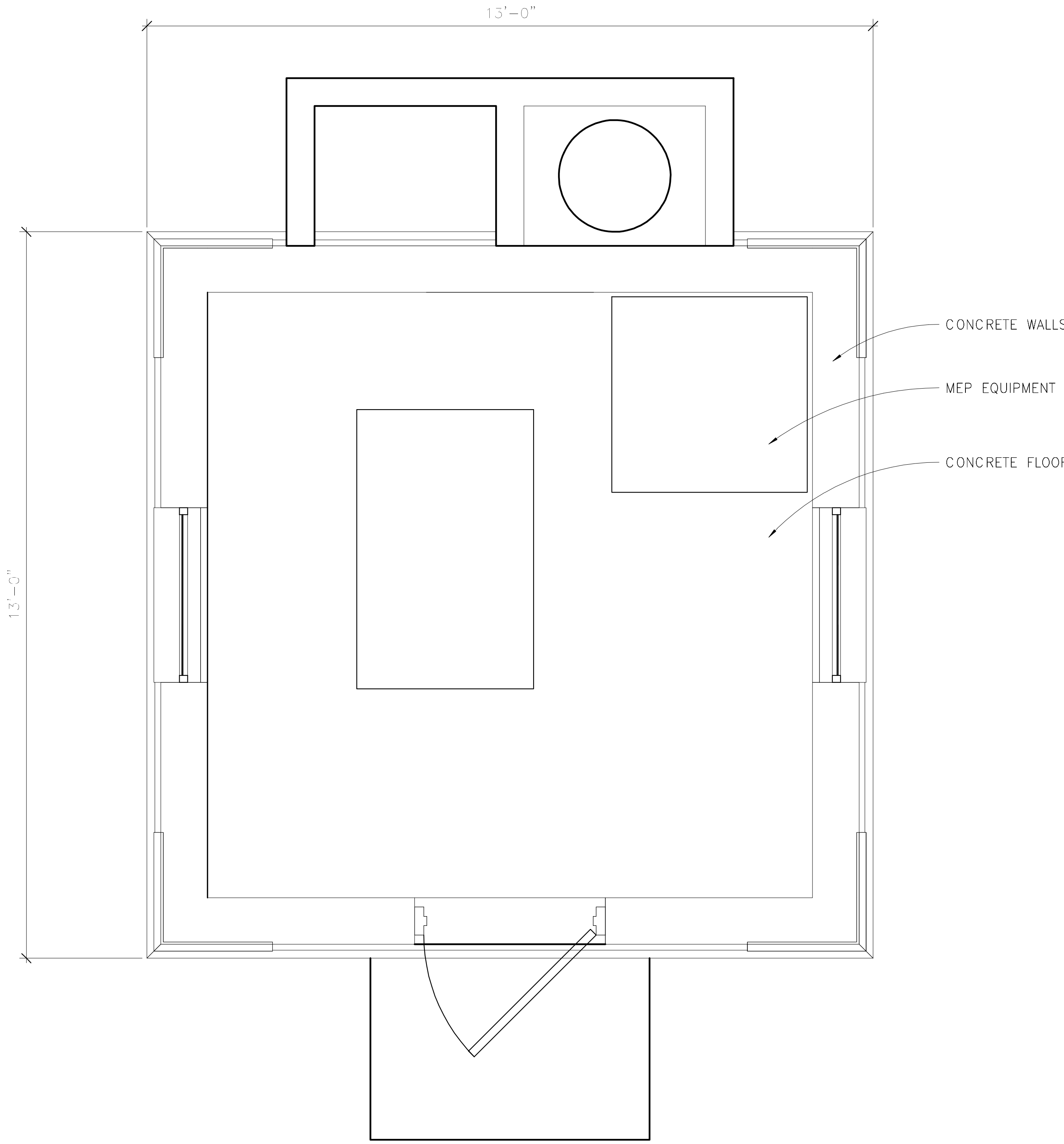
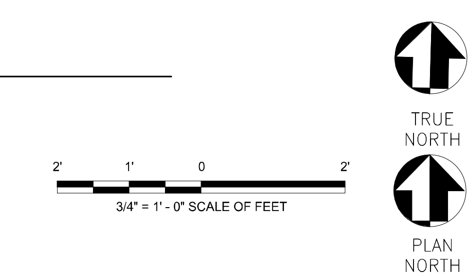


2 H06 POWERHOUSE ROOF PLAN
3/4" = 1'-0"



1 H06 POWERHOUSE FLOOR PLAN
3/4" = 1'-0"



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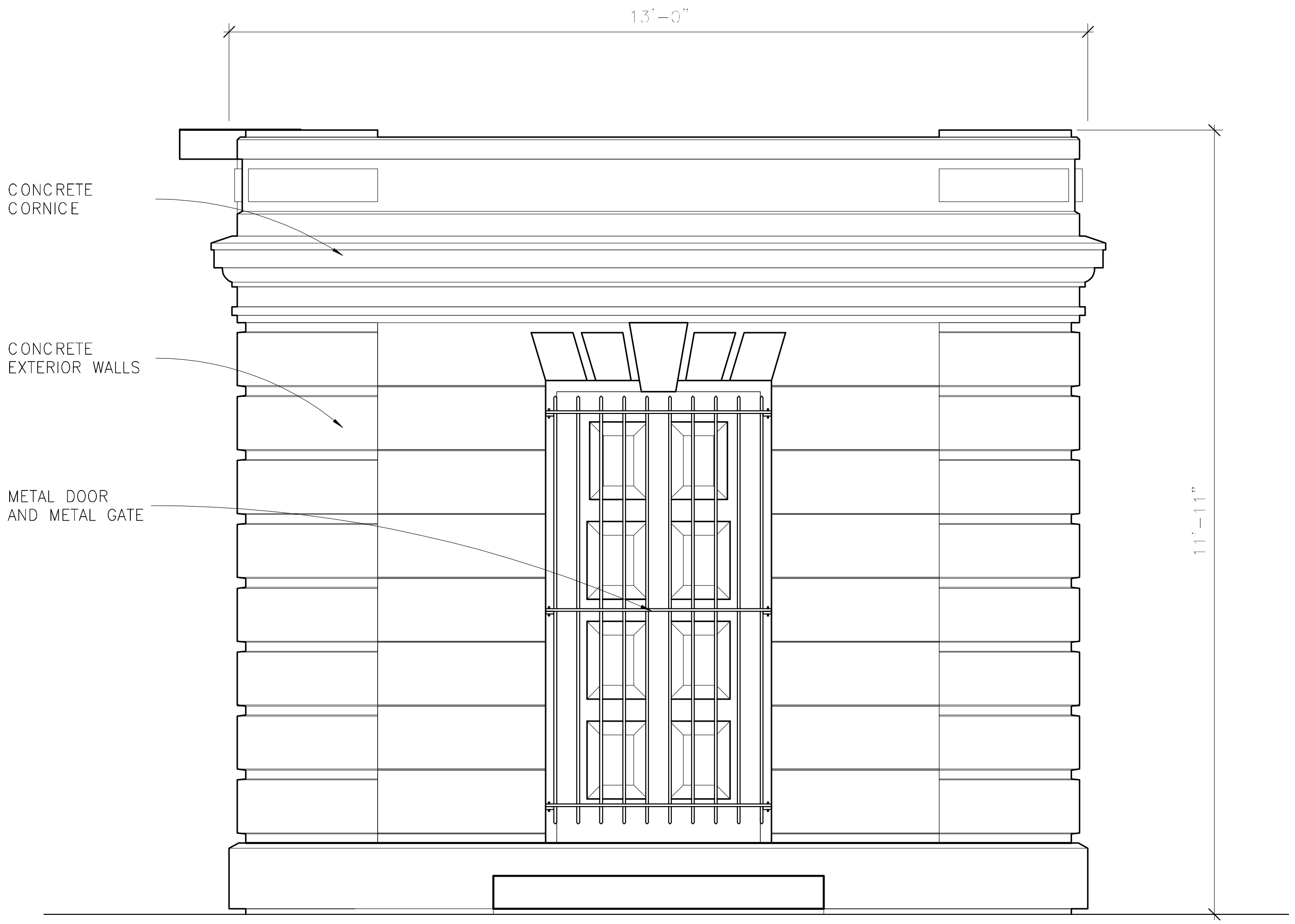
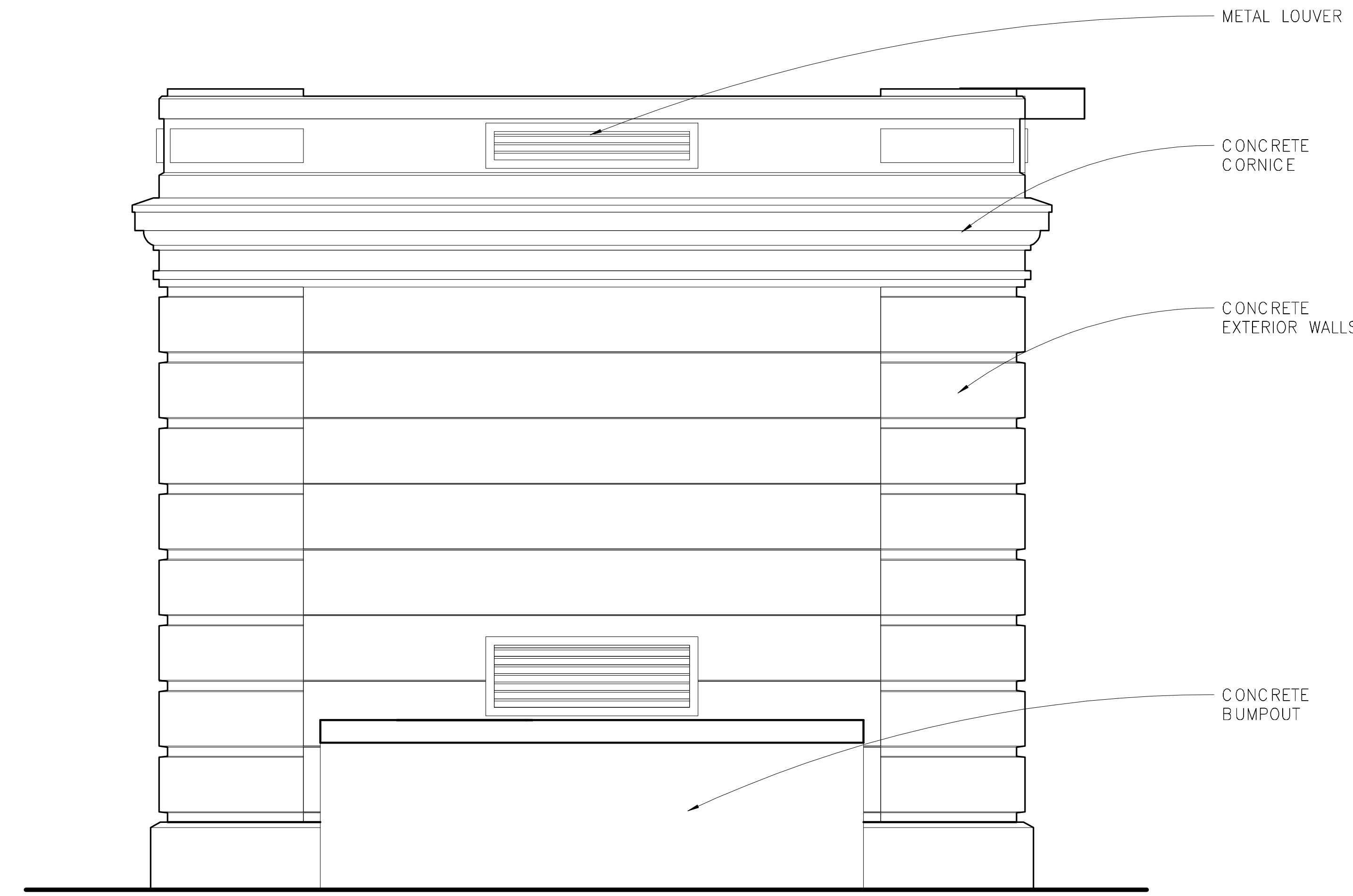


1 H07 EXISTING SOUTH ELEVATION
3/4" = 1'-0"



2 H07 EXISTING NORTH ELEVATION
3/4" = 1'-0"

2' 1' 0 2'
3/4" = 1' - 0" SCALE OF FEET

DESIGNED: LS	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
CADD: GK	H07	POWERHOUSE ELEVATIONS	
TECH. REVIEW: PR		HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE	PKG. NO.
DATE: 01/13/2023		WRIGHT BROTHERS NATIONAL MEMORIAL	SHEET 8 OF 9

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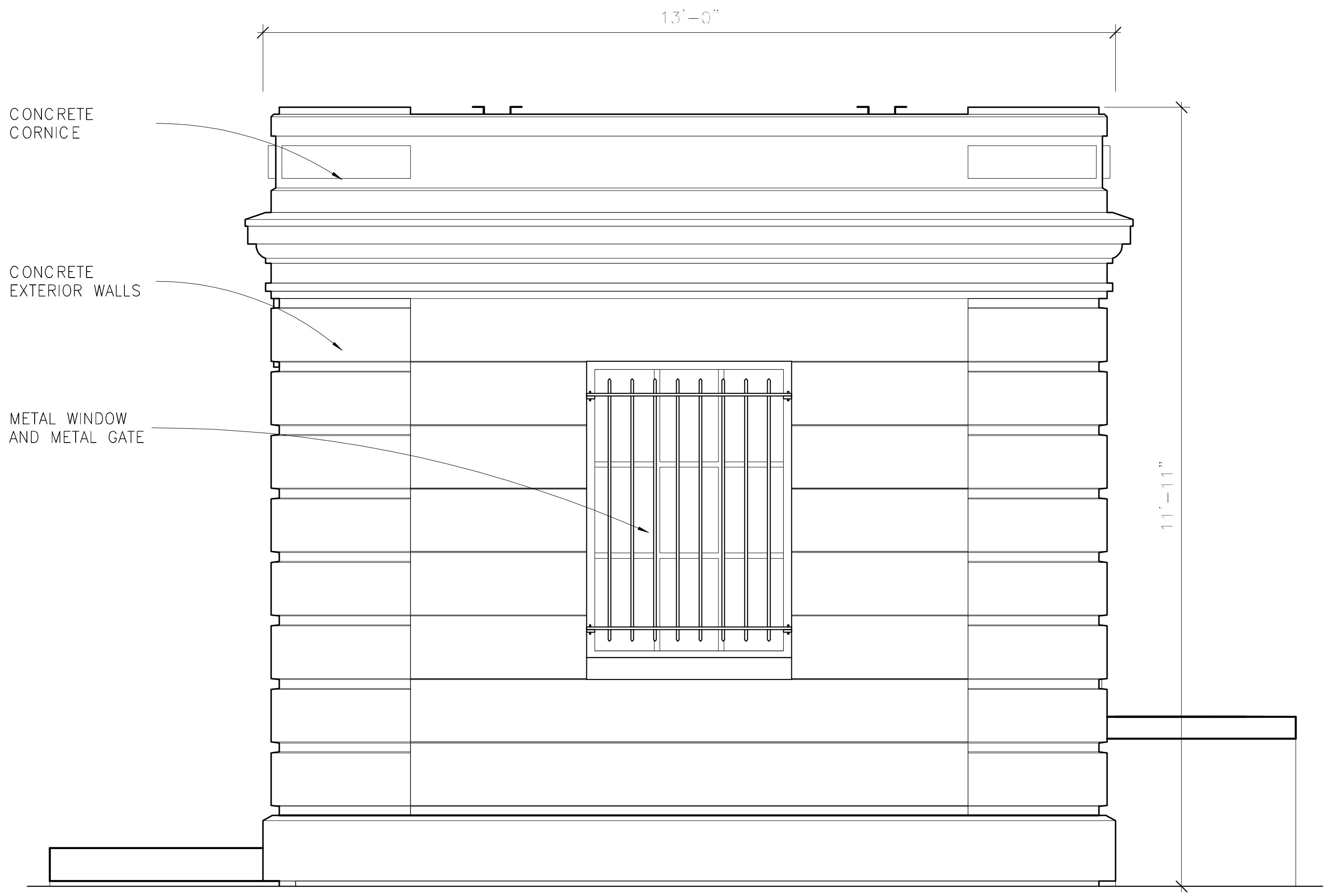
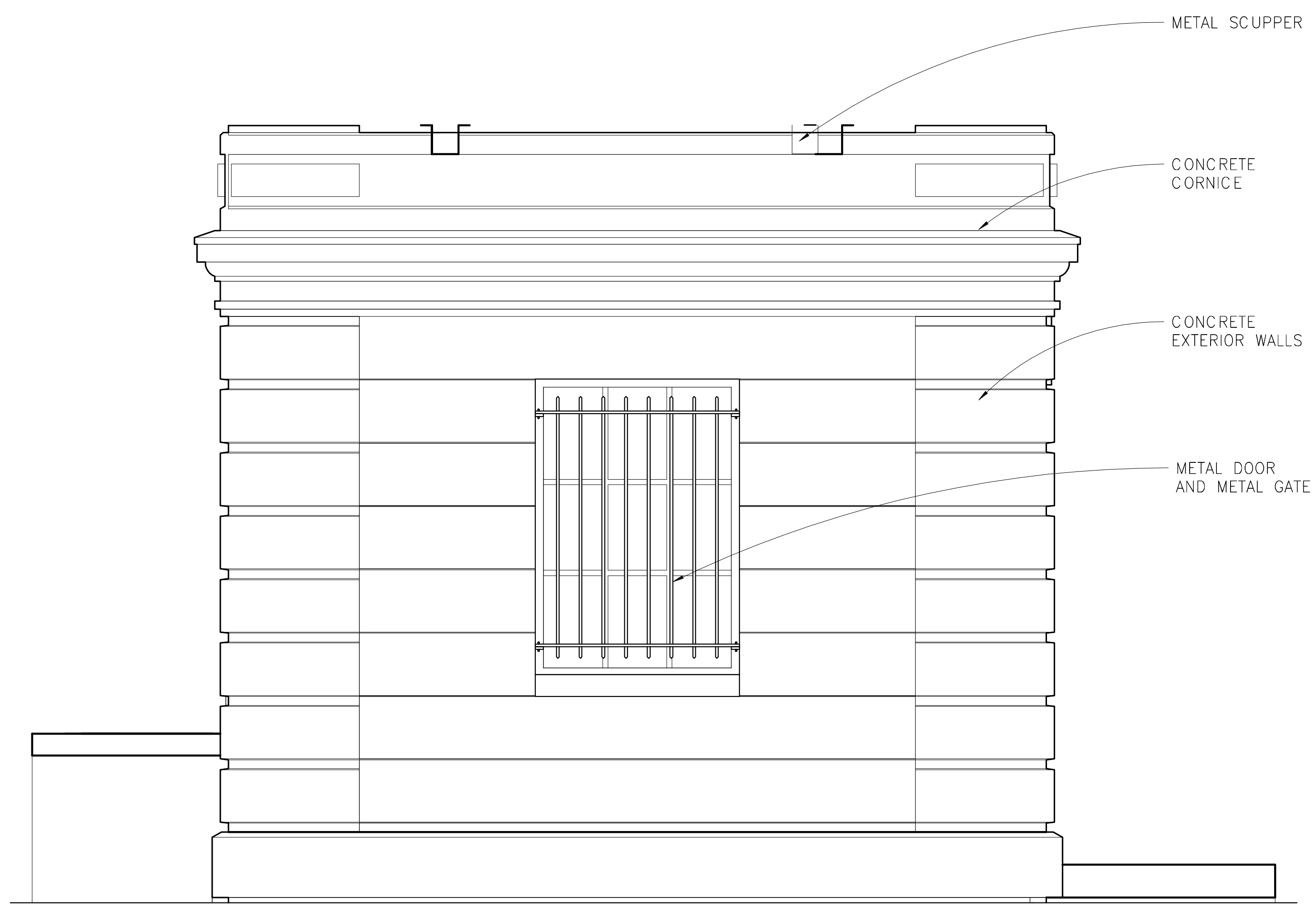


1 H08 EXISTING EAST ELEVATION
3/4" = 1'-0"



2 H08 EXISTING WEST ELEVATION
3/4" = 1'-0"

2' 1' 0 2'
3/4" = 1' - 0" SCALE OF FEET

DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
LS CADD GK TECH. REVIEW: PR DATE: 01/13/2023	H08	POWERHOUSE ELEVATIONS HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE WRIGHT BROTHERS NATIONAL MEMORIAL	PKG. NO. SHEET 9 OF 9

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Appendix E

Treatment Drawings: Surrounding Site, Monument, and Powerhouse

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AERIAL PLAN

SHEET #	TITLE OF SHEET
T00	COVER SHEET
T01	TREATMENT SITE PLAN
T02	MONUMENT TREATMENT PLANS
T03	MONUMENT SOUTH TREATMENT ELEVATION
T04	MONUMENT NORTH TREATMENT ELEVATION
T05	MONUMENT WEST & 1B TREATMENT ELEVATIONS
T06	MONUMENT EAST & 1A TREATMENT ELEVATIONS
T07	MONUMENT SECTION TREATMENT DIAGRAM
T08	POWERHOUSE TREATMENT PLANS
T09	POWERHOUSE N. & S. TREATMENT ELEVATIONS
T10	POWERHOUSE E. & W. TREATMENT ELEVATIONS

HSR

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
INTERIOR REGION 2

HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE

WRIGHT BROTHERS NATIONAL MEMORIAL

REGION	COUNTY	STATE
NE	DARE	NC

DRAWING NO.

PMIS/PKG NO

SHEET 1 OF 11

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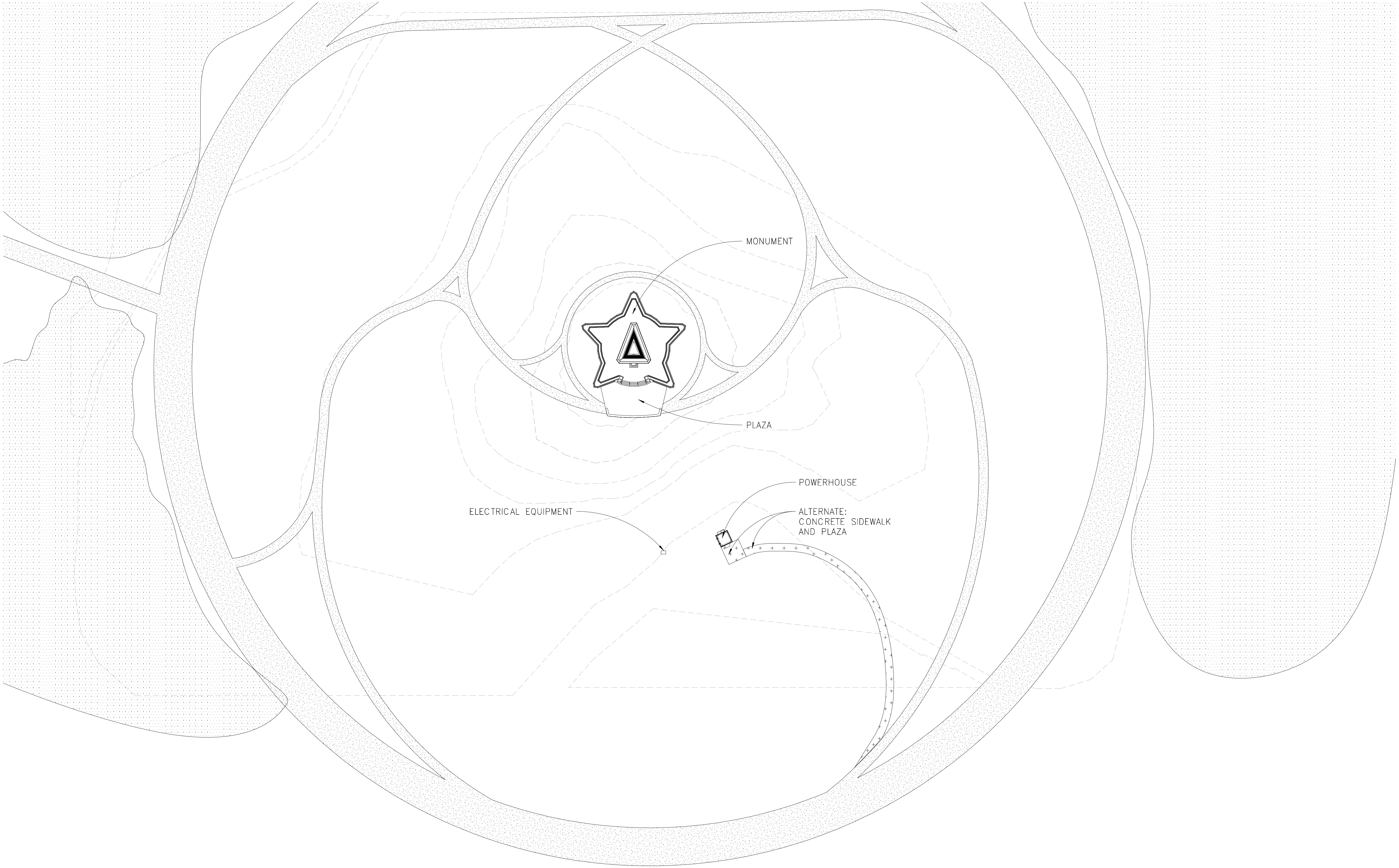

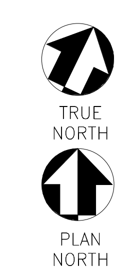

1 T01 TREATMENT SITE PLAN
1" = 50'-0"

75' 50' 25' 0" 50' 75'
1"= 50' - 0" SCALE OF FEET

DESIGNED: LS CADD GK TECH. REVIEW: BT DATE: 01/13/2023	SUB SHEET NO. T01	TITLE OF SHEET TREATMENT SITE PLAN HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE WRIGHT BROTHERS NATIONAL MEMORIAL	DRAWING NO. PKG. NO. SHEET 2 OF 11

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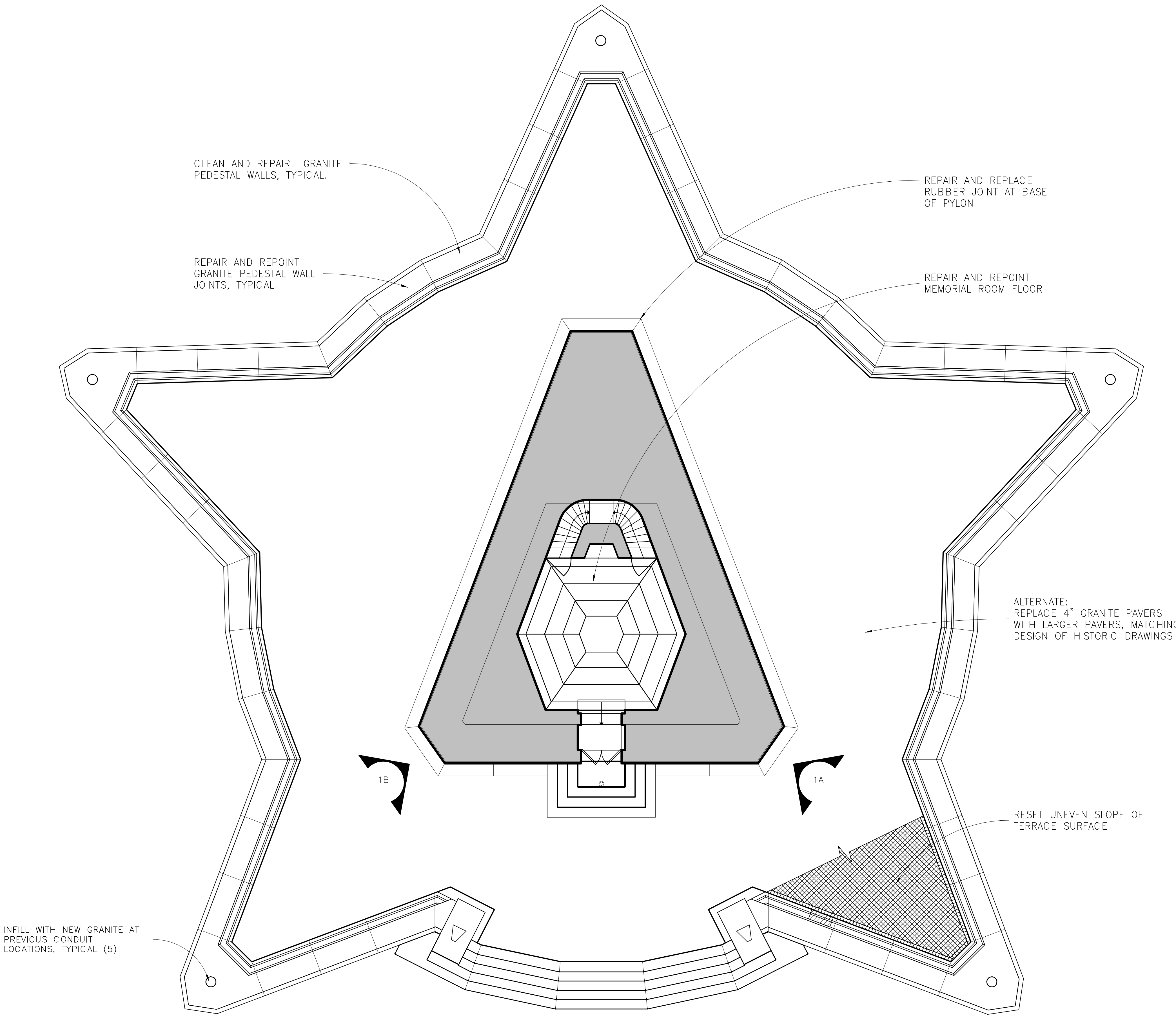
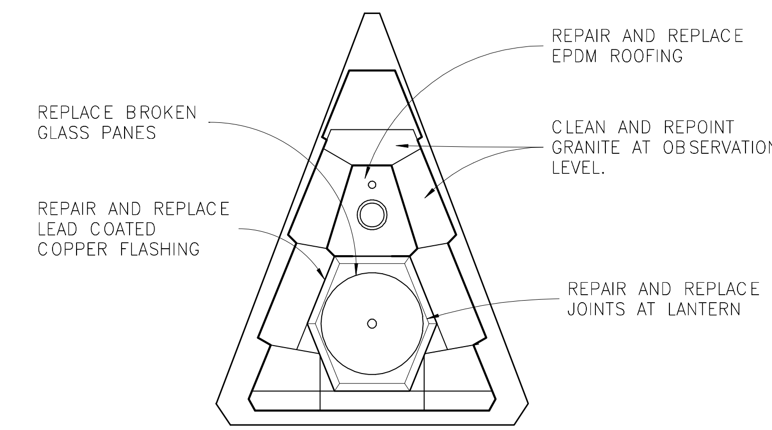


1 T02 GROUND FLOOR TREATMENT PLAN
3/16" = 1'-0"



2 T02 OBSERVATION PLATFORM TREATMENT PLAN
3/16" = 1'-0"

TRUE NORTH

5' 2' 0' 5' 11'
3/16" = 1' – 0" SCALE OF FEET

PLAN NORTH

DESIGNED: LS	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
CADD: GK	T02	MONUMENT TREATMENT PLANS	PKG. NO.
TECH. REVIEW: BT		HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE	SHEET 3
DATE: 01/13/2023		WRIGHT BROTHERS NATIONAL MEMORIAL	OF 11

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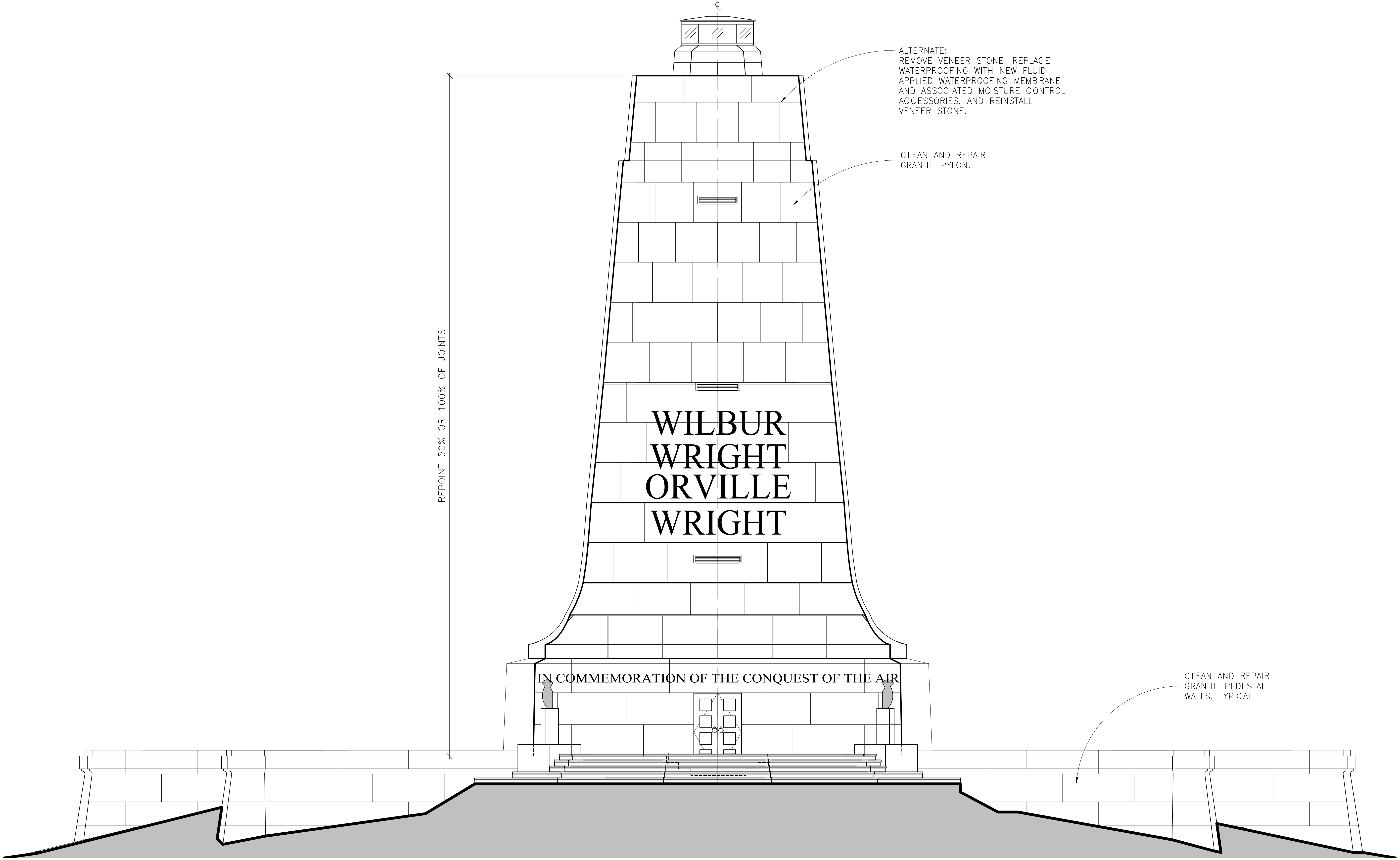

1 / T03 SOUTH TREATMENT ELEVATION

1/4" = 1'-0"

4' 2' 0 4' 8'

1/4" = 1' - 0" SCALE OF FEET

DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
LS	T03	MONUMENT SOUTH TREATMENT ELEVATION	
CADD: GK		HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE	PKG. NO.
TECH. REVIEW: BT		WRIGHT BROTHERS NATIONAL MEMORIAL	SHEET 4 OF 11
DATE: 01/13/2023			

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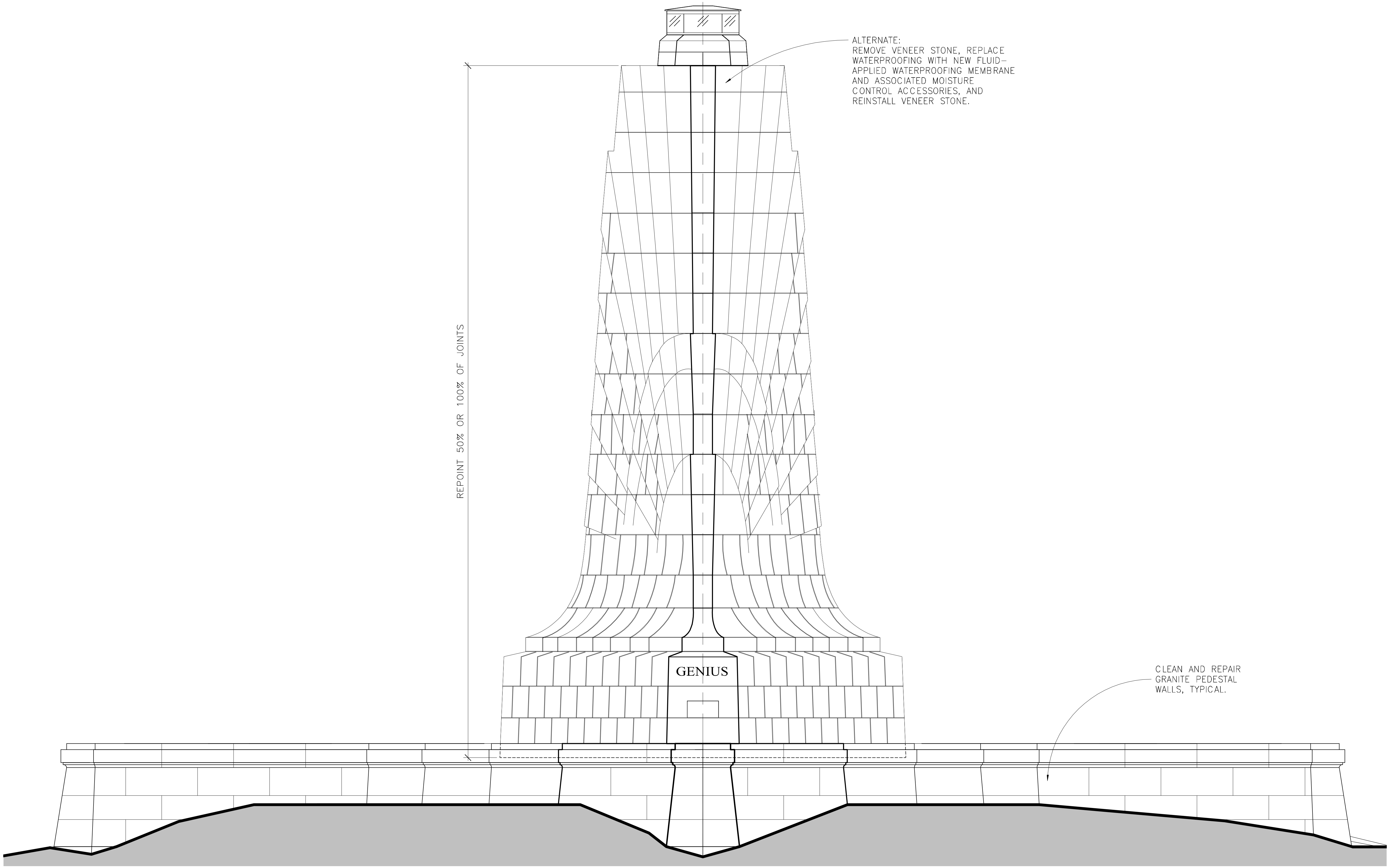

1 / T04 NORTH TREATMENT ELEVATION
1/4" = 1'-0"

4' 2' 0 4' 8'
1/4" = 1' - 0" SCALE OF FEET

DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
LS CADD GK TECH. REVIEW: BT DATE: 01/13/2023	T04	MONUMENT NORTH TREATMENT ELEVATION HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE WRIGHT BROTHERS NATIONAL MEMORIAL	PKG. NO. SHEET 5 OF 11

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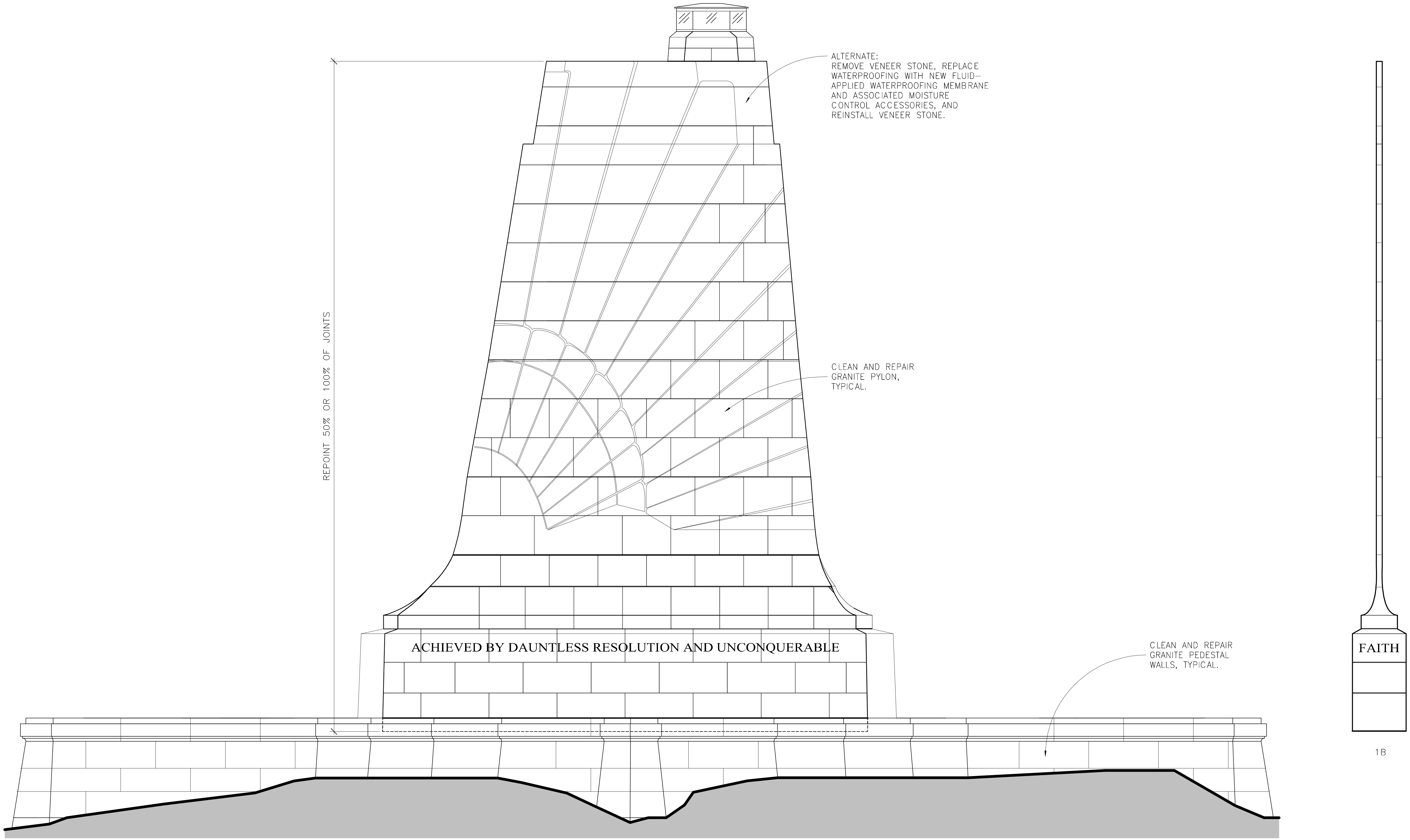

1 / T05 WEST TREATMENT ELEVATION
1/4" = 1'-0"

4' 2' 0 4' 8'
1/4" = 1'-0" SCALE OF FEET

DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
LS CADD GK TECH. REVIEW: BT DATE: 01/13/2023	T05	MONUMENT WEST & 1B TREATMENT ELEVATIONS HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE WRIGHT BROTHERS NATIONAL MEMORIAL	PKG. NO. SHEET 7 OF 11

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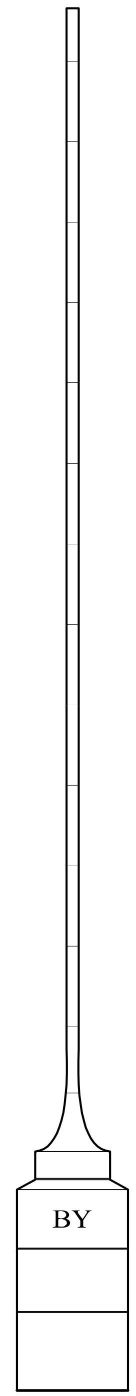
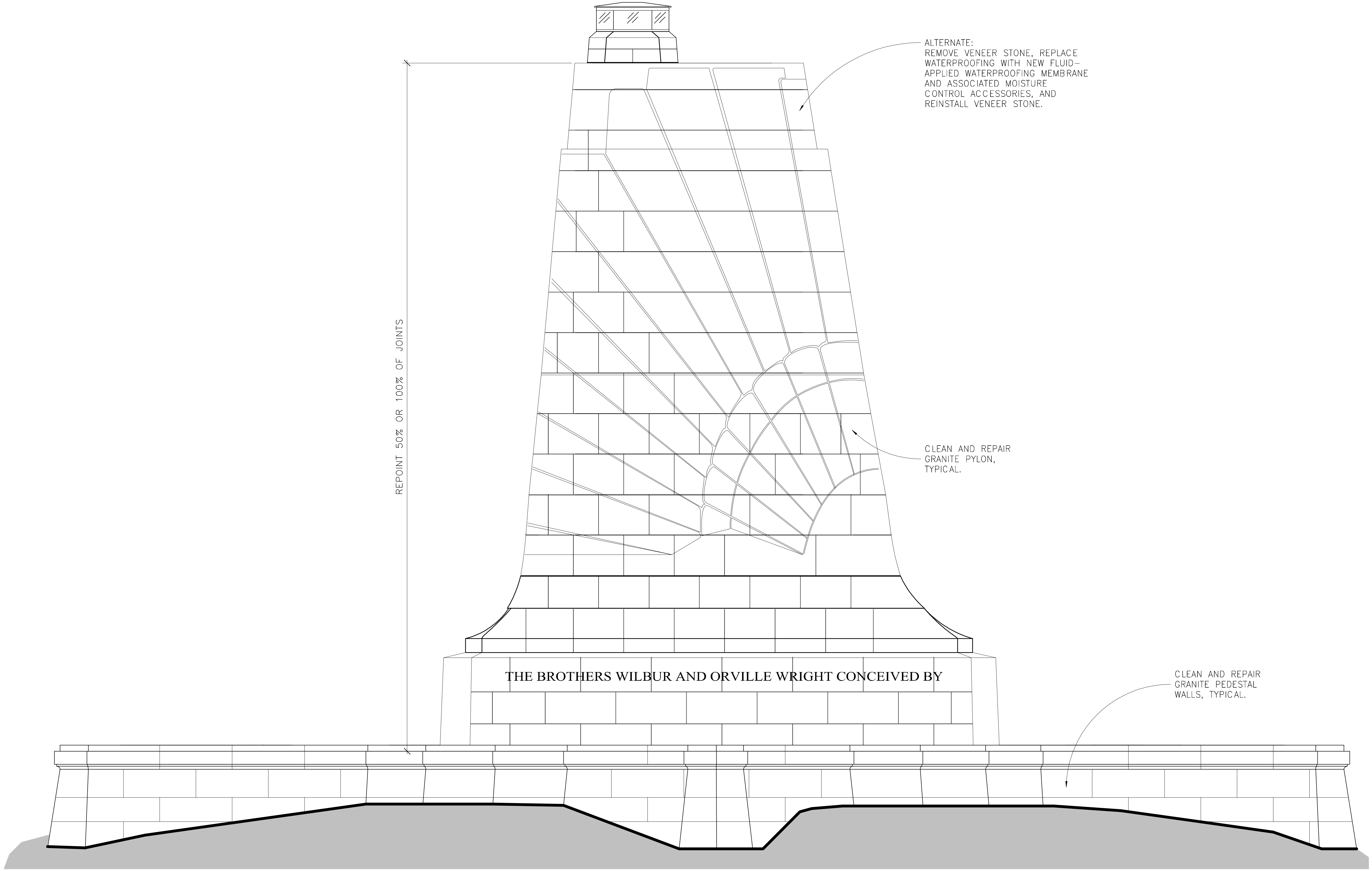


1A



1
T06
EAST TREATMENT ELEVATION
1/4" = 1'-0"

4' 2' 0 4' 8'
1/4" = 1' - 0" SCALE OF FEET

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LS	T06	MONUMENT EAST & 1A TREATMENT ELEVATIONS	
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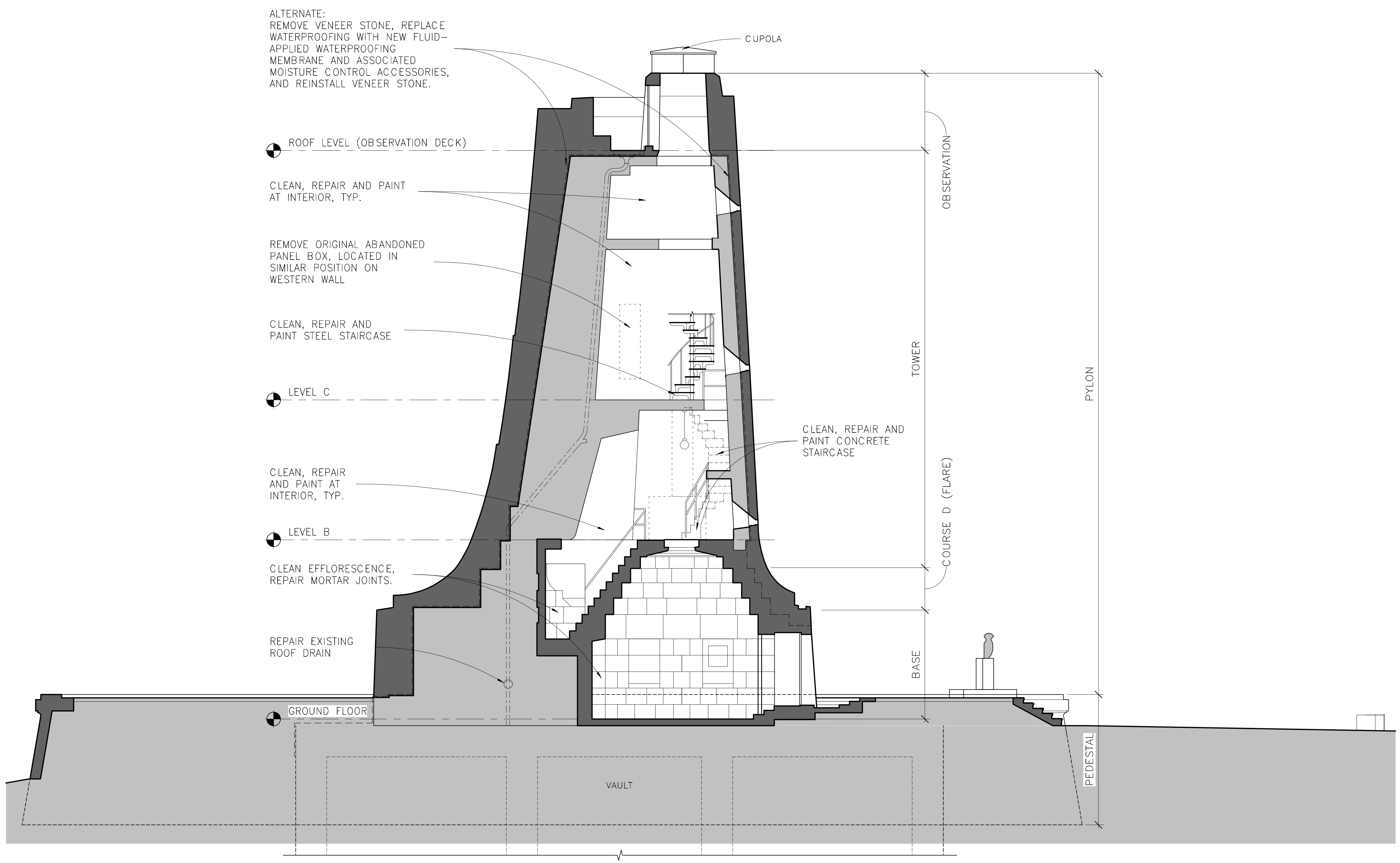

1
T07
MONUMENT NORTH-SOUTH BUILDING SECTION TREATMENT DIAGRAM
3/16" = 1'-0"

5' 2' 0' 5' 11'
3/16" = 1' - 0" SCALE OF FEET

DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
LS	T07	MONUMENT SECTION TREATMENT DIAGRAM	
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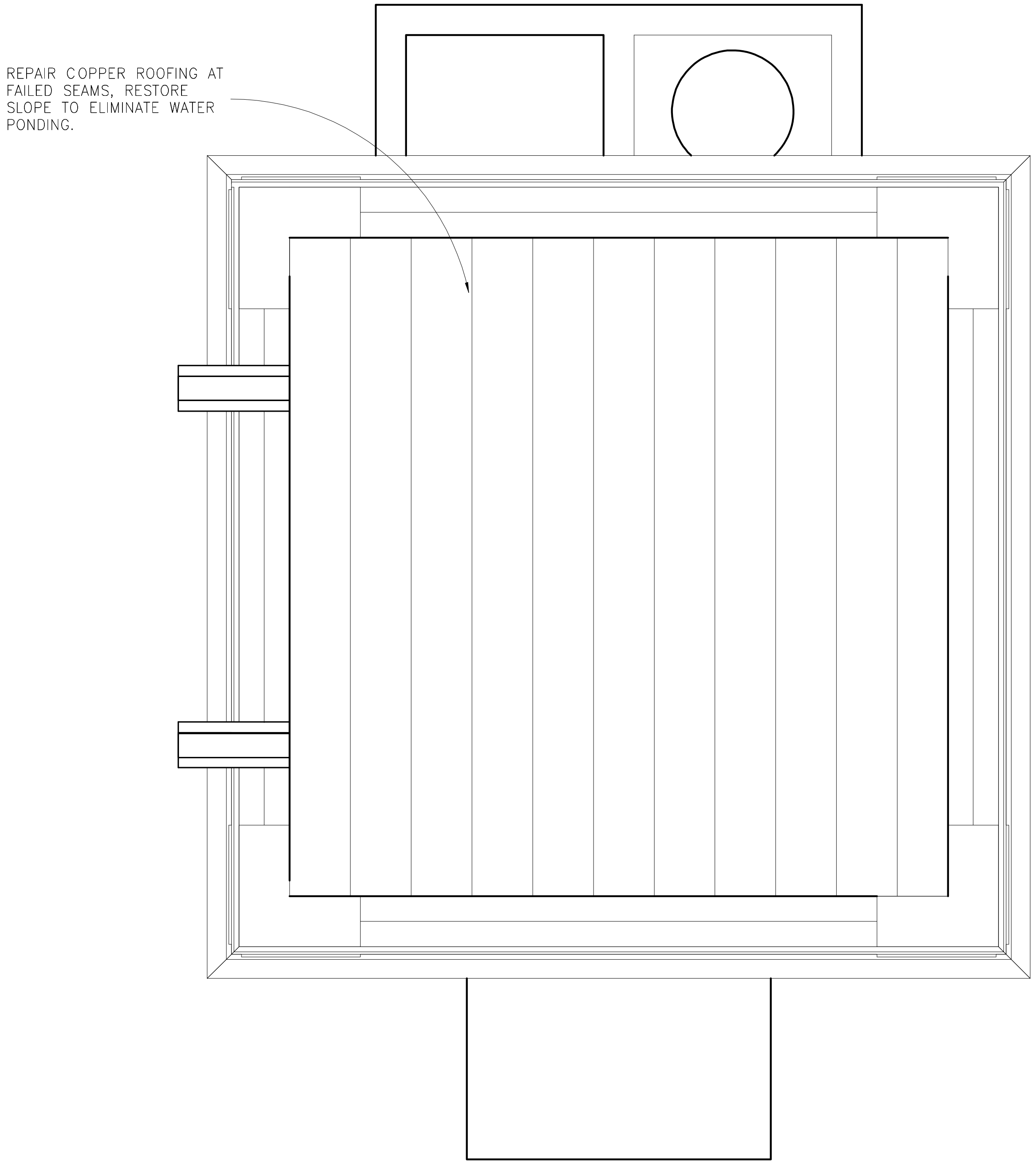
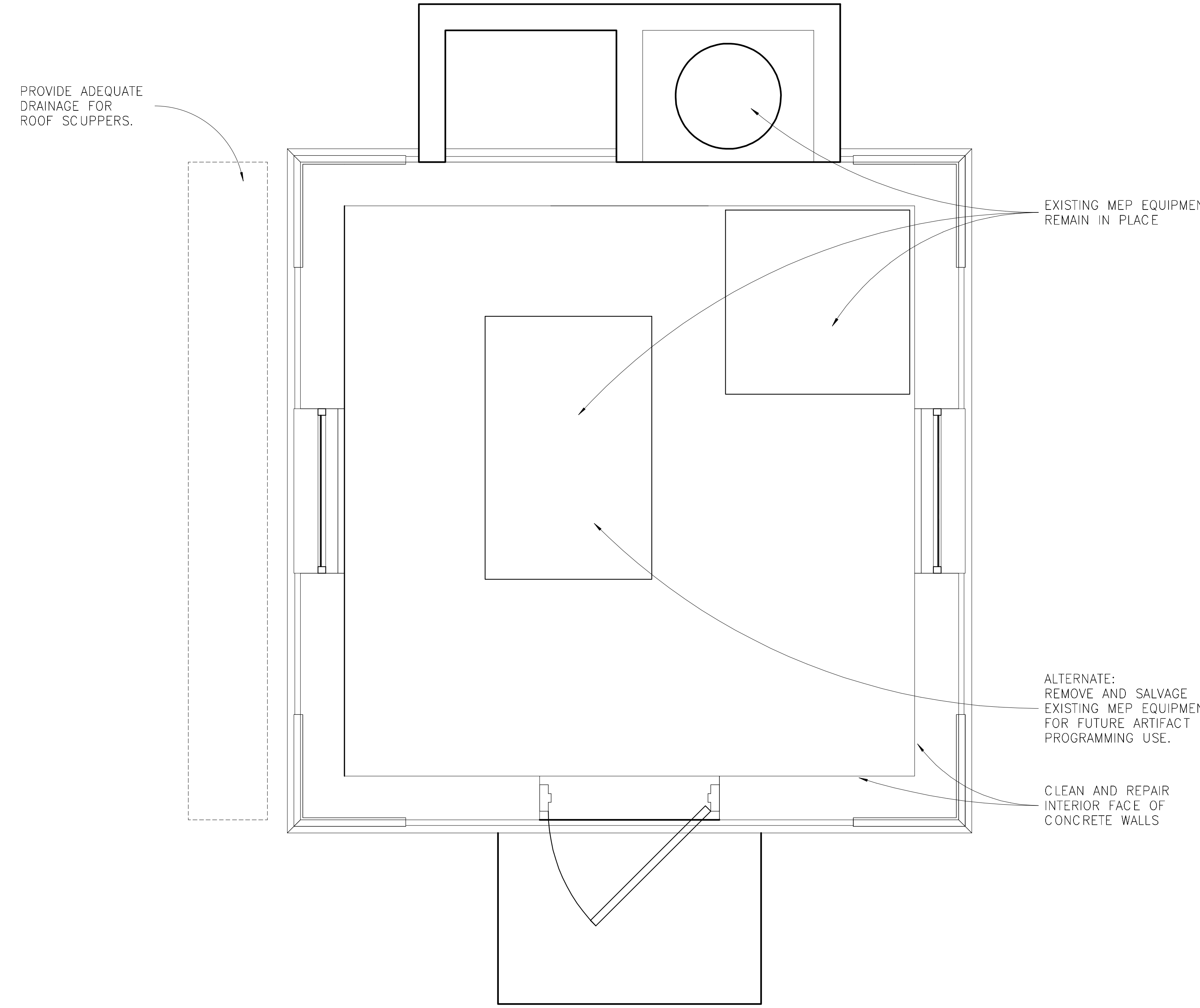


2 T08 POWERHOUSE ROOF TREATMENT PLAN
3/4" = 1'-0"



1 T08 POWERHOUSE GROUND FLOOR TREATMENT PLAN
3/4" = 1'-0"

2' 1' 0 2'
3/4" = 1' - 0" SCALE OF FEET

TRUE NORTH

PLAN NORTH

DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
LS CADD GK TECH. REVIEW: BT DATE: 01/13/2023	T08	POWERHOUSE TREATMENT PLANS HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE WRIGHT BROTHERS NATIONAL MEMORIAL	PKG. NO. SHEET 9 OF 11

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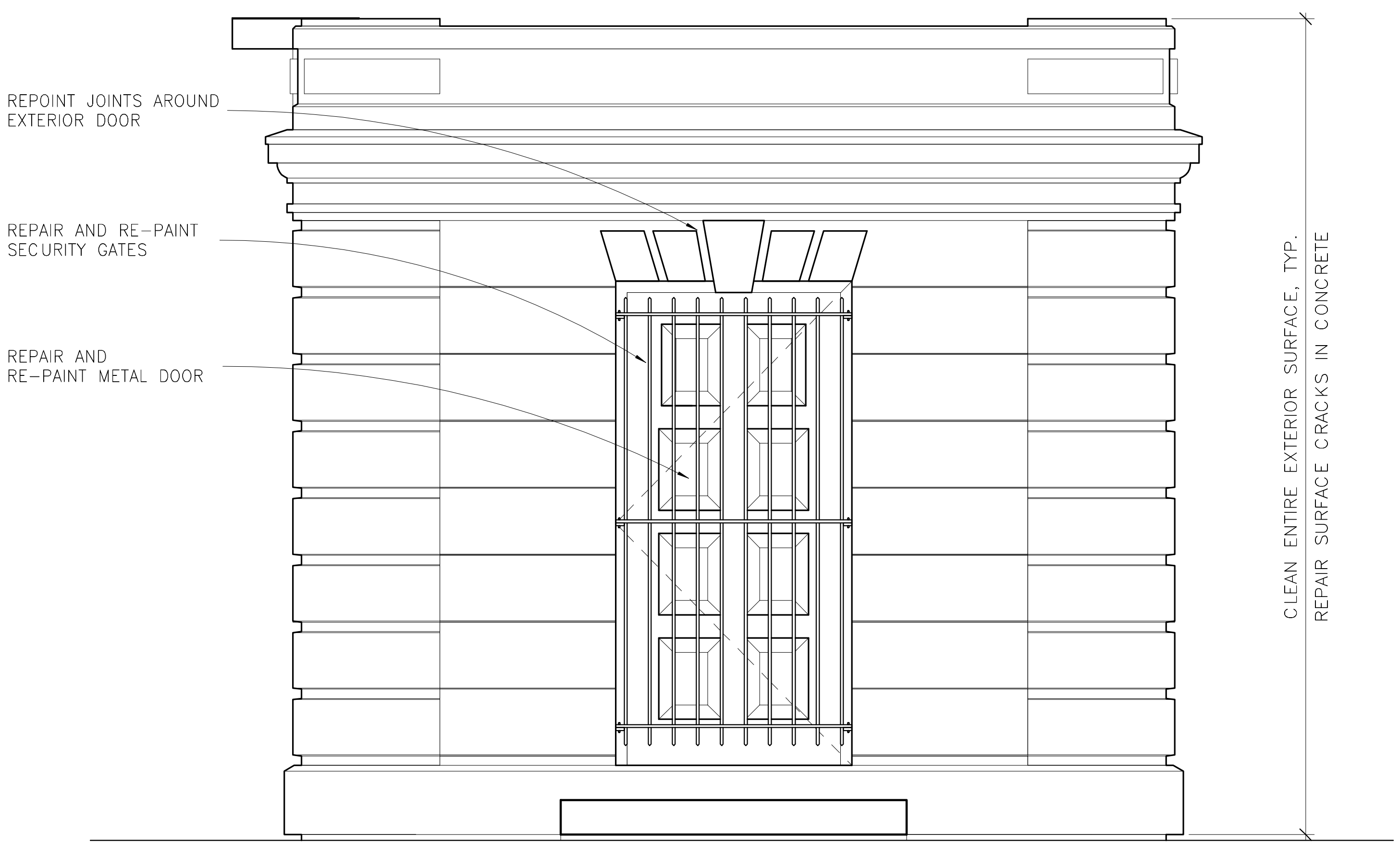
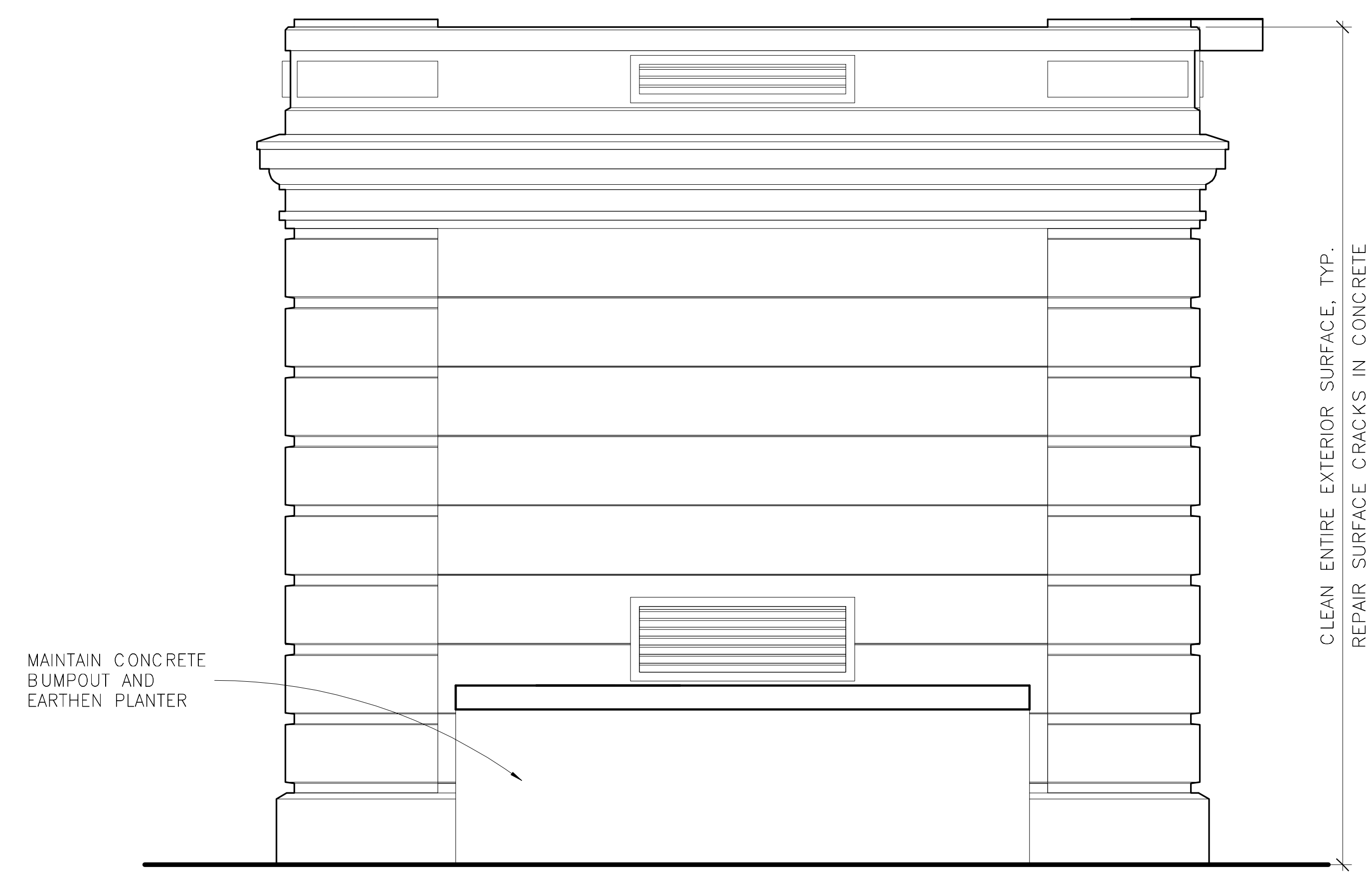


1 T09 POWERHOUSE SOUTH TREATMENT ELEVATION
3/4" = 1'-0"



2 T09 POWERHOUSE NORTH TREATMENT ELEVATION
3/4" = 1'-0"

2' 1' 0 2'
3/4" = 1' - 0" SCALE OF FEET

DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
LS CADD GK TECH. REVIEW: BT DATE: 01/13/2023	T09	POWERHOUSE N. & S. TREATMENT ELEVATIONS HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE WRIGHT BROTHERS NATIONAL MEMORIAL	PKG. NO. SHEET 10 OF 11

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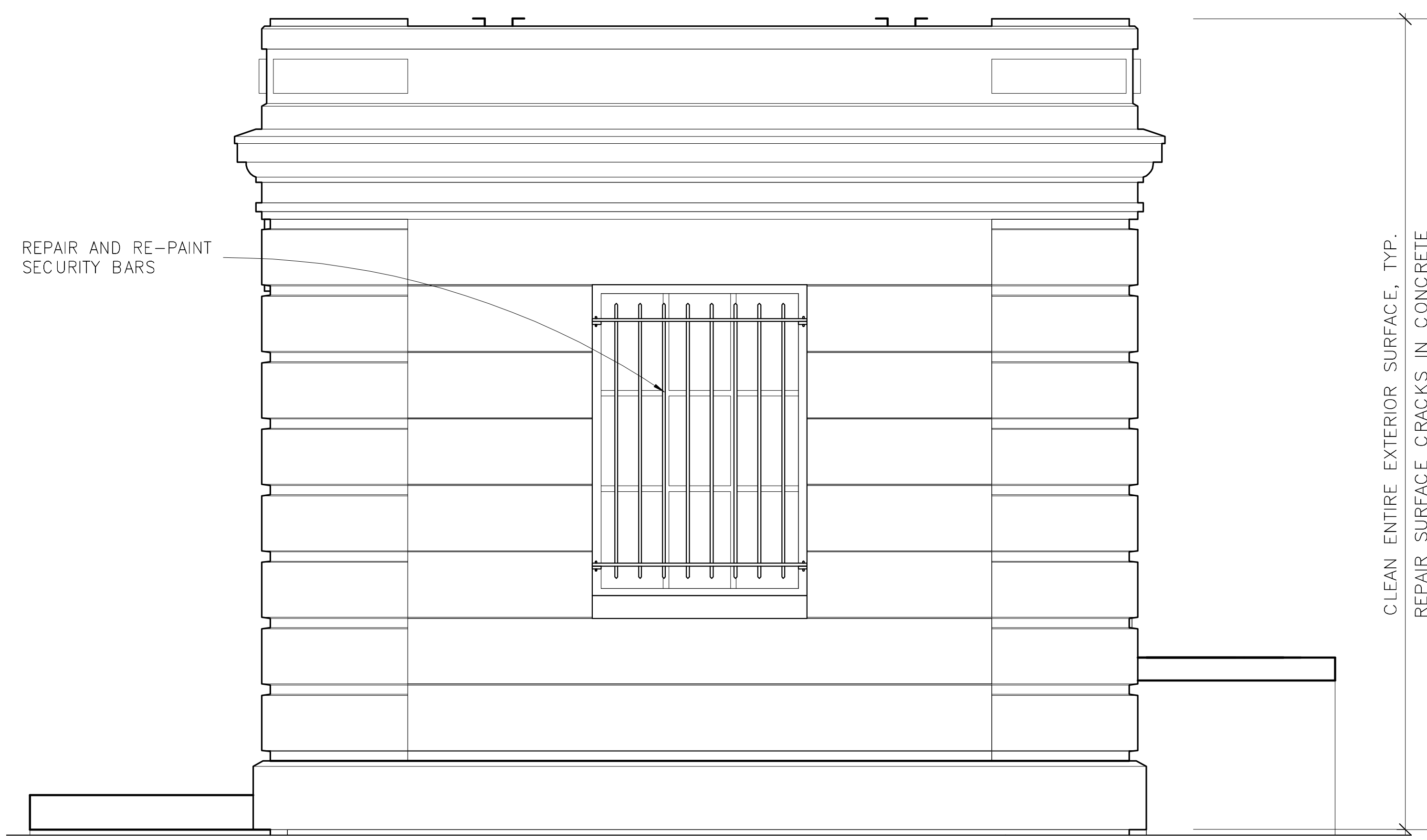

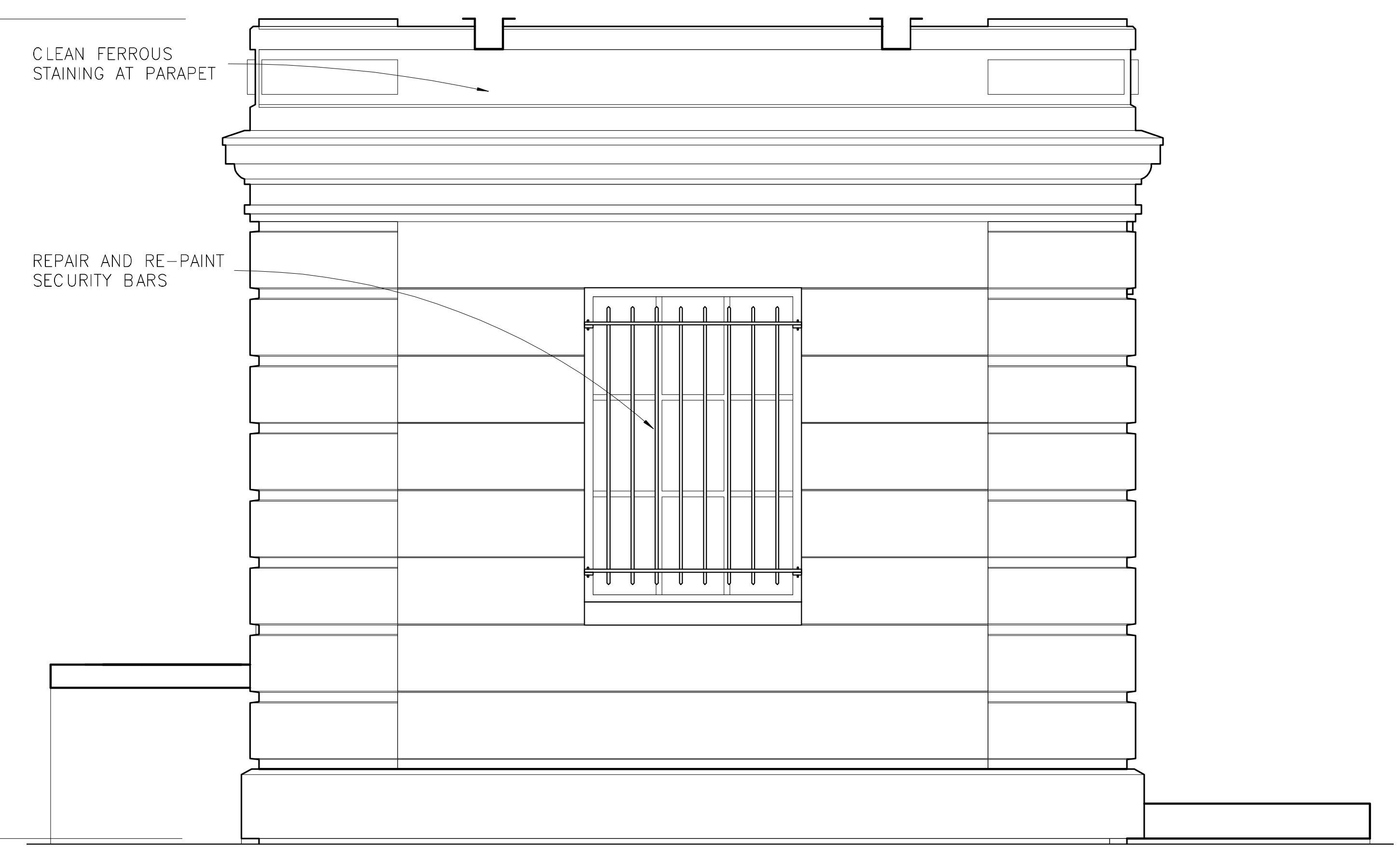

1 T10 POWERHOUSE EAST TREATMENT ELEVATION
3/4" = 1'-0"

2 T10 POWERHOUSE WEST TREATMENT ELEVATION
3/4" = 1'-0"

2' 1' 0 2'
3/4" = 1' - 0" SCALE OF FEET

DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
LS CADD GK TECH. REVIEW: BT DATE: 01/13/2023	T10	POWERHOUSE E. & W. TREATMENT ELEVATIONS HISTORIC STRUCTURES REPORT WRIGHT BROTHERS MONUMENT AND POWERHOUSE WRIGHT BROTHERS NATIONAL MEMORIAL	PKG. NO. SHEET 11 OF 11

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Appendix F

Evaluation of Testing, Wright Brothers National Monument, 2017

A moisture intrusion investigation of the Monument was completed in February 2017 for Amidon, Inc., by Atkinson-Noland & Associates, Inc. and Masonry Solutions International, Inc.

The objectives of the work were to:

1. Determine as-built conditions that may be leading to moisture infiltration on the interior of the Monument and

2. Evaluate potential moisture intrusion pathways using nondestructive and minimally destructive methods which included surface penetrating radar screening, pachometer scanning, infrared thermography, water testing at the roof drain, pavement and foundation space investigations, videoscope investigations of a drainpipe, the wall, and conduit and access panels, and laboratory testing of a series of mortar joint and stone surface samples.

The investigation concluded that the moisture intrusion may derive from a number of sources, including through delaminated mortar jointing at the stone veneer, a damaged roof conductor, and void spaces behind the stone and electrical conduits which transfer the water around the Monument.

The full report is also available within the NPS Integrated Resource Management Applications (IRMA) at the following link: https://irma.nps.gov/DataStore/Reference/.

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Evaluation and Testing

Wright Brothers National Memorial Monument

CAPE HATTERAS NATIONAL SEASHORE

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Prepared for:
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ANA Job No. 16-115
February 6, 2017

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1.0 INTRODUCTION

An investigative program was carried out at the Wright Brothers National Memorial Monument, located in Kill Devil Hills, North Carolina. The objectives of the work were to 1) determine as-built conditions that may be leading to moisture infiltration; 2) evaluate potential moisture intrusion pathways using nondestructive and minimally destructive methods. Engineer Michael Schuller of Atkinson-Noland was present on site November 29 to December 1, 2016, with Wayne Ruth of Masonry Solutions, and Chris Rhodes and Brad Siver of Amidon. McGee and Sons Plumbing was also on site to conduct roof drain leak tests and videoscope surveys.

The following diagnostic procedures were carried out as part of the investigative program.

- Surface penetrating radar scans
- Infrared thermography imaging
- Pachometer metal scanning
- Videoscope examination at drilled holes
- Laboratory chloride testing of mortar samples and stone scrapings
- Roof drain water leak test
- Drain pipe videoscope surveys
- Stone paver investigations
- Foundation space investigation

This report includes a description of tests conducted both on site and in the laboratory, investigative results, discussion, and conceptual recommendations for addressing moisture infiltration and other issues.

2.0 SURFACE PENETRATING RADAR SCANNING

Surface Penetrating Radar (SPR) is a nondestructive method typically used to determine subsurface conditions of building elements, locate structural reinforcing bars, locate regions of deterioration or distress, and evaluate internal moisture content. On this project SPR was instrumental in providing information to better understand construction typology at stone masonry and concrete sections. SPR and other techniques described in this report were used at interior and exterior walls, to map concealed subsurface conditions. The SPR system was calibrated on a solid stone stair wall at the lobby level to arrive at an appropriate dielectric constant for system setup. Note that moisture and salts attenuate microwave radar signals, reducing penetration depth and complicating data interpretation. Scans were able to resolve features within about 12 inches of the wall face; at some locations signals were able to penetrate 24 inches or deeper into the section.

SPR techniques use reflections of microwave energy to identify internal anomalies. A GSSI SIR-3000 radar unit was used with a 1500 MHZ antenna mounted in a wheeled trolley for on-site scanning. The method provided information on the interior makeup of scanned sections, including:

- as-built conditions,
- detecting voids or rubble fill behind stone at the interior of walls,
- locating, conduit, and roof drains,
- determining thickness of concrete sections,
- locating reinforcement in concrete sections.

Figure 1. Surface penetrating radar scanning. Left: calibration at stone in lobby; right: scanning at interior concrete, 2nd level.

A total of 26 radar scans were conducted at interior and exterior wall sections. Radar scan locations are shown in the section drawing included in Appendix A. Data was post-processed in the office for interpretation; all radar scans are included in Appendix B.

Radar scanning provided several significant discoveries and conclusions:

1. Walls are significantly wet or saturated at all locations scanned, with a likely high salt content. Both of these conditions attenuate microwave energy, limiting the investigation depth.
2. Scans from the interior, at concrete walls, show horizontal and vertical reinforcement near the interior wall face. A second reinforcement layer was not detected at depth within the wall; detection is likely limited by saturated conditions. See Appendix B scans 003, 004, and 017 to 029.
3. Scans through concrete taken from the interior were intended to detect concrete thickness. Due to attenuative effects described above, concrete thickness was rarely detected by scans. The exceptions are at scan 018, where a reflection that could be the back of the concrete was observed at a depth of 2'-0"; also seen in this scan is what could be a layer of reinforcement at a depth of 1'-6" from the interior face. A similar slight reflection is seen in Scan 021 at a depth of 2'-0".
4. A series of scans conducted from the exterior, at the south stone wall just east of the entry door, detected an embedded metal drain pipe leading from the gutter above the entry door. The drain pipe is located approximately 10 inches deep from the exterior wall surface; stone thickness at this location is greater than 18 inches. The drain pipe appears to be 4 inches diameter. See Appendix A scan 005.
5. Two scans conducted at the north elevation cornerstone detected a strong metallic signature behind the cornerstone. There appears to be a metallic box or plaque behind the cornerstone, measuring approximately 10 inches high by 14 inches wide. See Appendix A scan 6 and 7.
6. Stone thickness facing lobby walls varies from 8 to 10 inches at the east and west walls, to 14 to 15 inches thick at the south wall. Reflections at the backs of stones ranged from very strong, indicating voids behind stones, to somewhat strong, likely meaning the space between stones is filled with mortar or grout.
7. A void signature appears in several vertical scans at the east and west lobby walls, (See Appendix A scans 009, 013, and 014). This strong reflection suggests a significant void exists approximately 40 inches from the interior face, possibly behind exterior facing stones. The

height of this void above the lobby floor puts the void space between grade and 2’-6” above grade at the exterior.

8. Scans at the south wall show stones 14 to 15 inches thick, with a significant void (or saturated mortar) between interior and exterior stones. Mortar head joints appear to be empty or delaminated from adjacent stone. See Appendix A scan 011.

3.0 PACHOMETER SCANNING

An eddy-current pachometer was used to calibrate and supplement SPR scanning. The pachometer detects embedded metals, and, at locations where SPR scans provided reinforcement depth, the pachometer was used to estimate reinforcement diameter. The pachometer was used mainly at structural concrete walls for scanning at interior surfaces. Results of pachometer scanning are combined with SPR results in the above SPR discussion section.

Figure 2. Pachometer scanning to search for metal stone anchors at the lobby.

4.0 INFRARED THERMOGRAPHY

Infrared thermography techniques measure heat emitted from surfaces to identify general condition, moisture, and subsurface anomalies. Transmission and emission of heat energy is affected by moisture content, internal voids, variations in materials or construction quality, and near-surface delaminations and spalls. A FLIR T420 thermal imaging camera was used to image the entire exterior and portions of the interior wall surfaces.

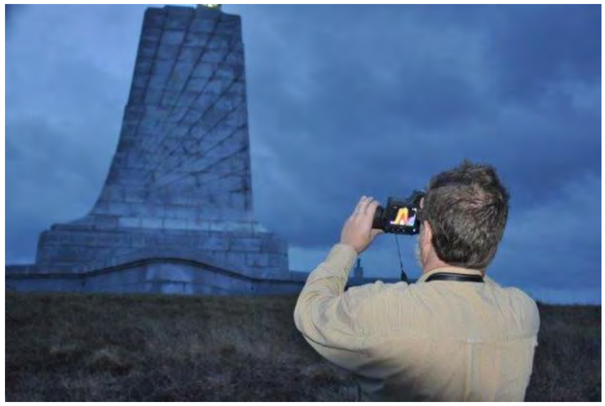


Figure 3. Infrared thermography scanning.

Interior temperatures were intentionally elevated using the Monument's dehumidifier system beginning Monday November 28, to provide a thermal gradient across wall sections. Two space heaters were also installed the morning of November 29 at the second and third levels to augment heat generated by the dehumidifier system.

Thermograms were captured throughout the Memorial exterior and at some interior lobby walls at three different times:

1. Prior to roof drain moisture tests, between 2:14 and 2:35 p.m. on Tuesday November 29.
2. During roof drain moisture tests between 7:08 and 8:43 a.m. on Wednesday November 30
3. At the conclusion of the heating cycle before sunrise and after a minor rain event, between 6:31 and 6:55 a.m. on Thursday, December 1.
4. Miscellaneous scans at lobby and interior concrete walls, between 9:02 and 10:55 a.m. on Thursday, December 1.

A total of 147 thermal MSX images were recorded for analysis and interpretation; a corresponding visual light photograph was taken with each thermal image. Infrared images are provided in Appendix C. A Tramex moisture meter was also used at isolated locations in the lobby to validate and augment moisture-related findings of the infrared surveys.

Significant observations made as a result of infrared thermography scans are illustrated and discussed below.

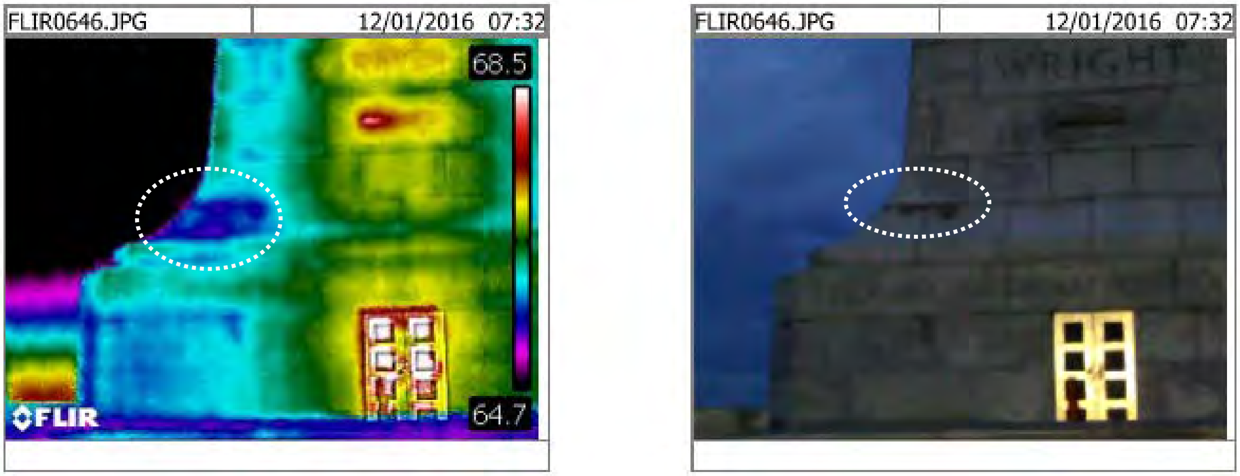


Figure 4. Exterior image taken after a rain event. Bulk water is observed and detected leaking from joints, at a joint where flashing is indicated on original construction details.

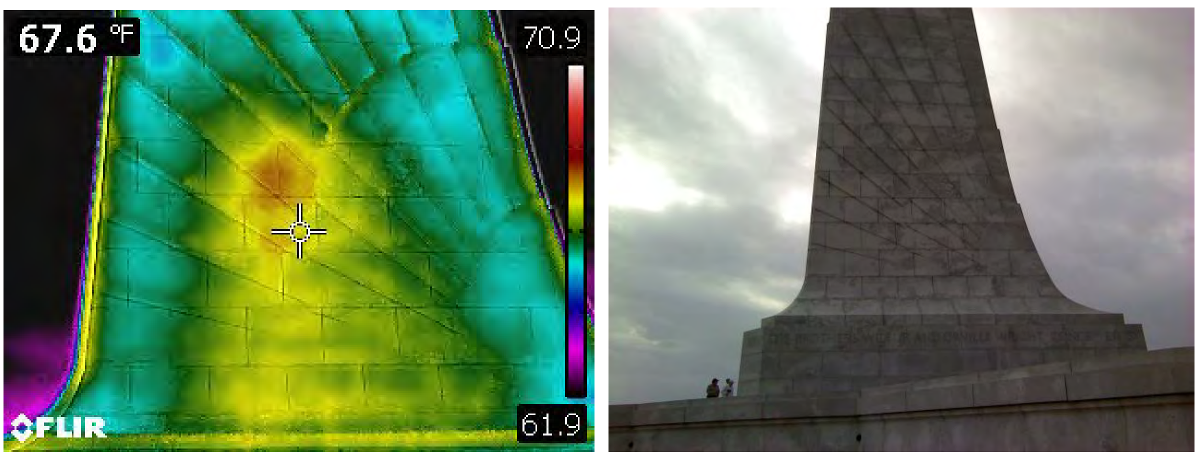


Figure 5. Internal heat penetrating through walls; walls are thinnest at the center portion and correspondingly these areas show the greatest temperatures. See plan drawing in Appendix A for wall thickness. Uneven surface appearance is not evident in infrared image, suggesting color variations are not caused by moisture variations.

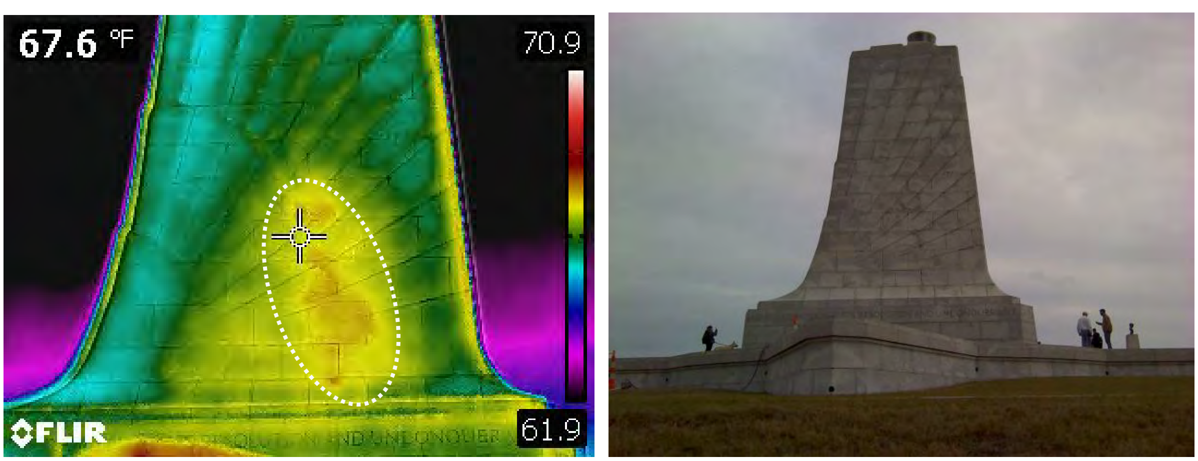


Figure 6. Heating effect apparent. Slight temperature differentials (reddish-orange zones) suggest differential internal construction. Uneven surface appearance is not evident in infrared image.

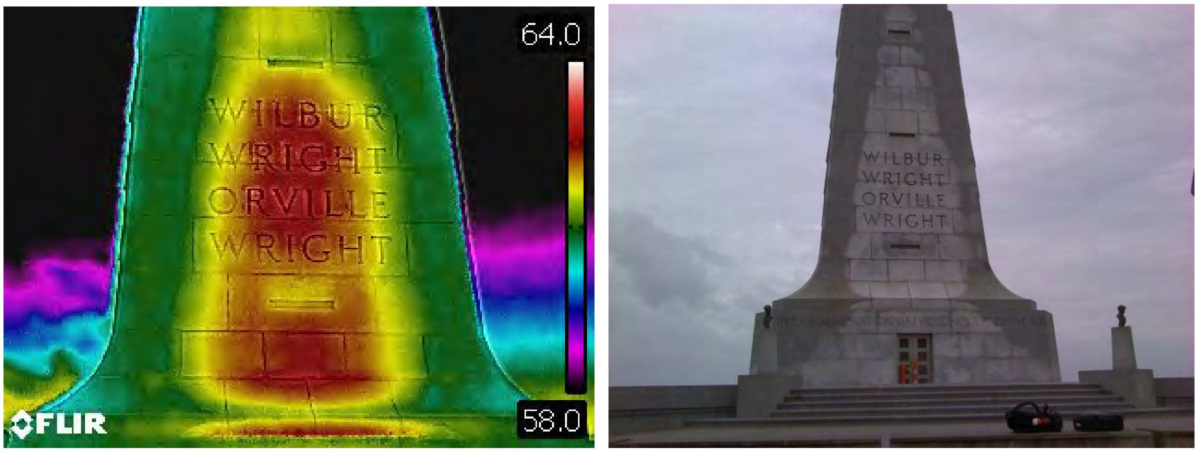


Figure 7. After 2 days of internal heating, temperature differentials are apparent. Higher temperatures at the middle of this elevation increase drying effects; corners are cooled by evaporative effects.

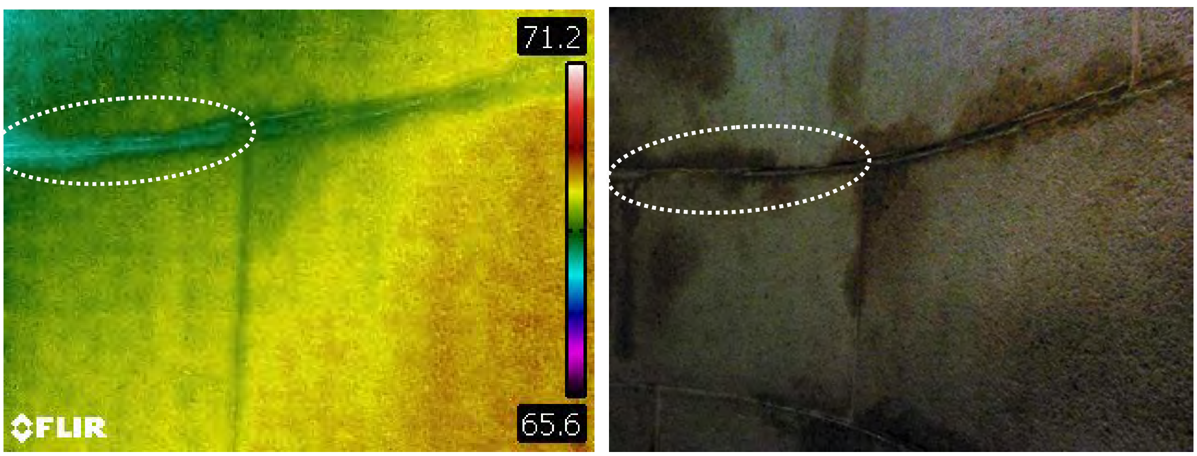


Figure 8. Interior lobby mortar joints. Water leak shows as coolness at mortar joint. Damp zones do not appear cooler indicating no evaporative cooling action.

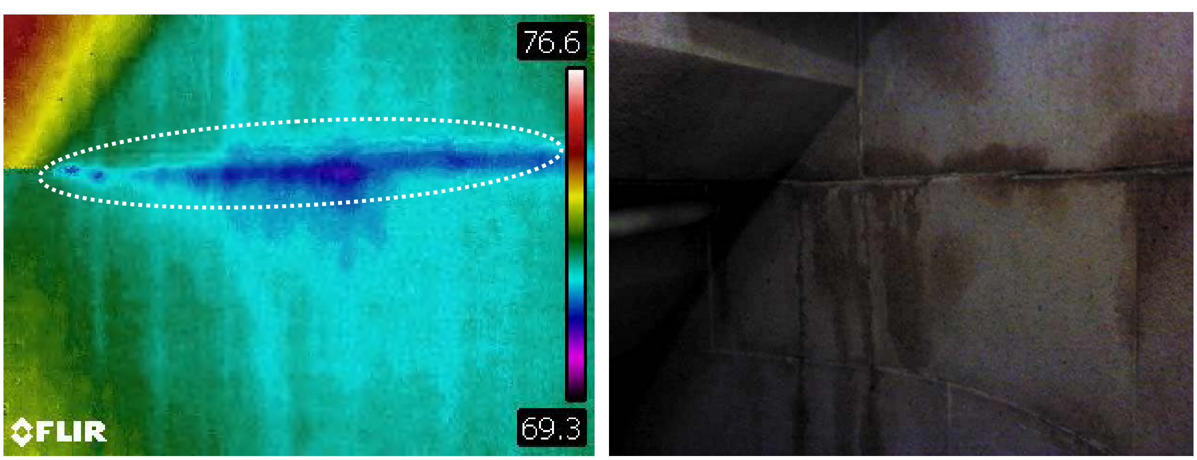


Figure 9. Interior lobby mortar joints. Water leak shows as coolness at mortar joint. Damp zones do not appear cooler indicating no evaporative cooling action.

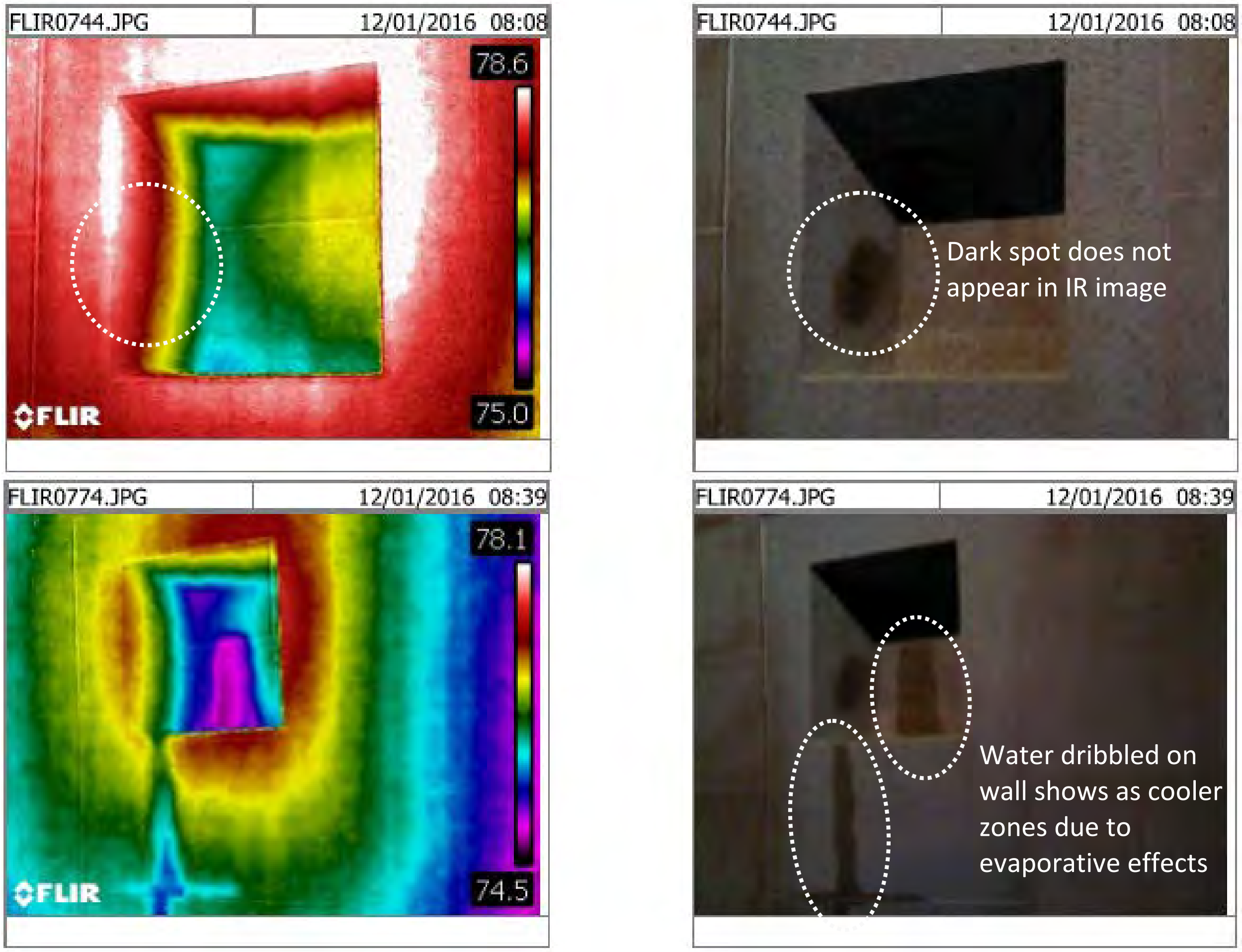


Figure 10. Blotches on stone does not appear in infrared image (top images); water dribbled down stone face is cooler due to evaporation effects (bottom images).

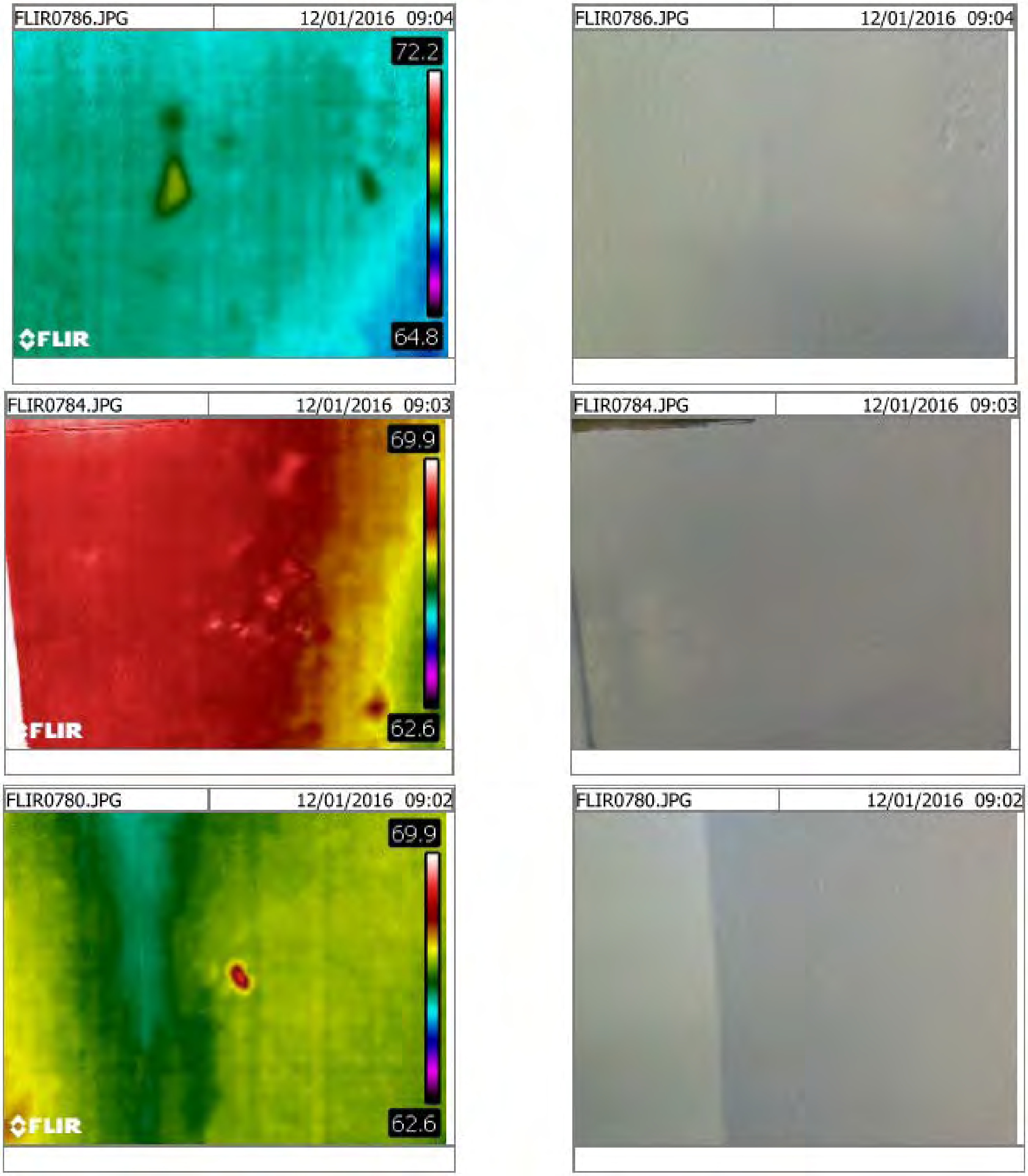


Figure 11. Image of interior painted concrete surface. Paint blisters are not always visible, but show in the infrared image as warmer zones.

5.0 WATER TEST AT ROOF DRAIN

McGee and Sons Plumbing used and inflatable plug to seal the roof drain pipe near its outfall. Water was pumped to the top of the Monument to fill the drain. The water level fell immediately and after 24 hours the inflatable plug was removed. When the drain plug was removed approximately 3 to 5 gallons water flowed from the outlet. This water volume suggests water remained in 7 to 8 feet of the 4-inch inside diameter drain pipe, and that a leak exists approximately 8 feet in from the outlet point under the stone paving. The outfall itself is located 24 feet from the monument.

Figure 12. Plug removal at completion of roof drain water test.

6.0 DRAIN PIPE VIDEOSCOPE EVALUATION

McGee and Sons Plumbing recorded observations made during videoscope examinations; recordings will be provided digitally. Plumbing videoscope included evaluations at the following locations; a summary of observations is included in Appendix D.

- Roof drain
- Floor drain at steps
- Roof trench drain above the entry door
- Clean out plug at walk way near front door entrance

7.0 LABORATORY TESTING

A series of samples were removed from mortar joints and stone surfaces for laboratory testing. Samples were removed from the following locations:

1. Sample 1: west elevation, mortar bed joint approximately 5’-0” above grade; pointing mortar from 0 to ¾” deep.
2. Sample 5: west elevation, mortar bed joint approximately 5’-0” above grade; bedding mortar from 1.5” to 2.5” deep. Tan color.
3. Sample 3: west elevation, mortar bed joint approximately 5’-0” above grade; bedding mortar from 1.5” to 2.5” deep. Greenish color when wet.
4. Sample 4: interior mortar head joint at stairs, pointing mortar 0 to 0.5” deep.

5. Sample 2: interior mortar head joint at stairs, bedding mortar 0.5” to 1” deep.
6. Sample 6: stone scrapings from interior pink granite at stairs, 2nd level.
7. Sample 7: stone scrapings from gray granite at interior, top of monument directly beneath beacon.

Samples were oven dried, crushed by hand with a mortar/pestle, and tested for chlorides and sulfates. Chlorides were present in all samples. Chloride concentrations were very high in exterior mortar samples, increasing with depth. Interior mortars had lower but still significant chloride contents. Stone scrapings, taken at locations where stone surfaces were sugaring, flaking, and powdering, showed lower but still significant salt content.

Sulfate contents were highly variable, with sulfate levels measured to be between 200 ppm and greater than 800 ppm.

Figure 13. Mortar removal for laboratory analysis using hand tools and drilling.

Figure 14. Scrapings removed from deteriorating stone surfaces. Left: stone at interior stairs, 2nd level. Right: interior granite surface at top beneath beacon.

Table 1. Chloride and sulfate concentrations.

Sample No.	Sample Location and Type	% NaCl (Sample)	Sulfates (ppm)
1	West Elevation, pointing mortar	1.5	200 to 400
5	West Elevation - 1.5"-2.5"	2.2	200 to 400
3	West Elevation head joint, 0.5"-1.0" deep	4.3	200 to 400
4	Interior @ Stairs - pointing mortar	0.24	>800
2	Stairs/ Interior bedding - 0.5"-1.0"	0.74	>800
6	Stone @ interior stairs, 2nd level	0.12	200 to 400
7	Gray Granite @ interior, top beneath beacon	0.08	>800

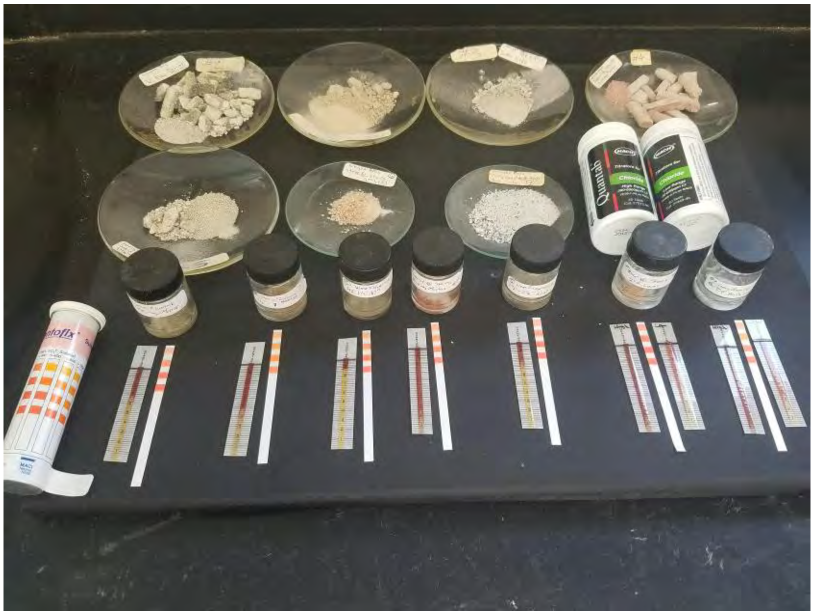


Figure 15. Mortar and stone samples tested for chlorides and sulfates.

8.0 WALL VIDEOSCOPE EVALUATION

A videoscope was inserted into 3/8-inch diameter holes drilled into mortar joints to observe interior conditions. Videoscope observations are noted throughout this report; a total of 22 still images and 11 videos were recorded at the following locations:

- Foundation void space beneath lobby floor
- Exterior mortar joint
- Interior mortar joint
- Empty conduit at the left side of the electrical panel, 3rd level
- Roof drain cleanout area at access hatch
- Electrical conduit above abandoned light fixture, east side of stairs.

Figure 16. Videoscope evaluation at an abandoned lighting conduit (left) and at the roof drain cleanout hatch (right).

Mortar joint videoscope evaluation

Video scope observations were made at two exterior mortar joints and one interior mortar joint. A single 3/8-inch diameter hole was drilled at each of the three locations and holes cleaned with water for videoscope observations.

West elevation exterior. Hole drilled in head joint. Videoscope images 5 and 7 and video 6 saved. Joint was observed to be solid to 10 inches deep.

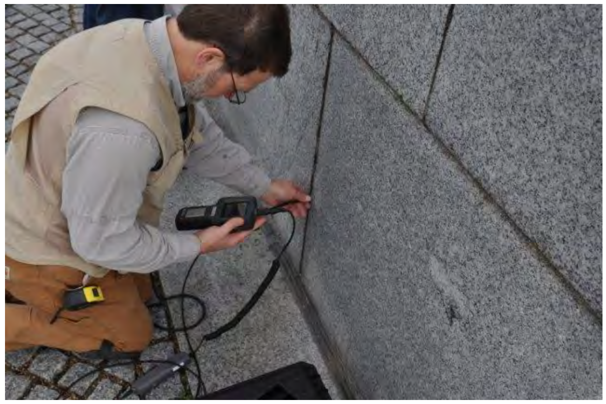


Figure 17. Videoscope evaluation at exterior mortar head joint.

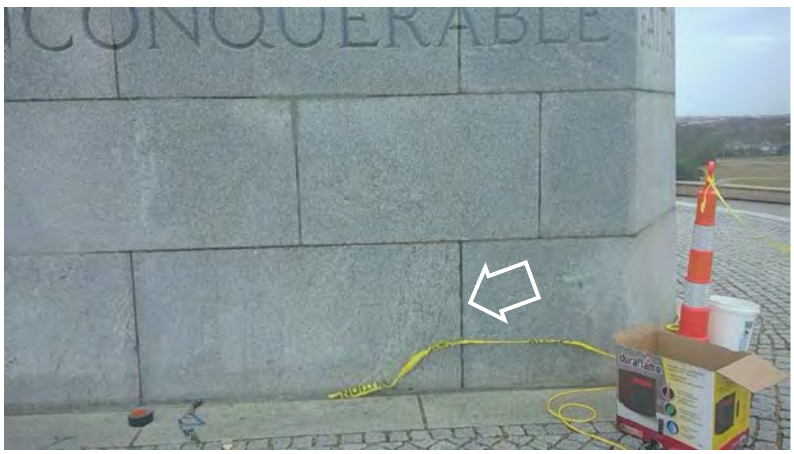


Figure 18. Videoscope evaluation at exterior mortar head joint at location indicated by arrow.

Figure 19. Field notes showing mortar joint composition at exterior wall face. Videoscope image is at transition between pointing mortar and brown joint fill beneath.

West wall interior at lobby. The hole was drilled to a depth of 10 inches. The adjacent stone unit measured 8 inches thick, and hard solid concrete (or granite?) was encountered at a depth of 10 inches. The mortar joint itself was completely solid full depth, with pointing mortar at the outer 3 inches. Mortar at the interior beyond pointing mortar was greenish in color. Photographs 20 and 21 are included below; video 19 and 22 were also saved.

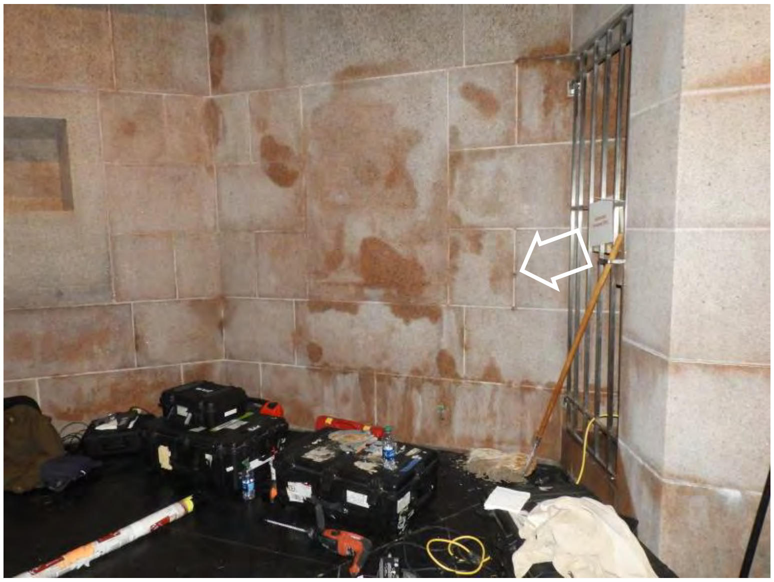


Figure 20. Videoscope at interior head joint at location indicated by arrow.

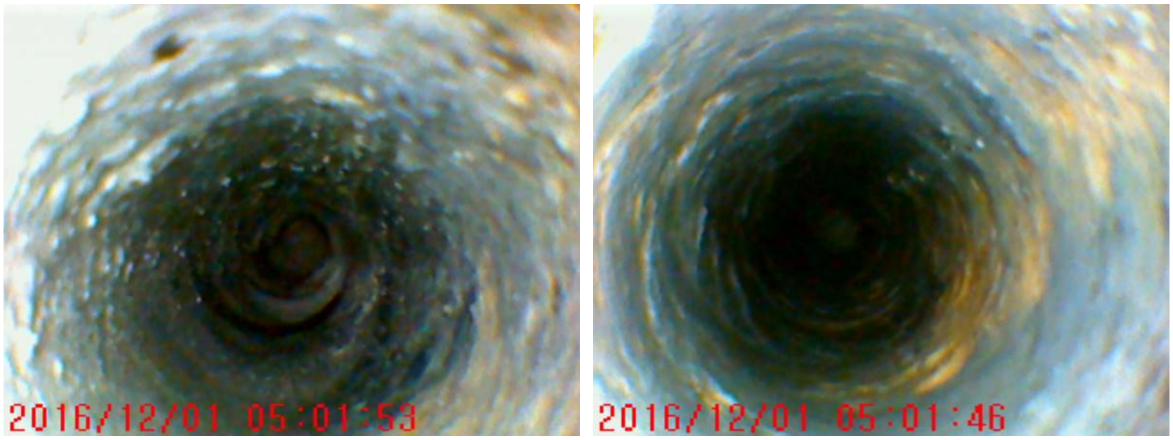


Figure 21. Videoscope photographs 20 and 21; mortar joints were observed to be solid full-depth. The videoscope scope hole is indicated in the top photograph.

9.0 CONDUIT AND ACCESS PANEL VIDEOSCOPE INVESTIGATIONS

Conditions were investigated at 2 conduit locations and at the 2nd level roof drain cleanout as described below.

3rd level electrical panel. Conduit investigated exiting to left side of box is 2” diameter. Significant corrosion debris was observed at the bottom of the conduit, but the conduit appears to remain intake. Two abandoned cables were observed at about 4 feet in from the box. Conditions at the interior were dry with no dampness observed. Photos and video 22 to 29 were recorded.

Figure 22. Videoscope images at conduit to left of 3rd level electrical panel. Corrosion was moderate to severe with oxidation flakes collecting at the bottom of the conduit.

3rd level electrical box. Conduit at the top of the panel was completely filled with old cable and the videoscope could not be inserted. The conduit was very wet and dripping water. Photos 36 and 37 recorded.

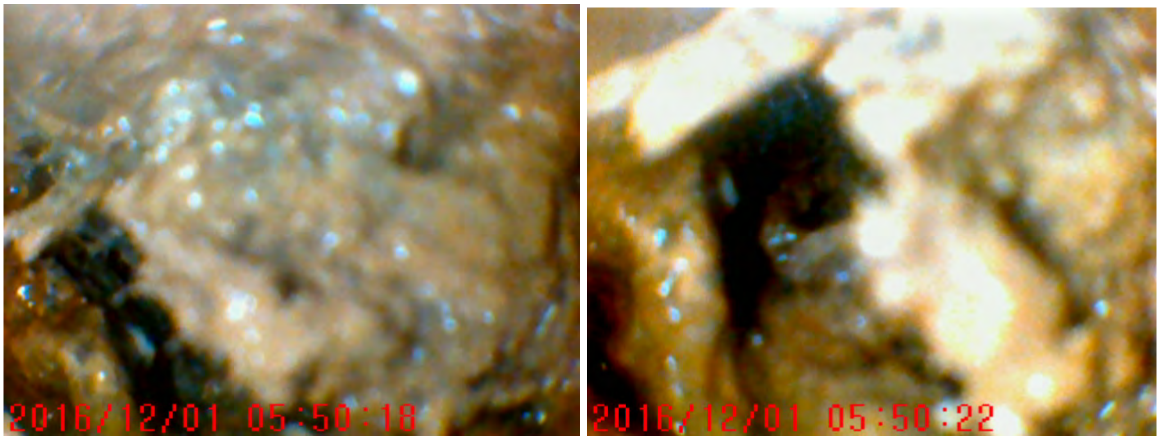


Figure 23. Videoscope evaluation at conduit exiting top of 3rd level electrical panel; interior was very wet with water dripping from conduit.

2nd level hatch at roof drain cleanout. Roof drain is cast iron pipe with minor superficial corrosion. Conditions within box are dry with no evidence of moisture intrusion or stains. Minor condensation was observed on a sheet metal sleeve. Video 30 to 35 recorded.

1st level conduit at removed light fixture, east stairs. Severe corrosion noted with localized wetness. Conduit is collapsed and corroded fully through the section 12 inches up from the fixture. Videos and photos 39 – 41 recorded.

Figure 24. Videoscope evaluation at 1st level conduit above removed light fixture. Severe corrosion and moisture noted.

10.0 PAVEMENT INVESTIGATION

Three granite pavers are missing at the Monument's northeast corner. Existing conditions were evaluated by locally removing sand and drilling beneath the pavers. Granite pavers were measured to be 3 ¼" square to 4" square by 3" deep, over 1" mortar, with concrete slab beneath. Coarse sand fills joints ranging from ½" to 1"wide.

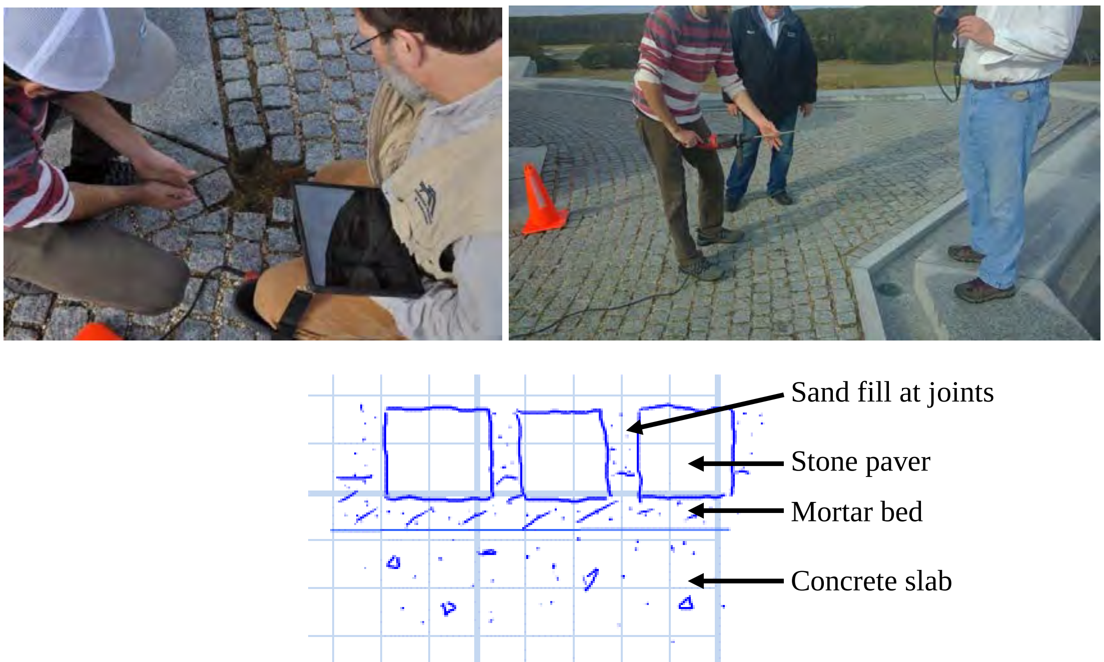


Figure 25. Exterior pavement investigation, northeast monument corner.

11.0 FOUNDATION SPACE INVESTIGATION

Subgrade conditions were observed via a floor drain at the southwest corner of the lobby. The floor drain does not appear to be original but was formed by coring several 2-inch diameter holes through the concrete floor structure.

As seen in the building section in Appendix A, the foundation consists of a concrete slab beneath the lobby floor, with a series of concrete columns and walls supporting the Monument above (also seen in the historic photograph provided in Figure 27). The foundation itself is a monolithic slab at the bottom of a large open space beneath the Monument. This space was investigated using the videoscope and a plumb bob, using a high-power LED light to illuminate the space.

The void space measured 33'-3" from the lobby floor to the top of the monolithic slab at the base of the foundation void. There was standing water approximately ½ to 1 inch deep on the slab at the bottom of the void space. A floor section is provided in the field sketch below; see also field notes in Appendix A.

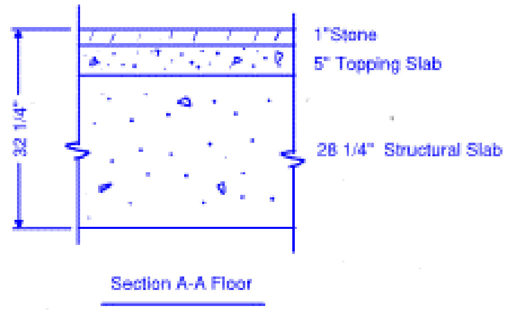


Figure 26. Videoscope examination at floor penetration.

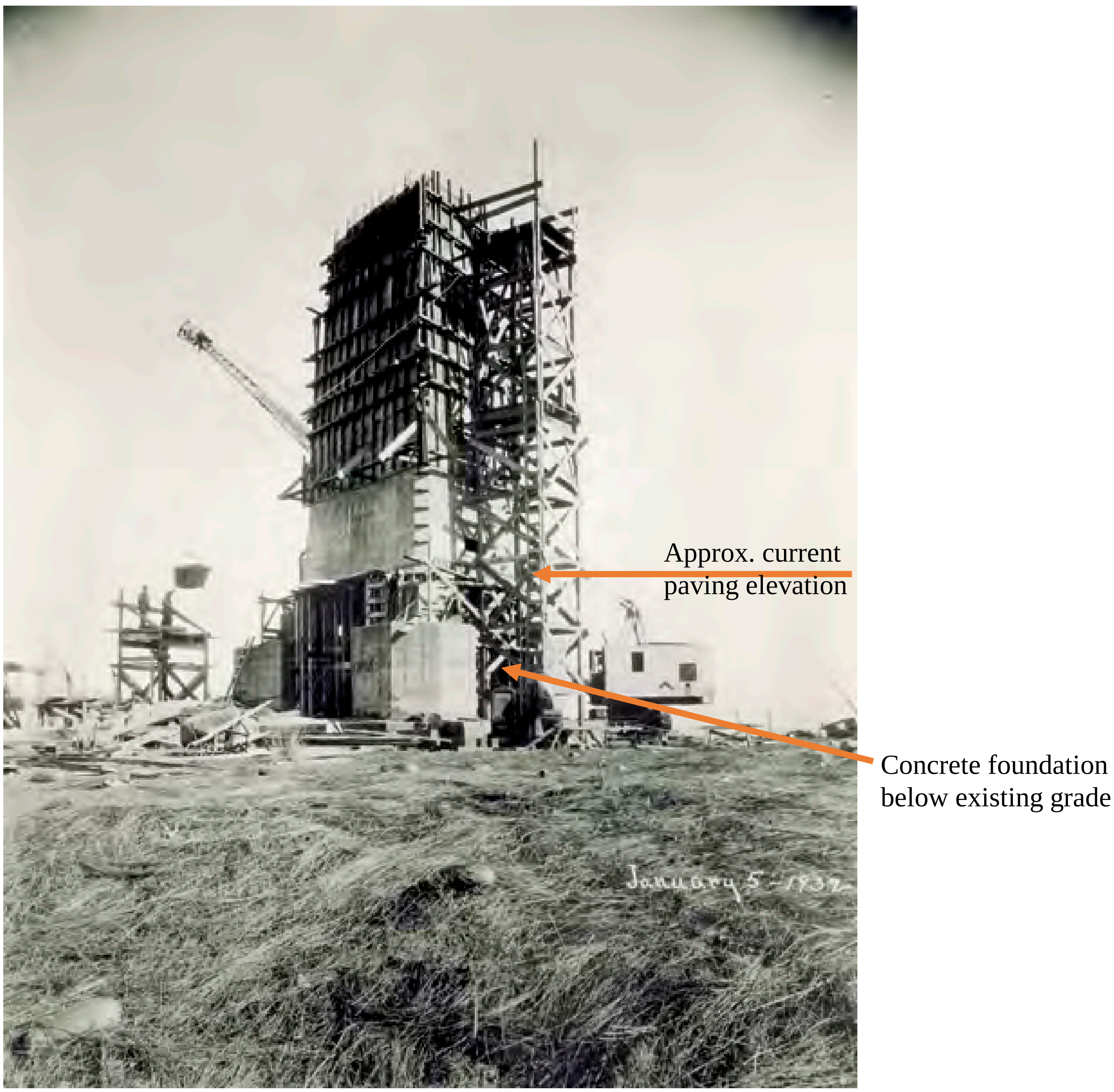


Figure 27. Construction photograph, dated January 5, 1932.

12.0 SUMMARY AND DISCUSSION

Moisture intrusion into the Monument is well-documented. Water is observed running from mortar joints at the interior and exterior and pooling at the lobby floor both during and following precipitation events (see photo in Figure 28). Water also enters the interior via electrical conduit, where leaks are significant enough to fill buckets with 5 to 10 gallons of water after a rainstorm.

Some type of flashing was originally installed (see photo in Figure 28) to collect moisture. Water was observed running out of the joint at the flashing level after a minor rain event. Some weeps were reportedly installed after the last mortar repointing effort but it is unclear if these weeps are functioning in any significant fashion.

Exterior mortar joints are commonly delaminated (Figure 29), providing many point sources for moisture entry. Radar scans suggest internal voids behind some stones; these voids serve to collect and transport moisture which appears as leaks to interior.

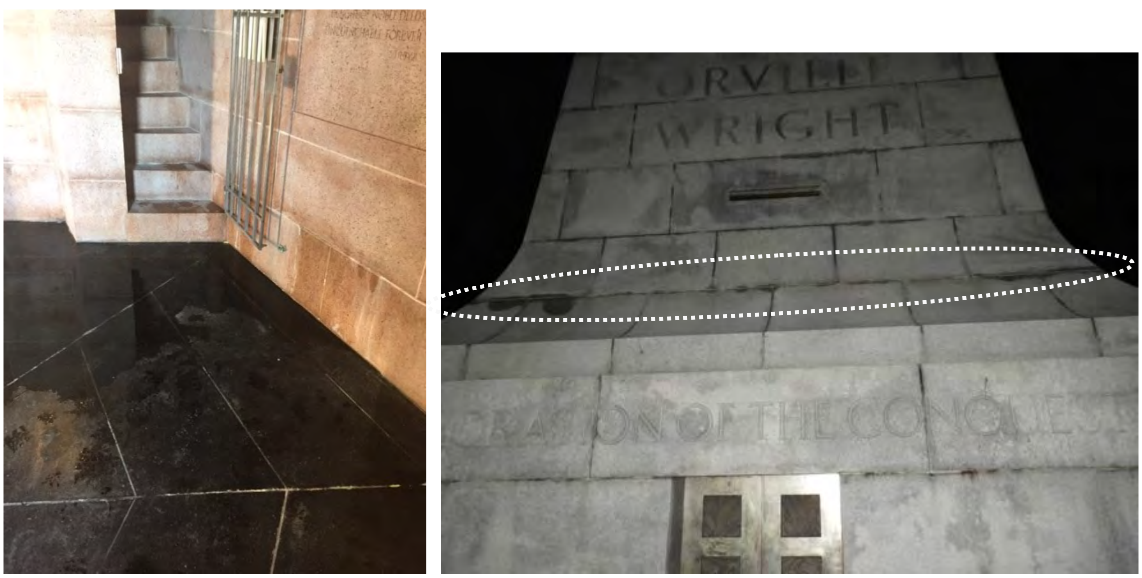


Figure 28. Water pooling in lobby (left) and exiting joint at flashing (right).

Figure 29. Example of delaminated mortar joint; delaminations permit moisture ingress during rainstorms.

Conduits (both in-service and abandoned) are moderately to severely corroded. Conduits often leak significant amounts of water (more than can be explained by just water coming in on location) suggesting water collecting behind stone is transported and concentrated by damaged conduits.

The blotchy, uneven appearance at interior and exterior stone surfaces (see Figure 29 and Figure 30) appears to be related to salt hydration rather than localized moisture leaks. The salt chromatographic effect is well known (reference Charola, A. Elena, and Blauer, Christine, *"Salts in Masonry: An Overview of the Problem,"* Restoration of Buildings and Monuments 2015, Birkhauser, 21(4-6): 119-135) and appears as internal salts hydrate through absorption of atmospheric moisture. The dehumidifier was turned off to facilitate heating for infrared scans, and dark spots appeared at interior stone surfaces within 24 hours. These dark spots look like dampness but could not be detected by IRT or moisture meter and hence are not free moisture, but moisture held within hydrating salts. This phenomenon has been in place since early in the Monument's life, and color variations visible today also appear in historic photographs.

All mortar samples tested showed very high chloride levels. The danger of having high chloride contents in mortar is the potential for corrosion of embedded metals such as anchors and concrete reinforcing bars, and the potential for damage resulting from salt crystallization and salt hydration. Chloride-induced corrosion of steel elements contained within cementitious materials such as concrete and mortar typically does not occur until a certain chloride ion threshold is surpassed. Chloride contents above the threshold indicate that corrosion is highly likely, but not necessarily certain. The American Concrete Institute Committee 222, *Corrosion of Metals in Concrete*, lists chloride ion thresholds for several different concrete applications. Chloride contents for new construction are recommended to be below 0.10 percent by weight of cement (BWOC) for concrete in wet conditions and 0.20 percent BWOC in dry conditions. These "design values" may be somewhat conservative and the committee lists research results showing corrosion initiation at chloride concentrations ranging from 0.2 percent BWOC to as high as 0.7 percent BWOC. A reasonable value for the critical chloride concentration, based upon research results, is in the range of 0.4 to 0.6 percent BWOC. Recommended chloride limits are not provided for masonry mortars and, for lack of adequate supportive data, mortar chloride limits are assumed to be similar to concrete chloride limits.

The chloride concentrations listed in Table 2 show have been converted to % chloride by weight of cement in the sample, assuming either Type N or Type S cement-lime-sand mortar. All measured chloride concentrations are extremely high, exceeding the level suggested as being required to initiate corrosion by 1.7 to 280 times. Measured chloride contents are great enough to initiate steel corrosion regardless of mortar type at all locations sampled.

Based on the chloride profile of mortar sampled at different depths, it appears that original bedding mortar used beach sand high in chlorides, and that chlorides have migrated throughout the joints to newer pointing mortars.

The concrete structure is reinforced, and, considering the extremely high chloride levels found in mortars, there is a high potential for reinforcement corrosion. It is possible that the interior paint coating is minimizing oxygen diffusion, limiting corrosion activity, but the high corrosion potential suggests a significant future problem.

Table 2. Mortar chloride test results.

Sample No.	Location	% Chloride ion by weight of sample	% Chloride ion by weight of cement in sample	
			Type N mortar	Type S mortar
1	West Elevation, pointing mortar	1.5	9.9	7.5
5	West Elevation - 1.5"-2.5"	2.2	14.5	11.0
3	West Elevation head joint, 0.5"-1.0" deep	4.3	28.4	21.5
4	Interior @ Stairs - pointing mortar	0.24	1.6	1.2
2	Stairs/ Interior bedding - 0.5"-1.0"	0.74	4.9	3.7

13.0 RECOMMENDATIONS

Moisture penetration

Measures must be undertaken to minimize moisture intrusion and facilitate moisture exit from the wall system. The first step is to address all open mortar joints, delaminated mortar joints, and other point sources for moisture entry. Skyward-facing joints are particularly vulnerable and must be sealed to be waterproof, usually requiring a sealant joint covered by a lead cap or other suitable aesthetic treatment.

Embedded conduit must be removed or filled with a non-shrink injection grout to prevent moisture accumulation and transfer. Injection grout should have an integral corrosion inhibitor to minimize future corrosion potential.

Additional investigation is needed to characterize solidity of grout fill between facing stones and the underlying concrete structure. Conditions at the space between stone and concrete would best be investigated by removing 2-inch diameter cores, drilled from the interior, and viewing with a videoscope. A total of 5 potential coring locations were marked while on site. General locations are called out on the drawing in Appendix A and marked on masking tape at each location as shown in Figure 30. Radar scanning was conducted to locate metal reinforcement and potential core locations were marked to miss subsurface reinforcement. Sections of removed cores can be tested for alkali-aggregate reactions and chloride concentrations.

Void spaces within masonry walls permit moisture to collect and travel within the wall system. Voids in in mortar joints and behind stones are best treated by injecting with a fluid grout, specially designed to be compatible with historic materials. Injection can be carried out using low pressure and small-diameter holes drilled into mortar joints. Injection from both the interior and exterior will be required to treat the massive wall sections.

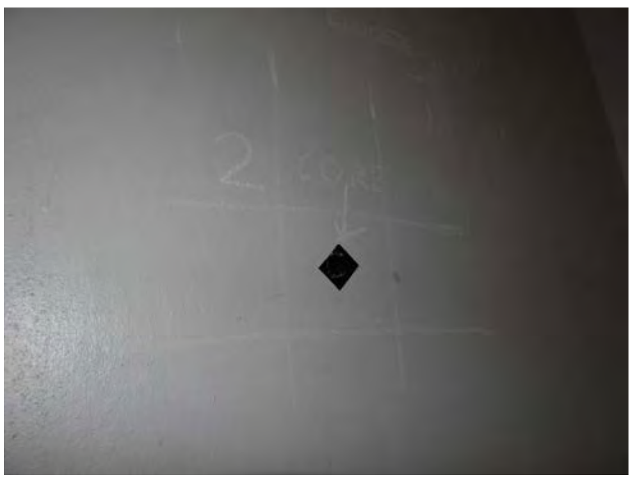


Figure 30. Potential core locations are marked at the interior with chalk and masking tape.

Salt contamination

Salts present at interior lobby stones may be removed by poultice applications. Poultices would likely remove only near-surface salts and, considering the structure's mass and high measured chloride levels, poultice efforts would likely have to be repeated at regular intervals, potentially every 3 to 5 years.

A more permanent solution would be to remove salts using electro-osmosis. This process is more commonly used with concrete construction, and a sample installation should be demonstrated at a small area prior to full-scale design and implementation.

Considering the extremely high chloride concentrations and high potential for metal corrosion, internal concrete reinforcement and stone anchors should be checked for damage and deterioration. Reinforcement corrosion can be mapped using the half-cell potential method, or spot-checked using small localized probes to expose embedded reinforcement. Depending on conditions uncovered it may be prudent to take preventative measures now, before corrosion becomes critical. One approach to halt metal corrosion is installation of an impressed current cathodic protection system to halt the corrosion process.

HVAC System

The internal dehumidification system appears to be working well at keeping internal humidity levels low enough to control salt hydration. When the dehumidifier was turned off, salt hydration stains were evident within 24 hours, disappearing rapidly once the system was again operational. The system should be checked regularly for proper operation. Air balance should also be checked to ensure internal spaces are positively pressurized. Negative internal pressure could be exacerbating moisture intrusion by drawing moisture through mortar joints into interior spaces.

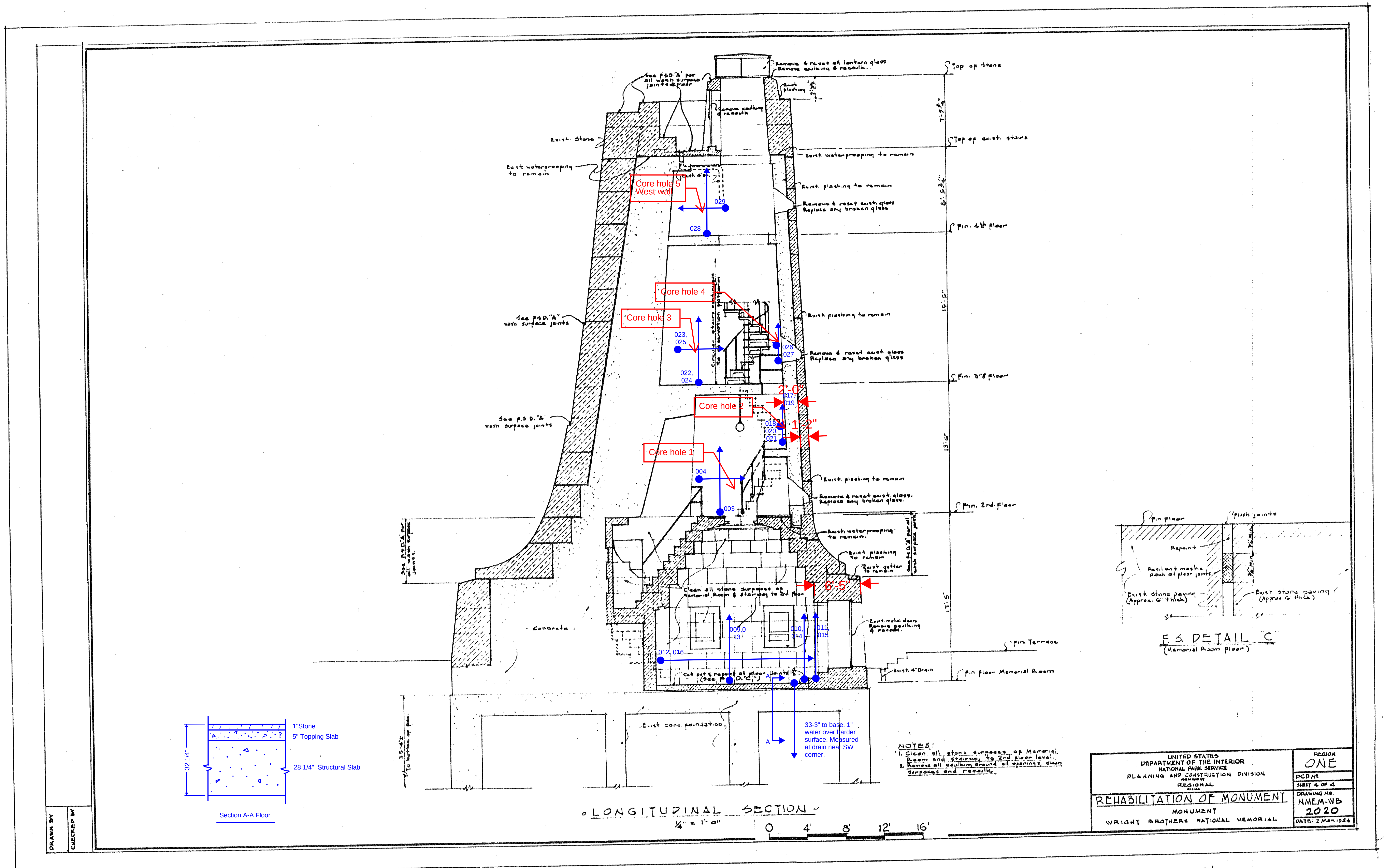
Louvers at the south elevation, used for dehumidifier makeup and exhaust air, should be opened and installation inspected to ensure the collar joint between stone and concrete is 100 percent sealed to prevent hot humid air from penetrating behind stone.

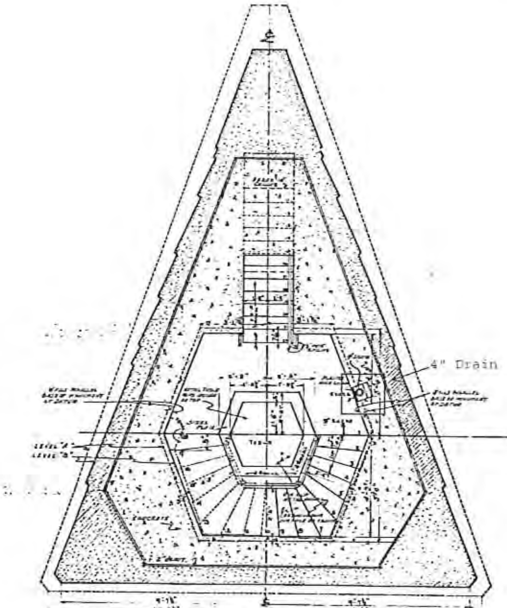
APPENDIX A

TEST LOCATIONS AND FIELD NOTES

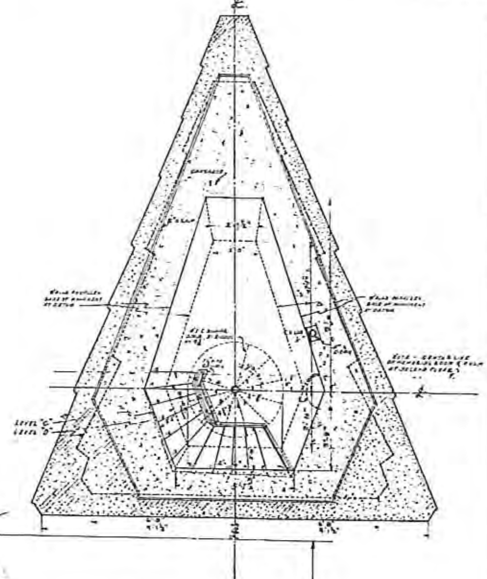
Radar scan locations are shown as blue arrows, with the arrow showing the scan direction.

Locations for corehole drilling are noted as well.

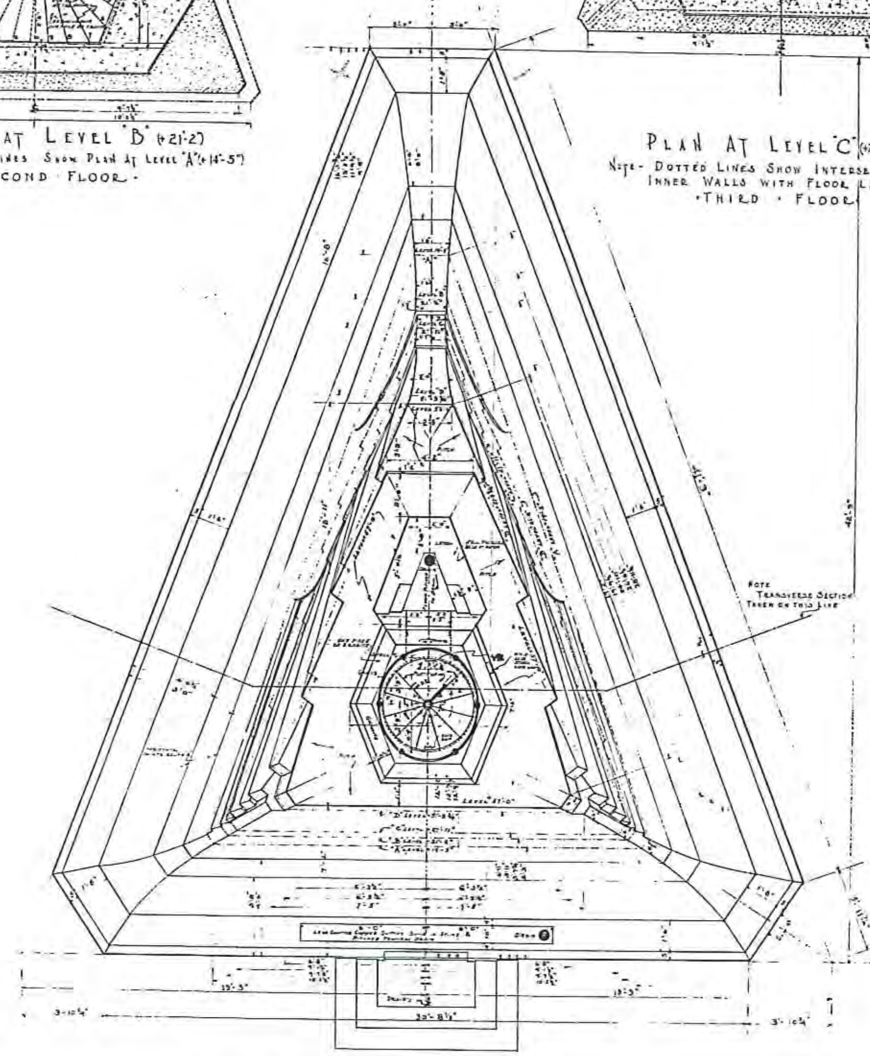

Remove & reset all lantern glass
Remove caulking & recaulk
Top of stone
Top of exist. stairs
Exist. waterproofing to remain
Exist. flashing to remain
Remove & reset exist. glass
Replace any broken glass
Fin. 4th floor
Fin. 3rd floor
Fin. 2nd floor
Fin. Terrace
Fin. floor Memorial Room
Exist. Stone
Exist. waterproofing to remain
See F.S.D. "A" wash surface joints
Concrete
Exist. conc. foundation
Exist. metal doors
Remove caulking & recaulk
Exist. 4" Drain
Clean all stone surfaces of Memorial Room & stairway to 2nd floor
Cut out & repoint all floor joints (See F.S.D. "C")
Core hole 5
West wall
Core hole 4
Core hole 3
Core hole 2
Core hole 1
028
029
022, 024
023, 025
026, 027
017, 019
018, 020, 021
004
003
009, 013
010, 014
011, 015
012, 016
2'-0"
1'-2"
6'-5"
7'-5 3/4"
8'-5 3/4"
15'-5"
13'-6"
17'-5"
35'-4" to bottom of fdn.
33-3" to base. 1" water over harder surface. Measured at drain near SW corner.
A
1"Stone
5" Topping Slab
28 1/4" Structural Slab
32 1/4"
Section A-A Floor
Fin. floor
Flush joints
Repoint
Resilient mastic
Exist. stone paving (Approx. 6" thick)
F.S. DETAIL "C"
(Memorial Room Floor)
NOTES:
1. Clean all stone surfaces of Memorial Room and stairway to 2nd floor level.
2. Remove all caulking around all openings, clean surfaces and recaulk.
LONGITUDINAL SECTION
1/4" = 1'-0"
0 4' 8' 12' 16'
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
PLANNING AND CONSTRUCTION DIVISION
REGIONAL
REHABILITATION OF MONUMENT
MONUMENT
WRIGHT BROTHERS NATIONAL MEMORIAL
REGION
ONE
SHEET 4 OF 4
DRAWING NO.
NMEM-WB
2020
DRAWN BY
CHECKED BY



PLAN AT LEVEL "D" (+21'-2")
NOTE – DOTTED LINES SHOW PLAN AT LEVEL "A" (+14'-5")
· SECOND · FLOOR ·



PLAN AT LEVEL "C" (+27'-11")
NOTE – DOTTED LINES SHOW INTERSECTION OF OUTER & INNER WALLS WITH FLOOR LEVEL AT "D" (+21'-4½")
·THIRD · FLOOR·



PLAN THRU LANTERN
SCALE = ½" = 1'-0"

36/25001
Sheet 3 of 9

WRIGHT MEMORIAL
KITTY HAWK N.C.
Job No. 46
DRAWING NO. 103
REVISIONS
Date 8/20/30
Scale ½" = 1'-0"
ROBERT PERRY RODGERS & ALFRED EASTON POOR
ARCHITECTS
NEW YORK

G711-26

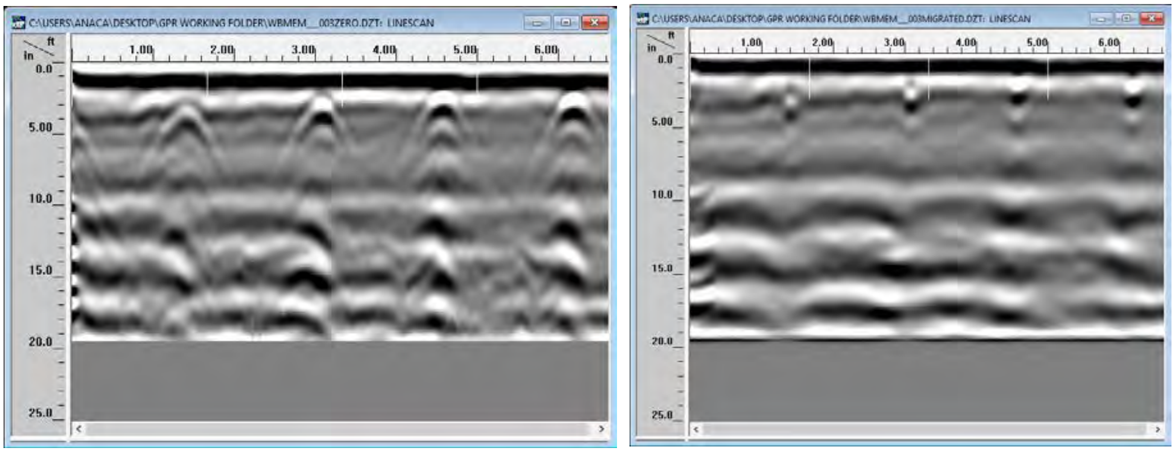
APPENDIX B

SURFACE PENETRATING RADAR SCANS

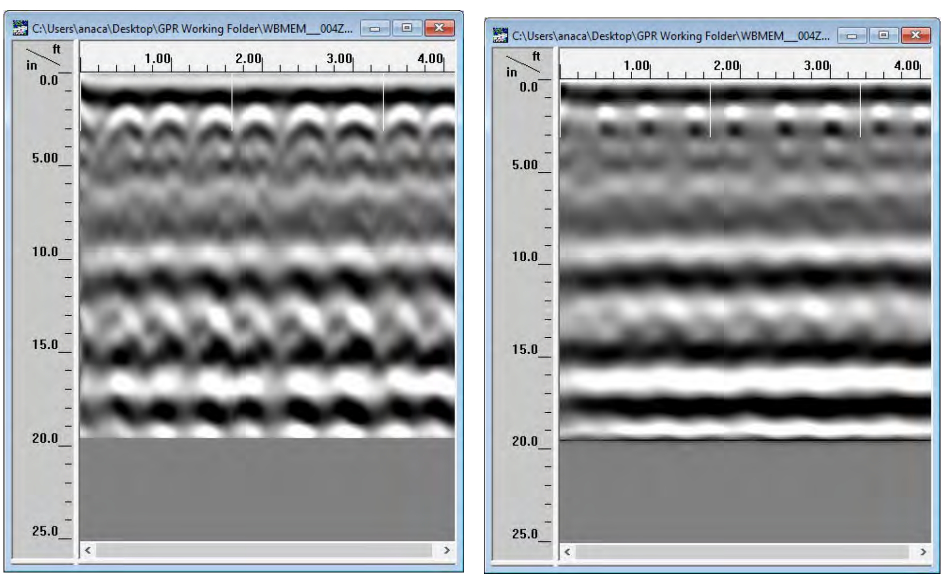
All surface penetrating radar scans saved on site are shown below. For scans at reinforced concrete sections, the second image in each pair includes data reduction to migrate traces to clarify reinforcing bar positions.

In each image the horizontal scale is in feet, along the length of the scan.
The vertical scale is inches into the depth of the wall, with the wall face at 0 inches.

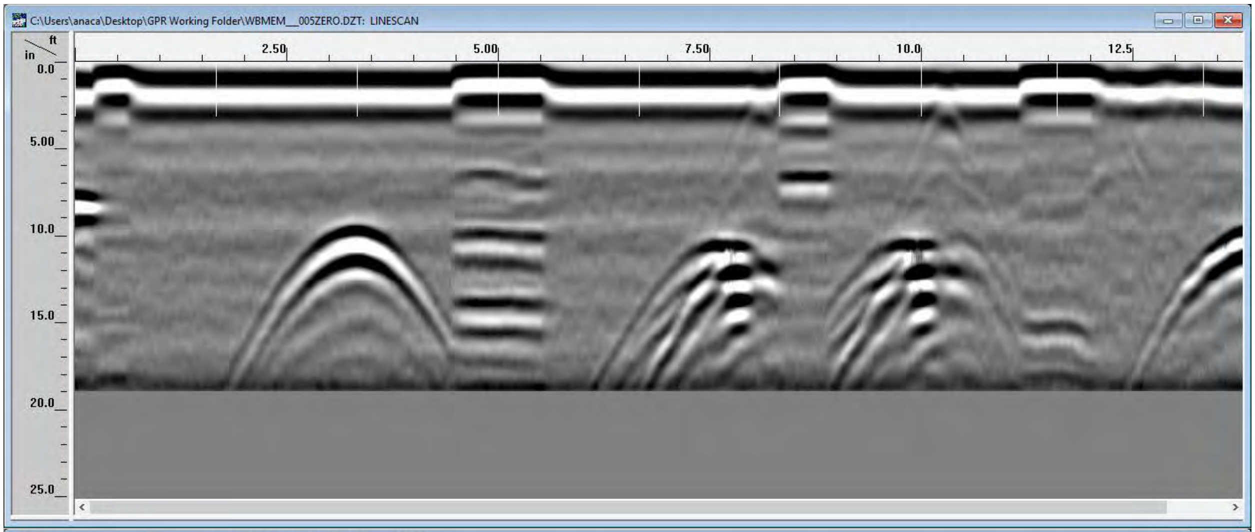
Numbered scan locations are shown on the Monument section in Appendix A.

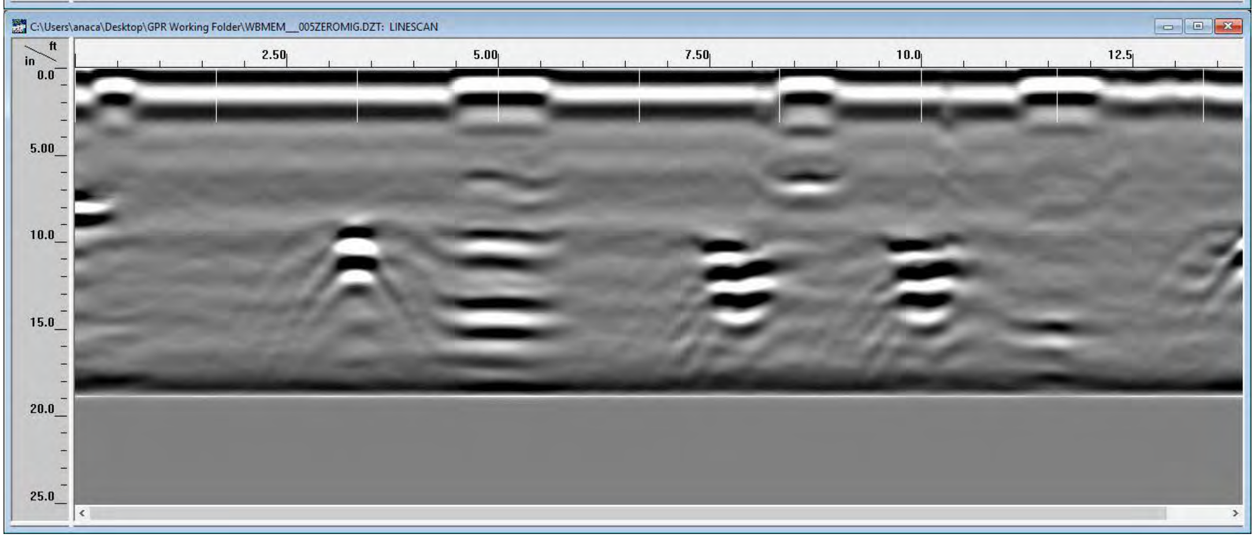


Scan 003, vertical scan, 2nd level interior, from floor upwards. Reinforcement at 17 to 19 ½" spacing. Depth varies: 3 to 4 inches.



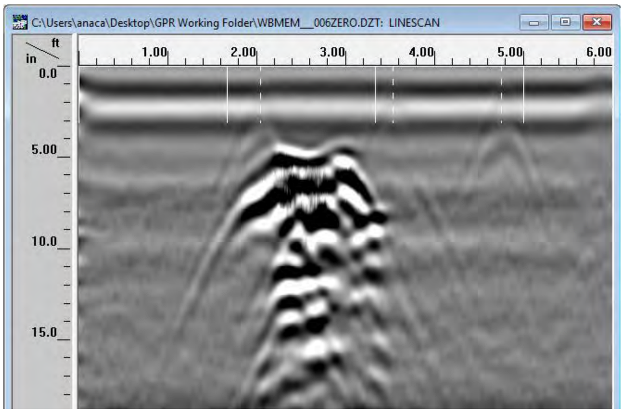
Scan 004: Horiz. @ 4' above 2nd floor. Reinf. @ 5" to 7" spacing. Depth = 1 3/4 "



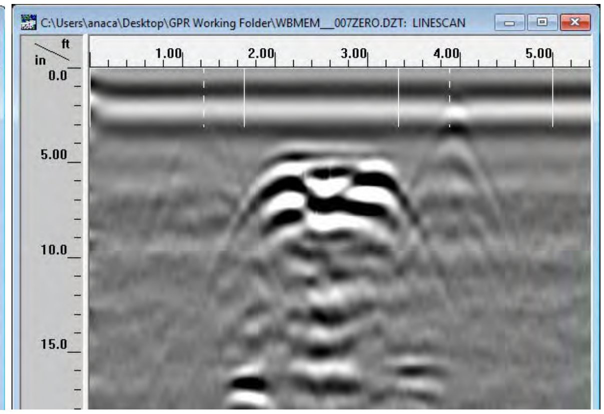


Scan 005: exterior, south elevation at drainpipe to east of entry door, 4 horizontal scans each, separated by wheel spins. Drainpipe detected at approximate 10 inch depth from wall face.

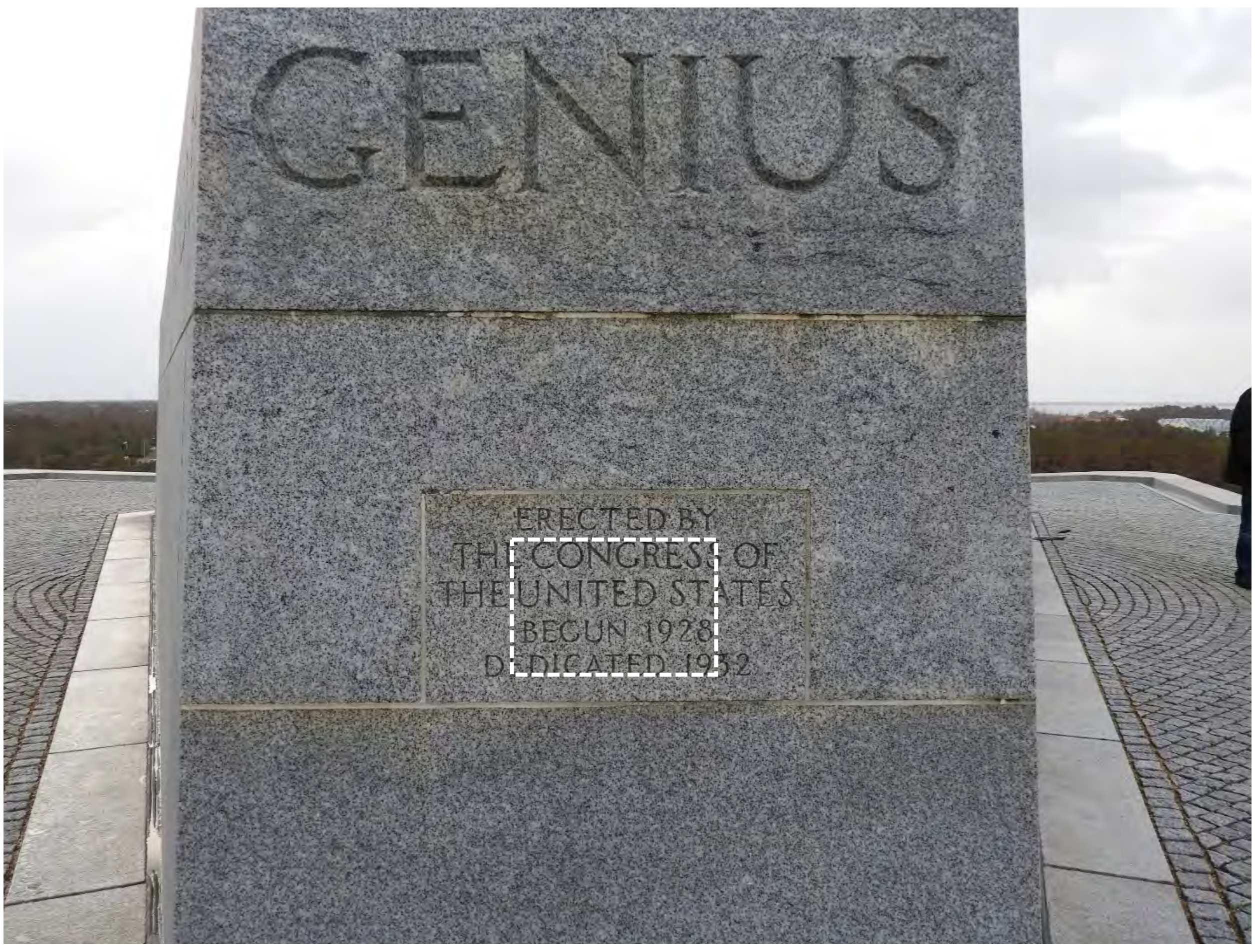
Scans at exterior, north elevation at "cornerstone." Markers (dashed lines) at mortar joints.



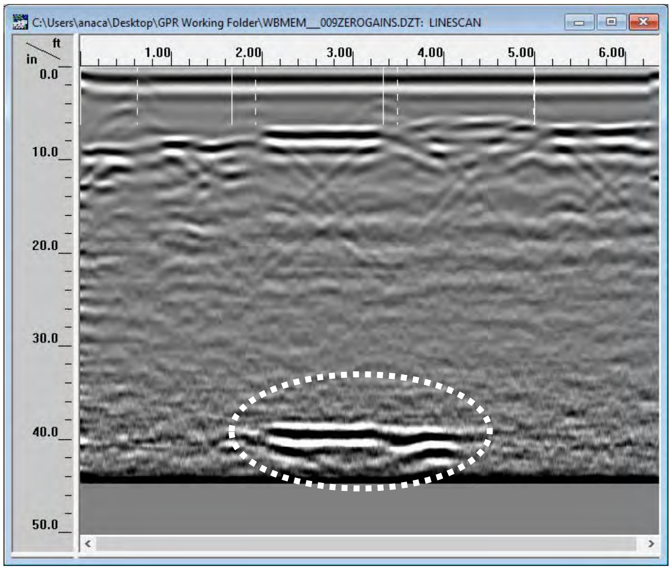
Scan 006: exterior vertical



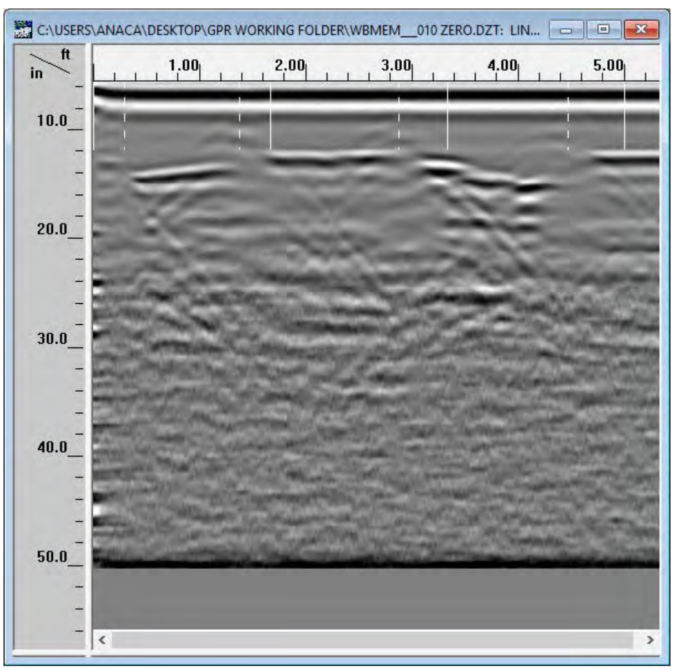
Scan 007: exterior horizontal



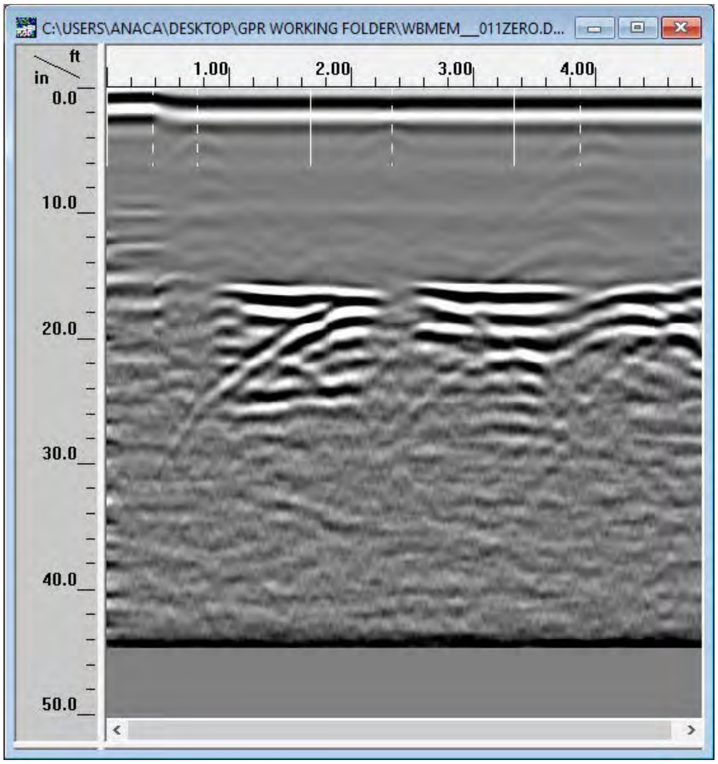
Photograph at "cornerstone" with embedded metal element shown as dashed outline.



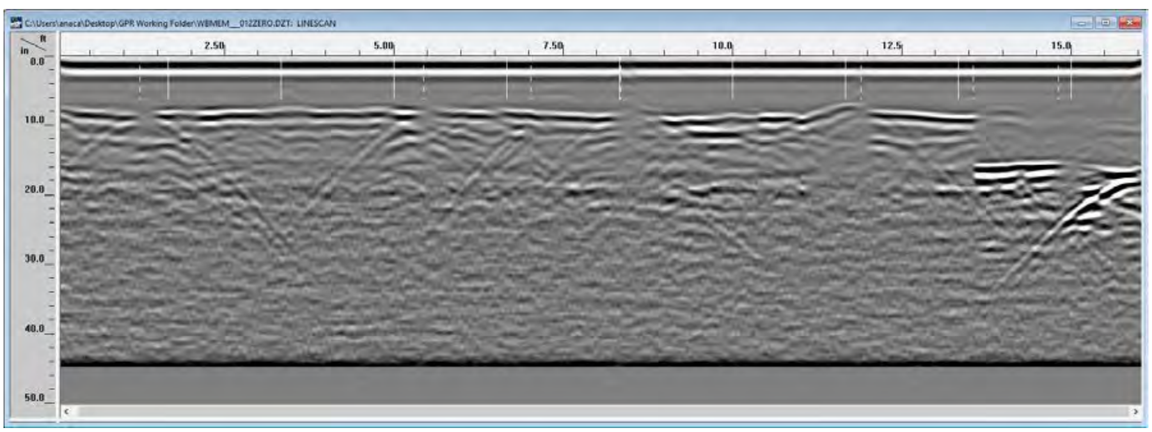
Scan 009: Interior Lobby, vertical, east wall. Stone veneer thickness varies from 8 to 9 inches, with voids behind some stones; backs of stones are somewhat irregular. Strong reflection at 40 inches deep (outlined) suggests a void behind the exterior stone at this location, from 2'-6" to 4'-6" above the interior floor line (above exterior pavement grade).



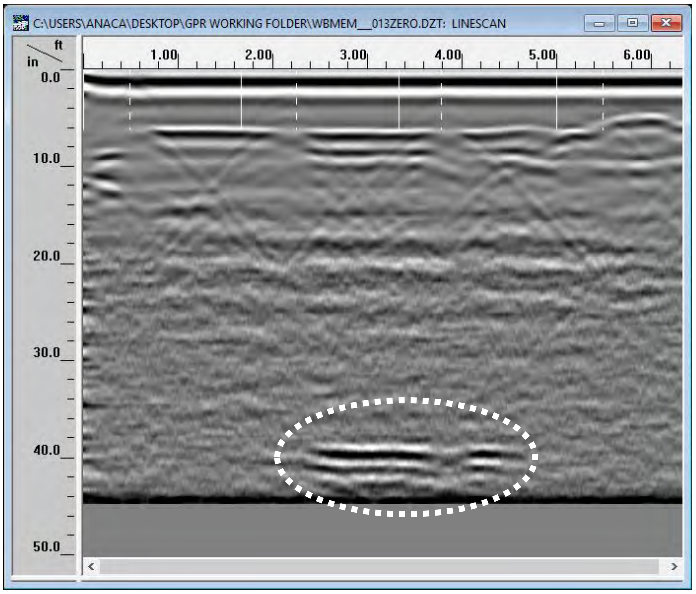
Scan 010: Interior lobby, vertical, east wall. Stone thickness 8 to 10 inches. Reflections at backs of stone suggest moderate voids in grout fill.



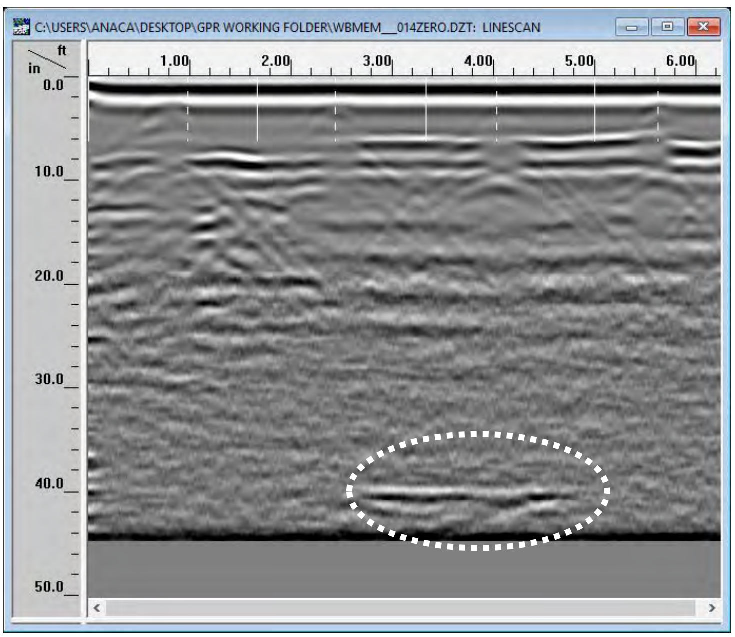
Scan 011: interior lobby, vertical scan, south wall to east of door. Stone much thicker, measuring at 14 to 15 inches thick. Strong reflections suggest significant voids behind stones.



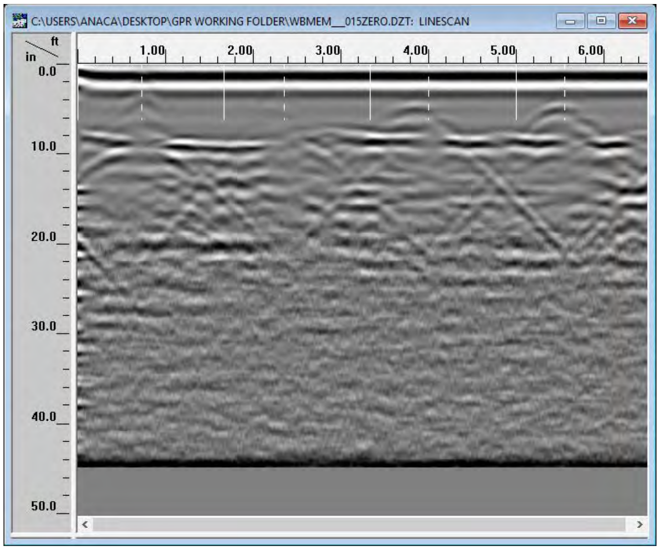
Scan 012: Interior lobby, horizontal, east wall. Stones transition from approx.. 8 inch to 14 inches thick at southeast corner. Reflections at back of stones suggest moderate to significant voids are present behind stones.



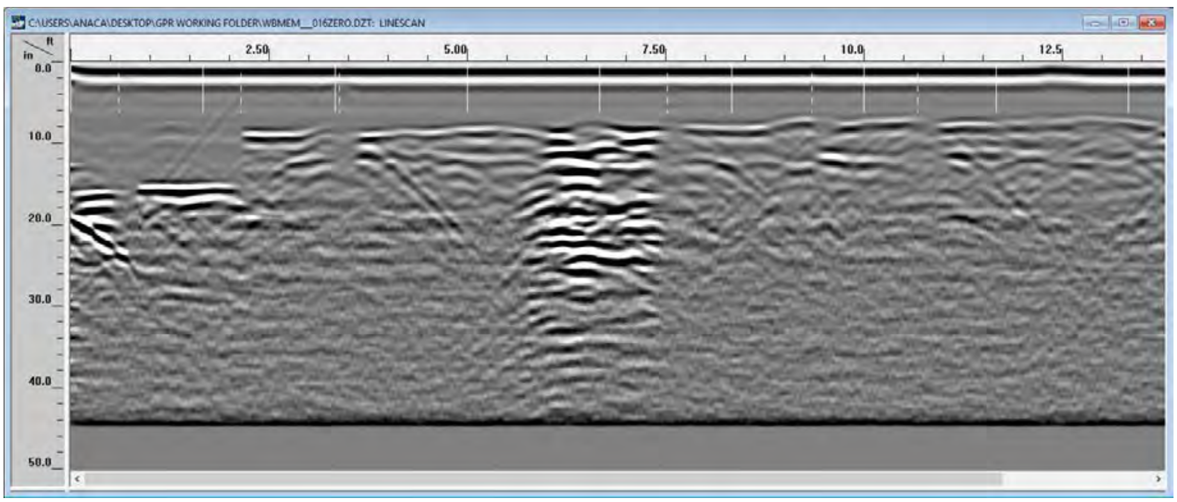
Scan 013: Interior lobby, vertical, west wall. Stone thickness 6 to 7 inches; same isolated void as seen in Scan 009.



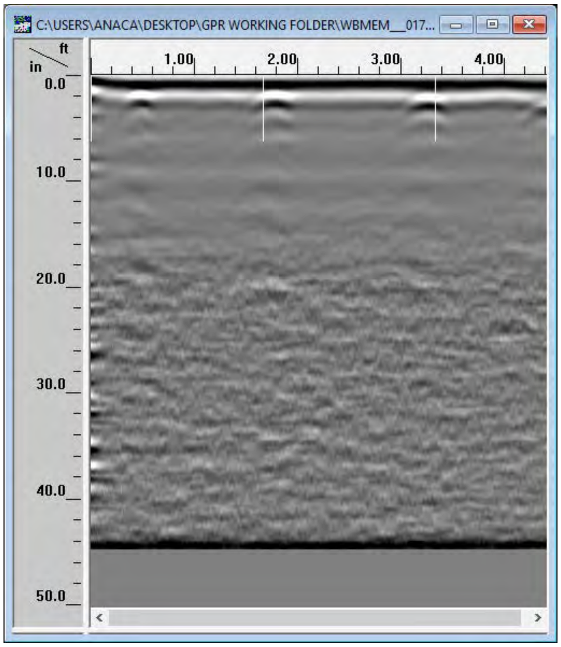
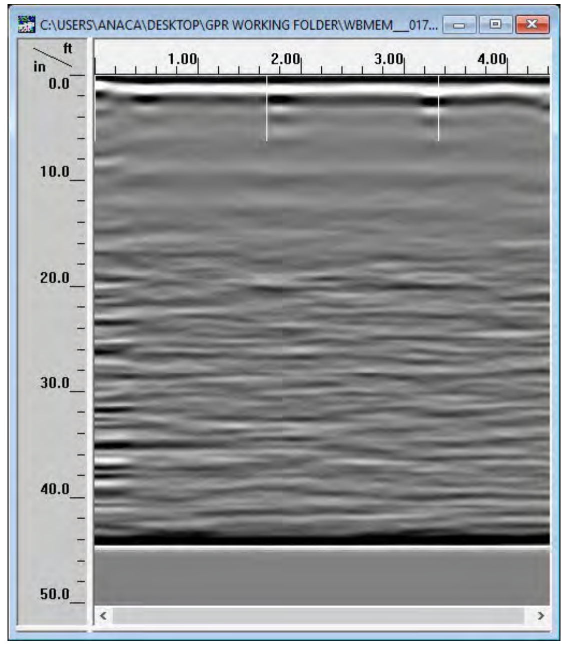
Scan 014: Interior lobby, vertical, west wall. Stone thickness 6 to 7 inches; same isolated void as seen in Scan 009 and 013.



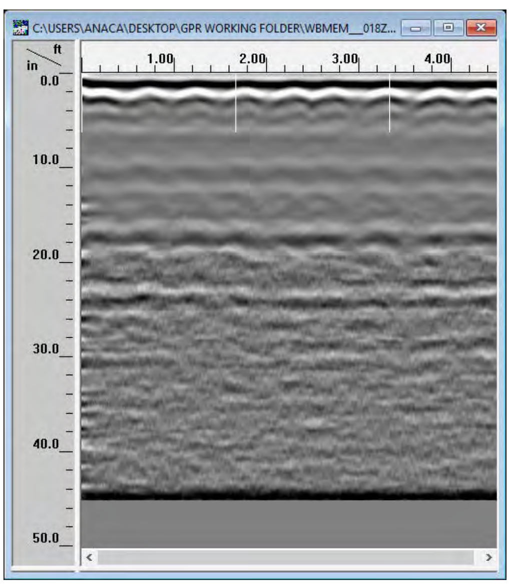
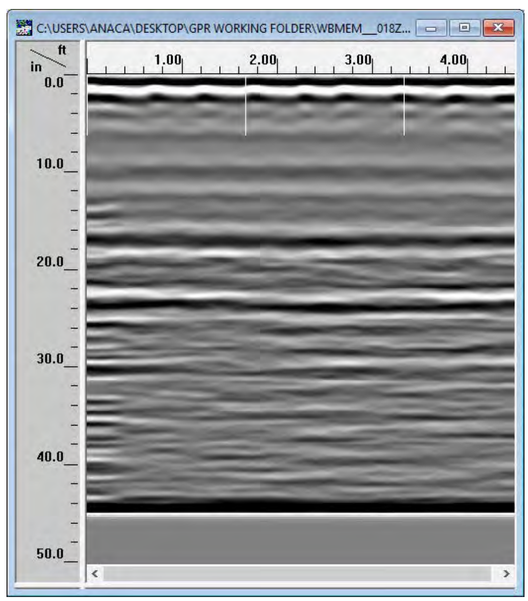
Scan 015: Interior lobby, vertical, south wall to west of door. Stone thickness 7 to 8 inches; significant mortar joint voids.



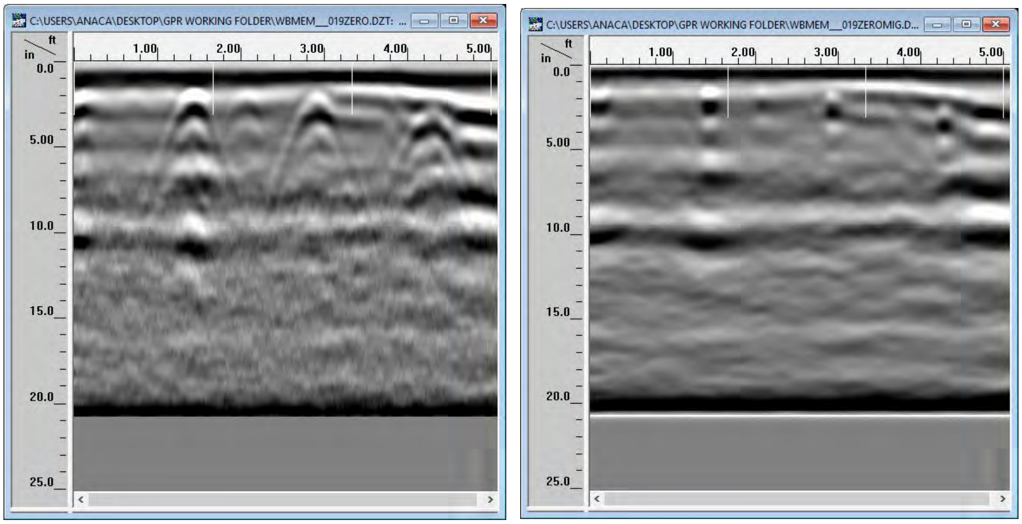
Scan 016: Interior lobby, horiz., west wall/ Stone thickness transitions from 15” to 8” at southwest corner.

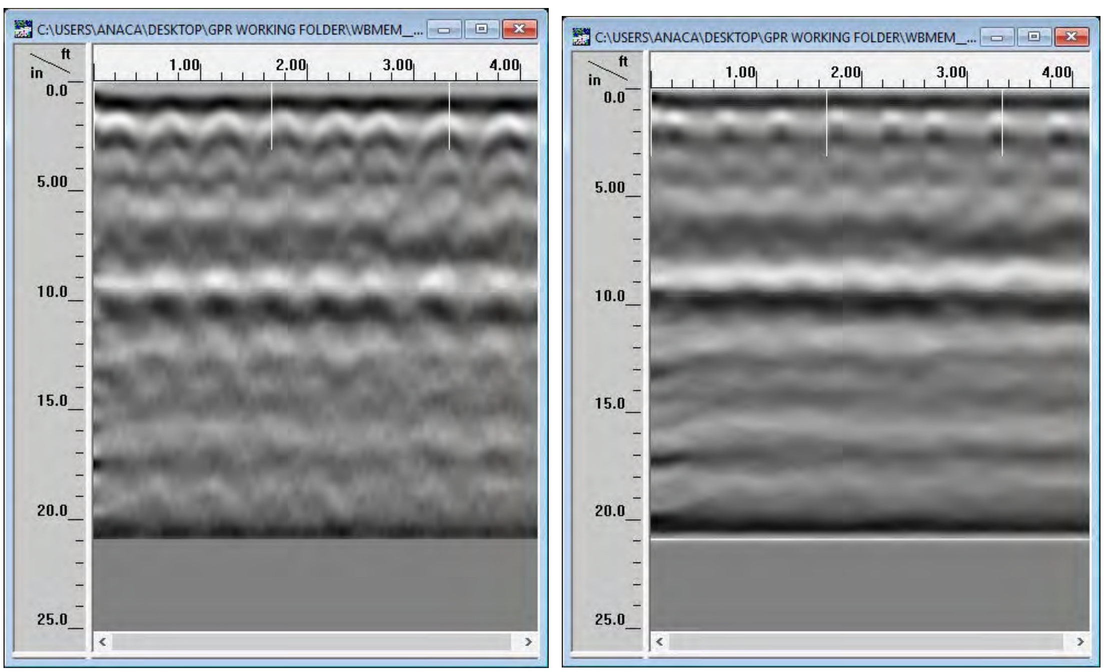
Scan 017: 2nd level concrete from stairs. South wall, vertical. Concrete very wet beyond about 18” depth.

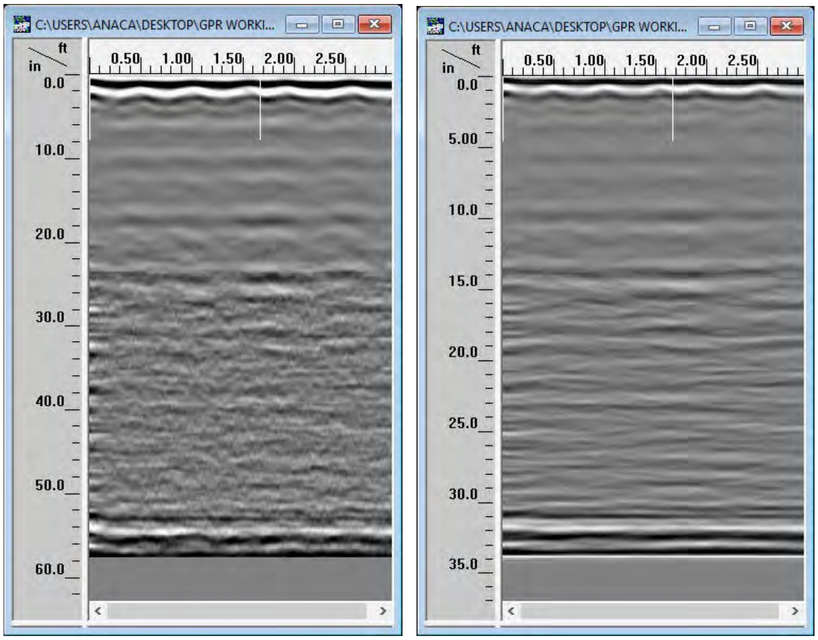
Scan 018: Same as 017, horizontal. Concrete 18” or 24" thick?



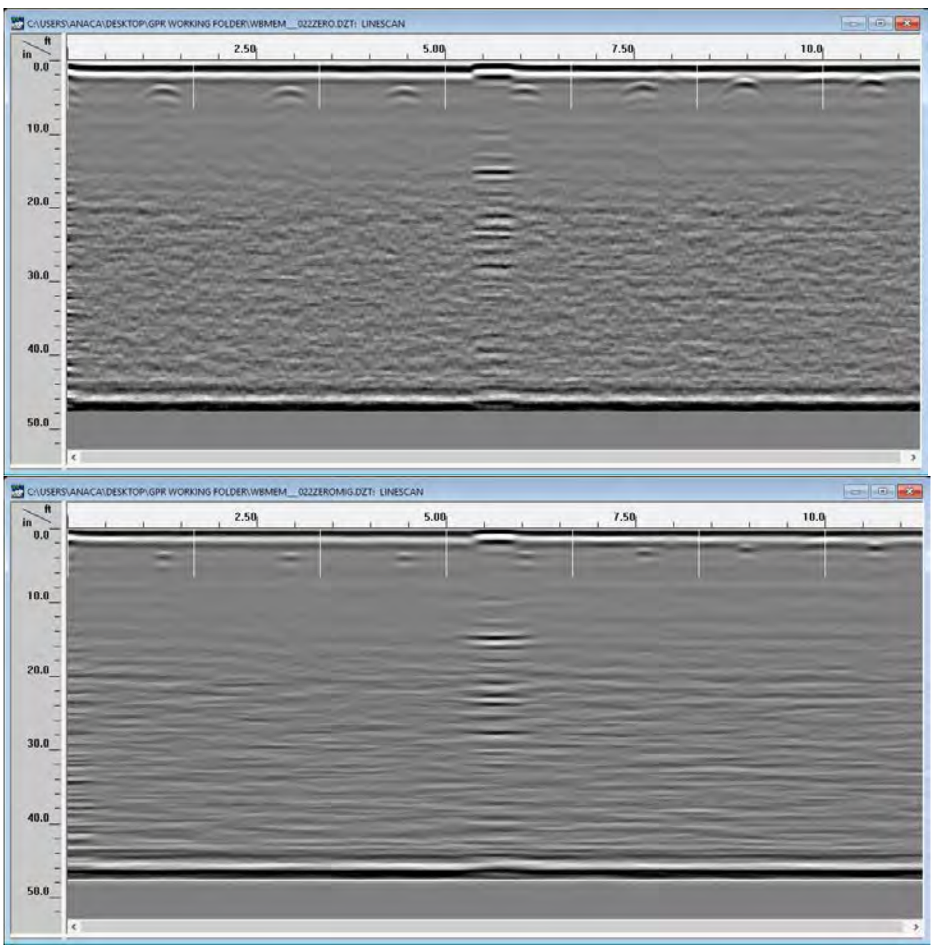
Scan 019: Same as 017, reduced time, rebar at 6" to 17" spacing, depth = 1 3/8" to 2 1/4"



Scan 020: Same as 018, reduced time, rebar at 5" to 8", depth = 1"

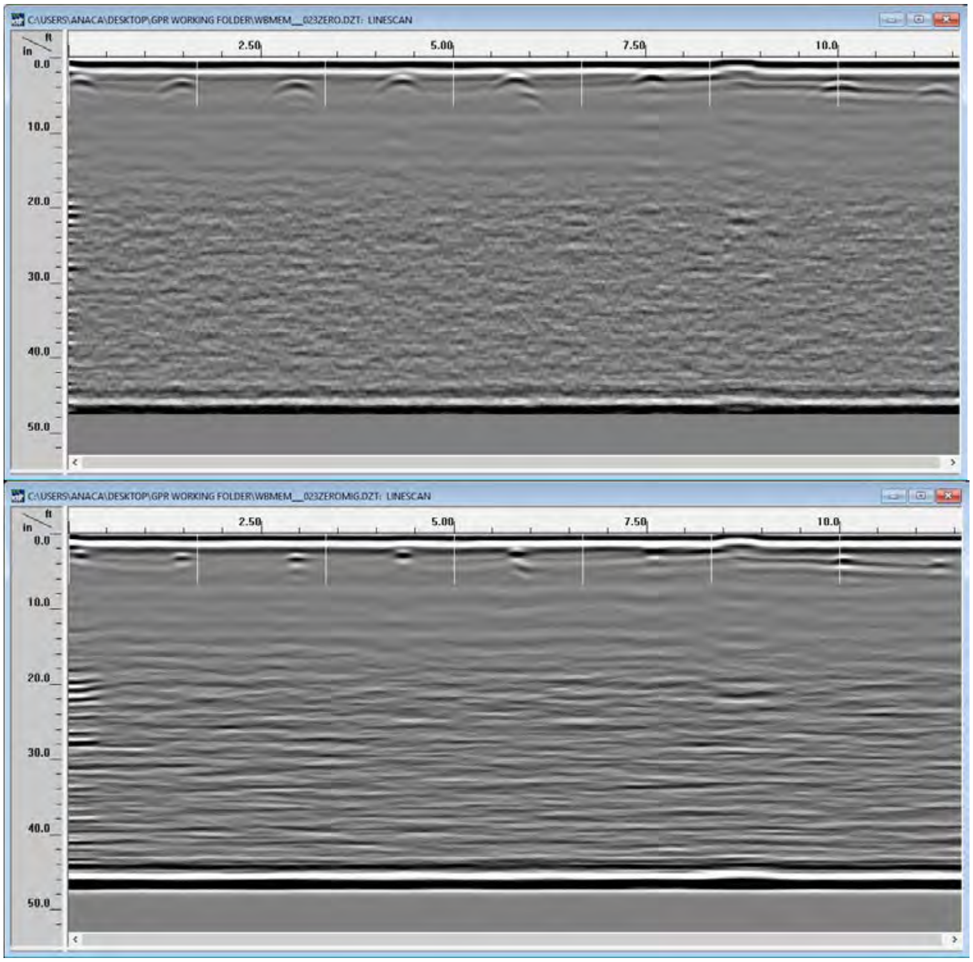


Scan 021: Same as 018, Same as 017, horizontal. Concrete 22" deep?

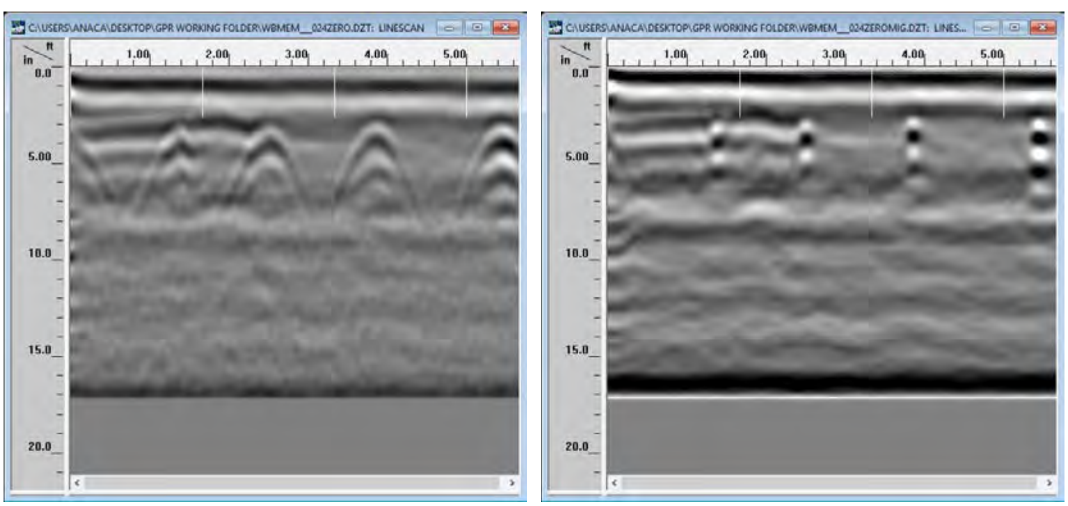


022

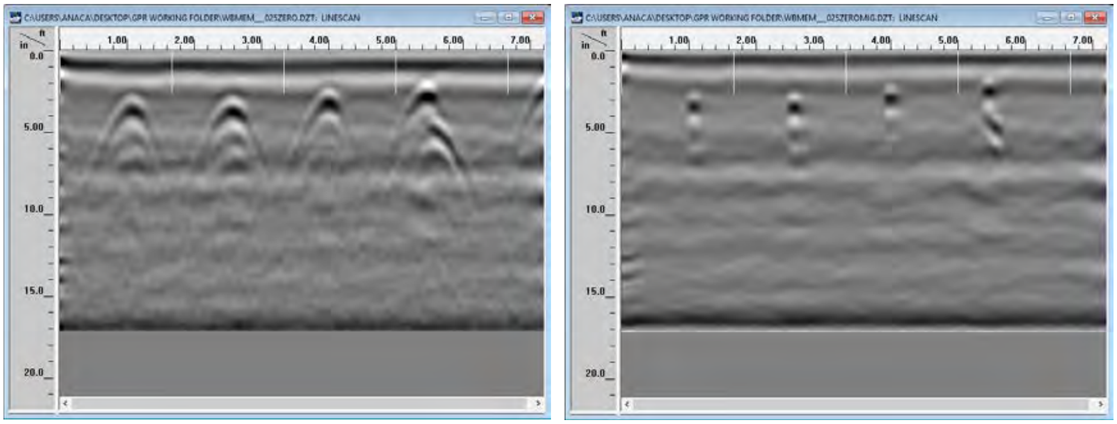
Scan 022, 024: 3rd level, vertical. Rebar at 14" to 19" , depth = 3"



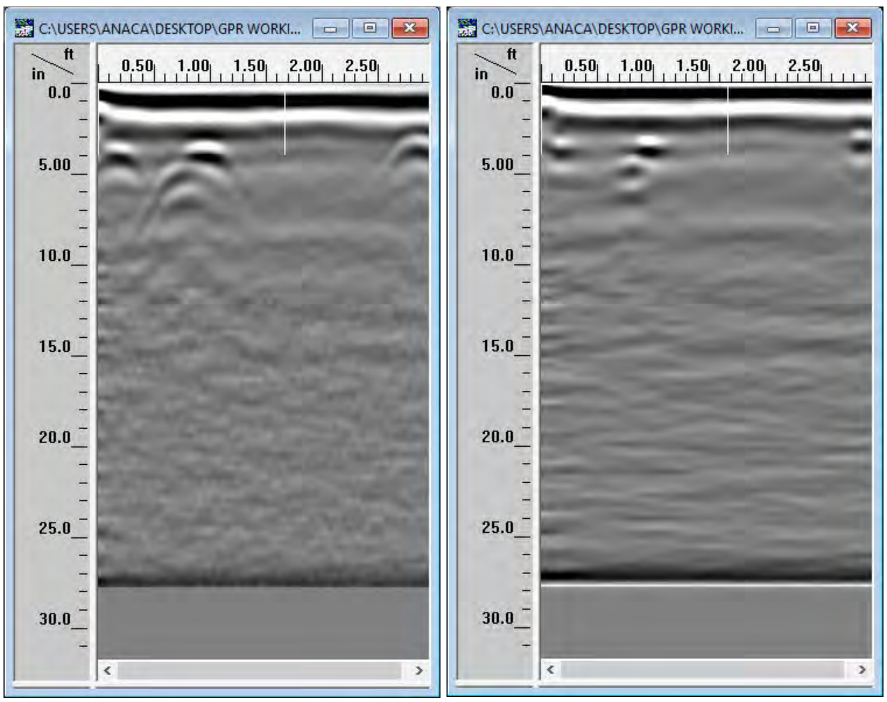
Scan 023: 3rd level conrete, horizontal. Rebar at 16", depth = 1 5/8" to 3"



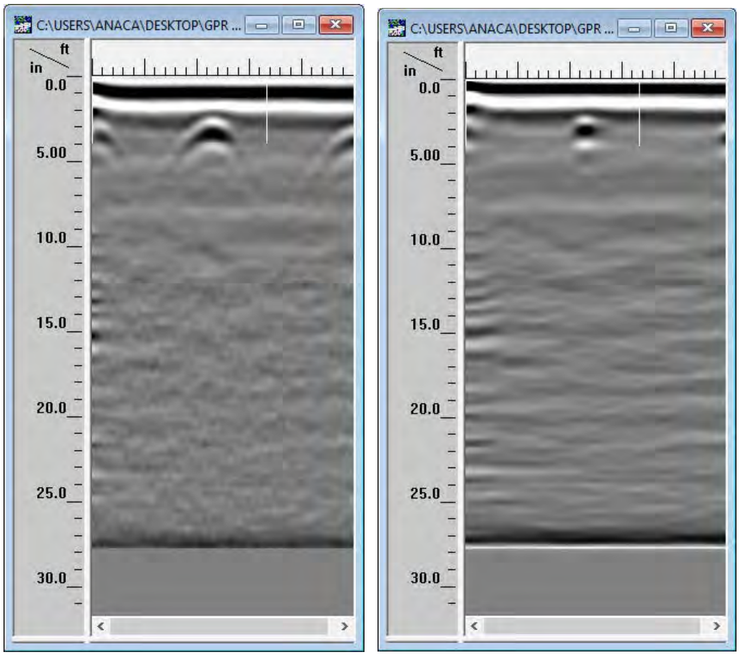
Scan 024: same as 022, 3rd level, vertical. Rebar at 14" to 19" , depth = 3"



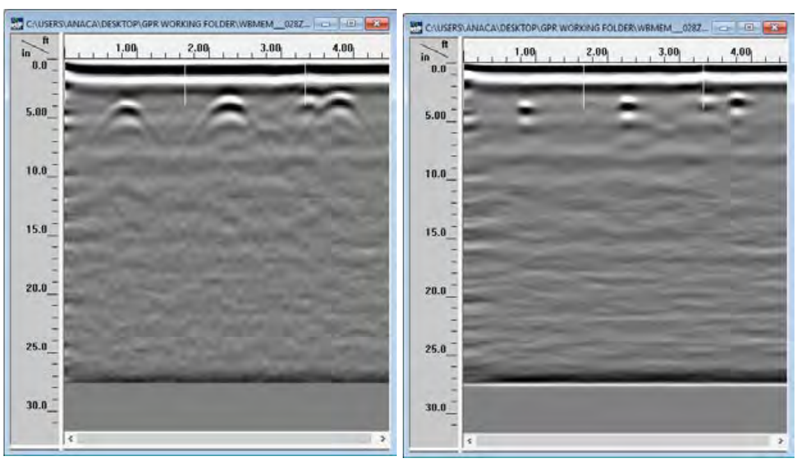
Scan 025: same as 023: 3rd level concrete, horizontal. Rebar at 16", depth = 1 5/8" to 3"



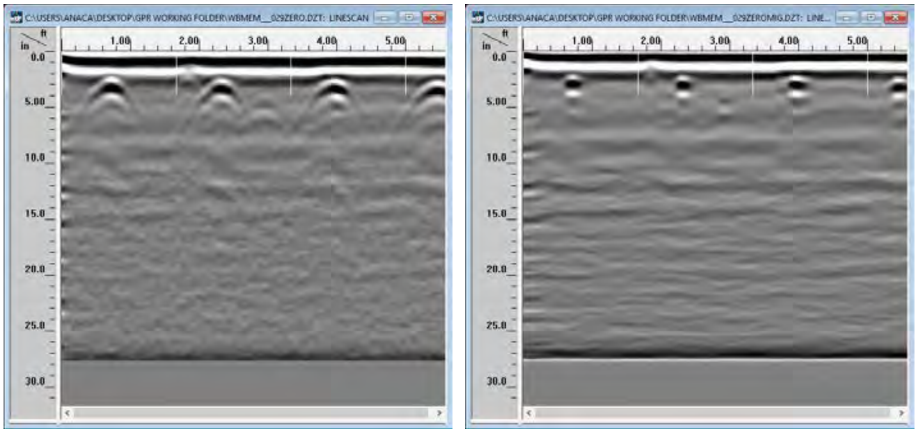
Scan 026: vertical, 3rd level concrete South wall



Scan 027: horizontal, 3rd level concrete South wall



Scan 028: 4th level vertical concrete, west wall, rebar at 16" to 17". One extra bar?

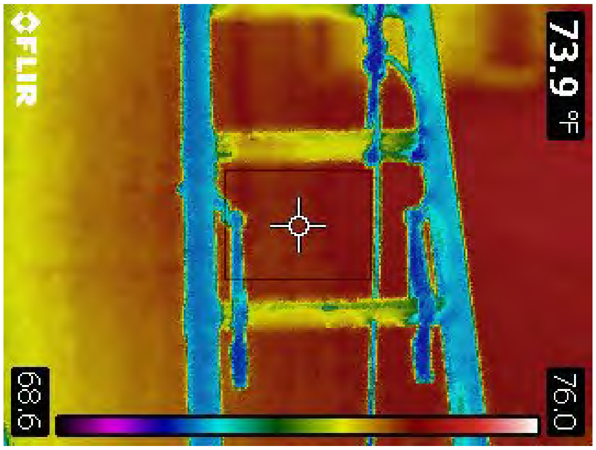


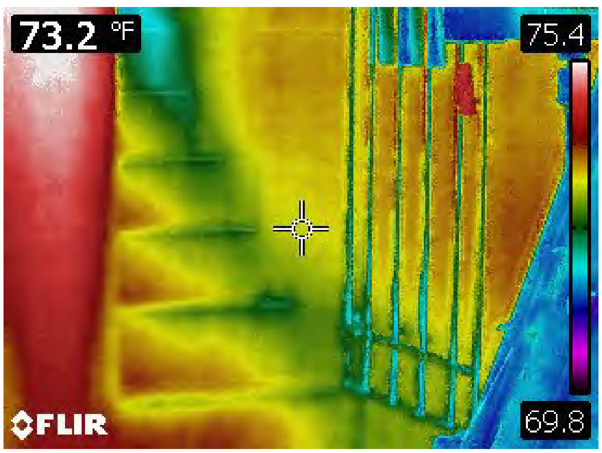
Scan 029: 4th level concrete, horizontal, west wall, rebar at 6" to 18".

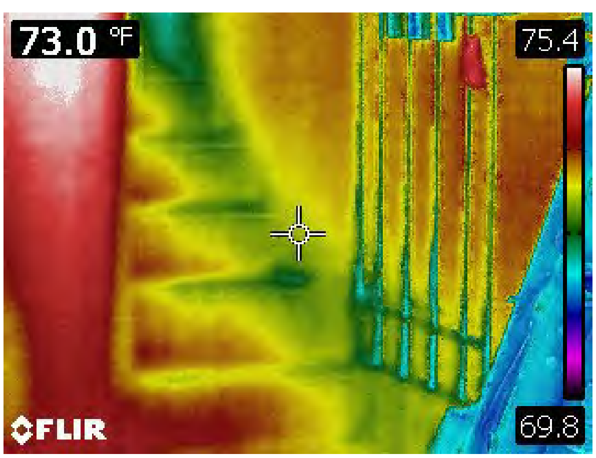
APPENDIX C

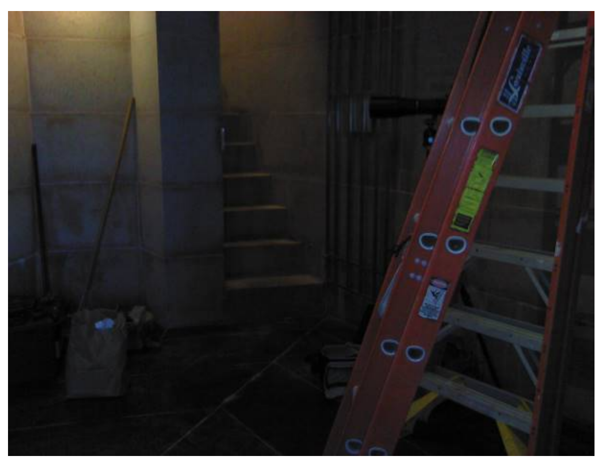
INFRARED THERMOGRAPHY SCANS

Infrared Thermography Scan Set 1: Tuesday November 29 between 14:14 and 14:35

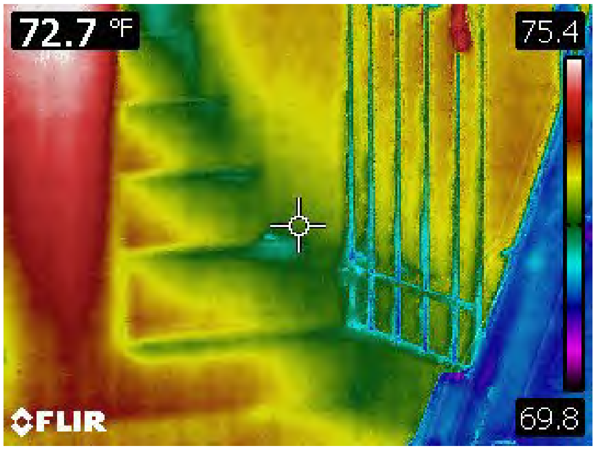


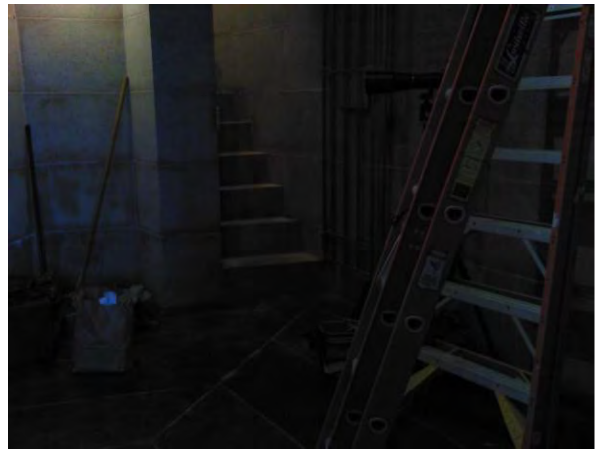


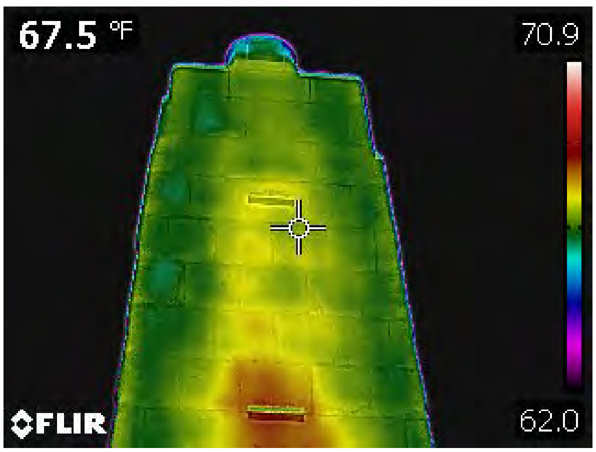


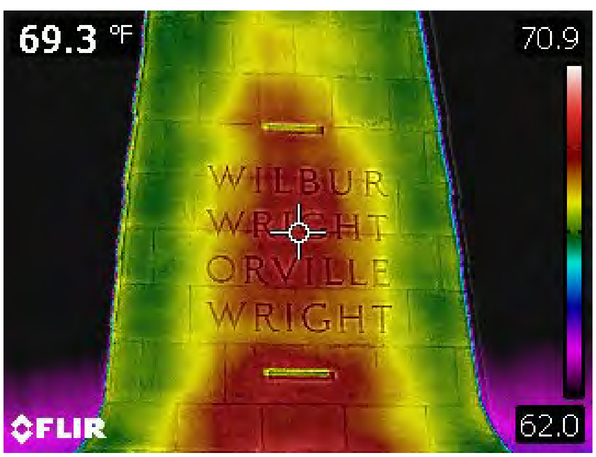


Infrared Thermography Scan Set 1: Tuesday November 29 between 14:14 and 14:35

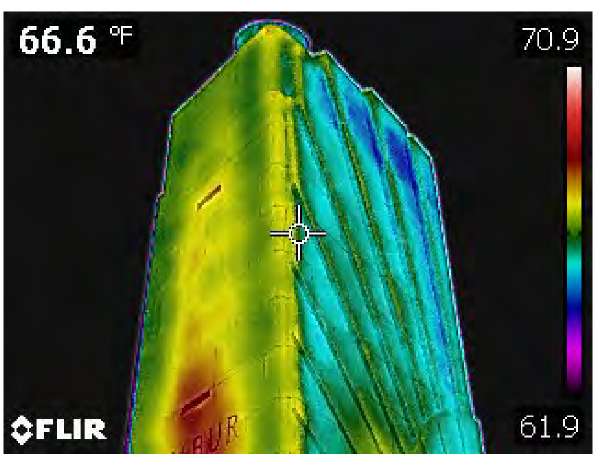




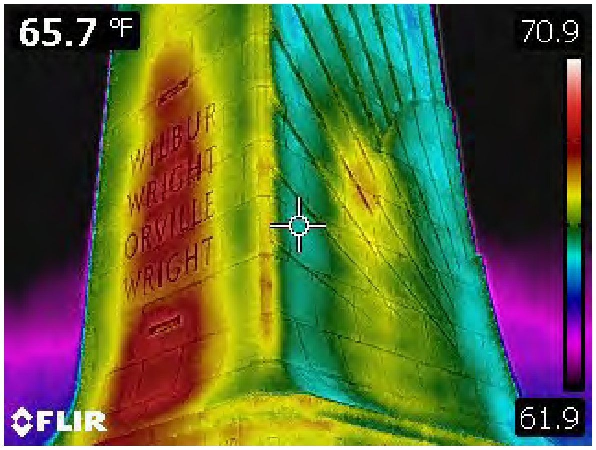


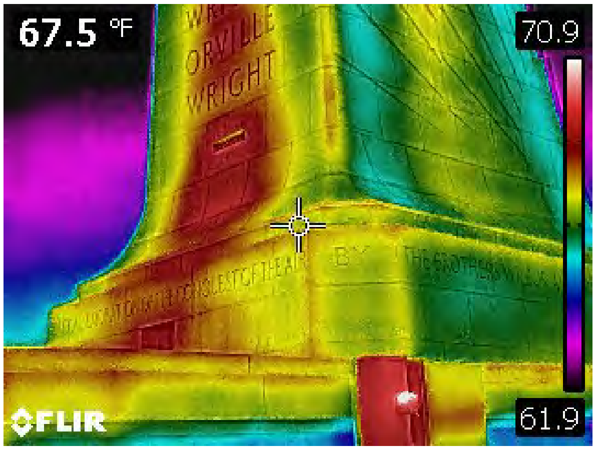


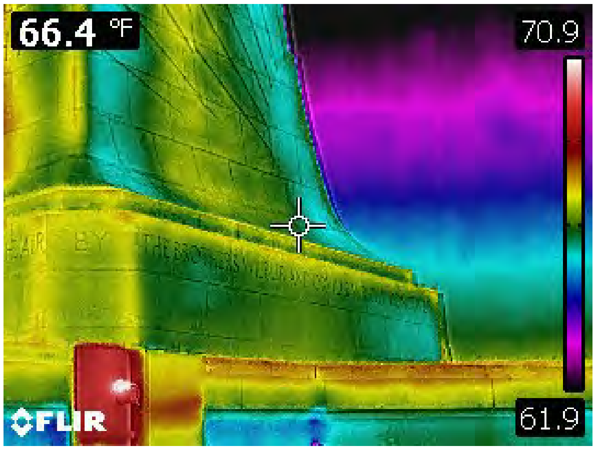
Infrared Thermography Scan Set 1: Tuesday November 29 between 14:14 and 14:35



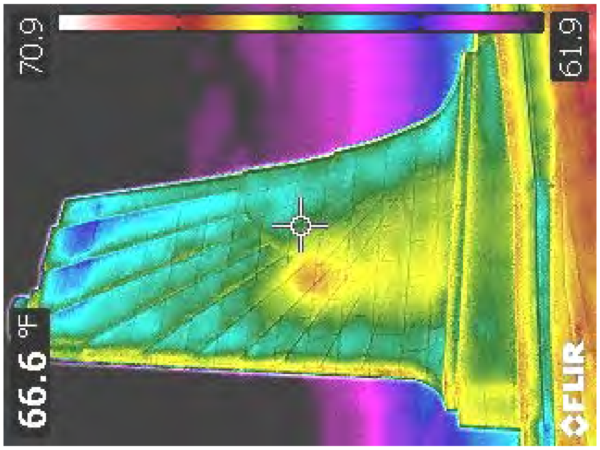
Infrared Thermography Scan Set 1: Tuesday November 29 between 14:14 and 14:35

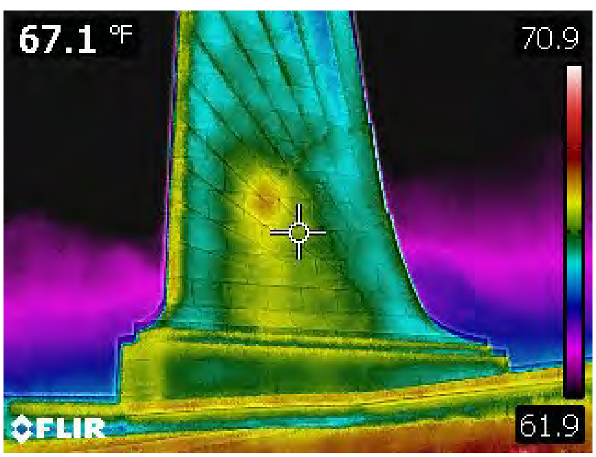






Infrared Thermography Scan Set 1: Tuesday November 29 between 14:14 and 14:35





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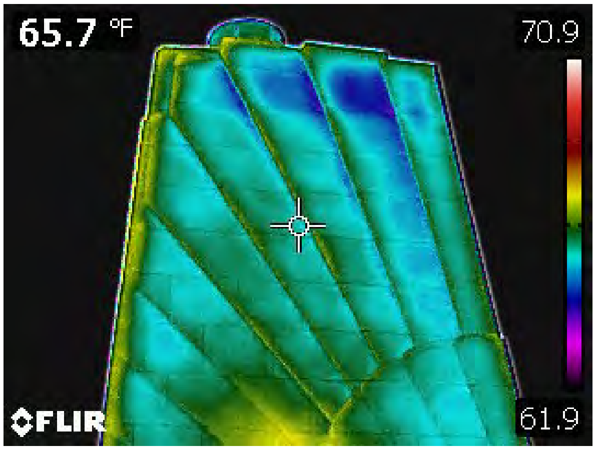
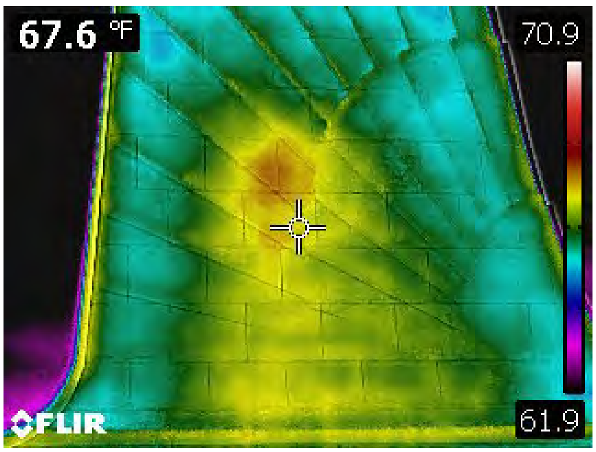
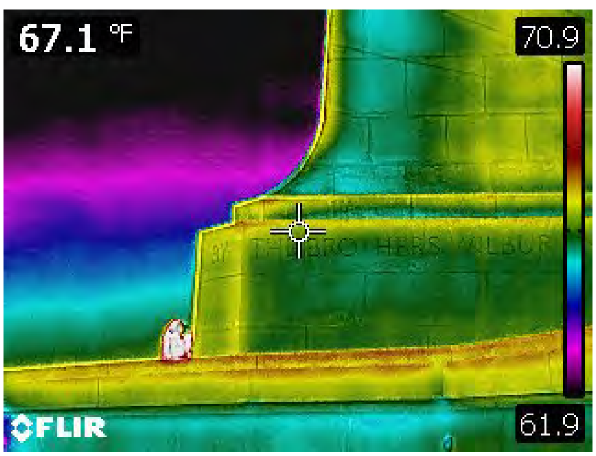
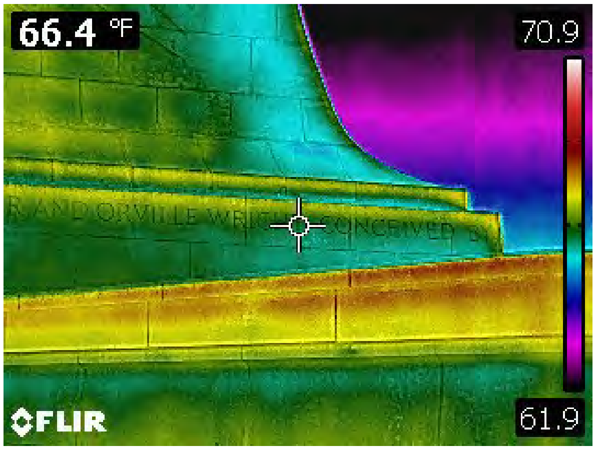
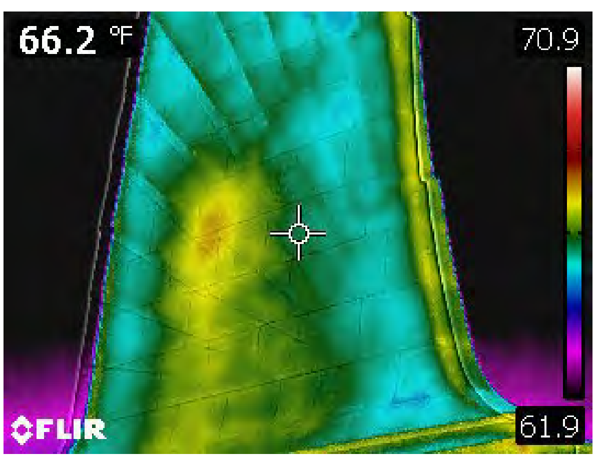




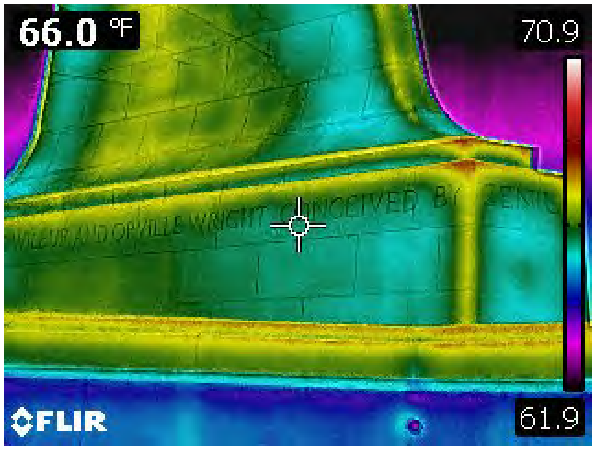


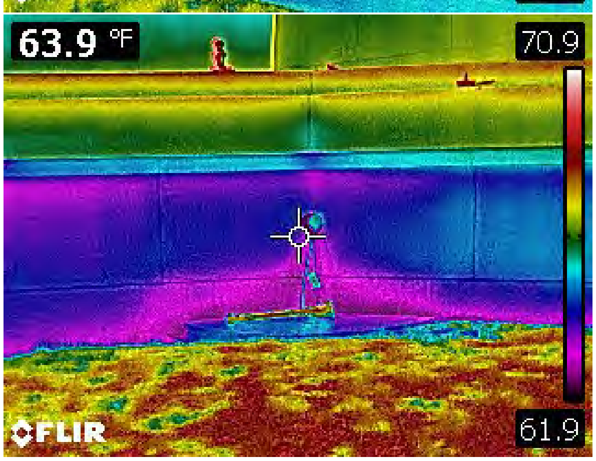
Infrared Thermography Scan Set 1: Tuesday November 29 between 14:14 and 14:35

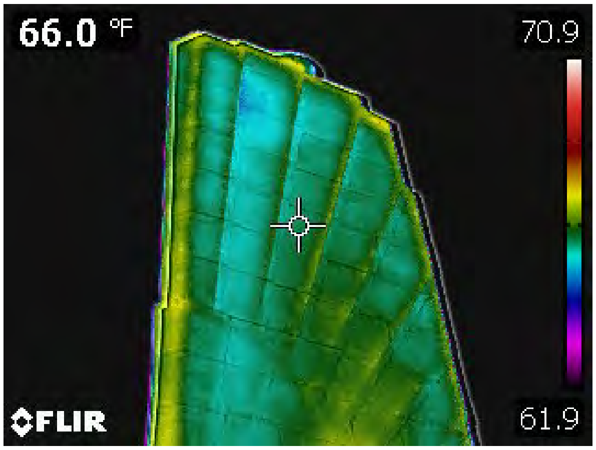


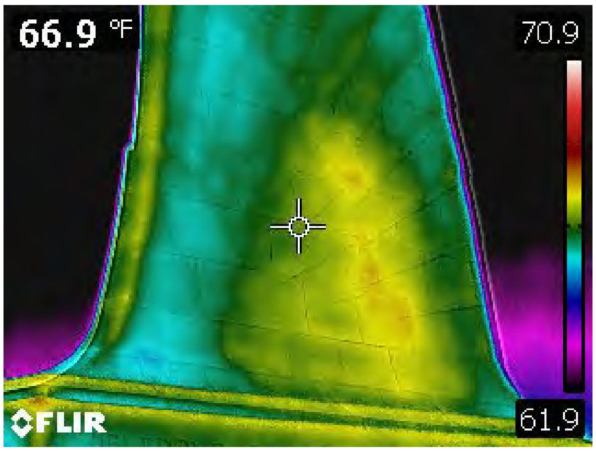


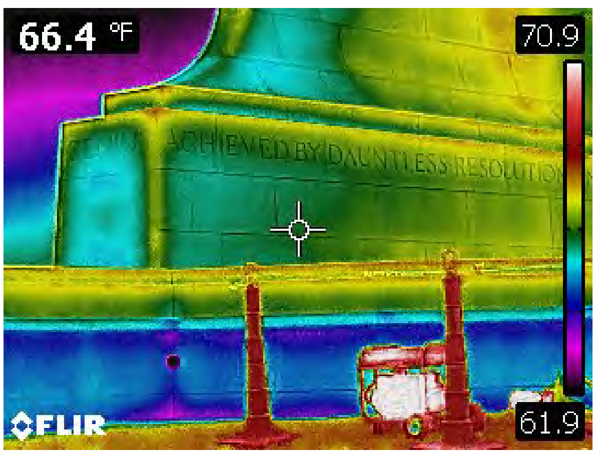
Infrared Thermography Scan Set 1: Tuesday November 29 between 14:14 and 14:35



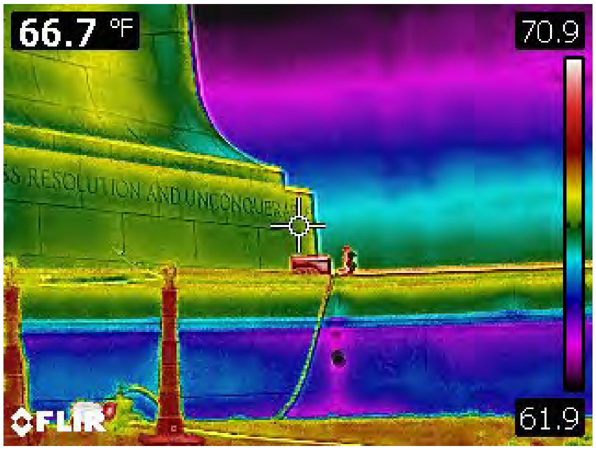


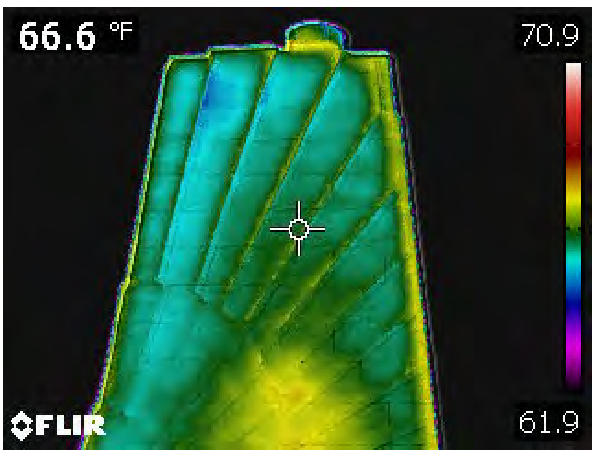

66.0 °F
70.9
61.9
FLIR

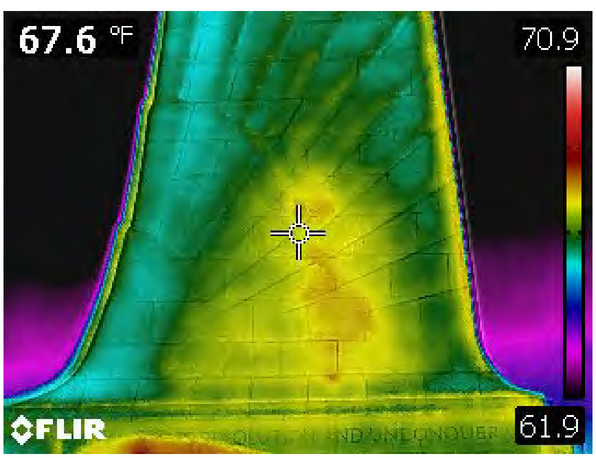

66.9 °F
70.9
61.9
FLIR

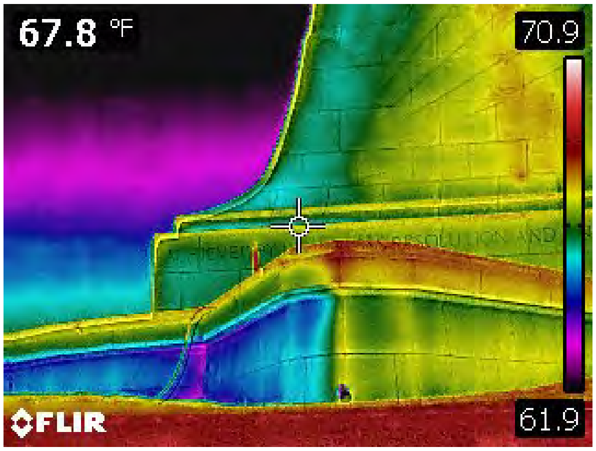

66.4 °F
70.9
61.9
FLIR
ACHIEVED BY DAUNTLESS RESOLUTION

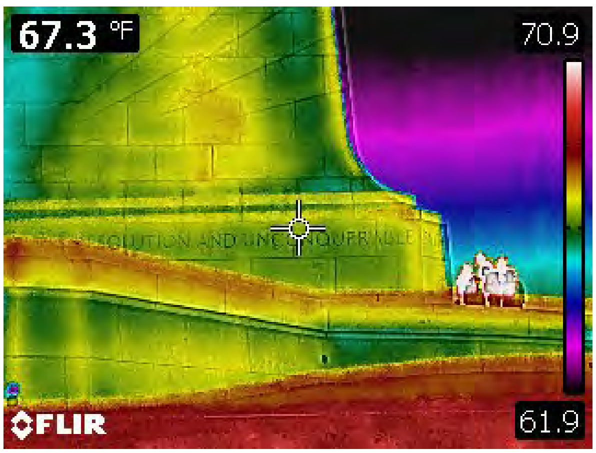

Infrared Thermography Scan Set 1: Tuesday November 29 between 14:14 and 14:35



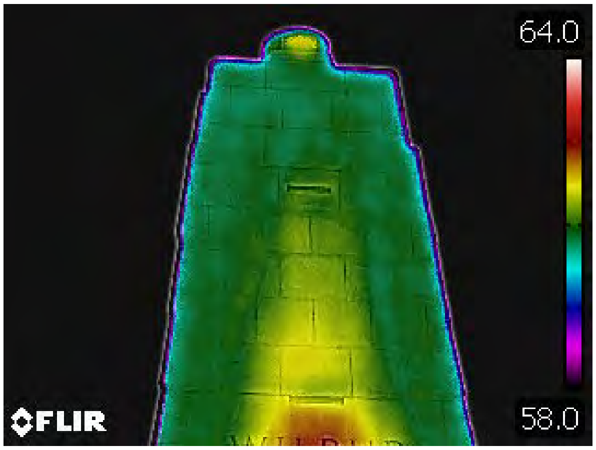


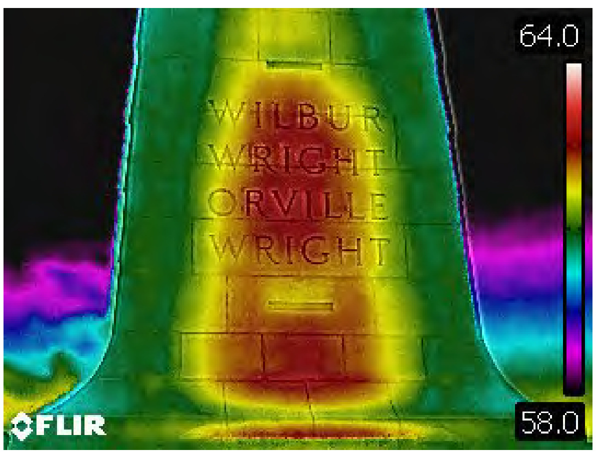



67.8 °F
70.9
61.9
FLIR

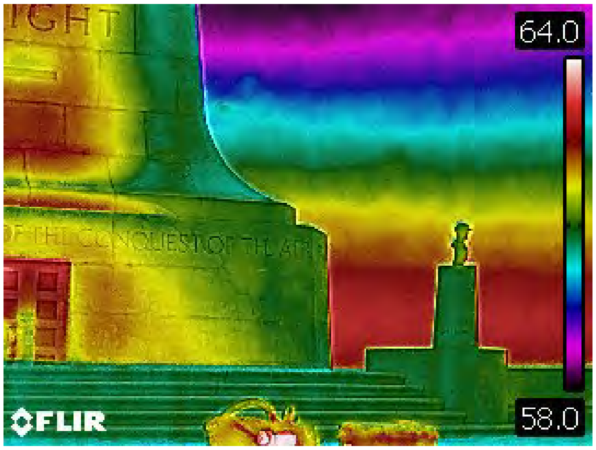

67.3 °F
70.9
61.9
FLIR

Infrared Thermography Scan Set 2: Wednesday November 30 between 07:08 and 08:43, during roof drain leak test

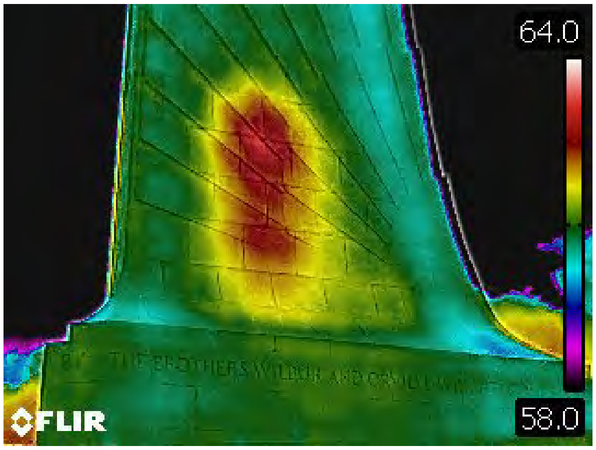


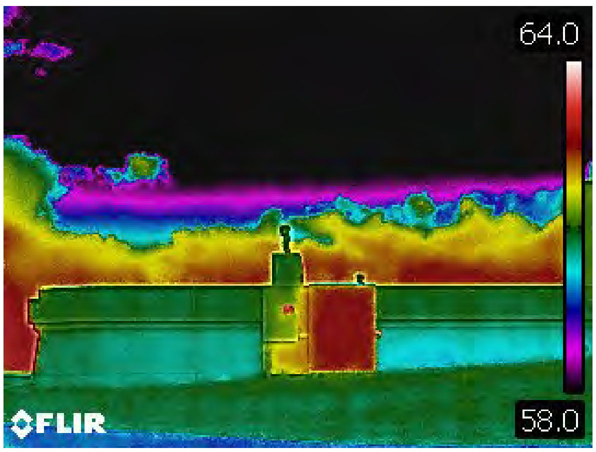


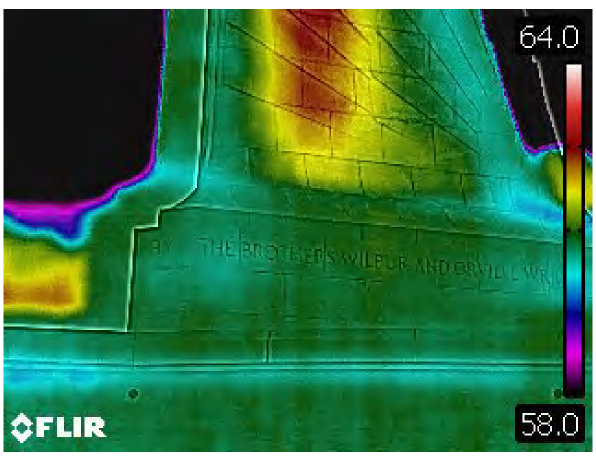
Infrared Thermography Scan Set 2: Wednesday November 30 between 07:08 and 08:43, during roof drain leak test



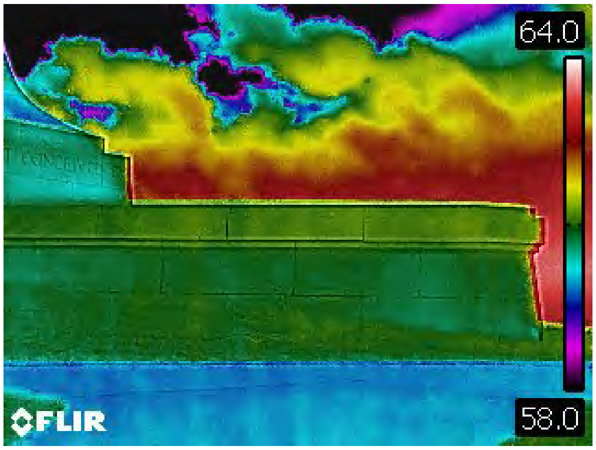
Infrared Thermography Scan Set 2: Wednesday November 30 between 07:08 and 08:43, during roof drain leak test

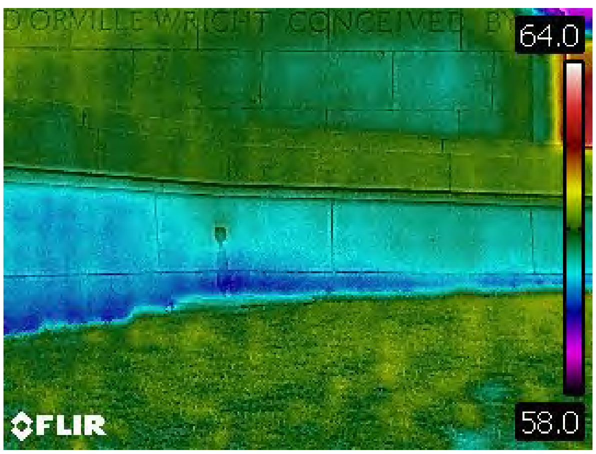


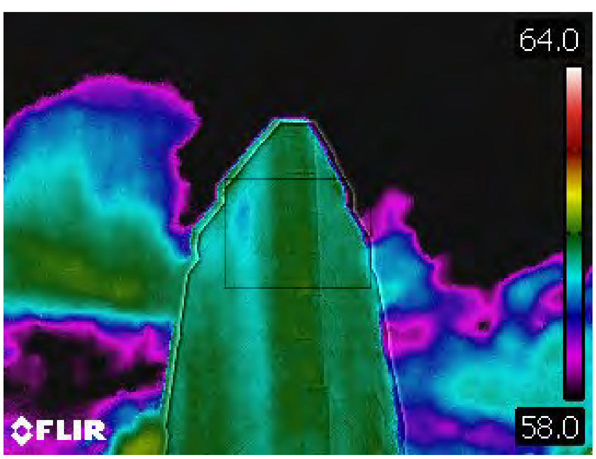


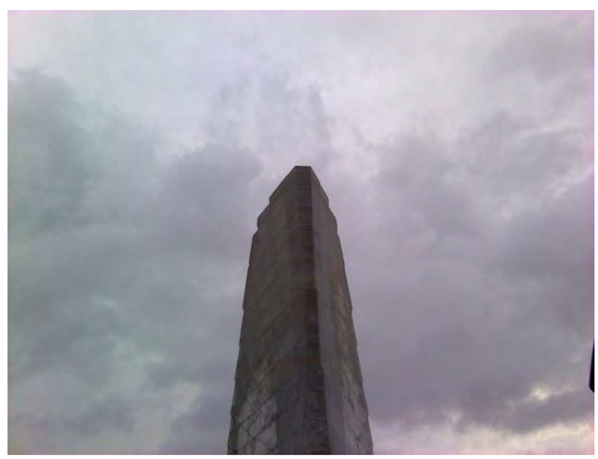


Infrared Thermography Scan Set 2: Wednesday November 30 between 07:08 and 08:43, during roof drain leak test

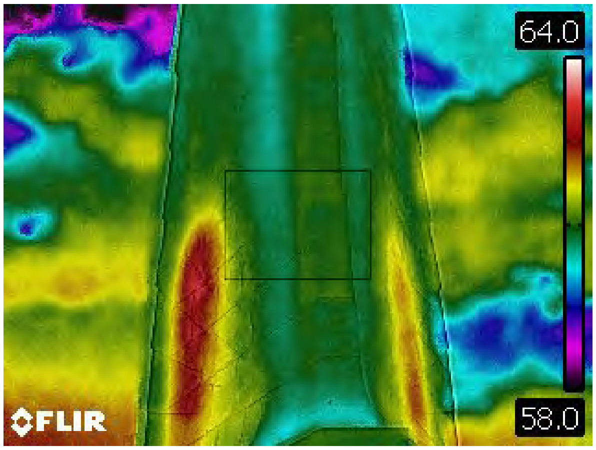


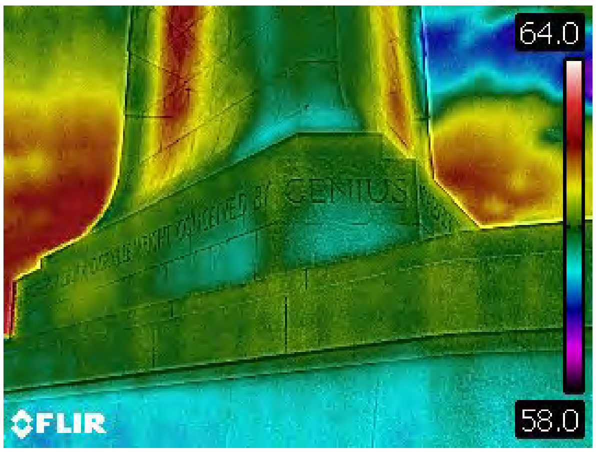


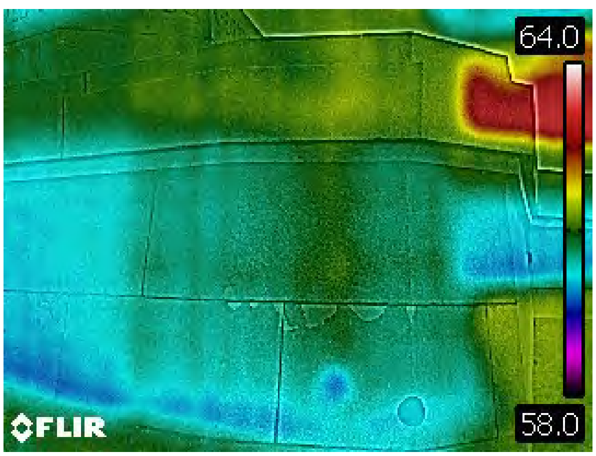




Infrared Thermography Scan Set 2: Wednesday November 30 between 07:08 and 08:43, during roof drain leak test







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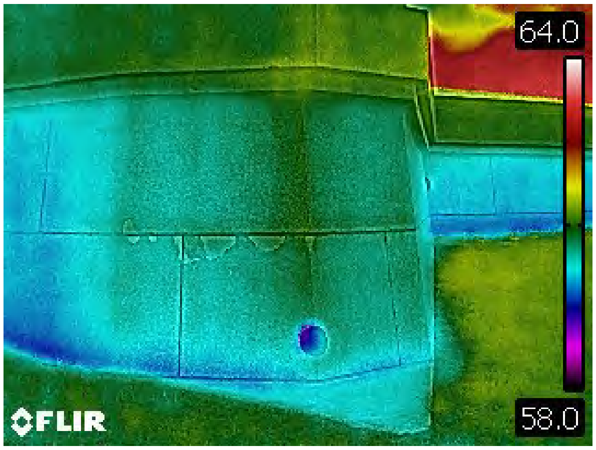
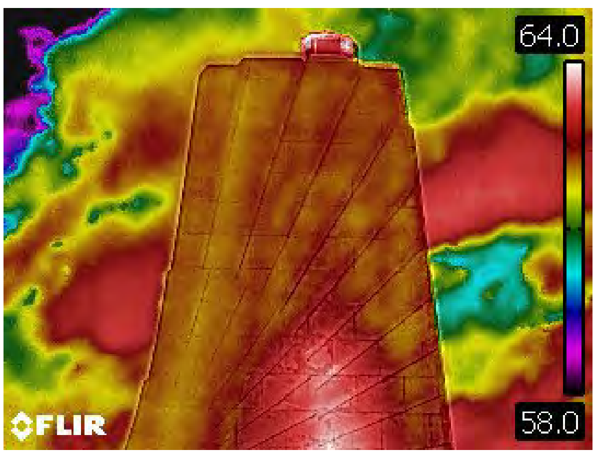
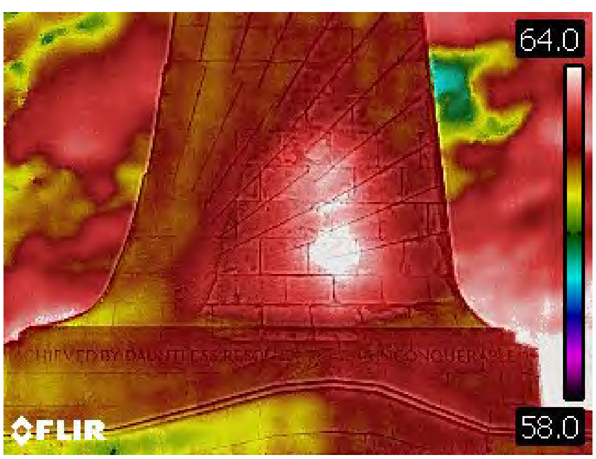
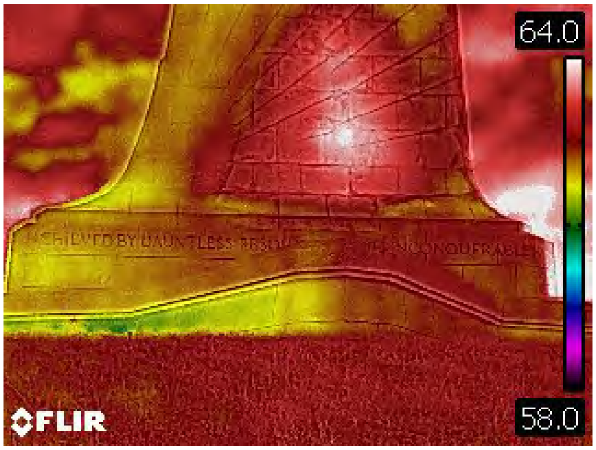
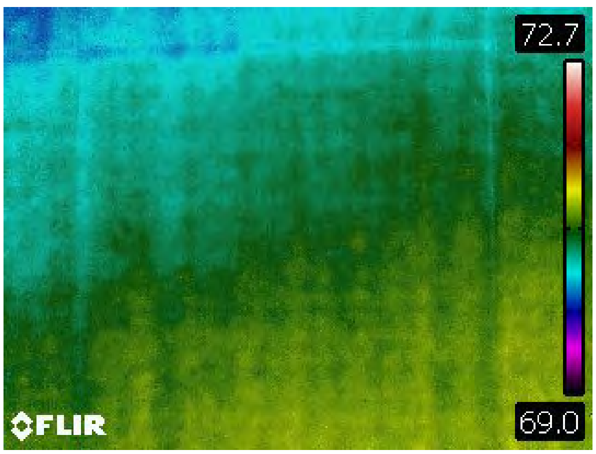


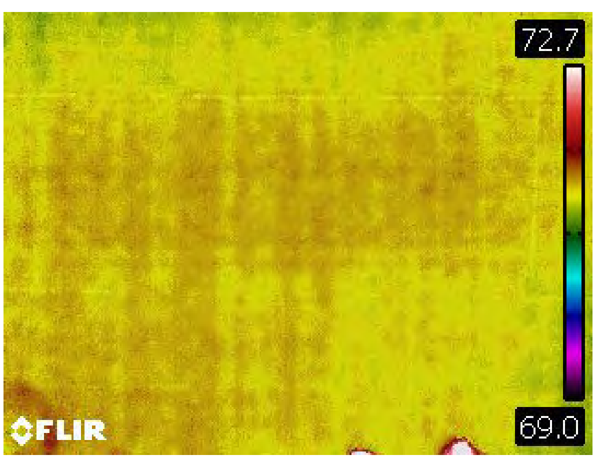




Infrared Thermography Scan Set 2: Wednesday November 30 between 07:08 and 08:43, during roof drain leak test







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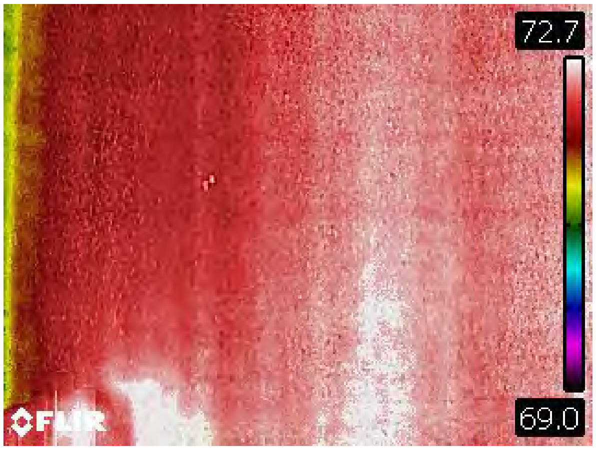
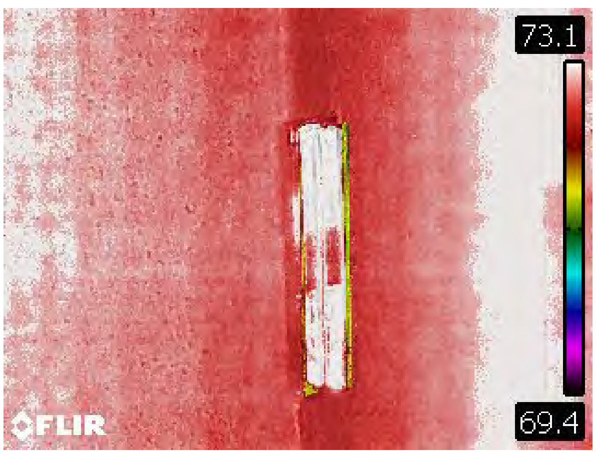
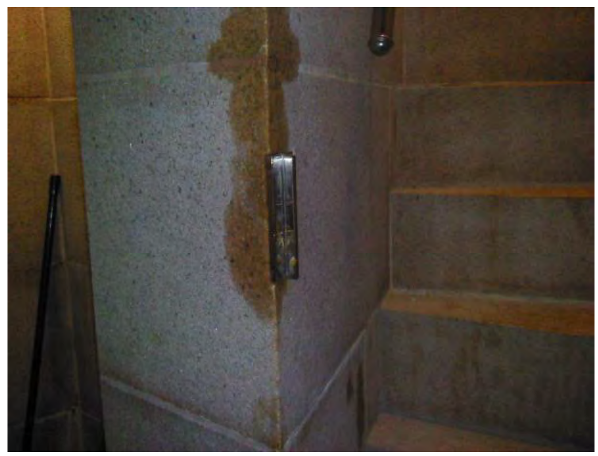
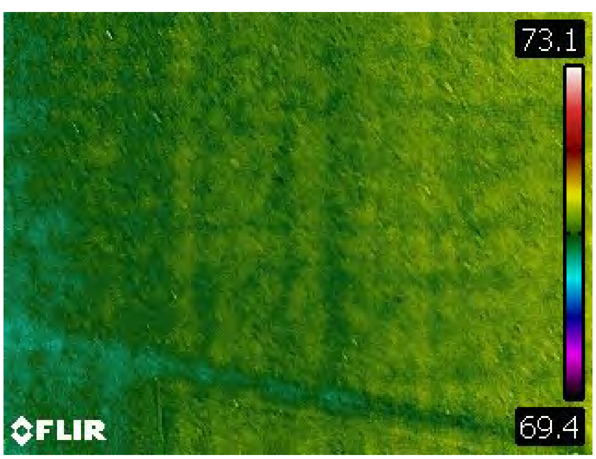
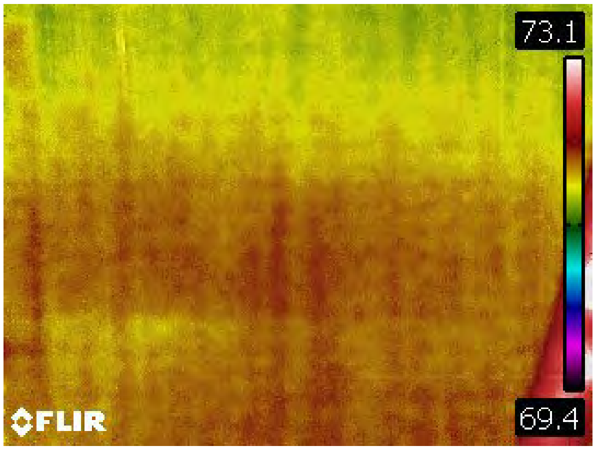


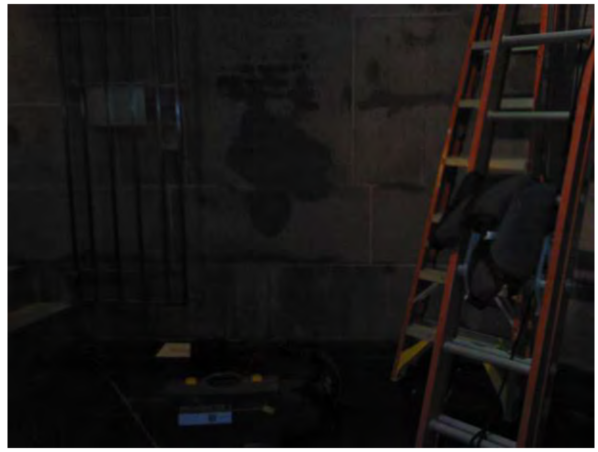


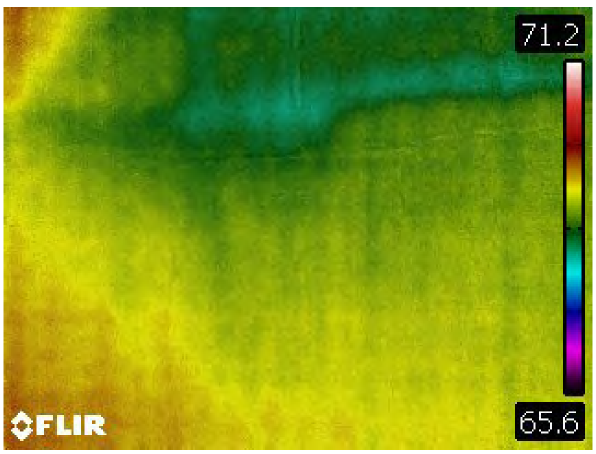


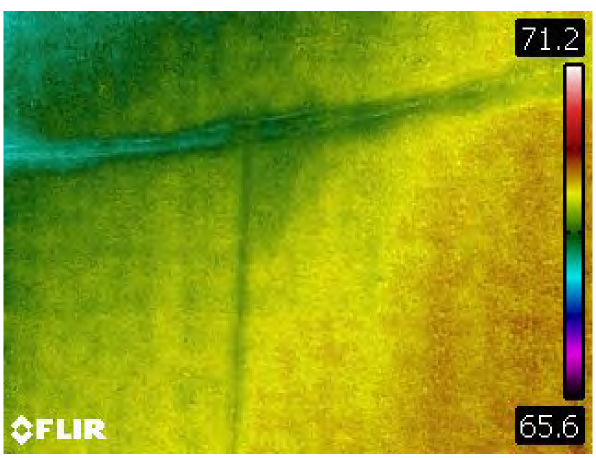


Infrared Thermography Scan Set 2: Wednesday November 30 between 07:08 and 08:43, during roof drain leak test



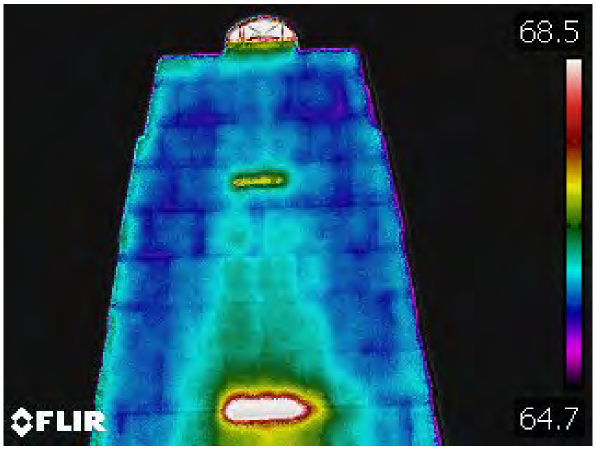


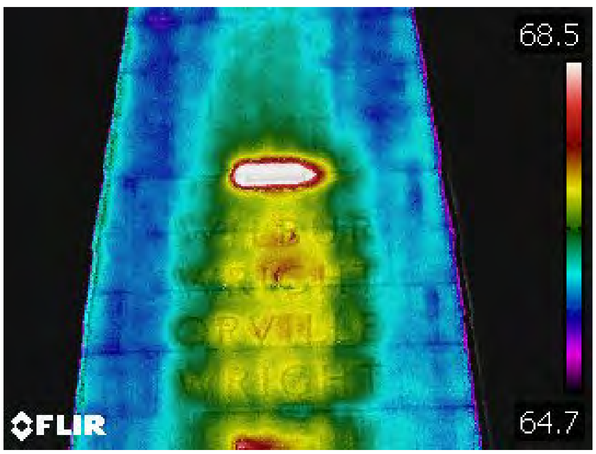


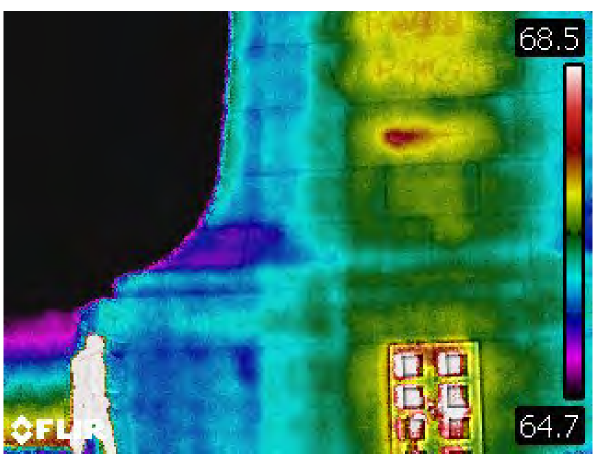


Infrared Thermography Scan Set 2: Wednesday November 30 between 07:08 and 08:43, during roof drain leak test

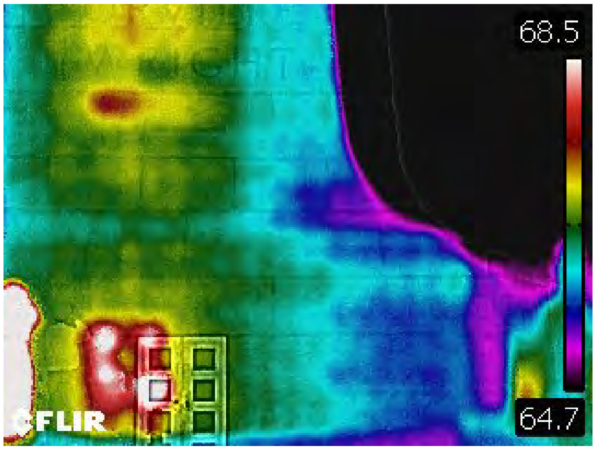
Infrared Thermography Scan Set 3: Thursday December 1 between 06:31 and 06:55, after roof drain leak test

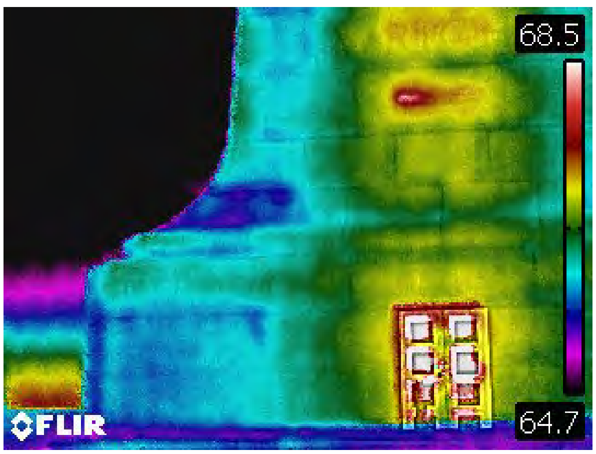


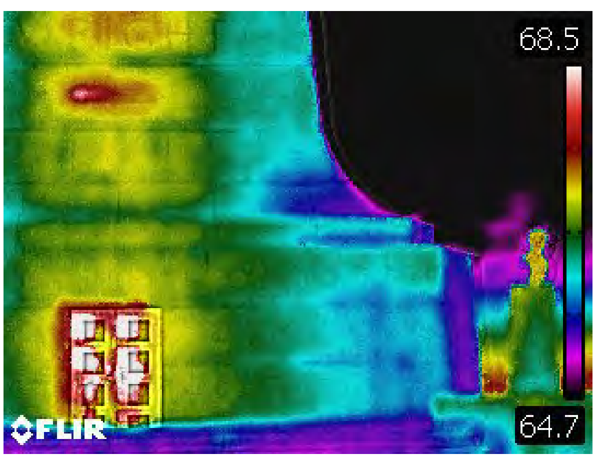




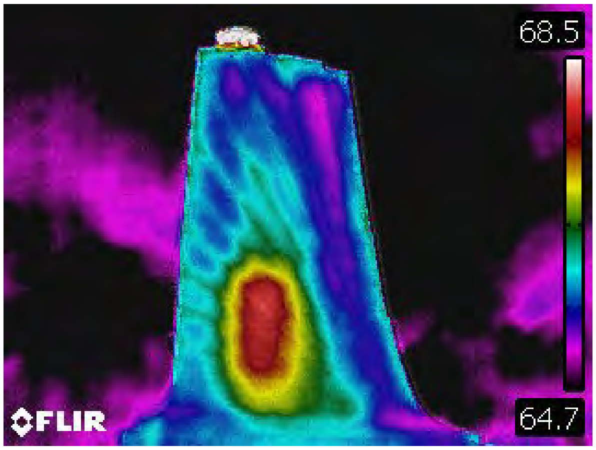
Infrared Thermography Scan Set 3: Thursday December 1 between 06:31 and 06:55, after roof drain leak test

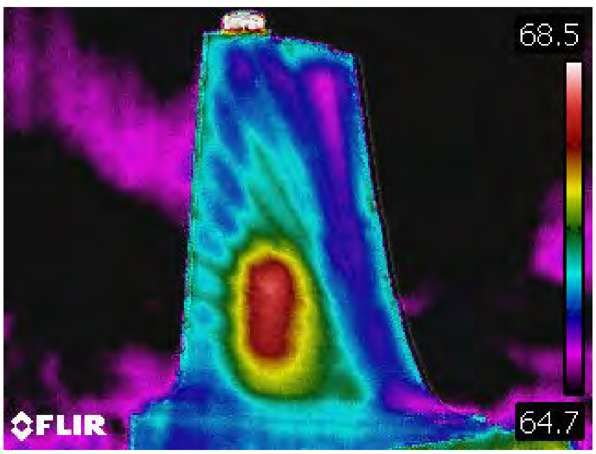


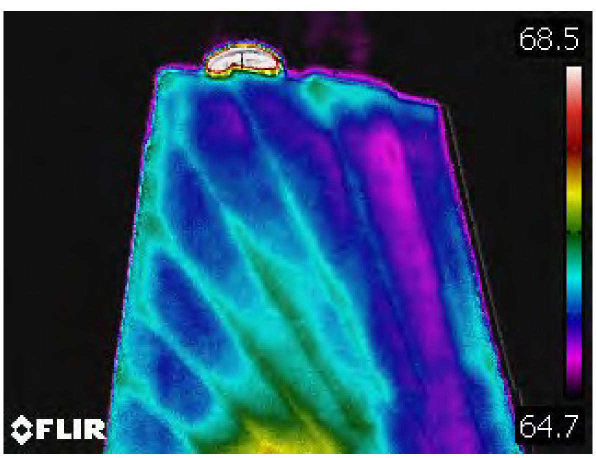


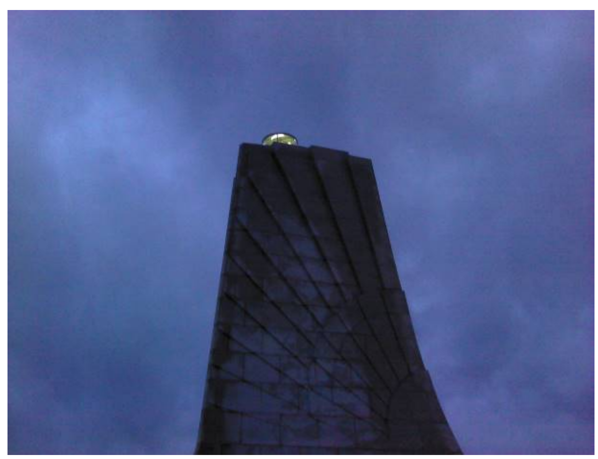


Infrared Thermography Scan Set 3: Thursday December 1 between 06:31 and 06:55, after roof drain leak test

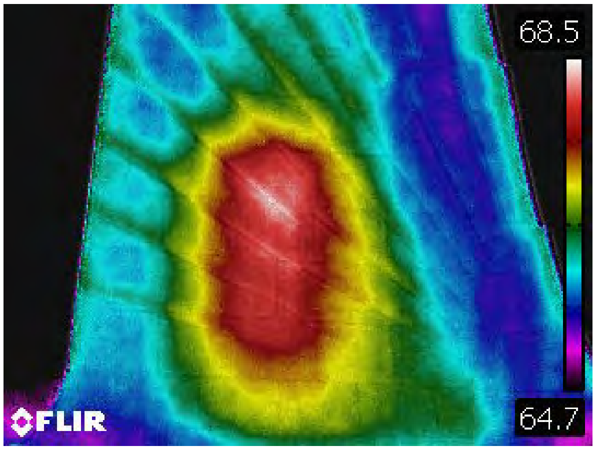


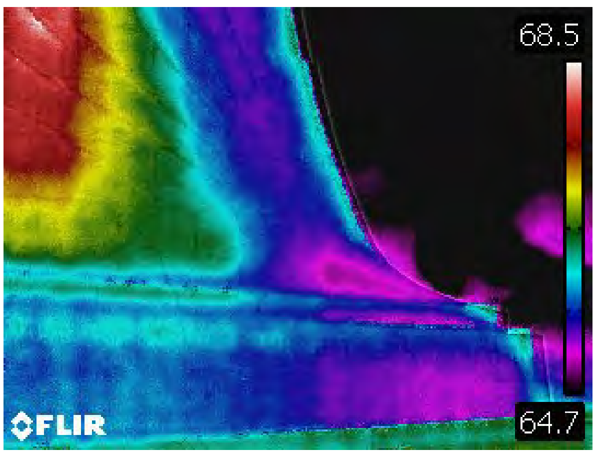


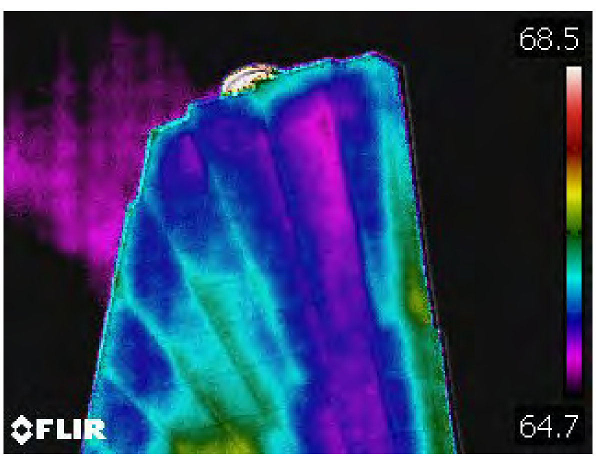


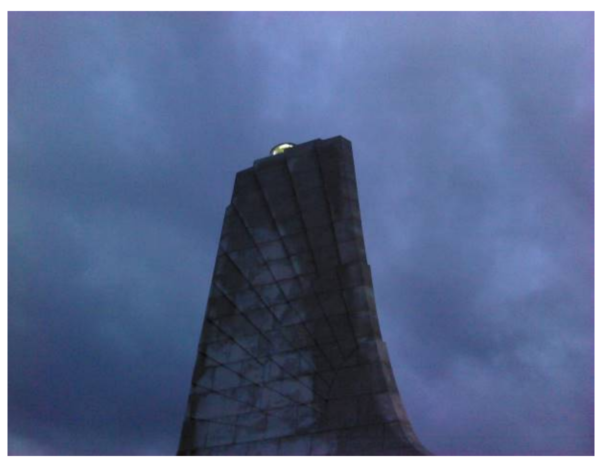


Infrared Thermography Scan Set 3: Thursday December 1 between 06:31 and 06:55, after roof drain leak test

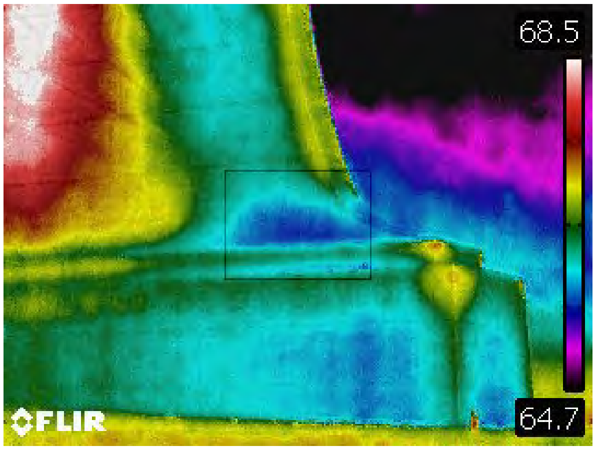


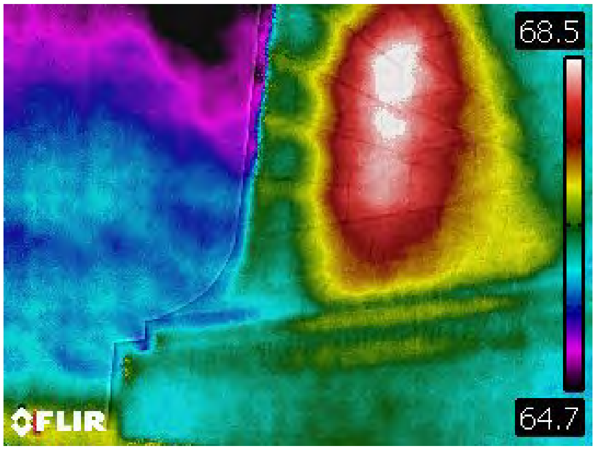


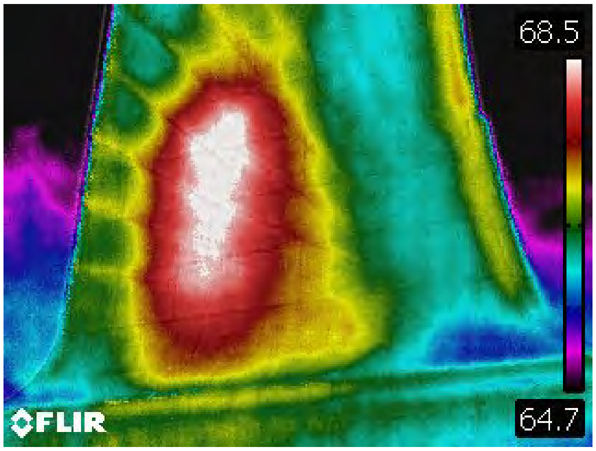




Infrared Thermography Scan Set 3: Thursday December 1 between 06:31 and 06:55, after roof drain leak test







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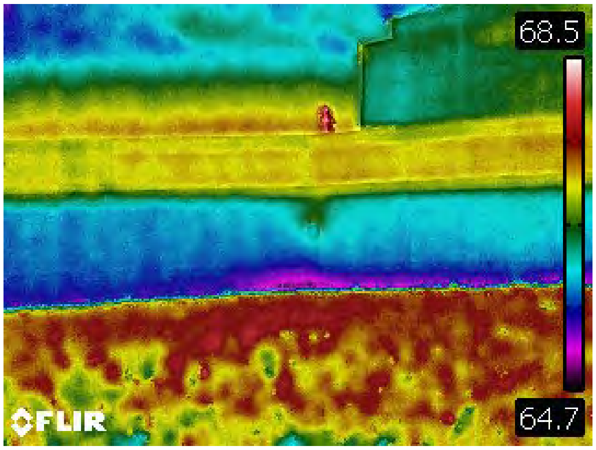

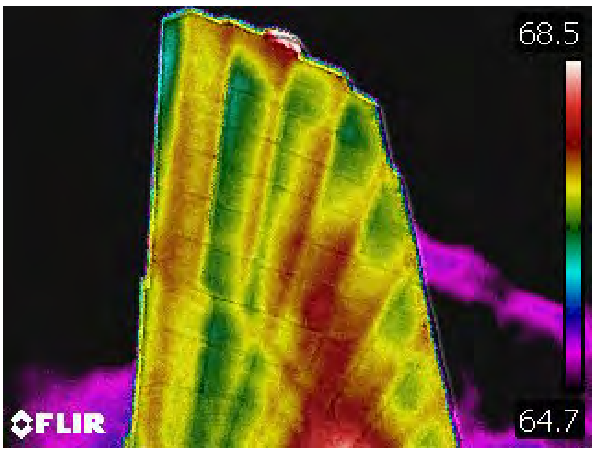

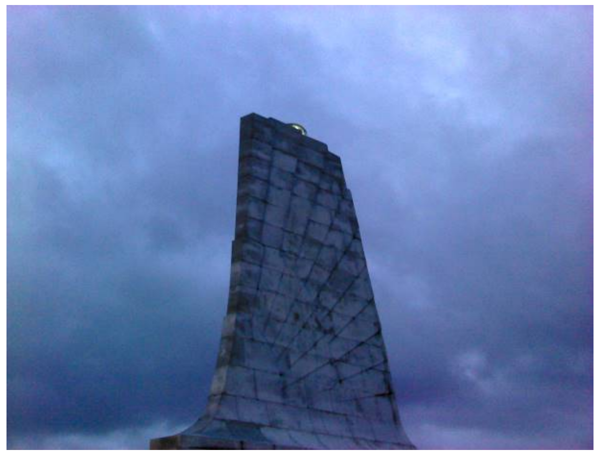

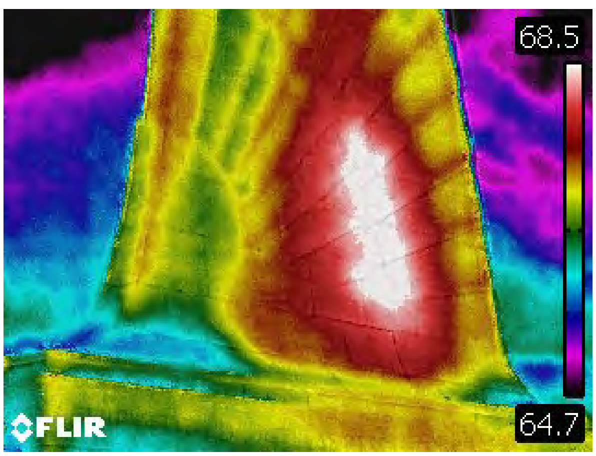

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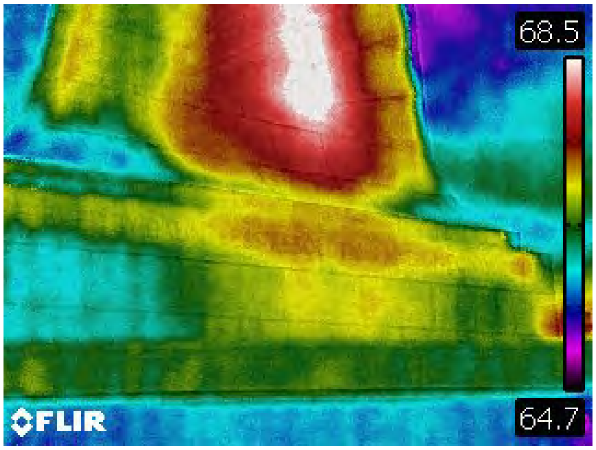
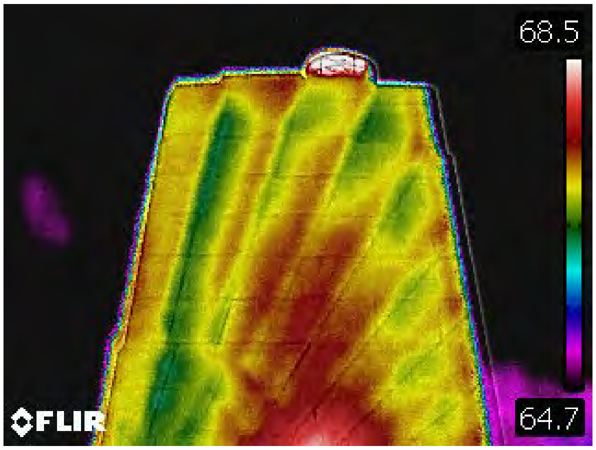
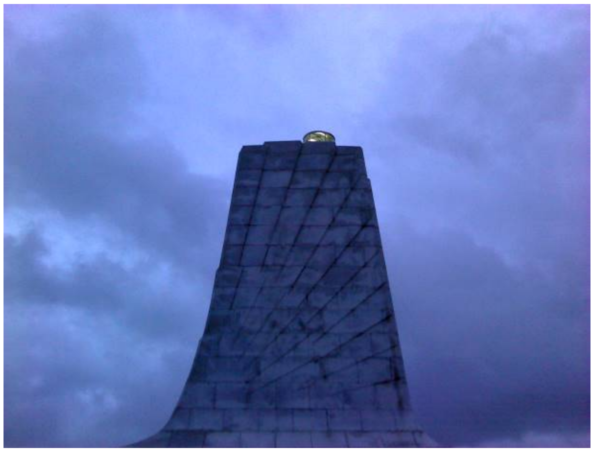
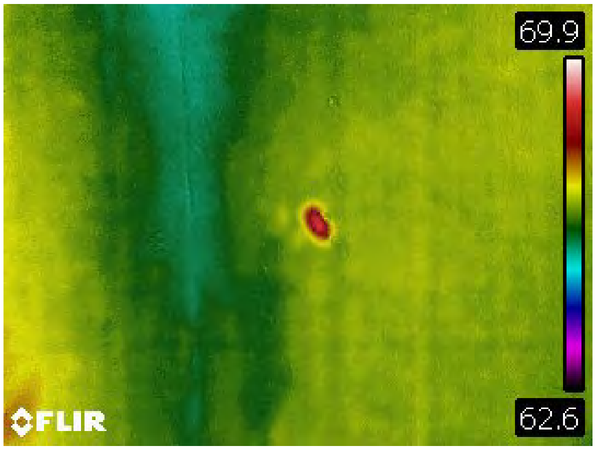
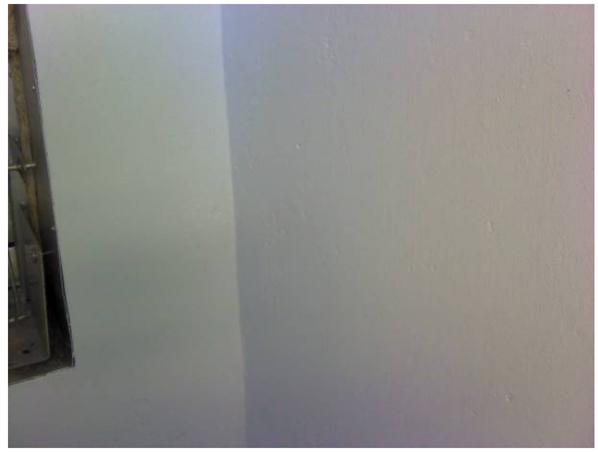


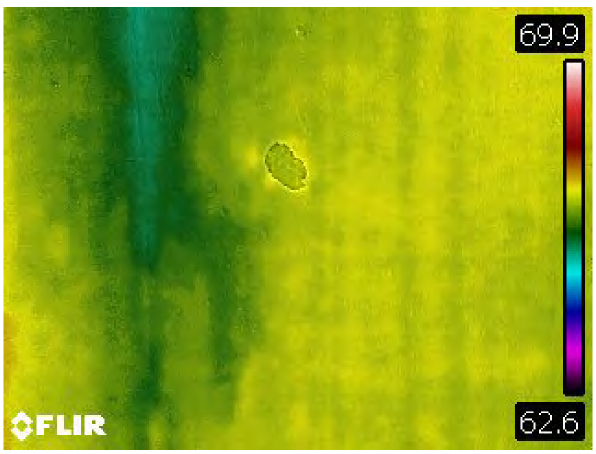


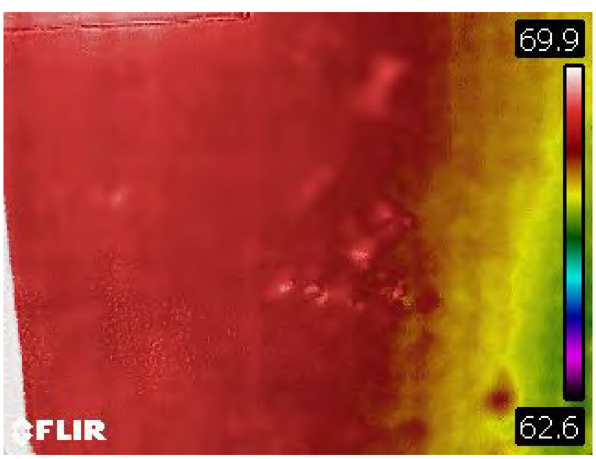


Infrared Thermography Scan Set 4: Thursday December 1 between 09:02 and 10:55, Miscellaneous interior scans









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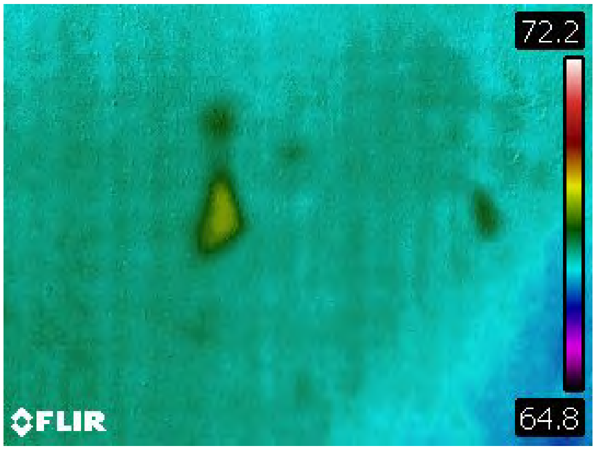

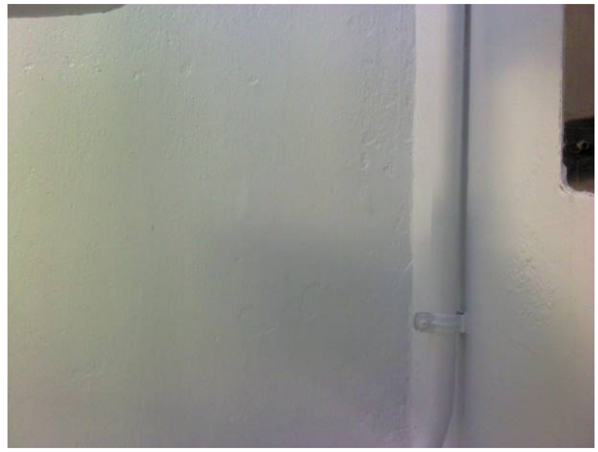

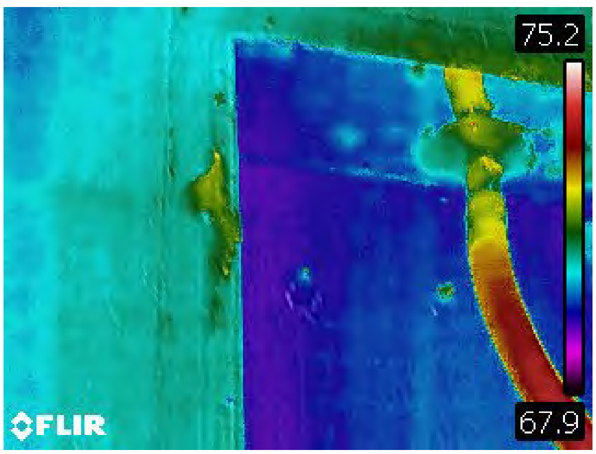

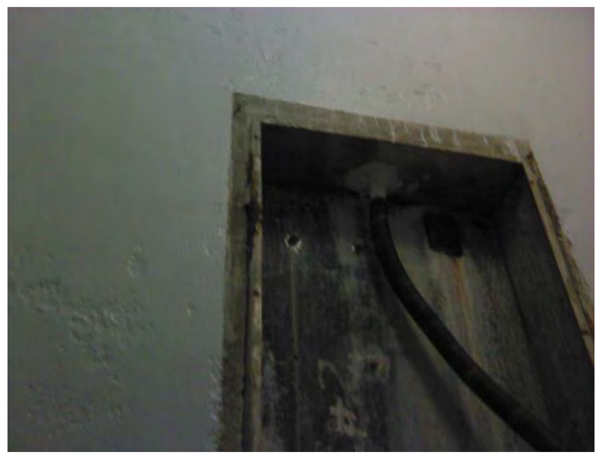

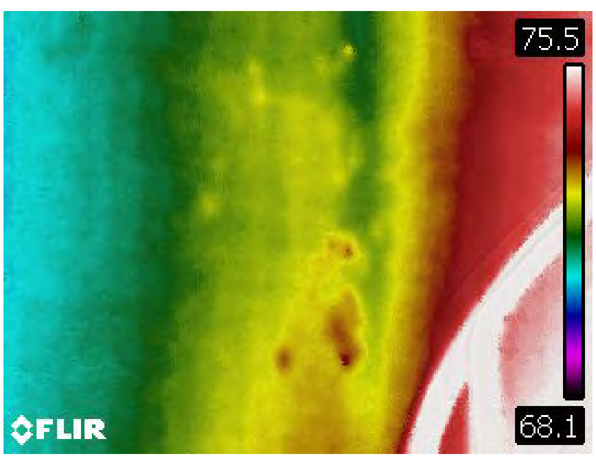

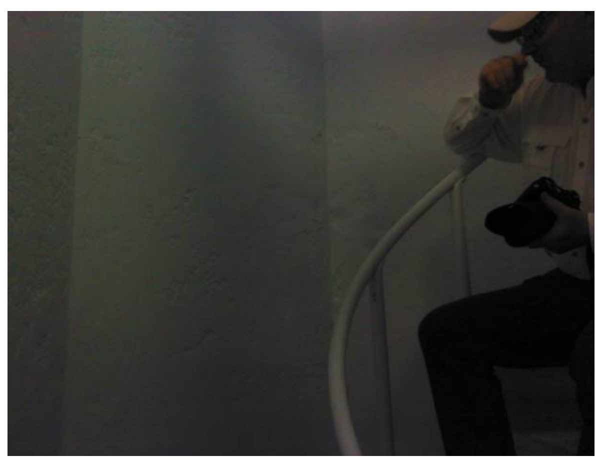

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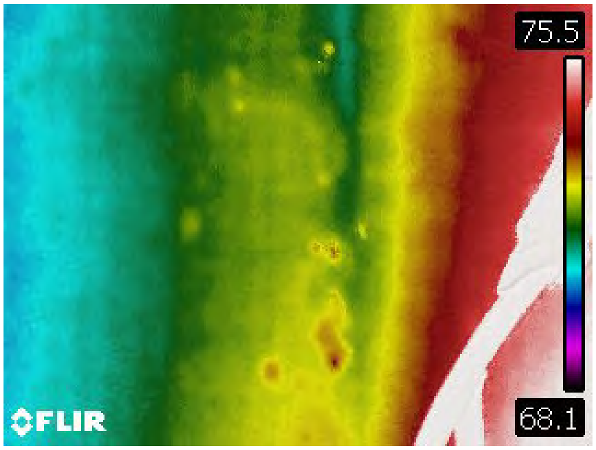

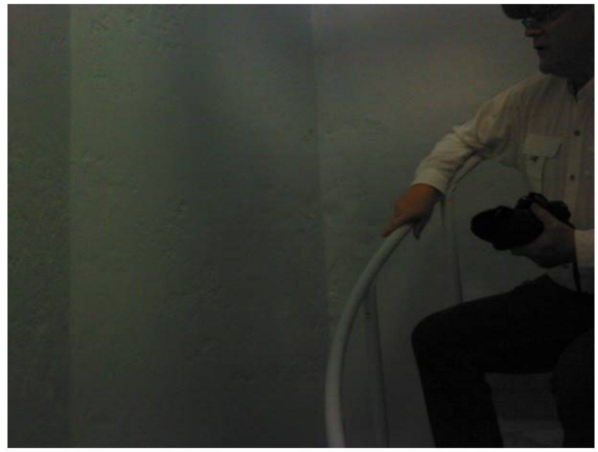

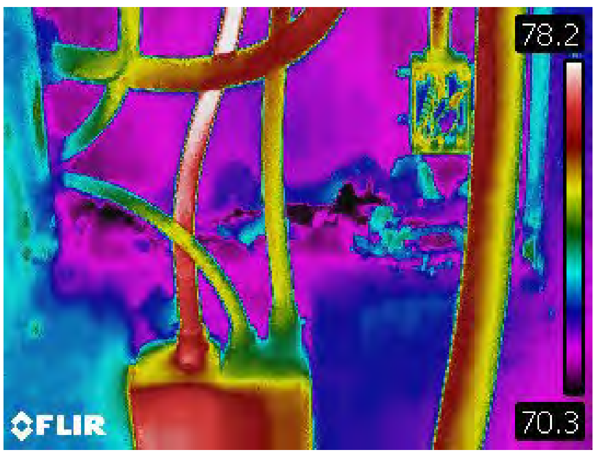

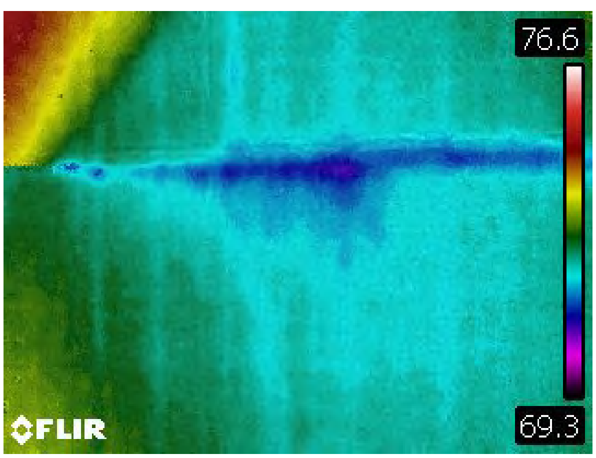

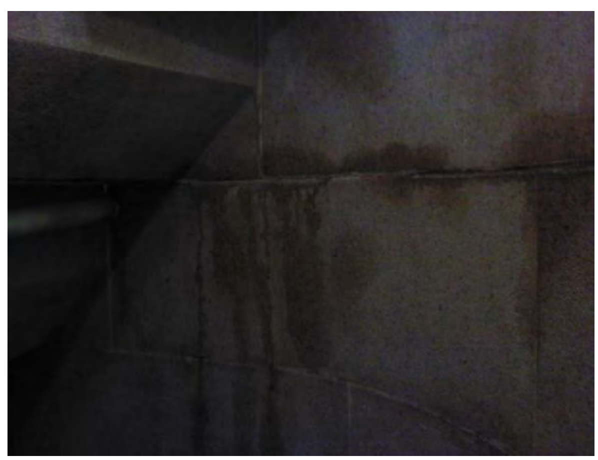

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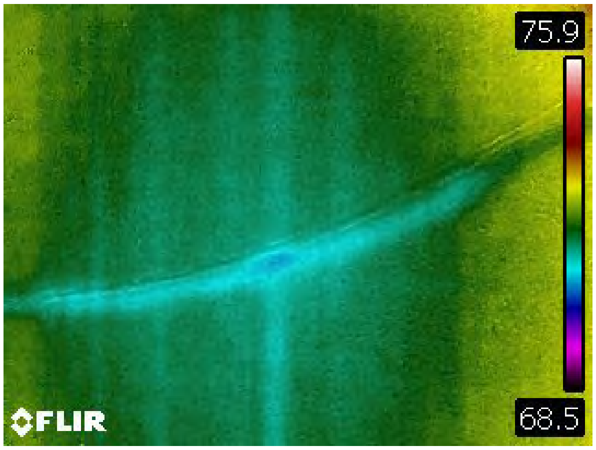

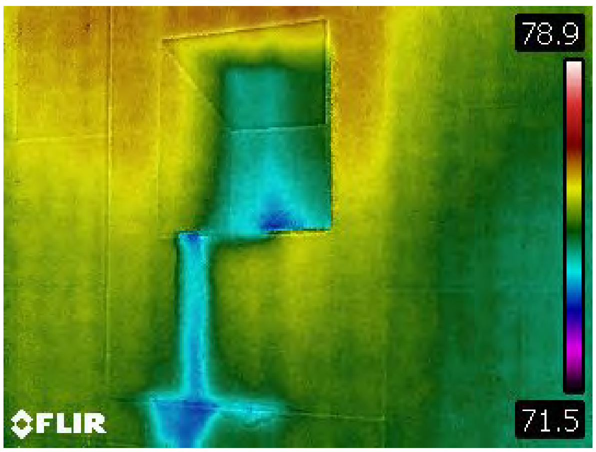

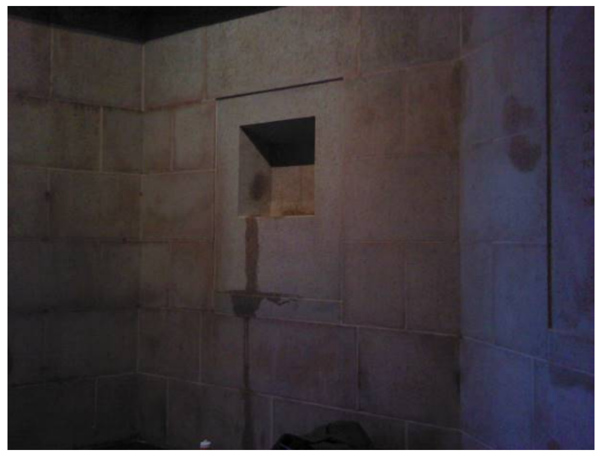

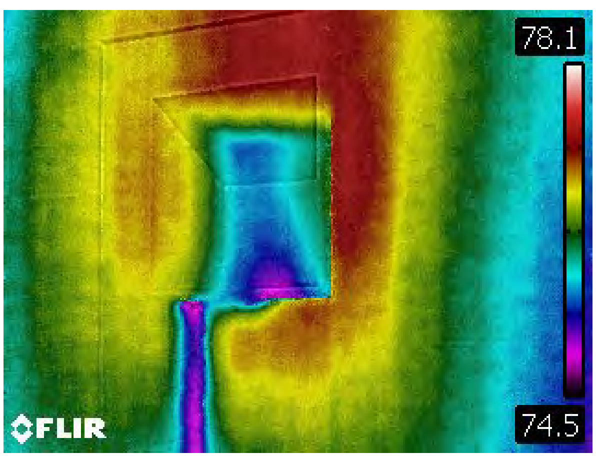

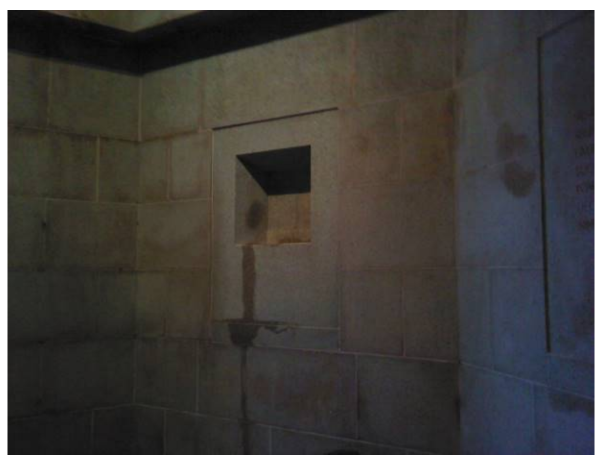

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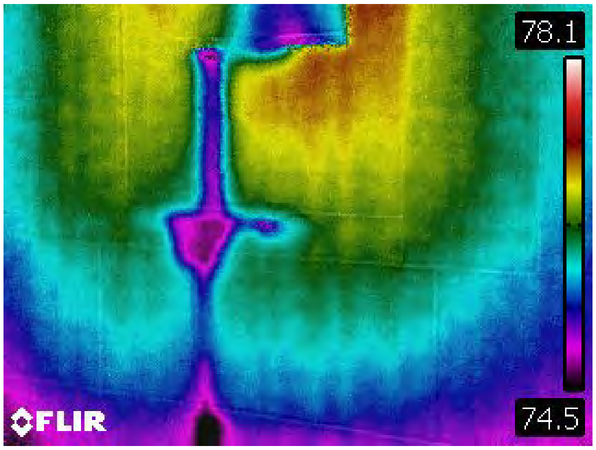

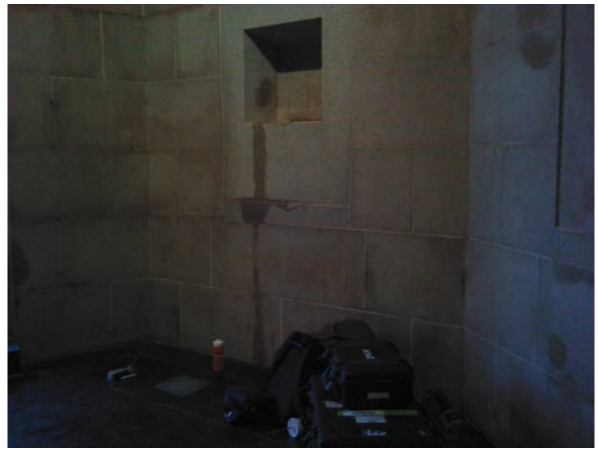

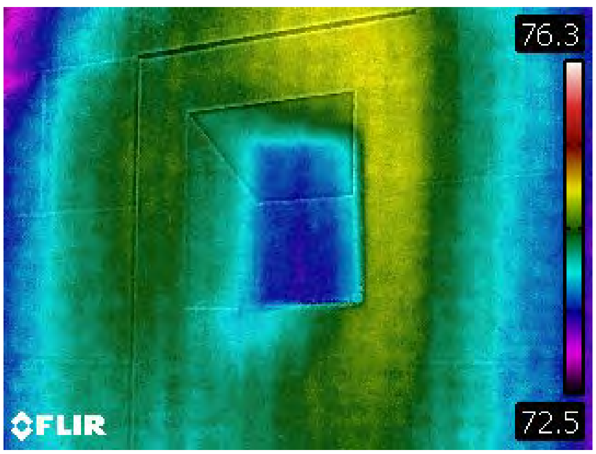

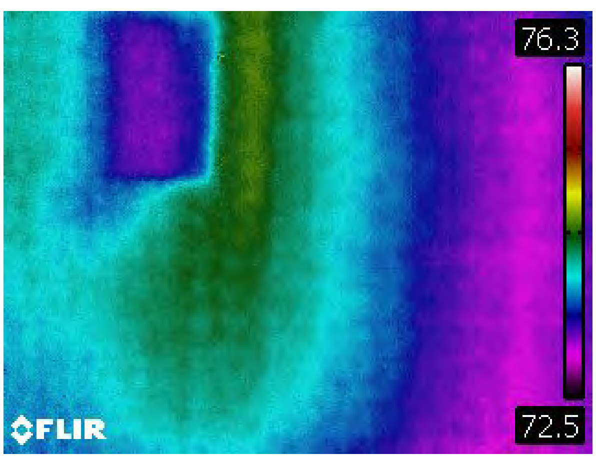

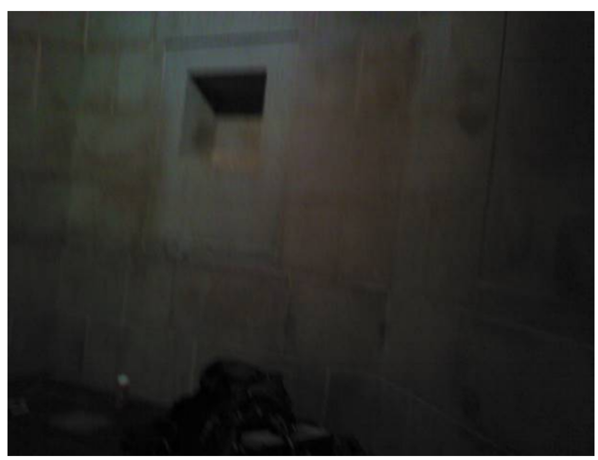

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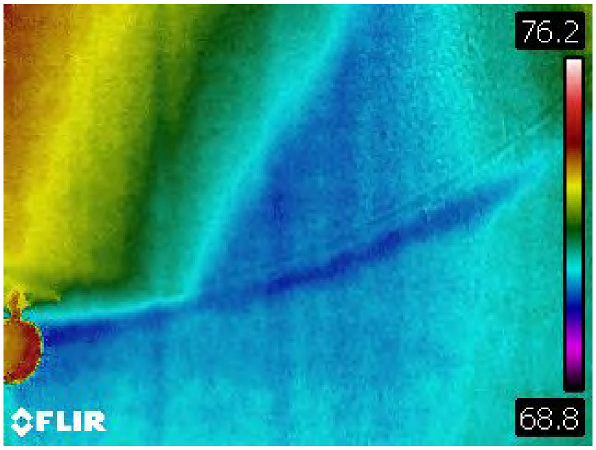

APPENDIX D

DRAIN PIPE VIDEOSCOPE: SUMMARY

Prepared by: McGee and Sons Plumbing
February 3, 2017

McGee & Sons . . presents . . .

The Gentleman Plumber, Inc.

208 W. Fresh Pond
Kill Devil Hills, NC

Phone: 252-480-3124
Fax: 252-255-1347
E-mail: mcgeeobx@aol.com

PROPOSAL

Good for 30 days

Date: February 3, 2017

Phone: 410-299-4227

E-mail: wtruth@masonrysolutions.com

Proposal Prepared For:

Wayne Truth
Masonry Solutions International, Inc.
10815 Beaverdam Road, Suite D
Cockeysville, MD 21030

Job Address:

Wright Brothers Memorial
S. Croatan Highway
Kill Devil Hills, NC 27948

Description of Work

Wright Memorial Roof Drain and Area Drain Report

Roof Drain:

On roof drain scope at the 52 foot mark, discovered a some what rusted anchor bolt protruding through roof drain pipe and at the 56 foot mark found a out of alignment roof drain piping with unreasonable angles and a bulge in the piping that you can see in the video. Camera eye and cable would not go any further past this point. Went to ground level of exit point of roof drain and ran camera eye 4 feet into pipe and found pipe to be broken and not connected all the way. Proceeded to run camera another 25 feet and found the previous defected pipe that is out of alignment and with the bulge coming through the side. Could not run camera eye any further. Removed rubber caulk from around roof drain grate connection and installed Oakum Wrap Seal and poured and caulked with iron 8oz of lead.

Floor Drain at Steps:

Ran camera eye 28 feet and camera eye was stopped and could not go any further due to what appears to be a plastic bottle and a 2 x 4. This drain exits out at ground level on east side of the Monument. Ran electric sewer cable with retriever head to clean out the drain and remove the objects. Was able to get drain cleared to drain, but could not remove objects. Further work will be needed. This drain is also tied into the rain gutter above the door and the clean out plug in the walk area in front of the door. This drain is not connected to the roof drain.

Roof Trench Drain above Door:

Ran camera eye 10 feet and discovered a roll of solder that has been left in drain line. This drain ties in with the grate floor drain in front of the door and clean out.

Clean Out Plug at Walk Way in Front of Door Entrance:

Ran camera eye 2 feet into clean out and found T fitting that ties roof trench drain and floor drain at steps together.

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Appendix G

Technical Investigation, 2022-2023

Pursuant to the ongoing design work being performed by Quinn Evans alongside this Historic Structures Report, an incremental investigation scope of work plan has been proposed to assist in the discovery and verification of the existing conditions of the Monument's exterior stone veneer and water control layers.

Included in this appendix is a table showing the schedule of proposed and potential technical investigations. This table includes information on the investigation scope, expected results as well as the estimated investigation cost and construction costs. Multiple investigative options were reviewed with NPS and the first two selections were selected in support of the near term rehabilitation project scope.

The objectives of the investigation are to confirm the condition of the collar joint between the veneer stone and the concrete superstructure, to confirm the presence and condition of the waterproofing layers and materials indicated on the original Monument drawings, and to assess the likelihood of the suspected bulk water intrusion points into the Monument interior. It will also inform the extents and condition of the in-wall moisture control componentry including waterproofing membrane(s), flashing membranes, weeping devices/embeds.

There will be a limited technical investigation in support of the near term rehabilitation project scope. This investigation will be conducted by exterior boring and Boroscope investigation, in a joint. The intent of this will allow for a close inspection of the granite cladding and for improved description of the extent of maintenance repointing. It will also assess and confirm conditions in the collar joint and existing flashings.

This investigative work is pending authorization and performance and is thus not completed at the time of this writing. The full report of findings will be made available within the NPS Integrated Resource Management Applications at the following link (to be populated with the report once completed):

Wright Brothers National Monument Technical Investigation 2022-2023 - (Code: 2293488) (nps.gov)

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Table Appendix G: Schedule of Proposed and Potential Technical Investigations 2022-2023							
Item	Status	Investigation Title	Investigation Scope	Expected Results	Estimated Investigation Cost	Affected Construction Cost - Low	Affected Construction Cost - High
1	Approved	Interior Boring and Boroscope Investigation	Drill through existing concrete superstructure, 2-in. core. Use a boroscope to assess condition of structure and material behind granite masonry. (Proposed in 2017 Atkinson Nolan Report, see Appendix F.)	Assess and confirm conditions in collar joints. This approach is not recommended after further study. Conducting this investigation at Level 1 would require removal of interior granite to allow anchorage of rig and drilling through concrete, with limited useful results due to the areas that could be accessed from this location. There is insufficient space at the other levels to set up the drilling rig.	$ 40,000	$ 75,000	$ 75,000
2	Approved	Exterior Boring and Boroscope Investigation, in joint	Drill at existing exterior mortar joints (1/4 inch). Use a micro-boroscope to assess and record the condition of structure and material behind granite masonry.	Assess and confirm conditions in collar joint and existing flashings. Information gathered will be limited due to restrictions from a bored access point.	$ 50,000	$ 75,000	$ 250,000
3	Reviewed	Exterior Boring and Boroscope Investigation, Through Stone	Drill through existing concrete superstructure, 2-in. core. Use a boroscope to assess condition of structure and material behind granite masonry. (Proposed in 2017 Atkinson Nolan Report, see Appendix F.)	Assess and confirm conditions in collar joints. This approach is not recommended. This approach would damage existing granite façade."	$ 75,000	$ 75,000	$ 250,000
4	Reviewed	Stone Removal (1 Stone)	Remove one granite unit from the exterior of the monument. Visually inspect and probe wall interior to assess condition of collar joint and flashing membranes. Estimated cost includes scaffolding and hoist.	Assess and confirm conditions in collar joint and existing flashings. This approach will provide the most information about the condition of these elements.	$ 150,000	$ 75,000	$ 250,000
5	Reviewed	Stone Removal (2 Stones)	Remove two granite units from the exterior of the monument. Visually inspect and probe wall interior to assess condition of collar joints and flashing membrane. Estimated cost includes scaffolding and hoist.	Assess and confirm conditions in collar joint and existing flashings. This approach will provide the most information about the condition of these elements. The second stone removal will verify whether collar joint conditions are unique to a particular location or condition.	$ 200,000	$ 75,000	$ 250,000
6	Reviewed	Stone Removal (3 Stones)	Remove three granite units from the exterior of the monument. Visually inspect and probe wall interior to assess condition of collar joints and flashing membrane. Estimated cost includes scaffolding and hoist.	Assess and confirm conditions in collar joint and existing flashings. This approach will provide the most information about the condition of these elements. The additional stone removals will verify whether collar joint conditions are unique to a particular location or condition and give the clearest understanding of substrate conditions.	$ 275,000	$ 75,000	$ 250,000

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Appendix H

An alternative treatment option for the Monument was described and presented to the National Park Service (NPS) in a previous HSR draft. This option was removed from the treatment section and placed in an Appendix for further investigation at a later time. The National Park Service (NPS) views each treatment episode in the life of a historic structure as one increment on a timeline that stretches deeply into the future. No single treatment is expected to solve every issue confronting a structure, it is desired that each treatment campaign be effective in meeting its assigned goals. NPS is aware that if the waterproof membrane behind the granite cladding is compromised to a degree that requires removal of all cladding, that finding would result in a project repair cost exceeding $20M. That level of funding would only be available with a lead time of around five (5) years, possible longer. In summary, NPS has decided that the scope of the rehabilitation project will focus on what can be successfully accomplished near term with accessible funds. This alternative presented below represents a long term rehabilitation project that can be studied for the future.

Alternative Treatment

Full Stone/Recladding Removal Option

Moisture penetration issues at the Monument are well documented (Refer to Chronology of Developmental and Use, starting on page 19), yet a fully-understood diagnosis of the water infiltration sources remains unknown and a watertight restoration solution has eluded the park's preservation efforts to date. Moisture issues have adversely affected NPS' ability to open the Monument to the public and have led to considerable dampness on the interior, especially at the ground level.

The alternate described herein recommends the most comprehensive effort to resolve the endemic water issues through intensive preservation work. While the work described in this alternate is more intensive than typical masonry repointing efforts, the work seeks to remain within the bounds and intent of the Preservation Management Category by sustaining the existing form, integrity, and materials of the historic Monument. This alternate calls for the removal of the entirety of the exterior granite veneer stone in order to wrap the super structure with a modern waterproofing membrane. Further study and consultation with a waterproofing consultant is suggested if alternate treatment route is pursued.

There is potential for Adverse Effect at the Monument. The removal of the exterior granite blocks -measuring one to two feet in thickness, runs the risk of significant damage and loss to the historic stone including breakage, cracks, chips, and scratches. There is also concerns over the significant amount of deconstruction to the historic monument. Any consideration of this drastic approach should only follow extensive research into other less invasive methods to mitigate moisture issues along with testing – including test removal of one or more of the veneer stones, study, and evaluation of the monument by experienced historic building/stone conservators.

This alternative option captures the intensity of impacts that would be required to re-engineer original design systems to eliminate all leaks through the façade. This option is not preferred by the National Park Service but is an important treatment approach to document to capture the effort needed to eliminate leaks at the Monument.

The following systems would be impacted in this alternate:

Roofing System

- Demolish existing roofing membrane and flashing.
- Remove existing cupola beacon assembly. Clean, repair, and salvage for reinstallation
- Demolish existing waterproofing layer materials and flashing components at observation platform level down to concrete structure (Figure 5–11).

Exterior Envelope System

- Remove one hundred (100) percent of existing stone veneer units from the concrete substructure. Provide proper identification, protection, storage, cleaning, repair and preparation for reinstallation to match exact conditions of existing granite veneer stone configuration.
- Apply fluid-applied membrane waterproofing to concrete super structure and backs of interior granite units at the ground level.
- Reinstall granite veneer stone using non-staining anchors with open air cavity behind (do not grout behind or back butter stone). Consideration should be given to providing discreet and historically-sensitive ventilation pathways to equalize pressure behind the stone veneer to discourage water penetration into the veneer.
- Provide thru-wall flashings at the top of the tower and top of the interior granite, and at the base of the tower. Provide weeps at flashing locations and flexible joint seal tees at sky-facing joints at the top of the tower.
- Benefits of the removal of the full stone cladding alternate include:
    - Fullest and clearest investigative understanding of the conditions of the moisture control elements;
    - Achieves most continuous, flexible, and strong vapor-retarding moisture control layer through waterproofing membrane;
    - Establishes an effective air barrier to resist the passage of moist humid air from condensing on cooler interior surfaces;
    - Establishes an air cavity between the veneer stone and the waterproofed backup concrete frame structure, complete with accommodation of air movement from base to top of Monument as a means to promote drying for the entire veneer stone layer, similar to a rainscreen assembly;
    - Rebuilds flashing componentry with continuity and compatibility to waterproof membrane proper weepage to exterior;
    - Comprehensive investigation of the conditions of the stone anchorage, confirmation of any corroded or compromised bearing capacity of the dovetail anchors. Previous investigative report recommends the inspection of anchorage given the high chloride concentrations and high potential for metal corrosion.[1] New anchorage solution will need to be designed as use of dovetail slots will be compromised by waterproofing membrane. Non-staining marine environment grade stone anchors should be explored. The anchorage needs appear to only account for lateral forces (as opposed to gravity and lateral forces), yet further research should

1 Atkinson-Noland & Associates, Inc, et al, 22.

be undertaken to assess if relief angle(s) may be beneficial to accommodate stone expansion. Designing stone veneer anchorage shall take into account building code requirements for coastal and hurricane-prone zones.[2] Further investigation with a structural engineer consultant is recommended;

  - Stone restoration/patching work can take place at grade or off site instead of on scaffolding; and
  - Accomplishes full re-mortaring when stones are reset, providing consistency of appearance.
- Terrace surface: Replace 4” granite pavers with large format pavers, matching design of historic drawings.

The most significant disadvantage to this alternative approach is that it requires the dismantling of the exterior cladding, which will require the use of hoisting equipment and imposes risk of damage to the existing cladding stones. Methodical dismantling of the cladding stones, working from the top of the monument down, will help to mitigate this risk.

Interior Condition

- Similar to work described in primary recommendation.

Openings: Windows & Doors, Exterior & Interior

- Similar to work described in primary recommendation.
- Provide waterproofing termination to doors and louver frames.

Ceilings & Walls

- Similar to work described in primary recommendation.

Electrical Building System

- Replace the interior panel and rework the existing electrical branch circuits to the new panel leaving the raceway to individual loads as they are. This will allow the cavity containing the panel to be weatherproofed and the conduit opening at the top of the opening to be sealed preventing water from running onto the panel. Lighting would then be able to be replaced with LED fixtures using the existing boxes and raceway. The lower level would remain with the traditional recessed switches and receptacles. If the lighting fixtures are not replaced it is recommended to replace the existing lamps with new LED lamps.

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2 2015 International Building Code, as adopted by North Carolina, Chapter 16 Structural Design, accessed March 3, 2022, https://up.codes/viewer/north_carolina/ibc-2015/chapter/16/structural-design#16.

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As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

WRBR ETIC#, October 2022
Wright Brothers National Memorial

Wright Brothers Monument and Powerhouse
Historic Structure Report

National Park Service
U.S. Department of the Interior

Wright Brothers National Memorial
1000 N Croatan Hwy
Kill Devil Hills, NC 27948

www.nps.gov/wrbr