Historic Property Survey Report

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Acronyms and Abbreviations

ACHP	Advisory Council on Historic Preservation
AIO	Arecibo Ionosphere Observatory
ARPA	Advanced Research Projects Agency
ARRL	American Radio Relay League
ASME	American Society of Mechanical Engineers
CA	Cooperative Agreement
CH2M	CH2M HILL, Inc.
DRPA	U.S. Department of Defense Advanced Research Projects Agency
DoD	U.S. Department of Defense
ETHW	Engineering and Technology History Wiki
HALCA	Highly Advanced Laboratory for Communications and Astronomy
HF	high frequency
HVAC	heating, ventilation, and air conditioning
IT	Information Technology
km	kilometer(s)
LIDAR	light detection and ranging
MW	megawatt(s)
NAIC	National Astronomy and Ionosphere Center
NASA	National Aeronautics and Space Administration
NHPA	National Historic Preservation Act
NPS	National Park Service
NRAO	National Radio Astronomy Observatory
NRHP	National Register of Historic Places
NSF	National Science Foundation
PA	programmatic agreement
SHPO	State Historic Preservation Officer
USGS	U.S. Geological Survey
VLBI	very long baseline interferometry
VSOP	VLBI Space Observatory Program
WAV	Waveform Audio

SECTION 1

Introduction

CH2M HILL, Inc. (CH2M) has prepared this historic property survey report on behalf of the National Science Foundation (NSF) in fulfillment of Stipulation I.B.1 of the 2017 Programmatic Agreement (PA) between NSF, the Advisory Council on Historic Preservation (ACHP), and the Puerto Rico State Historic Preservation Officer (SHPO) (NSF, 2017). The report summarizes the results of the intensive building survey conducted by CH2M between June 11 and 15, 2018, at the Arecibo Observatory in Arecibo, Puerto Rico. The survey was completed to evaluate buildings, structures, and objects that were not evaluated for the 2008 National Register of Historic Places (NRHP) nomination for the National Astronomy and Ionosphere Center (NAIC) Historic District, also known as Arecibo Observatory, or that were constructed between 2008 and 2015.

Since the execution of the PA on November 15, 2017, NSF has entered into a Cooperative Agreement (CA) with a new Awardee. NSF is still evaluating the feasibility of a transfer and is thus moving forward to implement those provisions of the PA that are applicable under both NSF ownership and a transfer scenario. Stipulations I.A.3 and I.B.1 require a survey of the property to evaluate the eligibility of any buildings or structures that were not previously surveyed during preparation of the 2008 NRHP nomination, and those buildings or structures built between 2008 and 2015.

According to the National Historic Preservation Act (NHPA), the NAIC Historic District meets the definition of historic property. The NAIC Historic District was listed in the NRHP in 2008 for national significance under Criterion A because of its contribution to the history of the science of ionosphere studies and the development of radio and radar astronomy in the United States, and under Criterion C because the district collectively represents a significant and distinguishable entity whose components lack individual distinction. In 2015, after discovering the Historic District was inaccurately listed in the NRHP as being owned by Cornell University, NSF contacted the National Park Service (NPS) and requested that the Historic District be delisted and then relisted with NSF as the owner. The Historic District was removed from the NRHP and relisted on December 22, 2015, to reflect the correct ownership information.

An intensive building survey is defined by the NPS as a precise evaluation of all potential historic properties in a defined survey area (NPS, 1985). This type of survey includes research and field evaluations of potential historic properties to determine whether the resources meet the definition of a historic property according to the NHPA.

In the 2018 survey, CH2M evaluated previously unevaluated aboveground resources to determine whether they are contributing or noncontributing resources to the NRHP-listed NAIC Historic District. This report provides a summary of the research design and survey methodology, a description of the historic context for the NAIC Historic District, and a discussion of the eligibility determinations for the previously unevaluated resources. Objects were not documented individually and are discussed only when associated with the newly evaluated buildings or structures in the survey area. Supporting documentation from the 2018 survey is provided in appendixes.

SECTION 2

Research Design

Prior to the survey, a Secretary of the Interior Professional Qualified Architectural Historian (Title 36 *Code of Federal Regulations* Part 61) completed a literature review of primary and secondary sources associated with history and use of the property. As the property is NRHP-listed, the original NRHP nomination was reviewed, and known significant themes of science, engineering, and education were explored. The unevaluated resources were reviewed to determine if any have association with William E. Gordon and T.C. Kavanaugh, known significant engineers associated with the property. The period of use from 2008 to 2015 was evaluated to determine if any significant events occurred during this time.

Primary sources included historic maps, site plans, oral histories, mechanical drawings, maintenance logs, newspaper articles, brochures, pamphlets, and other literature generated from the operation and use of the property. Secondary sources included journal articles, media publications, and other published histories. The documentation from the 2008 NRHP nomination and the 2016 site visit was also reviewed to provide clarification on the significance of the previously evaluated NAIC Historic District and associated research activities that may meet the definition of national, regional, or local significance (Sherfy, 1990).

Publicly accessible repositories were reviewed, which included the Cornell University Library's Arecibo Ionospheric Observatory Records from 1958 to 2000, which are housed in the Division of Rare and Manuscript Collections and available online, NSF's Digital Library for funding documentation and site history, other credible webpages featuring information and current events available from SRI International, Universities Space Research Association, the Universidad Metropolitana, and the NAIC. Other repositories included digital collections housed by subscription services like Newspapers by Ancestry, or public services like Google Scholar and Books. Google Translate was used for basic conversion from Spanish to English during the research process.

2.1 Survey Objectives and Research Questions

Following the literature review, the architectural historian conducted an intensive architectural survey at Arecibo Observatory from June 11 to 15, 2018. The purpose of the survey was to determine if previously unevaluated resources at the Arecibo Observatory are eligible for NRHP-listing as contributing resources to the NAIC Historic District. The survey included documenting previously unevaluated architectural resources, completing informal interviews with Arecibo Observatory staff, and collecting oral histories to obtain relevant information about operations and research activities. The survey included a walkthrough of the existing property to confirm the presence or absence of historical or cultural resources to be documented. Each newly documented architectural resource received an integrity evaluation for all seven integrity aspects (materials, design, workmanship, setting, location, feeling, and association (NPS, n.d.). The collected oral histories utilized the principles and best practices recommended by the Oral History Association (Oral History Association, 2009). Field investigations focused on the resources that were unevaluated from the original NRHP nomination completed in 2008. Any previously undocumented building or structure constructed between 2008 and 2015 was also evaluated for NRHP-eligibility, for a total of 32 resources surveyed.

Research questions focus on the known significance of the NAIC Historic District and seek to answer the following:

- Are any of the previously unevaluated resources included in development plans associated with eligible resources?

- Do any of the previously unevaluated resources demonstrate a significant building type, architectural style, method of construction, or are they associated with a significance builder, architect, or engineer?
- What types of activities occur in the previously unevaluated resources and how are the resources used?
- Have any significant events or discoveries occurred at any of the previously unevaluated resources? For example, are any of the previously unevaluated resources associated with significant scientific discoveries that occurred after the 2008 nomination (NAIC, 2018)? Published discoveries include:
  - Timing of a pulsar in a triple system (2013)
  - Galactic Arecibo L-Band Feed Array Survey (2014)
  - North American Nanohertz Observatory for Gravitational Waves search (2015)
  - Discovery of the first ever repeating fast radio burst (2016)
  - Discovery of vanishing or random pulsars (2017)
- Are any significant persons associated with any of the previously unevaluated resources?
- How do the previously unevaluated resources contribute to the overall history of the NAIC Historic District?

Typically, properties that have achieved significance within the past 50 years shall not be considered eligible for the NRHP. However, such properties will qualify if they are integral parts of districts that have achieved significance of exceptional importance within the past 50 years (NPS, 1990). In this case, at the time of NRHP-listing, the NAIC Historic District had achieved significance of exceptional importance within the past 50 years due to the engineering of the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers [T4, T8, and T12]), as well as several notable scientific discoveries in the atmospheric sciences, astronomy, and physics. The National Register Bulletin 22 (NPS, 1990) is referenced because of the existence of contributing resources that meet Criteria Consideration G. This survey effort will use newly collected and previously recorded oral histories, along with other sources, to direct research to determine if a newly evaluated resource has association with a significant event or discovery that meets the definition of exceptional importance, or if the newly evaluated resource contributes to the existing NAIC Historic District.

2.2 Survey Boundary

The Arecibo Observatory is in the town of Arecibo, Esperanza Ward, in Puerto Rico. The region contains one of the most important karst areas in the island (SHPO, 2008). A karst landscape is defined by the natural qualities that occur from the dissolution of underlying rocks by surface water or ground water. In this case, limestone is eroded over time leaving topographical features, such as caves, sinkholes, and underground rivers (USGS, 2012). The region remains largely undeveloped due to the terrain. As a result, the region retains some of the most forested landscape on the island. The site was selected for the Observatory in part because of the large sinkholes, which limited the need to excavate, and the distance from air and radio traffic interference (SHPO, 2008).

The 118-acre Arecibo Observatory parcel boundary is the extent of the surveyed area. The NRHP-listed NAIC Historic District boundary is located within this slightly greater parcel boundary (see Figure 1 in Appendix B). Any previously unevaluated buildings or structures determined eligible located outside the existing NRHP-listed Historic District boundary may require an addendum to expand the original NRHP boundary. As a result, National Register Bulletins 12 and 21 (NPS, 1997) are referenced for this study.

SECTION 3

Survey Methodology

Each newly documented resource received an architectural or structural description and statement of significance as applicable. The newly documented resources were evaluated based on the eligibility criteria and the periods of significance listed in the existing NAIC Historic District NRHP nomination. All seven aspects of integrity were evaluated (materials, design, workmanship, setting, location, feeling, and association). For instance, alterations to a building may have substantially changed the building's appearance and impacted its materials, design, and workmanship; likewise, new construction adjacent to a structure may have degraded its setting and feeling. The integrity evaluation assessed whether a resource retains sufficient integrity to convey any significance it may possess.

All newly documented resources are discussed in this report based on historic use and present function. The newly documented resources were evaluated for their potential association with the known historic themes and context as described by the 2008 NRHP nomination. The 2008 NRHP nomination focuses on use to define contributing resources within the existing NAIC Historic District. As such, only newly documented resources that are in continuous use and demonstrate the overall character, setting, and feeling of the NAIC Historic District will be recommended to be NRHP-eligible as contributing resources. The newly documented resources must also retain integrity of material and form to be considered as contributing resources.

The newly documented resources may be considered contributing resources despite a lack of design or workmanship because the NAIC Historic District, except for the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers), is not considered significant as a collection of resources based on its design or workmanship, but because of its association of use. These significant activities include educational and scientific use. If the newly documented resources support functions of existing contributing properties within the NAIC Historic District, they may be considered to be contributing resources. However, the supporting functions must add to the scientific use of the NAIC Historic District and may not be associated with other support functions such as residences or administrative buildings unless these resources have achieved known significance on their own (NPS, 1990). No state survey forms will be prepared for the Historic Property Survey Report.

3.1 Survey Methods

Thirteen buildings and structures were recorded in the 2008 nomination of the NAIC Historic District. Based on consultation with Bernice Sueiro at the Puerto Rico SHPO office, 9 of the 13 buildings and structures are contributing, and 5 of the 13 buildings and structures are noncontributing to the NAIC Historic District (see Tables 4-1 and 4-2, respectively). Seventeen resources were unevaluated on the 2008 nomination, with an additional 15 resources added to the property after 2008. Therefore, a total of 32 resources at the Arecibo Observatory, either within or just outside the NAIC Historic District boundaries, remained unelevated prior to June 2018 (see Table 4-3). Both a building numbering system used by the Arecibo Observatory and the 2008 NRHP-nomination numbering system are referenced on the tables within this report; however, only the building numbers associated with the Arecibo Observatory will be used for consistency within the remainder of this report and all applicable attachments.

To determine the age, significance, and integrity of the previously unevaluated resources, a building survey plan was drafted, and a literature review was completed. In July 2017, a site visit was conducted by CH2M to evaluate the current condition of the previously determined contributing resources. This information, as well as the existing NRHP-nomination, was used to generate an outline and research plan for this current survey. All referenced material is cited herein or found in an appendix to this report.

The collection of oral histories provided specific details related to the previously unevaluated resources, the resources' respective dates of construction, the types of uses, and the potential association of these resources to the existing NAIC Historic District and potentially significant events or persons associated with the resources during the period from 2008 to 2015. An oral history project summary and release form was made available to interviewees. All collected oral histories were used for research purposes only and are not intended for publication. Previously recorded oral histories, presentations, and videos available from Cornell University and material available from the Arecibo Observatory website were also referenced for this review.

3.2 Field Techniques

During the June 11 to 15, 2018 survey, the architectural historian completed a walkthrough of the existing NAIC Historic District over the course of 5 days. An Arecibo Observatory staff person knowledgeable with the operation and use of the property provided a guided tour when requested. A bilingual interpreter accompanied the architectural historian and provided translation when necessary. The architectural historian captured digital photographs, noted the direction the photographs were taken, the overall architectural appearance and material condition, and created hand-sketched plans of the building footprints and any associated structures. A staff person recorded the photograph log with the image number, photograph direction, and any key identifiers for each photograph. All digital photographs were captured to meet the guidelines outlined in the Interim National Register Photo Policy Factsheet (NPS, 2013). Photograph points will not be generated post-field work on a Universal Transverse Mercator grid system; however, photograph directions will be noted in the captions found in the photograph log (Cole, 1977).

A field form was completed to include the type of resource, architectural details, visible construction methods, condition, overall setting, and any other applicable feature determined in the field. For example, the architectural historian noted the proximity of buildings or relationship to known contributing resources. A hand-drawn site sketch with north arrow and site features was completed for each newly recorded building or structure. Data from field forms has been transferred into this report. A draft example of the building inventory form used in the field can be found as an attachment (see Appendix C). Oral histories were collected by digital recorder, saved as Waveform Audio (WAV) files, and summarized during the interviews by a staff person. Full transcriptions of the oral histories were not completed as part of this effort, as the interviews are for research purposes only. Digital copies of the interviews and release forms are the property of NSF and will be transferred to them at completion of this survey effort. An oral history log is provided in Table 3-1. This log includes the interviewee's name, title, approximate years with the Arecibo Observatory, and the date of interview. All other documentation related to the oral history collection is provided herein (see Appendix C). Felipe O. Soberal, Engineer and Head of Facilities with the Arecibo Observatory, as well as other staff persons, provided dates of construction for newly evaluated resources during this effort. Dates of construction were also reviewed through maintenance logs, site plans, and historic images.

Table 3-1. Oral History Log

Interviewee Name	Title	Approximate Years with the Arecibo Observatory	Date of Interview
Angel Vazquez	Head of Operations and Spectrum Manager	40	June 11, 2018
Arun Venkataraman	Head of Information Technology, Computer Department	40	June 11, 2018
Felipe O. Soberal	Director of Facilities and Engineering	30	June 12, 2018
Mike Sulzar	Head, Ionospheric Modification Group	40	June 13, 2018

Table 3-1. Oral History Log

Interviewee Name	Title	Approximate Years with the Arecibo Observatory	Date of Interview
Andy Ortiz	Executive Director of Education and Public Outreach, Co-Principal Investigator	20	June 13, 2018
Alfredo Santoni	Assistant Head of Operations, High Frequency Building	30	June 15, 2018

SECTION 4

Historic Context

As previously mentioned, a literature review was conducted prior to the survey. Additional research occurred after the field survey was complete to clarify the development and use of each newly documented resource. The literature results are found within Sections 3.0 and 4.0. All references are cited within the References.

4.1 National Astronomy and Ionosphere Center National Register of Historic Places Historic District

In the early 1960s, the Arecibo Ionosphere Observatory (AIO) at the NAIC was under construction for the world's largest single-dish radio astronomy telescope, later known as the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers). The project was funded by the U.S. Department of Defense's (DoD's) Advanced Research Projects Agency (ARPA; later known as DARPA) to perform radar back-scatter studies of the ionosphere. The ionosphere is the collective series of regions that contain electrically charged atoms and molecules that extend from about 60 or 70 kilometers (km) (37 or 43 miles) above the ground to sometimes as high as 500 km (311 miles) above the surface of the Earth (UCAR, 2018). We live in the lower atmosphere, and as a result, we require instrumentation that can penetrate the total regions of the atmosphere to generate accurate models. Earth-based radio telescopes are used for observations of the Earth's atmosphere, the solar system, and deep space objects and systems (Williams, 2015). The William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) would go on to function as a mixed-use instrument by implementing incoherent scatter and high frequency (HF) studies. Today, Arecibo Observatory is a center for multidisciplinary research and education. The three primary studies include space and atmospheric sciences, planetary sciences (through radar and passive observation), and radio astronomy (Altschuler, 2002; NSF, 2018).

4.2 The Early Years (1950s to 1960s)

In 1963, the William E. Gordon Telescope was constructed on the former location of a tobacco farm in response to the growing need to understand variables in the ionosphere. Gordon, the telescope's namesake, described the ionosphere as, "both the gateway to space and our first line of defense against the deadly radiation streaming toward us from the sun and other stars" (Gold, 2010). The study of atmospheric conditions and planetary sciences were reaching new levels of importance due to post-industrial environmental factors and nuclear-age concerns. The U.S. Air Force Cambridge Research Laboratories designed the telescope for a total cost of $9.3 million ($100 million in present value) with funding provided by DARPA (SHPO, 2008). The DoD funded the construction of the radar telescope during a time of increased interest in the vulnerability of communication technology due to the Cold War or post-Sputnik era. Moreover, as discussed in a paper published by the National Aeronautics and Space Administration (NASA) History Office:

> Planetary radar astronomy emerged in the late 1950s thanks to Cold War defense research that furnished the essential instruments of planetary radar experimentation. The vulnerability of the United States to aircraft and ICBM [intercontinental ballistic missile] attacks with nuclear explosives necessitated the creation of a network of ever more powerful and sensitive defensive radars. … The military-industrial or military-industrial-academic complex served as the

> social matrix which nurtured military and other Big Science research (Butrica, 1996).

Big Science, as described by Derek J. de Solla Price in his collection of essays entitled *Little Science, Big Science…and Beyond*, was the emergence of the large-scale character of modern science during the mid-twentieth century (de Solla Price, 1986). Big Science garnered its name not only because of the physical size of the monumental scientific instruments that were constructed out of this era, such as the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers), but also because of the exponential growth in the volume of scientific discoveries and national expenditures of manpower and money spent on the investment of science during this time (ibid.).

William E. Gordon, the namesake of the radio telescope, holds his place in the history of science for his ingenuity and persistence in building the radio telescope at the NAIC. He was the Walter R. Reed Professor of Electrical Engineering at Cornell University in 1959 when he began designing the radio telescope to study the Earth's ionosphere and nearby space (Gold, 2010). Gordon is credited with conceiving the use of naturally formed karst sinkholes to support a reflector dish large enough to reach the Ionosphere from the Earth, or what would become the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) (ibid.). His calculations were utilized to define the necessary diameter of the radio antenna for space exploration (SHPO, 2008). He would go on to serve as the Observatory's director until 1965 (ibid.). The Observatory emerged during the mid-twentieth century as one of the world's leading facilities to study the temperature, density, chemical composition, and other properties of the Ionosphere because of Gordon's innovation in concert with crucial support from others (ibid.). Gordon involved the Electrical Engineering Department, Civil Engineering Department, and Physics Department at Cornell University from the beginning, but he also incorporated Thomas Kavanaugh from the New York firm of Praeger, Kavanaugh and Waterbury to build the structural design. Gordon would go on to serve as the technical director during the construction of the project, which included leading site selection (SHPO, 2008). The DARPA program provided the necessary funding. APRA is well-known for its network (ARPAnet), or the predecessor of the Internet, which researched the transfer of data between computer systems (Altschuler, 2002). Cornell University operated the NAIC as a national research center beginning in 1963.

Ultimately, the site selection was decided due in part to the geomorphic needs in the terrain, the proximity to the equator, and moderate climate, as well as favorable political support from Puerto Rico (SHPO, 2008). In Puerto Rico, the political support was organized under Operation Bootstrap. Operation Bootstrap took place in two stages, with the first stage spanning from 1947 to 1965, which happened to align with the rapid planning and deployment of the NAIC (Carríon, 2017). Maria Elena Carríon writes about Operation Bootstrap, "The 1947 industrial program known as Operación "Manos a la Obra," or Operation Bootstrap, marked the beginning of a new stage of industrial planning based on external capital and tax exemptions. The origin of the program was the Ley de Incentivos Industriales (Industrial Incentives Act), passed that same year, based on exemption from the federal taxes that already existed in Puerto Rico under Article 9 of the Jones Act." (ibid.). The local government was well-poised for a showcase project such as the Arecibo Observatory. Public land was donated, public funding was earmarked for road infrastructure to the site, and legislation was developed for a radio-free zone (SHPO, 2008).

Gordon and Cornell University with Kavanaugh's engineers managed the initial construction of the radio telescope, while the U.S. Air Force Corps of Engineers developed the support facilities, including the operation buildings, roads, water reservoir, and power plant (SHPO, 2008). On November 1, 1963, the AIO was in operation with an inauguration event featuring Gordon as the first director (Altschuler, 2002). John W. Findlay served as the second director from 1965 to 1966. Findlay would go on to design the first fully steerable telescope at the Green Bank Observatory in West Virginia (NRAO, 2018). Frank Drake, who conducted the first search for signals from other technology known as Project Ozma at the

Green Bank Observatory in West Virginia in 1960, served as the third director at AIO from 1966 to 1968 (Altschuler, 2002).

Numerous publicly available sources detail the NAIC's construction and engineering, including original images, sketches, blue prints, and narrative descriptions. The 2008 NRHP-nomination and Altschuler's essay, *The National Astronomy and Ionosphere Center's (NAIC) Arecibo Observatory in Puerto Rico,* details the construction of the radio telescope and its support towers, as well as provides specific information related to the design and engineering. A few additional examples that describe the construction of the telescope include the American Society of Mechanical Engineers (ASME) Landmarks Program, the Engineering and Technology History Wiki (ETHW), and the Division of Rare and Manuscript Collections at Cornell University Library. The Division of Rare and Manuscript Collections retains the AIO Records from 1958 to 2000. A finding aid is available online and digital copies may be requested from the Cornell University Library.

The initial construction included significant ground-moving to accommodate the infrastructure, including grading and using infill soil within the sinkhole used to house the dish component of the radio telescope. The state-of-the art facility was developed in an otherwise rural area. Visible from space, the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) at the Arecibo Observatory transformed not only the location community of Arecibo, but also the scientific community at a national level, and potentially at a global scale. As intended by design, the telescope and Observatory have undergone upgrades since their construction in support of advanced studies.

4.3 The Cornell University Years (1970s to 2010s)

Cornell University was associated with the NAIC from the beginning; however, in 1969, a cooperative agreement between Cornell University and the NSF was put into place. In 1972 the AIO became known as the NAIC. The cooperative agreement between Cornell University and NSF lasted until 2011, when the transition to a new operator began because of changes in NSF funding (Cornell University, 2004; *The Cornell Daily Sun*, 2011).

Since its construction, the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) at the NAIC has provided the technological means to complete significant discoveries, including one that earned a Noble Prize in Physics in 1993 (Altschuler, 2002). These discoveries would not be possible without the ongoing upgrades and maintenance completed on the instruments and facility. These updates are required to complete such accurate and precise investigations. In addition to the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers), an Optical Laboratory (Building 27), which was added to the Observatory in 1987 and upgraded in 1997, is used for the passive study of terrestrial airglow. In 1996, the capability to conduct Light Detection and Ranging (LIDAR) surveying method with a Fabry-Perot interferometer was added to Building 55. LIDAR is primarily used to measure neutral winds and temperatures of the middle atmosphere (Arecibo Observatory, 2018). Together, these facilities provide the tools and space for the multidisciplinary studies conducted at the Arecibo Observatory to further their respective scientific fields.

Don Campbell, Professor Emeritus of Astronomy at Cornell University and the director of the Arecibo Observatory from 1982 to 1987, discussed the intentional design of the facility for expansion and evolution in a 2012 interview (Cornell University, 2018). He explained that the fundamental structure was designed to innovate and evolve, as it was intended for future generations to achieve discoveries. Campbell was at the Arecibo Observatory in 1969 when the first images of the surface of Venus were captured. The mapping of Venus was previously not possible due to the north-south ambiguity, which is described as the inability to differentiate between the north and south hemisphere of the planet due to the hemispheres' relatively similar distance when viewed from Earth (ibid.).

During the early 1970s, NASA installed a high-power transmitter that provided better resolution for imaging Venus (ibid.). The first upgrades to the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) occurred in 1972 to 1974 when the original mesh surface of the reflective dish was replaced with 38,000 aluminum panels (Cornell University, 2018). The aluminum panels were constructed on site in the warehouse building. Just as the original mesh surface was replaced with locally made panels, similar upgrades continue to be constructed on site by the maintenance and engineering staff to this day. The maintenance and engineering staff implement vernacular construction methods based on the remote nature of the location. These methods include building on site and using materials, such as concrete blocks, to best accommodate the local setting and environment. The resulting upgrades at the facility are considered a direct result of the rural location and an expression of scientific advances undertaken at the Arecibo Observatory.

For example, the study of atmospheric sciences transitioned toward utilizing higher frequencies that require an increased capacity in both hardware and networking. On November 15 and 16, 1973, a three-minute transmission, called the Arecibo Message, was sent by the upgraded radar (Altschuler, 2002). In 1974, the University of Massachusetts arrived at the Arecibo Observatory, then known as the NAIC, to search for pulsars, which led to the 1979 confirmation of gravitational waves by Taylor, Fowler, and McCulloch (ibid.). In 1993, Russell A. Hulse and Joseph H. Taylor, Jr, both of Princeton University, were awarded a Noble Prize for the discovery of a new type of pulsar, which established new lines of inquiry for the study of gravitation (Noble Prize, 2018). At the Arecibo Observatory, many scientific contributions that have contributed to the overall use and significance of the historic property were achieved because of these upgrades. Criteria Consideration G was reviewed at the time of NRHP-listing and for this supplemental evaluation because these upgrades included the construction of buildings within the last 50 years (NPS, 1990).

During an interview, Michael P. Sulzer, Head of the Ionospheric Modification Group at the Arecibo Observatory, who started at the Observatory as a graduate student in 1972, further discussed the ongoing upgrades to the instruments and facility to support the HF research in the 1970s (CH2M, 2018). He explained how the HF Transmitter Building (Building 74) was sited at the property in 2009 (ibid.). The one-story Quonset hut building is located northeast of the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) on the western side of the road near the maintenance, warehouse, and engineering buildings. Building 74 houses six large HF transmitters that support research activities that originated in the Operations Building (Building 1). The new facility replaced an earlier ionospheric heater in Islote, Puerto Rico, that was destroyed by Hurricane Georges in 1998. The new instrument uses the Observatory's 305-meter-diameter reflector dish for its antenna and retains all research activities involving ionospheric modification at the Observatory (ARRL, 2014).

Angel Vasquez, Head of Operations at the Arecibo Observatory, who has served at the facility for over 40 years, also elaborated on the new installation of the HF facility during an interview (CH2M, 2018). Vasquez was born in Arecibo, moved to New York, but eventually returned to Arecibo when the opportunity to work at the Arecibo Observatory occurred. Vasquez has witnessed many changes in operations at the Arecibo Observatory, including the implementation of remote observation. He discussed how new science and increased connectivity due to computer networking has enabled absentee and remote observation. This allows a broader base of international researchers to either submit code to the operators at the Arecibo Observatory or offers the researchers the ability to operate the instruments themselves. He pointed to the status of scientific discoveries at the Arecibo Observatory as a phase of understanding previous discoveries instead of finding radically new ideas. More than 50 years after the Arecibo Observatory was constructed, the discoveries have led to greater understanding of Earth's ionosphere, as well as of the studies of astronomy and space science. Vasquez further explained that when the Arecibo Observatory was first constructed, all the discoveries were new because the technology and science were nascent. Today, the focus of inquiry is less about new discoveries and more about scientists' refining their approach with new technologies, largely due to the

increase in computer processor speeds, to better understand what else can be gleaned from the captured data.

In addition to how discoveries at the Arecibo Observatory have adapted with new technology and scientific methods, Angel Vasquez went on to emphasize how the local community's view has evolved since the early years. Many community members have heard stories about how the facility originated from the military. The stories passed throughout the community may have exaggerated some of the functions of the facility, specifically related to defense uses and the search for extraterrestrials. He stated that Hurricane Maria in 2017 helped the community understand the Arecibo Observatory in more realistic terms. The Arecibo Observatory served in an outreach capacity by providing 20,000 gallons of water per day from the facility's well to the community.

Arun Venkataraman, Head of Information Technology (IT) at the Arecibo Observatory, echoed Vasquez's discussion on the growth of computer networking at the facility. Beginning as a research associate at the Arecibo Observatory in 1986, Venkataraman joined the IT department in 1988 (CH2M, 2018). In his time at the Arecibo Observatory, he has witnessed the transition from mainframe computers to the complex highly connected systems of today. He clarified the layering of additional instrumentation at the Observatory, including the Optical Labs (also known as the Photometry Shack and Optical Lab, or Building 27), which was added in 1985 and expanded in 1997. He also explained how observatories around the globe work together to complete testing as part of the Very Long Baseline Interferometry (VLBI) network. The Arecibo Observatory joined the VLBI network in the late 1990s as part of the Highly Advanced Laboratory for Communications and Astronomy (HALCA) mission, also known as the VLBI Space Observatory Program (VSOP), Muses-B, or Haruka mission of Japan's Institute of Space and Astronautical Science; the mission significantly improved resolution and allowed imaging of astronomical radio sources. The Arecibo Observatory received the necessary data acquisition system in 2001. The VLBI accounts for at least 4% of observation time on the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) (NAIC, n.d.; NASA, 2017).

Andy Ortiz, Executive Director of Education and Public Outreach at the Arecibo Observatory, has worked at the Arecibo Observatory for 20 years. He provided an overview of the outreach offerings and educational focus of the facility. As 30% of the visitors each year at the Arecibo Observatory are school-age students from Puerto Rico, he developed STEM programming to support educators on the island. In 2016, he directed the Inspiration for Science Program, which required additional administration space. The Inspiration for Science Trailer (Building 76) was sited near the Learning Center (Building 61) to provide additional space for the program. That program has since ended, and the trailer has been repurposed for other administrative functions. In 2017, the Arecibo Observatory became a Smithsonian affiliate, and currently a new Learning for STEM program is being developed to deploy teaching materials and training to over 200 educators in Puerto Rico. As evidenced by Ortiz's enthusiasm and dedication to creating enriching, hands-on learning experiences for students of all ages, the outreach component of the Arecibo Observatory works in tandem with the research component of the facility to inspire the next generation of scientists and dreamers. The outreach function of the facility demonstrates the necessary connection between science and education.

In 2018, the Arecibo Observatory is operated by SRI International under a cooperative agreement with the NSF (AST-1100968) and in alliance with Ana G. Méndez-Universidad Metropolitana and the Universities Space Research Association.

SECTION 5

National Register of Historic Places Eligibility Determinations for Previously Evaluated Resources

The NAIC Historic District boundary is located within a greater property boundary. The total Historic District covers 118 acres and the greater property is approximately 120 acres. The Historic District is located in the Esperanza Ward in Arecibo, Puerto Rico, at the southern end of Route PR-625. It is located at the following coordinates: latitude 18°20’53.88’’N and longitude 66°45’8.64’’W. The approximate elevation of the property is 996 feet above mean sea level but varies widely over short distances. The land surrounding Arecibo is rural countryside near the northwest coast of Puerto Rico. The property is in the Northern Coastal Plains. Rivers flow northward to the Atlantic Ocean through forest lands. The belt of closed forest is interrupted by the canyons and valleys of several rivers. The forest lands have little surface drainage, but a prevalence of underground drainage. These lands constitute the karst belt of northern limestone (USGS, 2012). Because of the erosion of the limestone bedrock, slopes have a nearly vertical incline that create a steep topography and sinkholes. The general topography gradient across the subject property is from the north to the south.

The front entrance of the property is accessed by a concrete gate with aluminum fence flanked by the Entrance Guard House (Building 4) to the east and the Main Gate Restroom (Building 47) to the west. The main road runs north to south and curves along the steep topography. Just northeast of the gate and the Guard House (Building 4), a small parking lot runs east to west on a plateau between two ridges. Below the plateau, the Tanama River is in densely forested land. Based on a map provided by the Arecibo Observatory, a concrete and wood structure is located below the parking lot in the ravine (see Figure 1 in Appendix B). In an interview with Wilson Arias, Head of Environmental Health and Safety at the Arecibo Observatory, the concrete and wood building is abandoned and in a state of ruin. The building is not easily accessible, and due to safety concerns, was not accessed during the survey. The building is not contributing to the functions of the Arecibo Observatory. Outside the entrance near the parking lot, a road leads southeast up an incline toward the Phase Reference Antenna (12-meter) and the antenna’s auxiliary building (Building 77). From the Entrance Guard House (Building 4) and the Main Gate Restroom (Building 47), a road continues southward toward the four main routes, along which the buildings are clustered. The North V.S.Q. Building and Utility Building (Buildings 57 and 58) are the only other buildings located outside the main campus besides the abandoned concrete and wood building in the ravine and the Phase Reference Antenna (12-meter) and Building 77 (see Figure 1).

The existing NRHP-listed NAIC Historic District boundary differs from the real property boundary. The Entrance Guard House (Building 4) and the Main Gate Restroom (Building 47), the abandoned concrete and wood building, and the buildings located in the storage yard (Buildings 59, 63, 64, 69, 70, 71, and 72) are located outside the existing Historic District boundary (see Figure 2 in Appendix B). Note that the storage yard is subject to frequent reorganization, and the buildings are not located exactly where detailed in Figure 1 or 2. The building locations are described in Section 4.2. All other resources are within the existing Historic District boundary and located as shown on Figures 1 and 2.

5.1 Contributing Resources

Thirteen buildings and structures were recorded in the 2008 nomination for the NAIC Historic District. Based on consultation with Bernice Sueiro at the Puerto Rico SHPO office, 9 of the 13 buildings and

structures are considered contributing to the NAIC Historic District (see Table 4-1). A contributing resource is defined as a building, site, structure, or object adding to the historic significance of a property (McClelland, 1997). The contributing buildings and structures are significant because the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) would not be able to operate without the support of many functions performed within these buildings (SHPO, 2008). The contributing buildings and structures are not considered significant for architecture, design, engineering, materials, or workmanship, but instead, for how the buildings and structures contribute to the use of the property for scientific research and education. The William E. Gordon Telescope (305-meter-diameter radio telescope and support towers [T4, T8, and T12]) are the exception, as they are considered significant for engineering.

All other contributing buildings are utilitarian in design and feature common material types such as concrete block with parged concrete exteriors. Most buildings feature rectangular or square plans with flat roofs. The Visitor Center (Fundación Angel Ramos Visitor and Educational Facility, Building 54) and the Learning Center (Building 61) are two buildings that differ in plan more than the other contributing resources (see Appendix A for Images 56 and 68). Based on observations gathered during site visits completed by CH2M in July 2017 and June 2018, all previously recorded NRHP-contributing resources continue to add to the historic significance of the property.

During the June 2018 effort, maintenance logs and historic photographs were reviewed to evaluate alterations. Some common alterations have occurred due to ongoing material maintenance. These common alterations include painting and heating, ventilation, and air conditioning (HVAC), electrical, and plumbing updates that are required to continue the use of the resources. All contributing resources remain in continuous use. Therefore, the common alterations have not altered the historic integrity of the contributing resources, because the original 2008 NRHP-nomination discussed the significance of the contributing resources in terms of use instead of design. The feeling, setting, and material integrity remain intact for all the contributing resources. The William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) continue to demonstrate an integrity of design and workmanship in addition to the previously mentioned aspects of integrity (see Appendix A for Images 96 to 100). The NAIC Historic District is significant for its association with science and education under Criterion A, and the property is eligible under Criterion C because the Historic District represents a significant and distinguishable entity whose components lack individual distinction. The NAIC Historic District was determined to be eligible for listing on the NRHP based on Criteria Consideration G, as many of the contributing resources gained significance within the last 50 years.

Table 5-1. NAIC Contributing Resources

Building Number [NRHP Building Number]	Building Name	Year of Construction
N/A [N/A]	William E. Gordon Telescope and Support Towers T4, T8, and T12 (305-meter-diameter radio telescope and three support towers)	1963
Building 1 [NRHP Building 1]	Operations Building	1963 (addition in 1983)
Building 2 [NRHP Building 2]	Administration Building	1963 (addition in 1997)
Building 12 [NRHP Building 13]	Maintenance Building	1967
Building 17 [NRHP Buildings 11 and 12]	Warehouse and Business/Purchasing	1967

Table 5-1. NAIC Contributing Resources

Building Number [NRHP Building Number]	Building Name	Year of Construction
Building 27 [NRHP Building 7]	Photometry Shack and Optical Lab	1985/1997
Building 54 [NRHP Building 5]	Visitor Center (Fundación Angel Ramos Visitor and Educational Facility)	2001 (addition 2015)
Building 61 [NRHP Building 6]	Learning Center	2001
Buildings 66 and 68 [NRHP Building 1A]	Atmospheric Science Trailer, and Visiting Science Trailer	

*Buildings and Structures Listed as Contributing in the Original 2008 NRHP Nomination.

5.2 Noncontributing Resources

Five of the 13 buildings and structures recorded in the 2008 nomination are considered noncontributing to the NAIC Historic District (see Table 4-2). A noncontributing resource is one that does not add to the understanding of a historic property's original use or significance (McClelland, 1997). For example, a building that was built outside the established period of significance, or a building where the primary use has been changed to an unsympathetic use, may be considered noncontributing to a historic property.

Table 5-2. NAIC Noncontributing Resources

Building Number [NRHP Building Number]	Building Name	Year(s) of Construction
Building 3 [NRHP Building 3]	Visiting Scientist Quarters and Cafeteria	1963
Building 10 [NRHP Building 4]	Swimming Pool/Restrooms	c. 1965
Buildings 41, 42 [NRHP Building 8]	West Hill V.S.Q. Bachelor Unit 1 and 2	**c. 1970s
Buildings 43, 44 [NRHP Building 9]	West Hill V.S.Q. Family Unit 1 and 2	**c. 1970s
Building 57 [NRHP Building 10]	North V.S.Q. Bldg	1996

* Buildings and Structures considered Noncontributing to the Original 2008 NRHP Nomination.

**Originally noted as c. 1990 in previous studies, however, the date was corrected by Arecibo Observatory staff in June 2018.

5.3 Previously Unevaluated Resources

As previously mentioned, a total of 32 previously unevaluated resources were documented during the June 11 to 15, 2018 survey. Seventeen of the 32 resources were not evaluated during the original 2008 NRHP-nomination. The remainder of unevaluated resources were either constructed between 2008 and 2015 or were newly discovered during the survey (see Table 4-3).

Table 5-3. NAIC Previously Unevaluated Resources

Building Number	Building Name	Year of Construction	Findings
Building 4	Entrance Guard House	**1975	Noncontributing Resource
Building 5	Cable Car House	1963	Contributing Resource
Building 6	Pump House/Water Treatment Building	1963, 2010	Noncontributing Resource
Building 11	Lewis Building-Rigging Loft	c. 1965	Noncontributing Resource
Building 13	Bowl Shack	1963	Noncontributing Resource
Building 21	Antenna Testing Range	c. 1985	Noncontributing Resource
Building 25	Paint Storage Building	c. 2010	Noncontributing Resource
Building 34	High Voltage Power Supply Building	1973	Noncontributing Resource
Building 35	Cummins Generator Control Building	2010	Noncontributing Resource
Building 47	Main Gate Restroom	**c.1975, 2016	Noncontributing Resource
Building 50	Interference Monitoring Shack	**1992	Noncontributing Resource
Building 51	Grease Pit	No longer extant	N/A
Building 53	Emergency Generator Building	1992	Noncontributing Resource
Building 55	LIDAR Laboratory Building	1996	Contributing Resource
Building 58	North V.S.Q. Utility Building	2002	Noncontributing Resource
Building 59	Visitor Center Trailer (Storage)	2016	Noncontributing Resource
Building 60	Antenna Testing Range Building	**c. 1995	Contributing Resource
Building 62	HFF Storage Trailer	**2007	Noncontributing Resource
Building 63	Ionosonde Trailer	**2007	Noncontributing Resource
Building 64	Electronic Trailer	**1990	Noncontributing Resource
Building 65	Shielded Trailer	1983	Contributing Resource
Building 67	Cryogenics Lab Trailer	1967	Noncontributing Resource
Building 69	Electronic Trailer (Waveguide)	**2007	Outside NRHP- listed NAIC Historic District Boundary, Not Eligible for NRHP under any Criteria
Building 70	Computer Trailer	**2005	Outside NRHP- listed NAIC Historic District Boundary, Not Eligible for NRHP under any Criteria
Building 71	Electronics Cable Trailer	**2005	Outside NRHP- listed NAIC Historic District Boundary, Not Eligible for NRHP under any Criteria
Building 72	Electronics Trailer (Cryogenics)	**2005	Outside NRHP- listed NAIC Historic District Boundary, Not

Table 5-3. NAIC Previously Unevaluated Resources

Building Number	Building Name	Year of Construction	Findings
			Eligible for NRHP under any Criteria
Building 73	HF Transmitter Building	**2009	Contributing Resource
Building 76	Visitor Center Trailer (Inspiration for Science)	**2016	Noncontributing Resource
Building 77	Phase Reference Antenna (12-meter) and Building	2010	Contributing Resource
Building 78	Coffee Hut	**2002	Noncontributing Resource
Building 79	Engineering Office Building	**2010	Noncontributing Resource
Building 80	Cummins Diesel Generator Building	2010	Noncontributing Resource

* Buildings and Structures Previously Unevaluated during the Original 2008 NRHP Nomination.

**Originally noted with a different date or unknown date during previous studies; however, date was corrected through additional research or Arecibo Observatory staff.

***Shading indicates newly determined contributing resource to the NRHP-listed NAIC Historic District.

SECTION 6

National Register of Historic Places Eligibility Determinations for Previously Unevaluated Resources

As discussed in Section 2.0, the previously unevaluated resources must add to the recognized significance associated with the scientific use of the NAIC Historic District. The historic context from the 2008 NRHP nomination was referenced, as well as the periods of significance for the NAIC Historic District. The previously unevaluated resources were evaluated to determine whether the resources may be either contributing or noncontributing resources to the NRHP-listed NAIC Historic District. All contributing resources are provided with a discussion on all seven aspects of integrity; however, noncontributing resources are limited to material condition due to their lack of any association with the recognized historic significance of the Historic District. Images of the newly documented resources are found in the photograph log with the image numbers cross-referenced within this document for ease of use (see Appendix A). All building numbers used throughout this document are those assigned by the Arecibo Observatory. As the Arecibo Observatory building numbers differ from those found in the 2008 NRHP nomination, both are provided in Tables 4-1 and 4-2. Note that previously unevaluated resources are not assigned NRHP building numbers, because they were not documented as part of the 2008 NRHP nomination (see Table 4-3).

6.1 Contributing Resources

6.1.1 Building 5, Cable Car House

The Cable Car House is a one-story concrete block building with a rectangular plan and a shed roof (see Appendix A for Images 6 to 9). The shed roof features an open rake design with a slight overhang. The roof is covered by rolled asphalt. The building is sited on a slope and built at grade. The building has a front patio located on the north elevation. The patio is covered by a corrugated metal shed roof that extends from the front elevation of the main building. The patio roof rests on a metal posts and beam. The patio roof support posts rest on a concrete block retaining wall that runs along the front (north) and side (east) elevations. There are no windows on the building, although the rear (south) elevation features an open bay near the roofline. The open bay serves as an access point for the cable or rigging to enter the building. The open bay is above another open bay that serves as an access point for riders to enter the cable car. The cable car meets the exterior of the building. There is a one bay projection with a shed roof directly next to the cable car entry point on the rear (south) elevation near the side (east). A small, metal-louver-covered opening is found on the rear (south) elevation of the one bay projection. The foundation is concrete block. The material condition is good.

Built in 1963 as part of the original site design, the Cable Car House is located near the Operations Building (Building 1) and the Lewis Building-Rigging Loft (Building 11). Based on historic drawings and site plans, the building does not appear to have had any additions or substantial alterations (Site Plan, 1972). The patio roof is an addition that does not detract from the overall original form or use. The Cable Car House is essential to the maintenance and access of the platform of the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers). The Cable Car House is not a location where scientific discovery occurs; however, the building provides a key function in the maintenance and use of the instrument. Therefore, NSF has determined that the Cable Car House is a contributing resource to the NRHP-listed NAIC Historic District. The building may be considered an

accessory building to the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers).

6.1.2 Building 55, LIDAR Laboratory Building

The LIDAR Laboratory Building is a one-story concrete block building with a one-bay shed addition and ancillary equipment inside a fenced compound (see Appendix A for Images 45 to 47). The LIDAR Laboratory was built after the original airglow laboratory, known as the Optical Labs (Building 7), because of upgrades in the instrumentation used for observations of the upper atmosphere (Isham et al., 2000). The concrete block building features a parged concrete exterior. It has a rectangular plan with two double-leaf metal doors on the front (south) elevation. A shed roof and stoop porch provide access to each of the double-leaf doors on the front (south) elevation. The roof is flat; however, near the front half of the building, there are four gable roofs. The gable structures are corrugated metal structures placed on the rooftop to provide additional overhead space for the instruments housed within the building. The rear (north) elevation features an overhead door made accessible by a poured concrete slab. Metal handrailing runs along the roofline. A metal staircase is found on the side (west) elevation that provides access to the roof. The foundation is a poured concrete slab. The material condition is good.

The use of the LIDAR Laboratory Building is to house LIDAR that is fully pointable and primarily used to measure the neutral winds and the temperatures of the middle atmosphere. The Arecibo Observatory has expanded its studies over time from the study of the upper Ionosphere to include study from the ground to upper space (Cho and Isham, 1997). LIDAR serves as a tool to provide better understanding of how human agriculture and technology impact the atmosphere (ibid.). Optical observations at Arecibo began in 1967 using a photometer, and by 1968, a Fabry-Perot interferometer was used at the Arecibo Observatory (Isham et al., 2000). Cho and Isham explain that by the early 1990s, “Arecibo scientists also study the atmosphere using optical radars known as LIDARs. A LIDAR works almost exactly like a radar—the difference is that pulses of light instead of radio pulses are used. This difference can be seen in their names: RADAR stands for Radio Detection and Ranging, while LIDAR stands for Light Detection and Ranging. LIDAR can measure atmospheric density, temperature, winds, as well as dust and pollutants. The extraterrestrial metal atoms deposited in the upper atmosphere by meteors can also be observed by the Arecibo LIDAR” (ibid.).

The use of LIDAR at the Arecibo Observatory is further discussed in a previous call for proposals:

> At Arecibo we have a variety of airglow and LIDAR [LIDAR] instrumentation. […] The “active” optical instruments (LIDARs) have the capability to monitor the upper stratosphere to lower thermosphere. We have three systems, two of which are configurable to monitor one each of the meteoric metals: Na, Fe, Ca, or Ca+. Alternatively, one of the two metal LIDARs [LIDAR] can be configured as a Rayleigh LIDAR to measure temperature from the upper stratosphere to the mesosphere, from about 35 to 70 km. The third LIDAR [LIDAR] is a Doppler-resonance LIDAR [LIDAR] that measures temperatures within the metal layer by sensing the Doppler broadening in the D1 resonance line of K (NAIC, 2016).

Built in 1996, the LIDAR Laboratory Building is located near the Antenna Testing Range Building (Building 60). Based on observation, the building appears to have had one metal shed addition but no other substantial alterations. The addition does not detract from the overall original form or use. The LIDAR Laboratory Building was constructed during one of the recognized periods of significance for the NAIC Historic District. The LIDAR Laboratory Building is essential to educational and scientific uses of the historic property. The LIDAR Laboratory Building is a location where scientific discovery occurs, and the building provides a key function in the continued scientific use of the NAIC Historic District. Therefore,

NSF has determined that the LIDAR Laboratory Building is a contributing resource to the NAIC Historic District.

6.1.3 Building 60, Antenna Testing Range Building

The Antenna Testing Range Building is a one-story concrete block building with a one-bay metal shed addition (see Appendix A for Images 53 and 54). The building has a flat roof with closed soffits and overhanging eaves. The front (north) elevation features an overhead door accessed by poured concrete stairs. The stairs are oriented to the side from west to east and feature metal handrails. A single-leaf metal door is located on the side (west) elevation. The single-leaf door is accessed by poured concrete stairs. The stairs are oriented from north to south and feature metal handrails. A ladder is located behind the side entrance. The one-bay metal shed addition is located on the side (east) elevation. The addition is composed of corrugated metal and features a low-pitched shed roof of the same material. The addition is recessed from the front (south) elevation. The material condition is good.

Built circa 1995, the Antenna Testing Range Building is the second of such buildings at the Arecibo Observatory. The new Antenna Testing Range building replaced the use of the original Antenna Testing Range Building (still extant as Building 21 and now used to house a deionization system). The Antenna Testing Range Building (Building 60) is located to the north of the LIDAR Laboratory Building (Building 55). Based on observation, the building appears to have had a single-bay shed addition with no other substantial alterations. The single-bay shed addition does not detract from the overall original form or use. The Antenna Testing Range Building supports educational aspects of the Arecibo Observatory and research uses of the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers). The Antenna Testing Range Building was built within one of the periods of significance for the NAIC Historic District, and the building supports the educational and scientific use of the historic property. Therefore, NSF has determined that the Antenna Testing Range Building is a contributing resource to the NAIC Historic District.

6.1.4 Building 65, Shielded Trailer

The Shielded Trailer is placed through an opening in the wall of the Operations Building (Building 1). The trailer, like some vehicles at the Arecibo Observatory, is shielded so that electromagnetic emissions from instrumentation within the trailer do not interfere when the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) is operational. The trailer is next to transformers (see Appendix A for Images 59 to 61). The trailer does not demonstrate a remarkable building type or method of construction; however, temporary spaces, like trailers, tend to be used long-term at the Arecibo Observatory. Because use is a contributing factor to the significance of the NAIC Historic District, the use of the Shielded Trailer was evaluated. Based on interviews with Arecibo Observatory staff, the Shielded Trailer provided space for necessary instrumentation and equipment utilized for significant scientific activities that occurred at the historic property during the designated periods of significance.

Sited at the location in 1983, the Shielded Trailer is located on the side (east) elevation of the Operations Building (Building 1). Based on observation, the building does not appear to have had any additions or substantial alterations. The Shielded Trailer is essential to the activities undertaken within the Operations Building (Building 1) with support by the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers). The Shielded Trailer is a location that supports that facilitation of scientific discoveries. Therefore, NSF has determined that the Shielded Trailer is a contributing resource to the NAIC Historic District. The building may be considered an accessory building to the Operations Building (Building 1).

6.1.5 Building 73, HF Transmitter Building

The HF Transmitter Building is a one-story Quonset hut building with an attached one-story concrete block wing (see Appendix A for Images 68 and 69). The building has an L-plan. The Quonset hut is

oriented east to west, while the one-story concrete block wing extends from the side (south) elevation of the hut near the rear (west) elevation. The Quonset hut has an arch design with overhead door on the front (east) elevation. A single-leaf metal door is located just north of the overhead door. A concrete ramp runs from east to west toward the overhead door. A small ramp extends to the north, which provides access to the single-leaf door. The ramp features metal handrails. The Quonset hut has a poured concrete slab foundation. Twelve 3-inch coaxial lines feed the individual antenna elements, totaling 1,500-feet in length. The coaxial lines extend from the side (south) roof. Six transmitters and associated equipment are located inside the Quonset hut. "Another important instrument at Arecibo is the HF facility, which is an upward-pointing shortwave radio transmitter used to study plasma waves and turbulence in the Ionosphere" (Cho and Isham, 1997). This is housed in the HF Transmitter Building. An abstract published by Michael P. Sulzer, Head of the Ionospheric Modifications Group, further discusses the plans for the HF Transmitter Building:

> The problem of illuminating the Arecibo 300 m dish was solved in the 1970s by hanging first a dipole antenna and later a log periodic antenna from the central area of the azimuth arm. This approach somewhat blocked the area, added undesirable weight to the structure, and did not provide optimum illumination. The new HF facility, now under construction and to be completed next year, uses a very different approach. For each of two frequency bands, there is a set of three crossed dipoles located relatively near the surface of the dish. The dish acts as a reflector for each of these dipoles. They transmit to a reflecting screen that is supported from the three main towers and hangs below the astronomy and radar feeds supported from the platform above. Modeling results give an expected antenna gain of about 25.5 db at 8.175 MHz. A building has been constructed for six transmitters, which were originally used in the Maine Over-the-Horizon Radar Facility. Each of these transmitters has a maximum power of 100 KW CW, and it will be possible to transmit various modulated waveforms. The effective radiate power will thus be greater than 150 MW. The power at 5.1 MHz will be about 80 MW. The transmitters have been installed in the building. There are three main tasks underway which must be completed before the transmitters can be used. These are electrical power input, the rf transmission line system, and the cooling systems, air and water. The electrical power will be supplied by generators which will replace the observatory's aging turbine. These are expected to be available at the end of February. The dipole antennas and the reflecting screen have been designed and are in the process of bidding for construction. Also, a control system will be built to allow the certain transmitter parameters to be set from the observatory control room to allow coordinated experiments with the radar. The dipole antennas are to be constructed in a manner that will allow their length to be modified so that the frequency band can be shifted somewhat by constructing different length sections. The matching is designed so that loading networks can be added to give additional degrees of freedom to match the new impedance at the altered frequency. We plan for the facility to be ready for use in the coming year (Sulzer, 2009).

Ultimately, the "HF facility started operations in November 2015. Three successful campaigns have been performed, totaling more than 20 experiments. The HF facility consists of six 100 kW transmitters that feed two sets of three crossed dipoles, centered at 5.1 [megahertz] MHz or 8.175 MHz. The antenna elements transmit a high-frequency (HF) electromagnetic radio beam that illuminates the 305 m Arecibo dish using a Cassegrain feed. For the 8.175 (5.1) MHz, the obtained gain is 25.5 (22) dB, and the HPBW is 8.5 (13) degrees." (Nossa et al., 2018).

During a tour of the HF Transmitter Building in 2018, Alfredo Santoni, a transmitter engineer who works in the HF facility explained to CH2M staff how he escorted the transmitters from Alaska where they were shipped after the Over-the-Horizon Radar Facility in Moscow, Maine, was dismantled in 2005. The Over-The-Horizon Backscatter Radar was described as the world's largest radar, which was developed by the U.S. Air Force over 25 years for $1.5 billion and occupied an area nearly double the area covered by New York's Central Park (Associated Press, 2005). The radar was designed to monitor Cold War threats nearly 2,000 miles away, until the U.S. Air Force divested the, "outdated warhead silos and other relics of the arms race" (ibid.). The transmitters were repurposed by the Arecibo Observatory to study the Ionosphere.

By 2010, the HF Transmitter Building was sited at a location where a paint storage building was previously sited. Inside the building, each transmitter is patched identically to aid efficiency when trouble shooting. Generators channel a total of 150 megawatt (MW) to power the transmitters. To better understand the scale of a MW, a single MW from a coal-powered plant can generally power 650 homes (Eskom, 2015). Chilled water is piped into radiant tubes to cool the equipment. The control room features a board with a model of the antenna so that operators can easily know the source of potential concerns. Filters are used to clean up any harmonic frequencies found in feeds, which are problematic for testing.

The one-story, concrete block building next to the Quonset hut that houses the six transmitters functions as the control room. The concrete block building has a flat roof with closed soffit and overhanging eaves. The exterior of the concrete block building is covered with parged concrete. Windows on the front (north) and rear (south) elevations feature metal-louver shutters. A single-leaf metal door is located on the front (north) elevation next to a single window. The foundation is a poured concrete slab. Inside the concrete block building, operators monitor the transmittal feed and make necessary adjustments. The material condition of the HF Transmitter Building is good.

Built in 2010 as part of upgrades to increase research capability, the HF Transmitter Building is located near the Maintenance and Engineering Buildings (Building 17 and 79), just north of the 305-meter-diameter reflector dish. The facility continues work that began with the first HF radio wave ionospheric interaction experiments in 1971 using an HF feed mounted above the 305-meter-diameter reflector dish, which led in the late 1970s to a dedicated high-power HF transmitting facility in Islote, Puerto Rico, that no longer exists (Isham et al., 2000). As stated by Isham and others, "Although Arecibo does not operate the only such high-frequency transmitter facility, nor the only one located near an incoherent scatter radar, it is uniquely situated under the relatively smooth midlatitude bottom side F region. This, in conjunction with the sensitivity of the 430-MHz incoherent scatter radar and the extensive instrument cluster, allows studies to be performed at Arecibo that are not possible elsewhere" (2000). The building has not undergone any alterations since original construction. The HF Transmitter Building is essential to the use of the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) for HF testing. The HF Transmitter Building is a location where scientific discovery occurs because the building serves a key function in the use of the 305-meter-diameter reflector dish for research activities, leading to the advancement of our understanding of the ionosphere. Therefore, NSF has determined that the HF Transmitter Building is a contributing resource to the NRHP-listed NAIC Historic District.

6.1.6 Building 77, Phase Reference Antenna (12-meter) and Building

In 2010, the Phase Reference Antenna (12-meter) was added to support VLBI studies. The Arecibo Observatory joined the VLBI network in the late 1990s as part of the HALCA mission of the Japanese VSOP project (NAIC, 2013). The Phase Reference Antenna has a 12-meter-diameter dish set on a squat steel column with an attached metal ladder. The column is welded onto a plate on top of a poured concrete slab. The Building is a one-story concrete block building (see Images 71 to 74). The rectangular plan building has a flat roof with closed soffits and overhanging eaves. The building exterior is covered with parged concrete. A double-leaf metal panel door is located on the front (east) elevation. The side

(north) elevation has a small, metal-louver window. The foundation is a poured concrete slab. The material condition is good.

Built in 2010, the Phase Reference Antenna (12-meter) and Building are located northeast of the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) on a steep embankment. The antenna and building are accessed by a secured road just outside the Entrance Guard House (Building 4) and parking lot. The building is built onto the north side of the embankment below the 12-meter antenna. Based on observation, the antenna and building do not appear to have had any additions or substantial alterations. The Phase Reference Antenna (12-meter) and Building are essential to the activities undertaken within the scientific research associated with the property. Therefore, NSF has determined that the Phase Reference Antenna (12-meter) and Building are contributing resources to the NRHP-listed NAIC Historic District. The building may be considered an accessory building to the Phase Reference Antenna (12-meter).

6.2 Noncontributing Resources

6.2.1 Building 4, Entrance Guard House

The Entrance Guard House (Building 4) is a one-story building (see Images 1 to 5). The building has a rectangular plan with a flat roof. The roof has closed soffits and overhanging eaves. The main wing is a three-bay, flat roof building with a parged concrete exterior. Based on site plans, the building has a steel-frame structure. A single-leaf door is centrally located on the side (west) elevation. The door is flanked by one metal-louver window at each side. The main wing is accessed on the side (east) elevation by a concrete step and slightly raised walkway. A metal handrail runs from north to south along the walkway. The foundation is a poured concrete slab. The material condition is good.

A one-bay gable structure is located on the front (north) elevation. The moderate pitched gable roof has closed soffits and eaves that overhang slightly. The gable structure has a door on the side (south) elevation, and various window types on all other sides. A slider window is located on the side (west) elevation to allow the guards to communicate easily with arriving visitors. The foundation is a poured concrete slab. The material condition is good.

A parged concrete block wall runs east to west from the rear (south) elevation of the gable structure and the northern-most section of the main wing. The wall is approximately 15 feet in height. The wall extends between the Entrance Guard House (Building 4) and the Main Gate Restroom (Building 47) with a retractable chain-link gate at the center.

Built in 1975, the Entrance Guard House or Guard Shack (Building 4) replaced an earlier building, which was located closer to the Visiting Scientist Quarters and Cafeteria (Building 3). Historic images, provided by the Arecibo Observatory, show the earlier Guard Shack situated above the Visiting Scientist Quarters and Cafeteria (Building 3) with Tower. Site plans from 1975 detail the construction of the new Entrance Guard House. The earlier Guard Shack appeared to be modular construction with a low-pitched gable roof and shed extension. By 1975, construction of the new Entrance Guard House was underway. The framing details show an aluminum frame with insulation and corrugated aluminum panels.

Based on historic images, the building has had some alterations or modifications since its original construction, including changes to the windows and doors. Additionally, the Main Gate Restroom (Building 47), which is located just west of the Entrance Guard House, was altered in 2016. The building may support necessary security functions that relate to the overall use of the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) and other instruments, but it does not directly relate to the recognized significance associated with scientific use. The Entrance Guard House serves as a recognizable structure to visitors, but it does not add to the overall understanding, setting, or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons,

architects, or engineers are associated with the construction or use of the building. The Entrance Guard House does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the Entrance Guard House is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.2 Building 6, Pump House/Water Treatment Building

The Pump House/Water Treatment Building (Building 6) is a one-story, concrete block building with exterior equipment related to water treatment (see Appendix A for Images 10 to 15). The building has a flat roof with closed soffits, and metal-wrapped overhanging eaves. The roof is covered with gravel. An exhaust vent is located on the rooftop near the building center. The building has a rectangular plan. The front (south) elevation has a single-leaf metal security door near the side (west) elevation, and a double-leaf metal-louver door near the other side (east) elevation. The side (east) elevation has a single, central, metal-louver window with simple lug sill. The cornice line of the building, half of the rear (north) elevation, and the side (west) elevation feature a parged concrete treatment, while the remainder of the building features white painted concrete block. The foundation is a poured concrete slab. The material condition is good.

Built in 1963, the Pump House/Water Treatment Building is located near the Operations Building (Building 1) and Administration Building (Building 2). Based on a historic image, the building has not had alterations or modification beyond exterior painting; however, a potable water tank was replaced in 2010 (see Appendix A for Image 20). The building provides a support function to the property, but it does not add to the overall understanding, setting, or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the building. Therefore, NSF has determined that the Pump House/Water Treatment Building is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.3 Building 11, Lewis Building-Rigging Loft

The Lewis Building-Rigging Loft is a one-story, steel-frame building with a gable roof and rectangular plan (see Appendix A for Image 16). The low-pitched gable roof is covered with metal sheathing. The roof has closed soffits and slightly overhanging eaves. The exterior is covered with metal panels. The front (west) elevation features an off-centered, double-leaf corrugated metal door next to a single metal-louver window. The side (south) elevation had several windows; however, a tree crushed the roof and side (south) of the building during Hurricane Maria in October 2017. The building has a walk-out basement. The basement level is constructed with reinforced concrete. The building is in ruinous condition.

Built in 1965, the Lewis Building-Rigging Loft is located near the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) and the Cable Car House (Building 5). It is reported that the building was used by maintenance staff for storage and a meeting space prior to the damage caused by Hurricane Maria. The building provides a support function to the property, but it does not add to the overall understanding, setting, or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the building. Therefore, NSF has determined that the Lewis Building-Rigging Loft is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.4 Building 13, Bowl Shack

The Bowl Shack is a one-bay gable structure with a rectangular plan (see Appendix A for Images 17 to 19). The low-pitched gable roof is covered with tar paper. The roof has open rafters. The exterior is covered with pressure treated boards, which appears to be a modern replacement material. The front (north) elevation features a slightly off-centered single-leaf metal door. The side (east) elevation has a single off-centered metal-louver window. Four metal containers are located directly along the side (east)

elevation. The rear (south) elevation has a single metal-louver window with an open gable wall. Ladders and equipment are stacked on a rack along the side (west) elevation. The foundation is a poured concrete slab. The material condition is fair.

Built in 1963, the Bowl Shack is located under the reflector dish of the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) and adjacent to an anchor. The shack is marked as a reflector shed and serves as a storage shed. Based on observation, the Bowl Shack has not had alterations or modification beyond exterior painting. The shack provides a storage function to the property, but it does not add to the overall understanding, setting, or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the building. Therefore, NSF has determined that the Bowl Shack is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.5 Building 21, Antenna Testing Range

The Antenna Testing Range (Building 21) is a one-story building with a rectangular plan (see Appendix A for Images 20 to 22). The building has a medium gable roof covered with corrugated metal. The roof has an open rake design with a wide, composite wood cornice. The building exterior is corrugated metal. An overhead door is located on the front (north) side. The front door is accessed by a small concrete ramp that runs from north to south. A second door is located on the side (west) elevation near the rear (south). The side door is a single-leaf metal door. The foundation is a poured concrete slab. The material condition is good.

Built prior to 1985, the Antenna Testing Range is located above the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) near the Support Tower (T12) and the Visitor Center (Building 54). Based on observation, the Antenna Testing Range has not had substantial alterations or modification beyond exterior painting and maintenance. Arecibo Observatory staff reported that the interior of the building was recently retrofitted to support a deionized water system. The Antenna Testing Range does not add to the overall understanding, setting, or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the building. The Antenna Testing Range does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the Antenna Testing Range is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.6 Building 25, Paint Storage Building

The Paint Storage Building (Building 25) is a one-story Quonset hut building with a rectangular plan (see Appendix A for Images 23 to 26). The Quonset hut has an arched roof and a concrete slab foundation. The building exterior is covered with corrugated metal. The structure is steel frame. The front (west) elevation has an overhead door at the building center. Next to the overhead door, a single-leaf metal door is located near the side (north) elevation. The material condition is good.

Built circa 2010, the Paint Storage Building is located within the fenced compound surrounding the Warehouse (Building 17). The Paint Storage Building has not had alterations or modification. Arecibo Observatory staff reported that the building replaced an earlier paint storage building previously located where the HF Transmitter Building (Building 73) is constructed. The Paint Storage Building does not add to the overall understanding, setting, or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the building. The Paint Storage Building does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the Paint Storage Building is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.7 Building 34, High Voltage Power Supply Building

The High Voltage Power Supply Building (Building 34) is a one-story building with a square plan (see Appendix A for Images 28 to 30). The building has a moderate pitched gable roof covered with tar paper. The roof has closed soffits and minimally overhanging eaves. The building exterior is covered with composite wood panels near the roofline and parged concrete elsewhere. An off-centered overhead door is located on the front (north) elevation. The foundation is a poured concrete slab. The material condition is good.

Built in 1973, the High Voltage Power Supply Building is located near the Emergency Generator Building (Building 53) and the Learning Center (Building 61). A small fenced compound for active power supply equipment is located at the rear (south) of the building. Based on observation, the High Voltage Power Supply Building has not had alterations or modification. The High Voltage Power Supply Building does not add to the overall understanding, setting, or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the building. The High Voltage Power Supply Building does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the High Voltage Power Supply Building is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.8 Building 35, Cummins Generator Control Building

The Cummins Generator Control Building (Building 35) is a one-story building with a rectangular plan (see Appendix A for Images 31 to 34). The building has a flat roof with overhanging eaves. The building exterior is parged concrete. An off-centered, double-leaf metal panel door is located on the front (west) elevation. An off-centered, single-leaf metal panel door is located on the rear (east) elevation. The building has metal conduit that extends from the side (east) elevation toward the Cummins Generator Building (Building 80). The foundation is a poured concrete slab. The material condition is good.

Built in 2010, the Cummins Generator Control Building is located near the Cummins Generator Building (Building 80) and the Engineering Office Building (Building 79). Based on observation, the Cummins Generator Control Building has not had alterations or modification. The Cummins Generator Control Building does not add to the overall understanding, setting, or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the building. The Cummins Generator Control Building does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the Cummins Generator Control Building is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.9 Building 47, Main Gate Restroom

The Main Gate Restroom (Building 47) is a one-story building with a rectangular plan (see Appendix A for Images 35 to 37). The building has a flat roof on the side (south) wing, and a shed roof on the other side (north) wing. The building exterior is parged concrete. The front (east) elevation is covered by a wall that extends toward the gate wall. The wall is also parged concrete. The wall has a flat top and diagonal sides. The sides flare outward at an approximately 70-degree angle. The front (east) elevation has three bays. The openings provide access to two bathrooms, which were retrofitted in 2016. The third opening is a recessed bay that covers a drinking foundation. The bathrooms are accessed by two poured concrete ramps with metal handrails. One ramp runs from east to west near the side (north) elevation, and the other runs from north to south along the front (east) elevation. The rear (west) elevation has several small metal-louver windows. The foundation is a poured concrete slab. The material condition is good.

Built after 1975 and modified in 2016, the Main Gate Restroom is located near the Entrance Guard House (Building 4). Based on observation, the Main Gate Restroom underwent alterations to provide access for visitors with differing abilities. The Main Gate Restroom was built after the Entrance Guard House, but it was designed in similar scale, form, and material. Like the Entrance Guard House, the Main Gate Restroom does not add to the overall understanding, setting, or feeling of the NRHP-listed NAIC Historic District. The building may provide a support function to the property, but it is not directly associated with the recognized historic significance. No known significant events, persons, architects, or engineers are associated with the construction or use of the building. The Main Gate Restroom does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the Main Gate Restroom is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.10 Building 50, Interference Monitoring Shack

The Interference Monitoring Shack is a one-bay building with a moderate pitched gable roof covered by rolled asphalt (see Appendix A for Images 38 to 40). The exterior features plywood sheathing. A single-leaf metal door is located on the front (east) elevation. A single opening with through-wall air conditioner is found on the side (south) elevation. An electrical box is fixed onto the side (west) elevation. The foundation is a poured concrete slab. The material condition is good.

Built in 1992, the Interference Monitoring Shack is located above the Optical Lab (Building 27) on a small, steep hill. The building provides shelter for equipment used in the monitoring of radio interference. The material integrity and condition are good, as the exterior building envelope does not appear to have had alterations or modifications since its original construction. Therefore, the form and design are intact. The building may support necessary security functions that relate to the overall use of the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) and other instruments, but it is sited at a remote location. The Interference Monitoring Shack does not add to the overall setting or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the building. The Interference Monitoring Shack does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the Interference Monitoring Shack is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.11 Building 51, Grease Pit

The Grease Pit was located near the Maintenance Shop (Building 12) and closed to conform with environmental health regulations. As a result, a new hydraulic lift structure is located near the former location of the Grease Pit (see Appendix A for Image 41). Neither the Grease Pit nor the new structure appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the former Grease Pit and the new structure are noncontributing resources to the NRHP-listed NAIC Historic District.

6.2.12 Building 53, Emergency Generator Building

The Emergency Generator Building is a small, wood-frame building with a very low gable roof (see Appendix A for Images 42 to 44). The roof is covered by corrugated metal. The exterior of the building has plywood sheathing around the cornice and vertical corrugated metal siding. An exhaust pipe and a double-leaf metal door are located on the side (south) elevation. The front (east) elevation features a protruding angled vent. The side (north) elevation has two doors composed of the vertical corrugated metal siding. The foundation is a poured concrete slab. The material condition is good.

Built in 1992, the Emergency Generator Building houses an operable generator. The building is located near the High Voltage Power Supply Building (Building 34) and the Learning Center (Building 61). The generator has not been in use since 2010. Arecibo Observatory staff reported that the generator was

purchased by either NASA or Cornell University; however, neither organization claims ownership of the generator. As a result, the generator remains in place and unable to be sold. The material integrity and condition are good; the exterior building envelope does not appear to have had alterations or modifications since its original construction. Therefore, the form and design are intact. The Emergency Generator Building is not directly used to support scientific activities conducted at the historic property. It does not add to the overall setting or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the building. The Emergency Generator Building does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the Emergency Generator Building is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.13 Building 58, North V.S.Q. Utility Building

The North V.S.Q. (Visiting Scientist Quarters) Utility Building is a one-story building with a rectangular plan and hip roof (see Appendix A for Images 48 to 50). The moderate pitched hip roof is covered by a standing seam aluminum material. The building is concrete block with a parged concrete treatment on the exterior. The front (southwest) elevation features two doors. The northwest door is a double-leaf aluminum and glass door. The southeast door is a single-leaf aluminum and glass door. A one-bay shed roof projection is located on the side (south) elevation. The rear (east) elevation has a single bay opening with a through-wall air conditioner and single-leaf metal door. A metal-louver vent is located near the roofline next to the rear door. The side (north) elevation has a metal-louver vent. The foundation is a poured concrete slab. The material condition is good.

Built in 2002, the North V.S.Q. Utility Building is located next to the North V.S.Q. Building (Building 57). Built in 1996, the North V.S.Q. Building provides housing for visiting scientists. The Utility Building has a laundry room and a bathroom. A small pool and recreational area is located behind the Utility Building. The material integrity and condition are good, as the exterior building envelope does not appear to have had alterations or modifications since its original construction. Therefore, the form and design are intact. The Utility Building is sited outside the NRHP-listed NAIC Historic District boundary. Neither the North V.S.Q. Utility Building or the North V.S.Q. Building adds to the overall setting or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the building. The North V.S.Q Utility Building does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the North V.S.Q. Utility Building is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.14 Building 59, Visitor Center Trailer (Storage)

The Visitor Center Trailer is a metal freight shipping container (see Appendix A for Images 51 to 52). The trailer has a flat roof and metal exterior. The front (west) elevation has double-leaf metal doors. The foundation is a metal frame on concrete blocks. The material condition is good.

Sited at the location in 2016, the Visitor Center Trailer is in the Staging Yard just northeast of the main campus. The Staging Yard is primarily used for storage. The Staging Yard was used during the original construction of the Arecibo Observatory and was included on the original site plans. The Visitor Center Trailer, however, postdates the known periods of significance for the historic property. Additionally, the Staging Area is located outside the existing NRHP-listed NAIC Historic District boundary. None of the resources within the Staging Yard add to the overall setting or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the resource. The Visitor Center Trailer does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the Visitor Center Trailer is a noncontributing resource to the NRHP-listed NAIC Historic

District. No addendum to the Historic District boundary is required, as the resources within the Staging Yard are not eligible for inclusion in the NRHP.

6.2.15 Building 62, HFF Storage Trailer

The HFF Storage Trailer is a prefabricated metal building with a moderate gable roof (see Appendix A for Images 55 to 56). The roof is covered by standing seam aluminum material. The cornice line slightly protrudes around the exterior of the building. A gutter system is present. The exterior has vertical standing seam aluminum siding. An overhead door is located on the front (west) elevation near the side (north). A single-leaf metal door is located just south of the overhead door on the front (west) elevation. A single metal-louver opening is located on the front (west) elevation near the side (south). The side (north and south) elevations have two equally spaced metal-louver openings. The foundation is a poured concrete slab. The material condition is good.

Sited at the location in 2007, the HFF Storage Trailer is in the Staging Yard just northeast of the main campus. The Staging Yard is primarily used for storage. The Staging Yard was used during the original construction of the Arecibo Observatory and was included on the original site plans. The HFF Storage Trailer, however, postdates the known periods of significance for the historic property. Additionally, the Staging Area is located outside the existing NRHP-listed NAIC Historic District boundary. None of the resources within the Staging Yard add to the overall setting or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the resource. Therefore, the form and design are intact. The HFF Storage Trailer does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the HFF Storage Trailer is a noncontributing resource to the NRHP-listed NAIC Historic District. No addendum to the Historic District boundary is required, as the resources within the Staging Yard are not eligible for inclusion in the NRHP.

6.2.16 Building 63, Ionosonde Trailer

The Ionosonde Trailer is a metal military shipping container (see Appendix A for Image 57). Arecibo Observatory staff state that a former employee of the facility who was part of the U.S. National Guard arranged for a grouping of unused military containers to be utilized by the facility. The container is rectangular with a flat roof. A vent and heavy metal door are located on the front (east) elevation. The container itself does not demonstrate a building type or method of construction. The container stores a replacement Ionosonde or HF radar instrument. The material condition is good.

Sited at the location in 2007, the Ionosonde Trailer is in the Staging Yard just northeast of the main campus. The Staging Yard is primarily used for storage. The Staging Yard was used during the original construction of the Arecibo Observatory and was included on the original site plans. The Ionosonde Trailer, however, postdates the known periods of significance for the historic property. Additionally, the Staging Area is located outside the existing NRHP-listed NAIC Historic District boundary. None of the resources within the Staging Yard add to the overall setting or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the resource. The Ionosonde Trailer does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the Ionosonde Trailer is a noncontributing resource to the NRHP-listed NAIC Historic District. No addendum to the district boundary is required, as the resources within the Staging Yard are not eligible for inclusion in the NRHP.

6.2.17 Building 64, Electronic Trailer

The Electronic Trailer is a metal freight shipping container (See Appendix A for Image 58). The trailer has a rectangular plan with flat roof. The front (southwest) elevation features double-leaf metal doors. The container does not demonstrate a building type or method of construction. Arecibo Observatory staff

did state that shipping containers or trailers are often used to provide flexible space due to the remote nature of the location and funding constraints. As a result, temporary spaces, like trailers, tend to become used long-term. The material condition is good.

Sited at the location in 2007, the Electronic Trailer is in the Staging Yard just northeast of the main campus. The Staging Yard is primarily used for storage. The Staging Yard was used during the original construction of the Arecibo Observatory and was included on the original site plans. The Electronic Trailer, however, postdates the known periods of significance for the historic property. Additionally, the Staging Area is located outside the existing NRHP-listed NAIC Historic District boundary. None of the resources within the Staging Yard add to the overall setting or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the resource. The Electronic Trailer does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the Electronic Trailer is a noncontributing resource to the NRHP-listed NAIC Historic District. No addendum to the district boundary is required, as the resources within the Staging Yard are not eligible for inclusion in the NRHP.

6.2.18 Building 67, Cryogenics Lab Trailer

The Cryogenics Lab Trailer is a metal military shipping container (see Appendix A for Images 62 to 63). The trailer has a rectangular plan with flat roof. A vent and heavy metal door are located on the front (west) elevation. The container does not demonstrate a building type or method of construction.

The Cryogenics Lab Trailer was reported to be sited at the location in 1967. The trailer is near the Maintenance Shops (Building 12). However, based on the age of similar military shipping containers, it may postdate the reported age. The Cryogenics Lab Trailer is used for storage. No known significant events, persons, architects, or engineers are associated with the construction or use of the resource. The Cryogenics Lab Trailer does not appear to meet Criteria Consideration G for achieving exceptional significance within the last 50 years. Therefore, NSF has determined that the Cryogenics Trailer is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.19 Building 69, Electronic Trailer (Waveguide)

The Electronic Trailer is a metal military shipping container (see Appendix A for Image 64). Arecibo Observatory staff state that a former employee of the facility who was part of the U.S. National Guard arranged for a grouping of some unused military containers to be acquired by the facility. The container is rectangular with a flat roof. A vent and heavy metal door are located on the front (south) elevation. The container itself does not demonstrate a building type or method of construction.

Sited at the location in 2007, the Electronic Trailer is in the Staging Yard just northeast of the main campus. The Staging Yard is primarily used for storage. The Staging Yard was used during the original construction of the Arecibo Observatory and was included on the original site plans. The Electronic Trailer, however, postdates the known periods of significance for the historic property. Additionally, the Staging Area is located outside the existing NRHP-listed NAIC Historic District boundary. None of the resources within the Staging Yard add to the overall setting or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the resource. Therefore, NSF has determined that the Electronic Trailer is a noncontributing resource to the NRHP-listed NAIC Historic District. No addendum to the Historic District boundary is required, as the resources within the Staging Yard are not eligible for inclusion in the NRHP.

6.2.20 Building 70, Computer Trailer

The Computer Trailer (Building 70) is a metal shipping container (see Appendix A for Image 65). The shipping container is a standard cargo container used to ship freight. The container has a rectangular

plan with flat roof. Double-leaf metal doors are found on the front (west) elevation. The entrance is accessed by portable metal steps. An exterior electric supply is located on the side (front) elevation. The material condition is good.

Sited at the location in 2005, the Computer Trailer is in the Staging Yard just northeast of the main campus. The Staging Yard is primarily used for storage. The Staging Yard was used during the original construction of the Arecibo Observatory and was included on the original site plans. The Computer Trailer, however, is not directly associated with scientific operations at the property. Additionally, the Staging Area is located outside the existing NRHP-listed NAIC Historic District boundary. None of the resources within the Staging Yard add to the overall setting or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the resource. Therefore, NSF has determined that the Computer Trailer is a noncontributing resource to the NRHP-listed NAIC Historic District. No addendum to the Historic District boundary is required, as the resources within the Staging Yard are not eligible for inclusion in the NRHP.

6.2.21 Building 71, Electronics Cable Trailer

The Electronics Cable Trailer (Building 71) is a collection of six metal shipping containers (see Appendix A for Image 66). The shipping containers are standard cargo containers used to ship freight. The containers have a rectangular plan with flat roofs. A double-leaf metal door is found on the front (south) elevation of the containers. The containers are placed directly on the ground. The material condition is good.

Sited at the location in 2005, the Electronics Cable Trailer is in the Staging Yard just northeast of the main campus. The Staging Yard is primarily used for storage. The Staging Yard was used during the original construction of the Arecibo Observatory and was included on the original site plans. The Electronics Cable Trailer, however, is not directly associated with scientific operations at the property. Additionally, the Staging Area is located outside the existing NRHP-listed NAIC Historic District boundary. None of the resources within the Staging Yard add to the overall setting or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the resource. Therefore, NSF has determined that the Electronics Cable Trailer is a noncontributing resource to the NRHP-listed NAIC Historic District. No addendum to the Historic District boundary is required, as the resources within the Staging Yard are not eligible for inclusion in the NRHP.

6.2.22 Building 72, Electronic Trailer (Cryogenics)

The Electronic Trailer (Building 72) is a metal military shipping container (see Appendix A for Image 67). Arecibo Observatory staff state that a former employee of the facility who was part of the U.S. National Guard arranged for a grouping of some unused military containers to be acquired by the facility. The container is rectangular with a flat roof. A vent and heavy metal door are located on the front (northeast) elevation. The container itself does not demonstrate a building type or method of construction. The material condition is good.

Sited at the location in 2007, the Electronic Trailer is in the Staging Yard just northeast of the main campus. The Staging Yard is primarily used for storage. The Staging Yard was used during the original construction of the Arecibo Observatory and was included on the original site plans. The Electronic Trailer, however, postdates the known periods of significance for the historic property. Additionally, the Staging Area is located outside the existing NRHP-listed NAIC Historic District boundary. None of the resources within the Staging Yard add to the overall setting or feeling of the NRHP-listed NAIC Historic District. No known significant events, persons, architects, or engineers are associated with the construction or use of the resource. Therefore, NSF has determined that the Electronic Trailer is a

noncontributing resource to the NRHP-listed NAIC Historic District. No addendum to the Historic District boundary is required, as the resources within the Staging Yard are not eligible for inclusion in the NRHP.

6.2.23 Building 76, Visitor Center Trailer (Inspiration for Science)

The Visitor Center Trailer (Building 76) is a mobile trailer (see Appendix A for Image 70). The trailer has a rectangular plan with a flat roof. The exterior is covered with vinyl siding. The front (east) elevation has four bays. From south to north, two 3-by-3-grid fixed vinyl windows are followed by a single-leaf door with a glass panel storm door, which is next to another 3-by-3-grid fixed vinyl window. The front door is accessed by a poured concrete ramp and a side stair with metal handrails. The entrance ramp and stairs are covered with stacked stone. A poured concrete patio is located to the north of the trailer. The trailer likely has a pier foundation. The material condition is good.

Sited at the location in 2016, the Visitor Center Trailer is located near the Learning Center (Building 61). The trailer was purchased for Inspiration for Science, an education outreach program. The trailer previously housed the administration staff for the program. The program is no longer funded, and the trailer is repurposed to provide space for other staff members, including human resources, education, and public affairs. The Visitor Center Trailer provides an administration function and postdates the recognized periods of significance for the NRHP-listed NAIC Historic District. As a result, the trailer is not directly associated with the recognized significance of the property. No known significant events, persons, architects, or engineers are associated with the construction or use of the resource. The trailer does not represent a significant type, style, or method of construction. The trailer demonstrates a common building type that has not achieved exceptional significance within the last 50 years. Therefore, NSF has determined that the Visitor Center Trailer is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.24 Building 78, Coffee Hut

The Coffee Hut (Building 78) is a one-bay wood frame building with a pyramidal roof (see Appendix A for Images 75 to 76). The building features elements of the pagoda building type, or Tiki modern architecture, including elements of form, design, and material (Lu, 2014; Roadside Architecture, 2018). Wooden pagodas originated in China for use as Buddhist temples. The elements of the building type were popularized in architecture typically associated with restaurants and lounges in the West, including the United States, following World War II (ibid.). Either single to multi-storied, the pagoda building form can range from spherical to square with building materials including stone or wood. Tiki modern architecture often use the wood panel exterior treatment and flared eaves similar to the Coffee Hut.

The Coffee Hut has a pyramidal roof that is covered with asphalt shingle. The slightly flared eaves overhang the building exterior. The roof type and overall building form and scale reflect elements of the previously mentioned building type and style. Four simple wood brackets are located under the roofline on each elevation. The front (west) and side (north and south) elevations feature a central door. The front (west) elevation has a double-leaf wood door featuring wooden slats. The side (south) elevation features a single-leaf wood door with 4-by-3 lights above a solid wood panel. Fixed windows covered by graphic images of coffee plants flank the doors on all elevations. The front (west) entrance is accessed by a small poured concrete step, while the side (south) elevation is accessible by a poured concrete ramp. The side (north) elevation features an off-centered, double-leaf, wooden-slat door. Four fixed window panes with wood sash are located to the east of the door. The side (north) entrance is accessible by a wood deck, although the wood deck is in a ruinous state. The exterior is wood paneling. The foundation is a poured concrete slab. The material condition is good.

Built in 2002, the Coffee Hut is located near the Visitor Center Building or the Fundación Angel Ramos Visitor and Educational Facility (Building 54). The hut is not in use. The hut provided an entertainment function. The hut is not directly associated with the recognized significance of the property. No known

significant events, persons, architects, or engineers are associated with the construction or use of the resource. The hut does not represent a significant type, style, or method of construction. The hut demonstrates a common building type that has not achieved exceptional significance within the last 50 years. Therefore, NSF has determined that the Coffee Hut is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.25 Building 79, Engineering Office Building

The Engineering Office Building (Building 79) is a one-story concrete block building (see Appendix A for Image 77 to 78). It has a rectangular plan with flat roof. The roof is covered with gravel and has a wide cornice with closed soffits and overhanging eaves. A low-rise enclosure is located at the center of the roof near the front (north) elevation. The enclosure likely contains HVAC equipment. A one-bay hood roof extends over the front (north) entrance, which features a double-leaf glass panel and aluminum door. The door is accessed by a poured concrete ramp or three concrete stairs. The ramp is surrounded by metal handrails. The side (east and west) elevations have four bays. From north to south, the side elevations feature three metal windows and a smaller louver window near the rear (south) elevation. The rear (south) elevation has an off-centered door, which is flanked by louver windows at each side. The exterior is parged concrete. The foundation is a poured concrete slab. The material condition is good.

Built in 2010, the Engineering Office Building is located near the Maintenance Shops (Building 12) and the Warehouse (Building 17). The building provides space for engineering and operations staff. The Engineering Office Building is not directly associated with the recognized significance of the property. The ongoing maintenance facilitated by staff within the building is essential to the overall operation; however, the building itself is not directly associated with the recognized significance related to scientific use. No known significant events, persons, architects, or engineers are associated with the construction or use of the resource. The building does not represent a significant type, style, or method of construction. The building demonstrates a common building type that has not achieved exceptional significance within the last 50 years. Therefore, NSF has determined that the Engineering Office Building is a noncontributing resource to the NRHP-listed NAIC Historic District.

6.2.26 Building 80, Cummins Diesel Generator Building

The Cummins Diesel Generator Building is a one-story concrete and steel-frame building (see Appendix A for Images 79 to 80). The building provides shelter to generators. It has a rectangular plan with a one-bay shed addition on the side (south) elevation. The building has a flat roof with a low parapet. Metal exhaust vents are on the rooftop. The building has four over-sized bays on the front (west) elevation. The bays are enclosed by retractable metal-louver doors. A modest hood roof extends horizontally along the length of the front (west) elevation. Three vertical piers frame the second and third bay and support the hood roof. The side (south) elevation has a double-leaf security door, which is constructed with aluminum and has a small glass window pane in each leaf. The side (south) entrance is accessed by two metal stairs. The one-bay aluminum shed roof addition is located to the rear (east) of the entrance. The shed addition is in a slightly recessed opening. A single lead aluminum door with metal-louver window is found on the front (west) elevation. The addition has a low-pitched roof covered with corrugated metal. The roof has an open rake design. The rear (east) elevation has four over-sized bays enclosed by metal-louver doors. The rear elevation has a narrow, concrete, hood roof that extends the length of the rear elevation. The foundation is a poured concrete slab. The material condition is good.

Built in 2010, the Cummins Diesel Generator Building is located near the Engineering Office Building (Building 79). No alterations or modifications appear to have occurred. The building is not directly associated with the recognized significance of the property; instead, it serves in a support function by providing electricity. While the building is essential to the overall operation of the property, the building itself is not directly associated with the recognized significance related to scientific use. No known

significant events, persons, architects, or engineers are associated with the construction or use of the resource. The building does not represent a significant type, style, or method of construction. The building demonstrates a common building type that has not achieved exceptional significance within the last 50 years. Therefore, NSF has determined that the Cummins Diesel Generator Building is a noncontributing resource to the NRHP-listed NAIC Historic District.

SECTION 7

Conclusion

CH2M conducted a building survey between June 11 and 15, 2018 at the Arecibo Observatory in Arecibo, Puerto Rico to evaluate 32 buildings, structures, and objects that were not previously evaluated for the 2008 NRHP nomination for the NAIC Historic District, also known as Arecibo Observatory, or that were constructed between 2008 and 2015. The research methodology and field survey were designed based on criteria established by the 2008 NRHP nomination. The nomination determined that the NAIC Historic District was significant for the engineering of the William E. Gordon Telescope and Support Towers (305-meter-diameter radio telescope and three support towers), and its association with significant events that led to advancements in science and education. The approach used to determine NRHP eligibility was consistent with the approach used in the original nomination. Of the 32 previously unevaluated resources, six were determined to add to the understanding of the historic property's original use or significance, and 26 were determined noncontributing to the historic property.

The newly determined contributing resources are: the Cable Car House (Building 5), LIDAR Laboratory Building (Building 55), Antenna Testing Range Building (Building 60), Shielded Trailer (Building 65), HF Transmitter Building (Building 73), and the Phase Reference Antenna (12-meter) and Building (Building 77). All the contributing resources retain all seven aspects of historic integrity. The contributing resources add to the use and understanding of the historic property because they are directly related to significant research that occurred at the NAIC Historic District during the period of significance from 1963 to 2008. Only one of the newly determined contributing resources, the HF Transmitter Building (Building 73) was constructed in 2010 (two years after the recognized period of significance), but it is considered significant for its contribution to the ongoing use and function of the William E. Gordon Telescope and Support Tower (305-meter-diameter radio telescope). The newly eligible resources function as accessories to the William E. Gordon Telescope and are significant for their association with the telescope and its scientific advancements. In conclusion, updates to the 2008 NRHP nomination are required to add the six newly determined contributing resources to the NAIC Historic District, and expand the period of significance to 2010, in fulfillment with PA Stipulations I.A.3 and I.B.1.

SECTION 8

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