

Preservation Principles and Management Plan, Arecibo Observatory, Puerto Rico

Final

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National Science Foundation



Executive Summary

Arecibo Observatory, listed in the National Register of Historic Places (NRHP) as the National Astronomy and Ionosphere Center Historic District, is a radio astronomy observatory in Arecibo, Puerto Rico (Appendix A, Site Layout). The property is operated as a scientific research and education center. Cornell University operated the Observatory from its construction in the early 1960s until 2011. In 2018, the University of Central Florida, Yang Enterprises, and the Metropolitan University began operating the Observatory under a cooperative agreement with the National Science Foundation (NSF), the federal owner. Federal laws and regulations, in particular Sections 106 and 110 of the National Historic Preservation Act (NHPA), as amended (54 *United States Code* Section 300101, *et seq.*), specify the responsibilities of federal agencies regarding historic properties.

This Preservation Principles and Management Plan (the Plan) provides approaches to minimize the effects of operating, maintaining, and using Arecibo Observatory, a historic property. This Plan is the result of a Section 106 Programmatic Agreement between NSF, the Puerto Rico State Historic Preservation Officer, and the Advisory Council on Historic Preservation that envisions a historic preservation program for the long-term protection of the historic Arecibo Observatory (Appendix B, Programmatic Agreement).

The nationally significant Arecibo Observatory was listed in the NRHP in 2008 as a historic district 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. In 1963, the William E. Gordon Telescope and Support Towers (305-meter-diameter radio telescope and three support towers) were constructed. This engineering achievement led to a series of significant events associated with advancements in science and engineering. The district was also listed under Criterion C because it collectively represents a significant and distinguishable entity with components that may lack individual distinction. Criterion Consideration G also applied because the property was less than 50 years old at the time of listing. Being listed in the NRHP means that Arecibo Observatory meets the definition of a historic property under the NHPA.

In 2019, a NRHP Registration Form Addendum was prepared to document the nationally important advancements in science that occurred between 2008 and 2017. The addendum expanded the period of significance, now recognized as being from 1963 to 2017, and updated the resource count to 15 contributing and 19 noncontributing properties (Table 3, page 10, Section 3.1 of the NRHP Registration Form Addendum). The 118-acre historic district boundary has remained unchanged since 2008 (Appendix A).

This Plan is an internal management document to assist NSF and Arecibo Observatory operators with meeting their obligations under Sections 106 and 110 of the NHPA. The Plan summarizes federal historic preservation policy, establishes roles for historic preservation program participants, and makes recommendations on preservation principles and best practices that may be needed to accommodate the operational needs and mission of the property. The Plan takes into consideration potential operation-critical modifications, upgrades, and repairs, and incorporates these potential changes with National Park Service standards and guidelines, specifically the Secretary of the Interior's Standards for the Treatment of Historic Properties (the Standards) (*Code of Federal Regulations* [CFR] Title 36, Part 68). This Plan provides a communication strategy for identifying changes to the built environment and notifying the appropriate official. Input from responsible or interested agencies, organizations, and individuals was considered during the development of the Plan. Feasibility factors, including engineering, safety, and costs, should also be considered throughout the facility's life cycle. Architectural historians who meet the Secretary of the Interior's Professional Qualification Standards in architectural history, history, historic preservation, and historic preservation planning (36 CFR Part 61) prepared the Plan.

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Acronyms and Abbreviations

ACHP	Advisory Council on Historic Preservation
ALFA	Arecibo L-Band Feed Array
ARPA	Archaeological Resources Protection Act of 1979
ARRL	American Radio Relay League
ASME	American Society of Mechanical Engineers
CFR	<i>Code of Federal Regulations</i>
DARPA	Department of Defense Advanced Research Projects Agency
EO	executive order
FPO	federal preservation officer
FR	<i>Federal Register</i>
FRB	fast radio burst
GALFA	Galactic Arecibo L-Band Feed Array
GALFA-HI	Galactic neutral hydrogen
HABS	Historic American Engineering Record
HAER	Historic American Buildings Survey
HF	high frequency
HPO	historic preservation official
IEEE	Institute of Electrical and Electronic Engineers
IT	information technology
LIDAR	light detection and ranging
NAGPRA	Native American Graves Protection and Repatriation Act of 1990
NAIC	National Astronomy and Ionosphere Center
NANOGrav	North American Nanohertz Observatory for Gravitational Waves
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act
NRHP	National Register of Historic Places
NPS	National Park Service
NRAO	National Radio Astronomy Observatory
NSF	National Science Foundation
PA	programmatic agreement
PALFA	Pulsar Arecibo L-Band Feed Array Survey
SHPO	state historic preservation officer
UCF	University of Central Florida
UMET	Metropolitan University
U.S.	United States

UCAR	University Corporation for Atmospheric Research
USC	<i>United States Code</i>
USRA	Universities Space Research Association
VLBI	very long baseline interferometry
VSQ	visiting scientist quarters
YEI	Yang Enterprises

1. Introduction

After formal processes within the scientific community recommended divestment from Arecibo Observatory in Arecibo, Puerto Rico, the National Science Foundation (NSF) initiated consultation with the State Historic Preservation Officer (SHPO) and interested parties in 2016 to consider potential adverse effects that may occur to Arecibo Observatory, which is a National Register of Historic Places (NRHP)-listed historic property (NSF 2017). Federal laws and regulations, in particular Sections 106 and 110 of the National Historic Preservation Act of 1966 (NHPA), as amended (54 *United States Code* [USC] Section 300101, *et seq.*), specify the responsibilities of federal agencies regarding historic properties. NSF evaluated program alternatives, also referred to as action alternatives, initiated public involvement, and selected the preferred alternative, which was to collaborate with interested parties for the continuance of science-focused operations with reduced NSF funding at the Observatory (NSF 2017).

In 2017 a Section 106 agreement document, called a Programmatic Agreement (PA), was executed between NSF, SHPO, and the Advisory Council on Historic Preservation (ACHP) to streamline Section 106 compliance and encourage the facility to operate and evolve as needed under the preferred alternative, while avoiding adverse effects to the historic property. NSF signed a cooperative agreement with the University of Central Florida (UCF), Yang Enterprises (YEI), and Metropolitan University (UMET) in 2018. UCF, YEI, and UMET will serve as operators of the facility.

This Preservation Principles and Management Plan (the Plan) is an internal management document to assist NSF and the Arecibo Observatory operators with meeting their obligations under Sections 106 and 110 of the NHPA to minimize the effects of operating, maintaining, and using Arecibo Observatory, a historic property. This Plan introduces the facility operators to a historic preservation program that provides basic preservation principles to care for the property.

1.1 Federal Historic Preservation Policies

NSF is implementing its historic preservation program in accordance with federal legislation that is the foundation for the protection of federally owned or managed historic properties. Federal agencies are responsible for carrying out historic preservation planning and review for federal actions. This Plan specifies how NSF and the Arecibo Observatory operators will care for the management of the Observatory, a historic property. An overview of applicable federal statutes and regulations, executive orders, and standards and guidelines is provided in Table 1-1. The primary historic preservation policy, the NHPA, is explained in more detail in Section 1.2. A more detailed plan to implement these policies is included in Section 6.

Table 1-1. Federal Historic Preservation Policy

Legislation Name (Abbreviation) (Legal Citation)	Summary
<i>Federal Statutes and Regulations</i>	
American Antiquities Act (16 USC §§ 431–433)	Protects all historic and prehistoric sites on federal lands and prohibits excavation or destruction of antiquities without the permission of the secretary of the department with jurisdiction over those lands.
American Indian Religious Freedom Act of 1978 (42 USC §§ 1996, <i>et seq.</i>)	Established the federal policy to protect and preserve American Indian, Eskimo, Aleut, and Native Hawaiian freedom of religious beliefs, expression, and practice. This includes access to sacred sites, use and possession of sacred objects, and freedom to carry out traditional rites.
Archaeological and Historic Preservation Act (16 USC §§ 469–469c-2)	Requires federal agencies to preserve historic and archaeological data that may otherwise be lost or destroyed by any federal construction project, activity, or program.
Archaeological Resources Protection Act of 1979 (ARPA), as amended (16 USC §§ 470aa, <i>et seq.</i>)	Restricts unpermitted excavating, removing, damaging, altering or defacing of archaeological resources located on public or Indian land. Nonpermitted activities that include the selling, purchasing, or transferring of artifacts obtained in

Legislation Name (Abbreviation) (Legal Citation)	Summary
	violation of the law are a felony. Federal land-managing agencies must issue an ARPA permit prior to the start of archaeological investigations on federal property or property under federal control. In summary, ARPA permits are required when archaeological resources may be damaged by any excavation activities on federal or Indian lands (16 USC § 470cc[a]).
Historic Sites Act of 1935, as amended (16 USC §§ 461–467)	Declared a national policy for the preservation of public use of historic sites, buildings, and objects of national significance for the inspiration and benefit of the public. NPS is authorized to carry out a program of recording, documenting, acquiring, and managing places important to the understanding of U.S. history.
National Environmental Policy Act of 1969 (NEPA) (42 USC §§ 4321–4370h)	Requires federal agencies to consider effects from proposed actions on the human and natural environment prior to the approval of such actions. NEPA also calls for public involvement in the decision-making process. NEPA compliance documents must contain an assessment of impacts for a proposed action or activity on both natural and cultural resources. NEPA compliance does not substitute for Section 106 consultation. Section 106 of the NHPA can be coordinated with the NEPA process.
NHPA, as amended (54 USC § 300101, <i>et seq.</i>)	Established a national historic preservation program that requires Federal agencies to consider the effects from proposed activities on historic properties. The NHPA authorized the Secretary of the Interior to maintain, expand, and establish the NRHP (54 USC §§ 302101 and 302103); established SHPOs for all states and territories (54 USC § 302303); established the Section 106 process (54 USC § 306108); and established the ACHP (54 USC §§ 304102).
Protection of Historic Properties (<i>Code of Federal Regulations</i> [CFR], Title 36, Part 800)	The NHPA is the granting authority that requires federal agencies to take into account the effects of their undertakings on historic properties and afford the ACHP the opportunity to comment under Section 106 (54 USC § 306108). Whereas, the Section 106 implementing regulations procedures clarify how federal agencies meet these statutory responsibilities under the Protection of Historic Properties (36 CFR Part 800). The procedures define how federal agencies meet these statutory responsibilities by defining the purpose and participants, how the Section 106 process may proceed, and how an agency official may develop program alternatives to implement Section 106 and substitute them for all or part of them (36 CFR Part 800, <i>et seq.</i>).
Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), as amended (25 USC § 3001, <i>et seq.</i>)	Directs that federal agencies and institutions that receive federal funding must return Native American human remains, associated and unassociated funerary objects, sacred objects, and objects of cultural patrimony recovered from lands controlled or owned by the United States or held in collections. NAGPRA specifies that only federally recognized Native American tribes and Native Hawaiian organizations may claim cultural items.
Curation of Federally Owned and Administered Archaeological Collections (36 CFR Part 79)	Established the definitions, standards, procedures, and guidelines that federal agencies follow for preserving collections of prehistoric and historic material remains and associated records recovered under the authority of the American Antiquities Act, the Reservoir Salvage Act (16 USC §§ 469–469c), Chapter 3061 of the NHPA, or ARPA for those remains and cultural artifacts not subject to NAGPRA.

Legislation Name (Abbreviation) (Legal Citation)	Summary
Executive Orders (EOs)	
Protection and Enhancement of the Cultural Environment, EO 11593, issued on May 13, 1971	Requires agencies of the federal executive branch to administer the cultural properties under their control in a spirit of stewardship and trusteeship for future generations; initiate measures necessary to direct their policies, plans, and programs in such a way that federally owned sites, structures, and objects of historical, architectural, or archaeological significance are preserved, restored, and maintained for the inspiration and benefit of the people; and institute procedures to ensure that federal plans and programs contribute to the preservation and enhancement of non-federally owned sites, structures, and objects of historical, architectural, or archaeological significance in consultation with the ACHP.
Indian Sacred Sites, EO 13007, issued on May 24, 1996	Requires federal agencies to allow access to, and ceremonial use of, sacred Indian sites located on federal lands by Indian religious practitioners of federally recognized tribes. Reasonable notice of proposed actions or land management policies that may restrict future access to, or ceremonial use of, or adversely affect the physical integrity of, sacred sites must be provided to federally recognized tribes.
Consultation and Coordination with Indian Tribal Governments, EO 13175, issued on November 6, 2000	Clarified the legal relationship between the federal government and Indian tribal governments to reiterate the sovereignty of tribal governments. A consultation process must ensure meaningful and timely input by tribal officials for regulatory policies with tribal implications.
Preserve America, EO 13287, issued on March 3, 2003	Requires federal agencies to advance the protection, enhancement, and current use of historic resources under their ownership or management. ACHP provided recommended strategies and techniques to stimulate initiative, creativity, and efficiency for federally owned historic resources. Partnerships with federal agencies and other governmental bodies and agencies at the state, tribal, and local levels, and with the private sector, were encouraged to promote the economic development of preservation and heritage tourism.
Tribal Consultation, Presidential Memorandum, issued on November 5, 2009	Directs federal agencies to develop a detailed plan of action for implementing the policies and directives of EO 13175, Consultation and Coordination with Indian Tribal Governments, for a formalized tribal governments consultation process that considers tribal interests.
Historic Preservation Standards and Guidelines	
Secretary of the Interior's Standards for the Treatment of Historic Properties (the Standards) (36 CFR Part 68)	Provides guidelines for the treatment of historic properties and includes standards for preservation, rehabilitation, restoration, and reconstruction projects (refer to Section 5.2 for further discussion).
Secretary of the Interior's Professional Qualification Standards (the Qualifications) (48 <i>Federal Register</i> Part 44716)	Defines the minimum education and experience required to perform identification, evaluation, registration, and treatment activities in the fields of history, archaeology, architectural history, architecture, and historic preservation. States and territories may have more specific qualifications, and some tasks may require more specialized experience than a minimal qualification may provide (refer to Section 5.4 for further discussion).

Legislation Name (Abbreviation) (Legal Citation)	Summary
<i>Programmatic Agreement (PA)</i>	
PA for Potential Changes to Arecibo Observatory Operations, executed on November 15, 2017	Governs the implementation of the resolution of adverse effects from potential changes in operation of the federally owned research facility. Stipulation 1.A.4 in the PA called for the creation of this Plan to implement a historic preservation program that defines the roles for NSF, as the federal owner, and for the collaborator(s) as operator of the historic property. If NSF retains ownership of the property, the PA will expire in 10 years from its execution, or on November 15, 2027 (see Appendix B, Programmatic Agreement).

1.2 National Historic Preservation Act

The NHPA (54 USC § 300101, *et seq.*) established federal historic preservation programs and activities, including the NRHP. All federal agencies must pursue their own mission and mandates in a manner that is also in accordance with the NHPA. A federal agency must have a federal preservation officer (FPO). The FPO is responsible for coordinating the agency's activities under the NHPA, while a SHPO is appointed to implement preservation activities at a state or territorial level.

Section 106 of the NHPA (54 USC § 306108) and its implementing regulation, Protection of Historic Properties (*Code of Federal Regulations* [CFR], Title 36, Part 800), require federal agencies to consider the effects of their undertakings on historic properties. An undertaking is any project, activity, or program that is funded, in whole or in part, permitted, licensed, or approved by a federal agency, including those carried out on behalf of a federal agency. An undertaking can occur on or off federally controlled property, and it may also include any new components of a project or program not considered by previously completed Section 106 reviews. Undertakings may include demolition, new construction, rehabilitation, mothballing, changes in setting, or changes in federal ownership. All foreseeable effects from undertakings to historic properties, both direct and indirect, as well as cumulative, must be considered under Section 106.

Section 106 is a four-step process that may conclude with an agreement document, either a PA or Memorandum of Agreement, that legally binds the federal agency to executing actions that resolve adverse effects to historic properties (Figure 1-1; refer to Section 6 for more discussion). Section 106 is a flexible four-step process that identifies, evaluates, assesses, and resolves effects on historic properties. Historic properties include historic or prehistoric sites, buildings, objects, structures, and districts listed in, or eligible for listing in, the NRHP. All federal agencies planning a project must identify potential historic properties and evaluate them for their NRHP eligibility.

Section 106 establishes the steps that must occur, but the process is neither proscriptive nor one size fits all. Solutions must be considered through consultation with the appropriate parties and qualified professionals. Not all solutions will be appropriate for the treatment of historic properties, and early engagement in consultation enables discussion to occur prior to decision making. Early engagement with consulting parties is highly encouraged (refer to Section 2.2 for further discussion on consulting parties). Consultation ensures that historic properties are recognized and considered, the appropriate treatment of historic properties is prioritized, and tangible outcomes minimize negative effects on historic properties. Section 106 is not intended to stop any changes from occurring to historic properties, but instead to ensure that federal agencies carry out reasonable and good faith consideration of any foreseeable adverse effects to historic properties when an undertaking is planned.

Section 110 of the NHPA sets out broad historic preservation responsibilities for federal agencies to establish a fully integrated historic preservation program that identifies, evaluates, and protects historic properties under federal control (54 USC §§ 306101, *et seq.*). Sections 110 and 111 of the NHPA define additional federal agency responsibilities, including the ongoing identification, management, maintenance, and use of historic properties. The ultimate program goal is to increase knowledge of our historic resources, establish best practices, and encourage effective planning and execution of preservation nationwide.

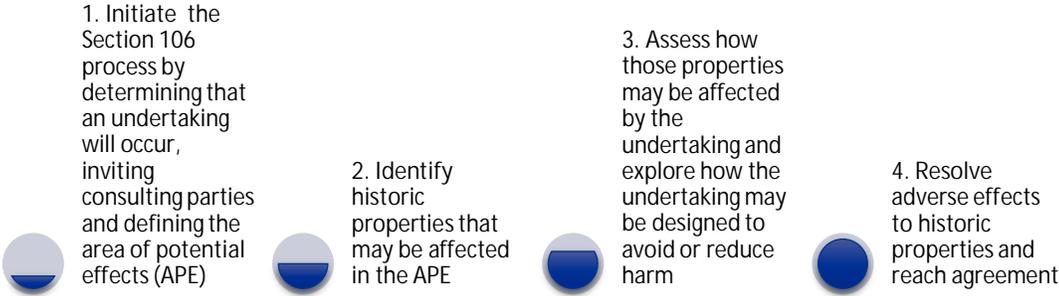


Figure 1-1. The Section 106 Four-Step Process

2. Historic Preservation Planning

Federal historic preservation mandates acknowledge that history and culture should be preserved because historic properties are irreplaceable heritage that benefit the public through the tangible attributes of increased knowledge and economic growth and development (54 USC § 300101, *et seq.*). Preservation planning is a process to help implement this policy through the long-term care of historic properties. By planning for change, preservation concerns may be addressed in actions that include large scale programs and activities, as well as day-to-day maintenance tasks. Effective planning has a successful outcome when an integrated historic preservation program meets the mission of all partners and participants, while taking into consideration how historic properties are protected and enjoyed by future generations. In the following chapters, the Plan identifies preservation needs and priorities, presents important information, documents the importance of Arecibo Observatory, makes recommendations on how to care for its historic characteristics, and creates a communication and documentation process tailored to the property.

2.1 Arecibo Observatory

Arecibo Observatory, historically known as the National Astronomy and Ionosphere Center (NAIC), is located in the western hills of the town of Arecibo, Esperanza Ward, Puerto Rico (Figure 2-1). It is the site of the William E. Gordon Telescope, the world's largest and most powerful radar and radio astronomy telescope of its time (Image 1). Since 2018, the UCF, YEI, and UMET have operated the Observatory under a cooperative agreement with NSF. The facility operators are entrusted with the care and maintenance of a nationally significant historic property, while also ensuring that the legacy of scientific research and operations continues into the future. Because historic preservation aspires to bring the historical and cultural foundations of the past into the present and future, Arecibo Observatory's distinction as an operable observatory and a nationally significant historic district is a dynamic opportunity to showcase how historic preservation and technology can work in concert to advance the American legacy of scientific research and education for future generations.

From Arecibo Observatory's founding in 1963 to today, the facility has contributed to the advancement of radio astronomy and its related sciences. It has also brought attention to its unique location and the natural resources found within this karst region. Every year, nearly 100,000 visitors experience the site and the educational offerings provided by the Visitor Center. The bilingual educational program offers varying engaging, sensory experiences that inspire visitors to explore the unseen universe and its wonder through technology and science. This exceptional combination of research and educational tourism affords unmatched immersive learning experiences for people of all ages and from all over the world within the welcoming culture of Puerto Rico.

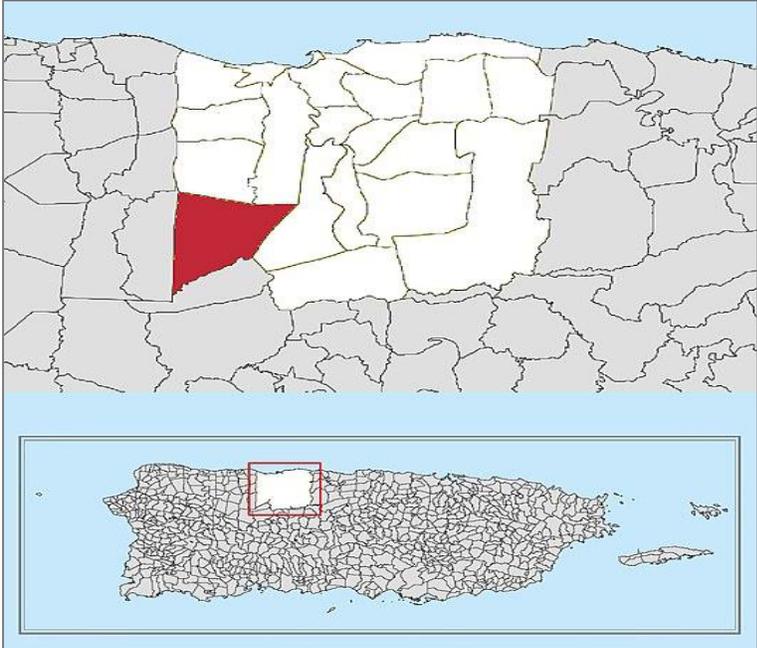
Arecibo Observatory is home to notable technology and discoveries with accolades that stretch beyond its designation in the NRHP. The William E. Gordon Radio Telescope sparks curiosity as an engineering marvel, including declaration by the Institute of Electrical and Electronic Engineers (IEEE) and the American Society of Mechanical Engineers (ASME) as an IEEE Milestone in Electrical Engineering and an ASME Landmark in Mechanical Engineering. Russell Hulse and Joseph Taylor were awarded the 1993 Nobel Prize in Physics for their work at Arecibo Observatory, which included the confirmation that gravitational waves exist. Discoveries made at the Observatory have informed the study of ionospheric physics, radar, and radio astronomy. The Observatory also was used in significant events in space history, such as helping the National Aeronautics and Space Administration (NASA) select lunar landing sites.

Today, Arecibo Observatory continues to embody its legacy of science and technology as an operable observatory and this legacy is demonstrated through the contributing resources in the historic district. The historic district offers real-world engagement with the past through its resources. Scientists continue to conduct research within the buildings and structures by adapting historic instrumentation to carry out contemporary studies. A visitor, or scientist, can easily imagine what it was like when some of the earlier studies were conducted that advanced astronomy or when more recent studies confirmed theories. Most of the architecture is from the Cold War era, and this period's architecture embodies a feeling of how an

originally military-funded facility transitioned over time into an academic and tourist destination and a center for discovery.



Image 1. William E. Gordon Telescope, facing south



Red polygon denotes Arecibo's location within the ward.
Source: Courtesy of the Eloquent Peasant, 2019.

Figure 2-1. Map of Esperanza Ward, Puerto Rico

2.2 Historic Preservation Participants

The value of Arecibo Observatory as an operable scientific facility and an intact historic district is supported by its good condition and strong sense of place. This Plan provides preservation principles that allow for changes that are necessary to continue its scientific and educational mission. A commitment from all levels of staff is required to successfully carry out an integrated historic preservation program. The director, administration, computer department, electronics department, facilities maintenance, visitor center, dining services, security, and visiting scientists have ownership in promoting the district's history and implementing its management and care as a historic property. The Plan is applicable to all Arecibo Observatory personnel, facilities, and activities, including tenants, contractors, grantees, licensees, and other parties operating under the auspices of Arecibo Observatory. As the district's good condition demonstrates, Arecibo Observatory is cared for by its many stewards and enjoyed by many local and international students, tourists, and scientists who visit each year. This plan complements the current structure of facility operations and is not intended to alter position titles or work processes other than to implement preservation considerations into the facility's use and maintenance activities.

Internal and external participants, including the public, may contribute to a historic preservation program but the federal agency is ultimately responsible for the compliance activities. As introduced in Section 1, early coordination with knowledgeable parties such as SHPO supports efficient and effective preservation outcomes. Responsible staff who carry out the care and maintenance of the facilities are crucial to the long-term preservation of the historic district. Identifying all potential staff who participate in the care of the facility and acknowledging their responsibilities for the nuts-and-bolts of material preservation will encourage a well-integrated historic preservation program. It is important to keep a clear line of communication in place and simple protocols to avoid burdensome procedures. For example, it is recommended that historic preservation considerations be merged with existing procedures, such as maintenance procedures and annual reporting. Successful preservation efforts can be strengthened by providing specialized historic preservation awareness training that aligns with existing responsibilities of appropriate staff. This Plan presents a table of recommended roles for historic preservation participants within a framework that addresses the preservation approach for the treatment of the district's significant characteristics and qualities that qualify it for listing in the NRHP (Table 2-1).

Assigned roles are necessary to ensure the successful implementation of the Plan. Some staff members, such as the program director or maintenance staff, must ensure preservation is considered throughout the operation's planning and management process. The appointed historic preservation official (HPO) on site will report directly to either the FPO or program director. The HPO coordinates with maintenance staff to ensure historic preservation awareness and policy are integrated within all programs and tenant organizations at Arecibo Observatory. The director/HPO may appoint the department head of facilities or another applicable department to oversee the day-to-day implementation. The HPOs ensure that both short-term actions and long-term property planning activities take into account the effects on historic properties. Departmental staff who plan and complete property maintenance must be aware of preservation principles and best practices, because they are tasked with the brick-and-mortar activities that could damage historic property.

During the Section 106 process, NSF consulted with a number of parties who had interest in the historic property. Consulting parties are interested groups or individuals who participate in the Section 106 process. These parties include the SHPO, local officials, and individuals or organizations with a demonstrated interest due to their legal or economic relationship to a project or to affected properties, or their concern with the effects on historic properties. Native American groups may also be consulting parties, but there are no federally recognized tribal groups in Puerto Rico at this time. Consulting parties advise and assist the federal agency official in its historic property identification efforts and help inform the process. A consulting party may also serve as a signatory (SHPO), invited signatory, or concurring party when invited to sign a Section 106 agreement document. However, unlike a signatory or an invited signatory, concurring parties do not have the authority to amend or terminate the agreement (36 CFR Section 800.6[c][3]).

The only parties with responsibilities mandated by the PA are NSF, SHPO, and the operators. The following individuals participated in the Section 106 process and were invited to sign the PA as concurring parties:

- Anthony van Eyken, Ph.D. (STI International)
- Brett Isham, Ph.D. (Interamerican University-Bayamon)
- Xavier Siemens, Ph.D. (American Nanohertz Observatory for Gravitational Waves)
- Nicholas White, Ph.D. (University Space Research Association)
- Qihou Zhou, Ph.D. (Miami University)
- Ms. Luisa Zambrano-Marin (Arecibo Observatory)
- Daniel R. Altschuler, Ph.D. (University of Puerto Rico)
- Mr. Miguel Babilonia (Puerto Rican Karzo Speleological Research Foundation)
- Carmen Pantoka, Ph.D. (University of Puerto Rico)
- Joan Schmelz, Ph.D. (University Space Research Association)

The number of consulting parties and the high level of engagement demonstrates the importance of Arecibo Observatory to Puerto Rico and the scientific community.

In summary, implementation of a historic preservation plan is not possible without careful, day-to-day maintenance of the facility, long-term planning that considers the historic property, and integration of all levels of staff in the care and protection of historic properties. At Arecibo Observatory, the HPO ensures that adequate resources and training are provided to the property in terms of this Plan. The HPO also ensures that any potential adverse effects are communicated in advance so that appropriate compliance activities as determined by the federal agency may occur. A periodic review of this Plan is encouraged to confirm that the participants remain informed and adequately trained and that new staff are onboarded.

Table 2-1. Historic Preservation Participants

<p>Federal Preservation Officer</p> <ul style="list-style-type: none">• Oversees NSF's compliance activities and historic preservation program at an agency level.• Interacts with SHPOs, Tribes, and other FPOs to carry out the agency's mission and historic preservation obligations under the NHPA.
<p>Historic Preservation Official</p> <ul style="list-style-type: none">• Acts as the onsite official for historic preservation and reports to either the FPO or Program Officer.• Oversees compliance activities in coordination with the FPO.• Reviews the annual funding report to ensure that any proposed activities that may need Section 106 consultation are not initiated until compliance activities are resolved, and escalates such activities to either the FPO or Program Officer's attention.• May appoint a departmental head to carry out day-to-day oversight of operations at the Observatory.• Ensures a work flow is established that incorporates preservation principles with the established operation plan.• Ensures all completed work follows the recommended preservation approach and is logged appropriately with before-and-after photographs, site plans, drawings, or other appropriate documentation.• Responsible for ensuring facilities management and other staff receive preservation principles training.• Informs either the FPO or Program Officer before any changes occur to the historic property and its contributing resources.
<p>Facilities Maintenance Staff</p> <ul style="list-style-type: none">• Reports to the HPO.• Carries out the brick-and-mortar activities at the Observatory, including ordering materials and completing repairs.• Responsible for understanding what qualities and characteristics contribute to the historic district.• Responsible for identifying recommended and not recommended treatments for the care of historic material.• Responsible for making the HPO aware immediately if treatments are used that are not recommended.• Responsible for logging all completed work.
<p>Other Staff</p> <ul style="list-style-type: none">• Reports to departmental head.• Escalates concerns to the HPO, such as recognizing when preventative maintenance should occur or when other potential issues may be encountered. For example, visitor center and security staff communicate potential issues that may arise from site tourism.• Ensures job duties align with historic preservation principles. For example, ensures visiting scientists receive proper instruction on facility and instrument use.
<p>State Historic Preservation Officer</p> <ul style="list-style-type: none">• Responsible for administering historic preservation programs within Puerto Rico.• Provides comment on compliance reviews under Section 106 to either concur or not concur with the identification of historic properties and assessment of effects.• Required Signatory on Section 106 agreements.• Can provide technical assistance on preservation-related issues.
<p>Advisory Council on Historic Preservation</p> <ul style="list-style-type: none">• Federal agency that advises the President and U.S. Congress on national historic preservation policy.• May participate in resolving adverse effects to historic properties and Section 106 agreements.• May participate in Section 106 reviews when an undertaking has substantial impacts on important historic properties, presents important implications to policy interpretation, requires procedural guidance, or presents concerns for Native American tribes or Native Hawaiian organizations.
<p>Other Consulting Parties (Tribes, Local Officials, and Interested Parties)</p> <ul style="list-style-type: none">• May have roles in the Section 106 consultation process, such as assisting in the identification of historic properties, participating in discussions about avoidance, minimization and mitigation, and concurring on agreement documents.• Only federally recognized Native American tribes have specific protections under U.S. policy.

3. Documentation

Preservation seeks to retain historically significant components, even as they adapt to changing needs. Documentation is a tool to help inform preservation activities by defining historic characteristics, capturing existing conditions, and detailing changes that are made. This section describes previously completed documentation that defines what qualifies the historic district for listing in the NRHP, including which characteristics and qualities contribute to the historic district. This chapter will discuss how preservation principles may be implemented for the long-term protection of the historic property, and what activities may require further documentation.

Having clear documentation that explains what qualifies the property for listing in the NRHP makes it easier to understand which characteristics must be protected, which contributing resources retain the most historic integrity, and how the overall historic integrity of the district is intact. This information helps define preservation priorities and assists with determining what may be appropriate or not within the historic district. It is important for the documentation to remain accessible, organized, updated, and retained as necessary throughout the life cycle of the property.

Documentation serves as a reference point to determine how the condition of the historic district is faring and whether additional intervention measures are necessary. Documentation, such as maintenance logs, may also support future scholarship on the property's history and achievements. In some cases, new documentation will serve as mitigation for the potential loss of historic characteristics within the historic district. If demolition is proposed, the PA requires further documentation. Section 3.2 describes when further documentation is required under the PA. In Table 3-2, each PA stipulation is listed with a status column that should be reviewed and updated accordingly.

3.1 Completed Documentation

A historic context was prepared to explain why the historic district is important within its period of significance. Individual architectural and engineering resources were identified through survey, research, and consultation. Research involved primary sources, including oral histories from former and present Arecibo Observatory staff and faculty. The district's historic setting and character-defining features were also described. These features originated from federally funded and planned development that spurred national interest in radio astronomy and shaped the historic district's built environment.

Beginning in 2016, as the first step in the Section 106 process, NSF initiated consultation with SHPO and interested parties regarding potential changes in the operation of Arecibo Observatory, a historic district, which may have included transfer from federal ownership. These changes constituted a federal undertaking under Section 106 of the NHPA (54 USC § 306108). NSF conducted its Section 106 consultation process concurrently with, but separate from, its NEPA process. During this process, additional documentation of the district's built environment and history was made.

As the second step in the Section 106 process, NSF identified Arecibo Observatory, historically known as the NAIC, as a historic property that was listed in the NRHP as a district in 2008 under Criteria A and C. The district was determined nationally significant and listed in the NRHP 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. The district was listed in the NRHP under Criterion C because the district collectively represents a significant and distinguishable entity which has components that may lack individual distinction. In addition to Criteria A and C, Criteria Consideration G was applied for Arecibo Observatory because the district was less than 50 years of age when it achieved its significance. The 1963 construction of the William E. Gordon Telescope and Support Towers (305-meter-diameter radio telescope and three support towers) led to a series of significant events associated with advancements in science and education. The property has continued to operate as a scientific research and educational center. Subsequently, ongoing studies at the Observatory have led to advancements of national importance in science since its nomination in 2008. The NRHP registration form was updated in 2015 to correct property ownership and accurately reflect NSF as the property owner.

Arecibo Observatory was recorded as a district because it possesses a significant concentration of buildings and structures united historically by plan and physical development. The district is composed of a wide variety of resources that convey a visual sense of its historical use and its importance to our history. A district is one category of historic property; there are four other categories: buildings, structures, objects, and sites. A contributing resource is a building, structure, object, or site that adds to the historic significance of a district. Of the 13 buildings and 1 structure described on the 2008 NRHP registration form, SHPO identified 8 buildings and 1 structure as contributing resources to the district. A historic property survey was completed in June 2018 that evaluated all resources within the district, including previously unevaluated ones. The contributing resource count was subsequently updated to 15 contributing resources (refer to Table 3-1 for contributing and noncontributing resources and Appendix A for a map showing their locations). No archaeological resources were identified within the property.

Table 3-1. Arecibo Observatory Historic District Contributing and Noncontributing Resources

Building Number [2008 Nomination]	Resource Name	Year of Construction	Location (Universal Transverse Mercator [UTM]) 19 Quadrangle
Contributing Resources			
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 (upgrades in 1972 to 1974 and in 1997)	737295.58 m E 2029601.43 m N
Building 1 [Building 1]	Operations Building	1963 (addition in 1983)	737395.87 m E 2030000.43 m N
Building 2 [Building 2]	Administration Building	1963 (addition in 1997)	737402.22 m E 2030059.99 m N
Building 5*	Cable Car House	1963	737414.69 m E 2029968.81 m N
Building 12 [Building 13]	Maintenance Building	1967	737579.51 m E 2030034.27 m N
Building 17 [Buildings 11 and 12]	Warehouse and Business/Purchasing	1967	737619.95 m E 2030067.19 m N
Building 27 [Building 7]	Photometry Shack and Optical Lab	1985/1997	737335.67 m E 2030029.00 m N
Building 54 [Building 5]	Visitor Center (Fundación Angel Ramos Visitor and Educational Property)	2001 (addition 2015)	737510.00 m E 2029968.58 m N
Building 55 [N/A]	LIDAR Laboratory Building	1996	737322.75 m E 2030065.49 m N
Building 60 [N/A]	Antenna Testing Range Building	circa 1995	737316.53 m E 2030040.89 m N
Building 61 [Building 6]	Learning Center	2001	737486.00 m E 2029999.00 m N
Building 65 [N/A]	Shielded Trailer	1983	737422.26 m E 2030022.46 m N
Buildings 66 and 68 [Building 1A]	Atmospheric Science Trailer, and Visiting Science Trailer (counted as one building)		737389.00 m E 2030044.00 m N
Building 73 [N/A]	HF Transmitter Building	2009	737574.41 m E 2030011.37 m N

Building Number [2008 Nomination]	Resource Name	Year of Construction	Location (Universal Transverse Mercator [UTM]) 19 Quadrangle
Building 77 [N/A]	Phase Reference Antenna (12-meter) and Building (counted as one structure)	2010	737597.47 m E 2030187.28 m N
Noncontributing Resources			
Building 3 [Building 3]	Visiting Scientist Quarters and Cafeteria	1963	737412.93 m E 2030111.70 m N
Building 4 [N/A]	Entrance Guard House	1975	737531.91 m E 2030329.38 m N
Building 6 [N/A]	Pump House/Water Treatment Building	1963 (addition 2010)	737380.71 m E 2030056.63 m N
Building 10 [Building 4]	Swimming Pool/Restrooms	circa 1965	737438.92 m E 2030166.43 m N
Building 11 [N/A]	Lewis Building-Rigging Loft	circa 1965	737426.58 m E 2029947.82 m N
Building 13 [N/A]	Bowl Shack	1963	737454.41 m E 2029738.15 m N
Building 21 [N/A]	Antenna Testing Range	circa 1985	737489.00 m E 2029968.00 m N
Building 25 [N/A]	Paint Storage Building	circa 2010	737657.08 m E 2030068.49 m N
Building 34 [N/A]	High Voltage Power Supply Building	1973	737462.00 m E 2030002.00 m N
Building 35 [N/A]	Cummins Generator Control Building	2010	737677.55 m E 2030041.40 m N
Buildings 41 and 42 [Building 8]	West Hill VSQ Bachelor Unit 1 and 2	circa 1970s	737366.79 m E 2030174.00 m N 737368.75 m E 2030197.99 m N
Buildings 43 and 44 [Building 9]	West Hill VSQ. Family Unit 1 and 2	circa 1970s	737394.31 m E 2030288.22 m N 737380.08 m E 2030291.99 m N
Building 47 [N/A]	Main Gate Restroom	circa 1975 (addition 2016)	737500.46 m E 2030327.30 m N
Building 50 [N/A]	Interference Monitoring Shack	1992	737338.66 m E 2029971.25 m N
Building 51 [N/A]	Grease Pit	Not Extant	737580.48 m E 2030071.21 m N
Building 53 [N/A]	Emergency Generator Building	1992	737468.00 m E 2030024.00 m N
Building 57 [Building 10]	North VSQ Building	1996	737409.12 m E 2030374.66 m N
Building 58 [N/A]	North VSQ Utility Building	2002	737426.00 m E 2030343.00 m N

Building Number [2008 Nomination]	Resource Name	Year of Construction	Location (Universal Transverse Mercator [UTM]) 19 Quadrangle
Building 67 [N/A]	Cryogenics Lab Trailer	1967	737601.00 m E 2030032.00 m N
Building 76 [N/A]	Visitor Center Trailer (Inspiration for Science)	2016	737490.00 m E 2030034.00 m N
Building 78 [N/A]	Coffee Hut	2002	737507.00 m E 2030047.00 m N
Building 79 [N/A]	Engineering Office Building	2010	737649.00 m E 2030034.00 m N
Building 80 [N/A]	Cummins Diesel Generator Building	2010	737693.00 m E 2030025.00 m N
Resources Located Outside of the Historic District			
Building 59** [N/A]	Visitor Center Trailer (Storage)	2016	737787.82 m E 2030229.37 m N
Building 62** [N/A]	High Frequency Feed (HFF) Storage Trailer	2007	737776.65 m E 2030215.14 m N
Building 63** [N/A]	Ionosonde Trailer	2007	737746.00 m E 2030211.00 m N
Building 64** [N/A]	Electronic Trailer	1990	737779.55 m E 2030232.66 m N
Building 69** [N/A]	Electronic Trailer (Waveguide)	2007	737752.86 m E 2030212.60 m N
Building 70** [N/A]	Computer Trailer	2005	737785.35 m E 2030222.30 m N
Building 71** [N/A]	Electronics Cable Trailer	2005	737754.92 m E 2030252.36 m N
Building 72** [N/A]	Electronics Trailer (Cryogenics)	2005	737740.59 m E 2030218.36 m N

Notes:

*Shaded row indicates contributing resource newly determined during historic property survey in June 2018.

**Indicates resource located outside of NRHP Historic District boundary that is Individually Not Eligible for NRHP under any Criteria

A historic property must represent a significant part of history, architecture, archaeology, engineering, or culture of an area, and it must retain the characteristics that make it a good representative of similar properties. There are four NRHP Criteria and seven Criteria Considerations. A property is evaluated under the criteria to determine if it is eligible for the NRHP. A property need only be eligible under one criterion and retain sufficient historic integrity to qualify for listing in the NRHP (refer to Section 5.1.1 for further information on historic integrity).

On October 9, 2016, NSF submitted an assessment of effects report that identified potential adverse effects to the historic property as part of the third step of the Section 106 process. This assessment coincided with consulting party meetings on November 17, 2016. NSF presented five action alternatives

as part of the environmental impact statement prepared under NEPA that explored measures of avoidance. These alternatives included the following:

- Collaboration with interested parties for continued science-and-education-focused operations with reduced NSF funding (Preferred Alternative)
- Collaboration with Interested Parties for Transition to Education-focused Operations
- Mothballing Facilities
- Partial Demolition and Site Restoration
- Complete Demolition and Site Restoration

The majority of consulting parties and members of the public who submitted comments during the Section 106 and NEPA processes described the cultural and scientific importance of Arecibo Observatory and emphasized a strong preference for continued science-focused operation, which was consistent with NSF's Preferred Alternative. Because the change in operation had the potential to result in adverse effects to the historic district, and it was unknown whether a viable new collaborator could be found or what their needs might be, NSF elected to complete the Section 106 process through a PA (Appendix B). The PA addresses how potential adverse effects to the NRHP historic district may be resolved. It states that NSF will ensure that if the Preferred Alternative (Collaboration with Interested Parties for Continued Science-and-Education-focused Operations with Reduced NSF Funding) or one of the other Alternatives is selected, then stipulations defined by the PA will be implemented. The stipulations require consultation on preservation principles and management strategies, which include the creation of this Plan and subsequent training for new collaborators. The PA was executed on November 15, 2017, among the signatories: NSF, the ACHP, and the Puerto Rico SHPO, with Arecibo Observatory signing as an Invited Signatory.

In 2018, a Historic Property Survey Plan and Building Survey Report were prepared to document and assess the eligibility of architectural resources within the district (Jacobs 2018a, 2018b). The Historic Property Survey Plan presented research and survey methodologies to evaluate the individual NRHP-eligibility of resources within the historic district and determine whether they either contributed to the historic district (Jacobs 2018a). The Building Survey Report provided an updated historic context to address the extended period of significance and eligibility results from the building survey (Jacobs 2018b). On February 4, 2019, SHPO agreed with the eligibility findings from the Building Survey Report (SHPO 2019). SHPO also agreed with the extended period of significance, increasing it from 2007 to 2017, and acknowledged that the newly discovered observations qualified as significant events within the history of the district. The original NRHP Registration Form completed by SHPO in 2007 was referenced during the preparation of the NRHP Registration Form Addendum (Santos 2007; Wobig 2019). The addendum was prepared with the findings and information compiled in the Building Survey Report (Wobig 2019). This Plan uses the information from the NRHP Registration Form Addendum for its recommendations. It is recommended to review the original NRHP Registration Form and the Addendum when assessing the contributing resources and making maintenance decisions (Santos 2007; Wobig 2019).

3.2 Future Documentation Needs

The PA stipulations address adverse effects to the historic property from implementation of the Preferred Alternative under two scenarios: NSF retains ownership of Arecibo Observatory with reduced NSF funding, or NSF transfers ownership of Arecibo Observatory to a non-federal entity (Appendix B, Stipulation I.A. and I.B.). NSF will retain ownership of Arecibo Observatory for the foreseeable future, and therefore, Stipulation I.A. of the PA will be implemented (Table 3-2). Table 3-2 includes a Status column that should be reviewed and updated as changes occur. Identification and documentation of historic architectural resources has occurred, including the completion of a NRHP Registration Form addendum. Because no archaeological survey has occurred, a Secretary of the Interior-qualified archaeologist may be required to review for potential archaeology before any substantial ground-disturbing activities occur. Intact buried cultural deposits, however, are not likely present within the historic district because of the

natural soil properties of the karst region and previous ground-disturbing activities that occurred during the original site construction.

Should NSF transfer ownership of Arecibo Observatory to a non-federal owner, Stipulation I.B. of the PA would be implemented (Appendix B).

Table 3-2. Programmatic Agreement Stipulations that Apply if NSF Retains Ownership (Stipulation I.A.)

Stipulation	Action	Status
Avoidance of Adverse Effects (I.A.1)	NSF will encourage collaborator(s) to keep as many contributing resources in use as possible, and if abandonment is necessary, NSF will consider mothballing prior to demolition. If mothballing occurs, it shall be carried out in accordance with the NPS Preservation Brief 31: Mothballing Historic Buildings.	All contributing resources remain in use as of February 2020. No known plans for abandonment or demolition.
Support of National Historic Landmark Nomination (I.A.2)	NSF, subject to the consent of the collaborator(s), will support a National Historic Landmark Nomination if SHPO wishes to proceed with the nomination of Arecibo Observatory.	SHPO to determine whether nomination shall proceed as of February 2020.
Survey (I.A.3)	NSF will conduct a survey of the district to evaluate the eligibility of any previously unevaluated architectural resources, and submit a NRHP Registration Form Addendum.	Survey complete. Draft NRHP Registration Form Addendum prepared and submitted to SHPO for comment in March 2019. Awaiting SHPO comments.
Preparation of NAIC Historic District Preservation and Management Plan (I.A.4)	NSF, in consultation with SHPO, ACHP, and the collaborator(s), will prepare and implement, as applicable, a Preservation and Management Plan (this Plan) that defines roles for NSF as a federal owner and the collaborator(s) as operator(s) of the historic property.	Completed by May 2020.
Demolition of any Contributing Resource (I.A.5[a])	NSF will ensure that documentation is completed prior to the demolition of any contributing resource to the district (Table 3-1). An appropriate level of documentation shall be determined and completed.	No demolition proposed as of February 2020.
Demolition of any Noncontributing Resource (I.A.5[b])	No documentation is required prior to the demolition of any noncontributing resource to the district (Table 3-1).	No demolition proposed as of February 2020.
Proposed Demolition of Unevaluated Building or Structure Not Otherwise Listed or Identified (I.A.6)	NSF will conduct, as appropriate, a new Section 106 consultation prior to any NSF-approved demolition.	No demolition proposed as of February 2020.
New Construction or Other Changes within Historic District (I.A.7)	NSF will conduct, as appropriate, a new Section 106 consultation prior to any NSF-approved new construction or modifications.	Routine maintenance and hurricane relief efforts are ongoing. No new construction or modifications within district that constitute a new undertaking proposed as of February 2020.
Preservation Principles Training (I.A.8[a])	NSF will provide, and key facility staff of the collaborator(s) will attend, historic preservation awareness training to encourage awareness of the historic and cultural significance of Arecibo Observatory and to minimize the potential for adverse effects to historic properties.	Training to be scheduled by May 2020.

Stipulation	Action	Status
Preservation Principles and Management Plan (I.A.8[b])	The collaborator(s) will incorporate, where practicable, appropriate elements of the historic district Preservation and Management Plan (this Plan) into the management and operations of Arecibo Observatory in a manner that does not interfere with the ability of the collaborator(s) to conduct science-focused operations at Arecibo Observatory.	Maintenance Plan to be completed by May 2020.
Public Access (I.A.8[c])	The collaborator(s) will allow reasonable public access to the Arecibo Observatory site provided that such access does not unduly interfere with the collaborator's use of the property for science-focused operations and is consistent with health, safety, and security guidelines.	Public Access remains ongoing and there are no plans to change public access as of February 2020.

If additional documentation is required for architectural resources (Stipulation I.A.5[a]), the Secretary of the Interior's *Standards and Guidelines for Architectural and Engineering Documentation: HABS/HAER Standards* are encouraged to be referenced as a standard for documentation (48 FR 190). Careful consideration of each standard will lead to the appropriate documentation. The level of documentation needed will be reached through consultation with SHPO. There are four standards for documentation:

- **Standard 1:** Documentation shall adequately explicate and illustrate what is significant or valuable about the historic building, site, structure, or object being documented.
- **Standard 2:** Documentation shall be prepared accurately from reliable sources with limitations clearly stated to permit independent verification of this information.
- **Standard 3:** Documentation shall be prepared on materials that are readily reproducible, durable, and in standard sizes.
- **Standard 4:** Documentation shall be clearly and concisely produced.

Moreover, these standards have four levels of documentation in varying degrees of content, quality, materials, and presentation. The choice of level of documentation is based on the importance of the historic property and resources available. NSF, in consultation with NPS and SHPO, would determine the appropriate level before any demolition or dismantling of any resources would occur. Documentation may differ based on the significance of the contributing resources proposed for demolition, but it may include digital photography, laser scans or measured drawings, field notes, and a written architectural description and history.

No additional documentation, other than those outlined in Table 3-2, are recommended. NSF, as owner of the historic property, or the collaborators, as operator of the historic property, must follow the PA stipulations as outlined in Table 3-2 and Appendix B. If a new Section 106 review is necessary, NSF shall initiate consultation with Puerto Rico SHPO and all applicable consulting parties as specified under Section 106 of the NHPA (54 USC § 306108) and all other applicable regulations (refer to Section 1 for further discussion on the Section 106 process).

4. Historic Context

Because historic preservation seeks to preserve, conserve, and protect buildings, structures, objects, and sites important to our history, it is necessary to understand why Arecibo Observatory is nationally significant. Preservation protects the distinct qualities that contribute to the feeling of an important place. A place conveys its importance through its association, materials, design, location, setting, workmanship and feeling. These are the seven aspects of historic integrity (refer to Section 5.1.1 for further discussion on integrity). A historic property cannot convey its importance without sufficient integrity. It does not need all seven aspects to convey its importance, but it does need to retain the aspects that relay how it achieved significance. For example, the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) is the primary instrument that helped Arecibo Observatory achieve its national significance. The telescope's design demonstrates its contribution to engineering and radio astronomy. If the telescope was drastically changed from a dish to a cube, for example, it would no longer retain its integrity of design. The telescope would no longer be able to convey how it contributed to the history of radio astronomy during the early 1960s, and someone who was present at its time of construction would not recognize it. The historic context is what we interpret to understand why something is significant; historic integrity is what allows us to experience the past.

A historic property is evaluated in terms of the history of the relevant geographical area, the associated historical themes or subjects, and the historical and contemporary time period. NPS NRHP bulletins cover topics that include how to evaluate a historic property within its historic context. These bulletins informed Arecibo Observatory's 2008 and 2019 NRHP Registration Form and Addendum. Arecibo Observatory's historic context explains the significant events and achievements that contributed to advancements in the science of radio astronomy and engineering. A historic context is a summary document, not a thesis. It collects relevant, cited information that may support future research endeavors. The historic context includes a statement of context and background history, while it connects the physical resources of the district to the broad thematic associations that make it significant. The following sections provide Arecibo Observatory's historic context and some of the many important events that occurred during its period of significance from 1963 to 2017 (Table 4-1).

Table 4-1. Important Events in Arecibo Observatory's Period of Significance (1963–2017)

Important event	Date
William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) constructed.	1963
Cornell University and NSF signed cooperative agreement.	1969
NASA installed a high-power transmitter that provided better resolution for imaging Venus.	circa 1970
William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) upgrades occurred.	1972-1974
Three-minute "Arecibo Message" transmitted by radar.	November 15 and 16, 1973
Russell A. Hulse and Joseph H. Taylor, Jr. discovered binary pulsar with William E. Gordon Telescope and in 1993 earned a Nobel Prize in Physics for the discovery.	1974
Timing of a pulsar in a triple system.	2013
Comet 209P/Linear became the fourth (of seven) comets to have its nucleus, or the solid center part that is composed of rock, dust, and frozen gases, imaged from Earth. Observed at Arecibo Observatory. Galactic Arecibo L-Band Feed Array (GALFA) Survey completed.	2014
Discovery of the first-ever repeating fast radio burst (FRB).	2016
Discovery of vanishing or random pulsars.	2017

4.1 National Astronomy and Ionosphere Center NRHP Historic District

In the early 1960s, 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), was under construction at the NAIC. The project was funded by the U.S. Department of Defense'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 (37 or 43 miles) above the Earth's surface to as high as 500 kilometers (311 miles) above the Earth's surface (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 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 are 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) (Image 2). The study of atmospheric conditions and planetary sciences was reaching new levels of importance because of 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 (Santos 2007). The Department of Defense funded the construction of the radar telescope during a time of increased interest in the vulnerability of communication technology as a result of the Cold War or post-Sputnik era. Moreover, as discussed in a paper published by the NASA History Office (Butrica 1996):

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.

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 in science during this time. This growth fostered an uptick in scientific discoveries around the turn of the twenty-first century.



Image 2. Professor William E. Gordon and Telescope, circa 1965
Image courtesy of Cornell University Libraries.

William E. Gordon, the namesake of the radio telescope, holds his place in science history 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 (ibid.). His calculations were used to define the necessary diameter of the radio antenna for space exploration (Santos 2007). He served as Arecibo Observatory's director until 1965. 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. 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 served as the technical director during the construction of the project and led the site selection (Santos 2007). 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 Arecibo site was selected because of the geomorphology of the terrain, proximity to the equator, and moderate climate, as well as favorable political support from Puerto Rico (Santos 2007) (Images 3 and 4). 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 aligned with the rapid planning and deployment of the NAIC (Carrion 2017). Maria Elena Carrion 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" (Carrion 2017). 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 (Santos 2007).



Image 3. (Left) William E. Gordon Telescope during construction, 1962.
Image courtesy of Arecibo Observatory.

Gordon and Cornell University with Kavanaugh's engineers managed the initial construction of the radio telescope, while the U.S. Army Corps of Engineers developed the support facilities, including the operation buildings, roads, water reservoir, and power plant (Santos 2007). On November 1, 1963, the Observatory 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. He later designed 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 the Observatory 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, and provides specific information related to the design and engineering. A few additional examples that describe the construction of the telescope include the ASME Landmarks Program, the Engineering and Technology History Wiki, and the Division of Rare and Manuscript Collections at Cornell University Library. The Division of Rare and Manuscript Collections retains the Observatory 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 property was developed in an otherwise rural area. Visible from space, the William E.

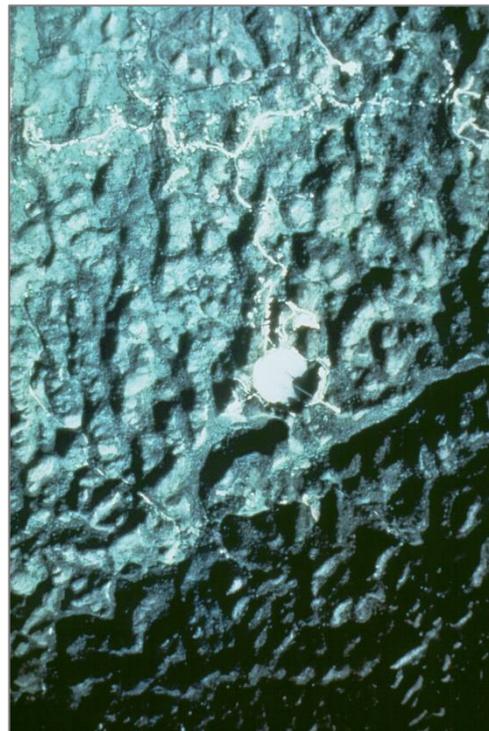


Image 4. (Right) High Altitude View of the Arecibo Observatory, Oriented North, Undated.
Image courtesy of Arecibo Observatory.

Gordon Telescope (305-meter-diameter radio telescope and support towers) at the Arecibo Observatory transformed not only the 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 the 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 was signed between Cornell University and NSF. In 1972 the Observatory 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 Nobel Prize in Physics in 1993 (Altschuler 2002). These discoveries would not be possible without the ongoing upgrades and maintenance completed on the instruments and property. 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), 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 property 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 because of 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.

During the early 1970s, NASA installed a high-power transmitter that provided better resolution for imaging Venus. The first upgrades to the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) occurred from 1972 to 1974 when the original mesh surface of the reflective dish was replaced with 38,000 aluminum panels (Cornell University 2018) (Image 5). The aluminum panels were constructed onsite in the warehouse building. Just as the original mesh surface was replaced with locally made panels, similar upgrades continue to be constructed onsite by the maintenance and engineering staff. The maintenance and engineering staff implement vernacular construction methods because of the remote nature of the location. These methods include building onsite and using materials, such as concrete blocks, that best accommodate the local setting and environment. The resulting upgrades at the property 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 using higher frequencies that require an increased capacity in both hardware and networking. On November 15 and 16, 1973, a 3-minute transmission, called the Arecibo Message, was sent by the upgraded radar (Altschuler 2002). In 1974, scientists from 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 Russell A. Hulse and Joseph H. Taylor, Jr. In 1993, Russell A. Hulse and Joseph H. Taylor, Jr., both of Princeton University, were awarded a Nobel Prize for the discovery of a new type of pulsar that established new lines of inquiry for the study of gravitation (Nobel 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 equipment upgrades. Criteria Consideration G was reviewed at the time of NRHP

listing and for the NRHP addendum because these upgrades and the related construction of new buildings occurred within the last 50 years (NPS 1990).



Image 5. First Upgrade to William E. Gordon Telescope.

Image courtesy of Arecibo Observatory, published in Daniel R. Altschuler's *The National Astronomy and Ionosphere Center's (NAIC) Arecibo Observatory in Puerto Rico*, 2002.

During an interview, Michael P. Sulzer, Head of the Ionospheric Modification Group at Arecibo Observatory, who started at the Observatory as a graduate student in 1972, discussed the second major upgrade at Arecibo Observatory, occurring during the 1990s (Image 6). Additional instruments and property had been added 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 originate in the Operations Building (Building 1). The new property 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).



Image 6. Second Upgrade to William E. Gordon Telescope, as photographed in 2018.

Angel Vasquez, Head of Operations at Arecibo Observatory, who has served at the property for over 40 years, also elaborated on the new installation of the HF property during an interview (CH2M 2018). Vasquez was born in Arecibo, moved to New York, and eventually returned to Arecibo when an opportunity arose to work at Arecibo Observatory. Vasquez has witnessed many changes in operations at 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 computer networking allows a broader base of international researchers to either submit code to the operators at Arecibo Observatory or for the researchers to operate the instruments themselves. He explained the status of scientific discoveries at Arecibo Observatory as a phase of understanding previous discoveries instead of finding radically new ideas. More than 50 years after 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 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, mostly resulting from the increase in computer processor speeds, to better understand what else can be gleaned from the captured data.

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

Arun Venkataraman, Head of Information Technology (IT) at Arecibo Observatory, echoed Vasquez's discussion on the growth of computer networking at the property. Beginning as a research associate at Arecibo Observatory in 1986, Venkataraman joined the IT department in 1988 (CH2M 2018). In his time at 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, 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. Arecibo Observatory joined the VLBI network in the late 1990s as part of the Highly Advanced Laboratory for Communications

and Astronomy mission, also known as the VLBI Space Observatory Program, 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. Arecibo Observatory received the necessary data acquisition system in 2001. The VLBI accounts for at least 4 percent of observation time on the William E. Gordon Telescope (305-meter-diameter radio telescope and support towers) (NAIC n.d., NASA 2017).

4.4 Scientific Achievements from 2008 to 2017

Since 2008, additional significant events or discoveries have occurred at Arecibo Observatory. The historic district contributing resources are associated with these significant scientific discoveries, as they were either part of instrumentation used during the studies or they housed the research activities that led to the discoveries. Three core scientific research areas are completed at Arecibo Observatory: astronomy, planetary science, and space science. This research directly applies to four identified natural threats: gamma ray bursts, asteroid or comet impact, space weather, and global climate change. Most often the initial studies that lead to discoveries occur years, or decades, prior to the published discovery. The NRHP Addendum used the recognized discovery date as published by Arecibo Observatory. This list of discoveries is not inclusive of all scholarly surveys or studies conducted at Arecibo Observatory with credible findings; it is limited to those discoveries deemed nationally important by leaders in their respective field of science. Between the 2008 nomination and 2017, scientific discoveries were made that marked important achievements to astronomy, physics, and the planetary sciences.

4.4.1 Timing of a Pulsar in a Triple System (2013)

Important to astronomy and physics

The North American Nanohertz Observatory for Gravitational Waves (NANOGrav) Collaboration used telescopes from Arecibo and Green Bank Observatories and millisecond pulsars to directly measure how gravitational waves impact the forces on an object in distance and time (Arecibo Observatory 2012). This further allowed scientists to test a concept called the Equivalence Principle. The principle states that the effect of gravity on a body does not depend on the nature or internal structure of that body (Ransom 2014). Founded in 2007, NANOGrav is a consortium of astronomers in North America who are partnered with European and Australian astronomers to create a galactic-scale gravitational wave observatory sensitive to gravitational waves. Gravitational waves are part of Einstein's general theory of relativity that describes the space-time dynamics from matter in motion. Pulsar timing array provides the ability to observe supermassive black hole binaries following galactic mergers, or other early universe phenomena such as inflation, with the ultimate potential to revolutionize how the universe is viewed (Jenet et al. 2009).

4.4.2 Imaging of Comet 209P/Linear from Earth (2014)

Important to planetary science (Comet 209P/Linear was the fourth of seven comets to have its nucleus, or the solid center part that is composed of rock, dust, and frozen gases, imaged from Earth)

Researchers at Arecibo Observatory took radar images of the comet (Universe Today 2014). The comet was the third nearest orbit of any comet in two centuries (Schleicher and Knight 2016). Arecibo Observatory used its radio telescope like a radar gun to shoot pulses at the comet (Plait 2014). Imaging with radio telescopes is an active technique that requires the antenna to broadcast a signal at the object and then receive the reflected signal that bounces off the object. The time it takes for the signal to bounce can be measured by the speed of light, and the distance between the two points can be measured. The points are put together to form a map of the object. Arecibo Observatory was able to take advantage of this closeup image because the comet passed so near the Earth. Details were visible, such as the comet's nucleus, that would otherwise be less distinct or unrecognizable due to what typically would be a large distance (Lakdawalla 2011).

4.4.3 Galactic Arecibo L-Band Feed Array (GALFA) Survey (2014)

Important to astronomy and physics

This research studied how hydrogen enters the Milky Way to form new stars (Putnam and Stanimirovic 2012). It revealed slender structures in interstellar space that are aligned with dust polarization and the magnetic field. The survey was built on work that began in 2004 when the Arecibo L-Band Feed Array (ALFA) was installed on the 305-meter radio telescope. The ALFA can monitor seven positions at once, whereas its predecessor, the L-Band wide receiver, could cover only one. Because of the increased mapping efficiency, different science teams came together to consider the next generation of high-fidelity, high-resolution sky atlases. The GALFA consortium, which consists of three independent groups, arose out of that discussion and is divided by what each group studies: radio recombination lines, continuum radiation, and the 21-centimeter line transition of Galactic neutral hydrogen (HI) (GALFA-HI). The GALFA-HI survey studied a broad range of topics under the umbrella of the neutral hydrogen and the Galactic interstellar medium (Peek et al. 2009). High-resolution data from the GALFA-HI survey was used to show that the linear structure in HI correlates with the magnetic field, or that the structure of a neutral interstellar medium is more closely related to the magnetic field than previously known. This discovery provided a new tool in the search for inflationary gravitational wave B-mode polarization in the cosmic microwave background, or the theory of inflation in the universe (Clark et al. 2015). Inflation is thought to be the period of extreme expansion that occurs during the first few moments of a universe, or the Big Bang; it then expands relatively gradually over time (NASA 2010).

4.4.4 Discovery of the first-ever repeating Fast Radio Burst (2016)

Important to astronomy and physics

FRB 121102 was discovered on November 2, 2012, at Arecibo and Green Bank Observatories, and it has been seen to repeat more than 150 times since its discovery (Klesman n.d.). FRBs were first identified in 2007 using archival data from 2001 (USRA 2018). The discovery was possible because of advances in computing hardware, software, and data processing (Chatterjee 2017). “FRB 121102 was found to repeat and is the only known FRB source to do so,” noted Dr. Andrew Seymour, Universities Space Research Association (USRA) postdoctoral researcher at Arecibo Observatory (USRA 2018). The burst originated from beyond the Milky Way galaxy at a distance of 3 billion light years from Earth. For a burst, which only lasted a few seconds, to reach the Earth, it would have required 100 million times the energy produced by the Sun in a day. In January 2018, Arecibo Observatory announced that the FRB likely originated from bursts from a neutron star in an extreme environment of magnetized plasma, possibly from near a giant black hole, or one embedded in a powerful nebula. The studies were conducted at high frequencies at Arecibo and Green Bank Observatories, which confirmed this new information (USRA 2018).

4.4.5 Discovery of vanishing or random pulsars (2017)

Important to astronomy and physics

A pair of intermittent pulsars, or rapidly rotating, highly magnetized neutron stars, shifted a widely shared belief that pulsars are constant, like clockwork. Dr. Andrew Seymour, USRA, as part of a 34-person team, used the 7-beam receiver to carry out the Pulsar Arecibo L-Band Feed Array Survey (PALFA) to discover the two intermittent pulsars (Verschuur and Schmelz 2017). The pulsars were discovered at Arecibo Observatory and then observed over several years at Jodrell Bank Observatory in Manchester, United Kingdom. The discovery is important to further understand the physical mechanisms that cause intermittency (Lyne et al. 2017).

4.5 Arecibo Observatory Today

Andy Ortiz, Executive Director of Education and Public Outreach at Arecibo Observatory, has worked at Arecibo Observatory for 20 years. He provided an overview of the outreach offerings and educational focus of the property. As 30 percent of the visitors each year at 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, 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 Arecibo Observatory works in tandem with the research component of the property to inspire the next generation of scientists and dreamers. The outreach function of the property demonstrates the necessary connection between science and education (Image 7).



Image 7. Angel Ramos Visitor Center and William E. Gordon Telescope, 2018, facing south.
Image courtesy of Arecibo Observatory.

As of 2019, Arecibo Observatory is operated by UCF, YEI, and UMET in collaboration with NSF.

5. Preservation Approach

This chapter defines the seven aspects of historic integrity and clarifies how each aspect of integrity is retained within the character-defining features that comprise the historic district. Arecibo Observatory has unique preservation challenges because the historic district is both a historic property and an actively used research property. The instrumentation and associated buildings or structures must be maintained, repaired, or upgraded to meet research specifications that may conflict with the property's historic integrity. This Plan addresses these challenges by clearly defining the characteristics that qualify the district for listing in the NRHP, establishing preservation principles, and creating a work plan for changes to the contributing resources within the district.

These preservation principles are recommendations of best practices to guide case-by-case assessment. The goal of the selected preservation treatment is to retain and preserve the historic form and characteristics of the district and its contributing resources to the greatest extent possible. Whenever feasible, historic materials should be retained. Changes or additions required by a new use should be reversible and should be made with the least possible disruption to historic form and materials. This recommendation is specific to buildings or structures, and a more flexible application of this principle should be applied to instrumentation.

5.1 Integrity and Character-Defining Features

5.1.1 Integrity

Historic properties must retain enough integrity to convey their significance. If the integrity is impaired, the property may lose its historic designation. The seven aspects of integrity are as follows:

- **Location:** the place where a historic property was constructed or where historic events occurred.
- **Design:** the combination of elements that create the form, plan, space, structure, and style of a property, and reflects its historic functions, technology, and aesthetics.
- **Setting:** a historic property's environment, including the basic physical conditions, both manmade and natural, that demonstrate the conditions under which a property was built and functioned.
- **Materials:** the physical elements that reveal information about the availability of materials and technologies. A property must retain the key exterior materials dating from its period of significance.
- **Workmanship:** the physical evidence of crafts and techniques important to how a property was created.
- **Feeling:** the expression of aesthetics or a period of time. Must retain physical features through setting, design, and material integrity.
- **Association:** the direct link between an important event or person to a historic property. Must retain physical features through setting, design, and material integrity.

"To retain historic integrity a property will always possess several, and usually most, of the aspects. The retention of specific aspects of integrity is paramount for a property to convey its significance" (NRHP Bulletin 15) (McClelland 1997).

The Arecibo Observatory historic district retains all seven aspects of integrity. In implementing the treatment approach, care must be taken to ensure that these aspects of integrity are not impaired. If compromise becomes necessary to continue property operations, the integrity of location, design, and setting should be given the highest consideration because these aspects are most important to the overall character of the historic district.

5.1.2 Character-Defining Features

Character-defining features are essential physical features that convey the district's significance. As all properties change over time, it is not necessary for the district to retain all of its historic physical features. However, it must retain "those features that define both why a property is significant... and when it was significant" (Andrus 1990). A good test to determine if a property retains its character-defining features is to ask whether a person from the past, that is, a historic contemporary, would recognize the property if they returned today. Although Arecibo Observatory has had some alterations and modern buildings, the district continues to appear similar in appearance to its period of significance from 1963 to 2017. Because the district's period of significance spans several decades and it contains 15 contributing resources, it is important to know how each architectural resource looked when it was put into service (Appendix A).

"A property... must retain those physical features that characterize the type, period, or method of construction that the property represents" (McClelland 1997). Arecibo Observatory's most striking character-defining feature is its minimally urban environment that is set in a rural setting, also referred to as its site and location. The site was selected and designed by a plan. That plan has character-defining features that include the locations where buildings and structures are placed, favored construction materials, and designs of buildings. For this reason, it is important to consider the natural and manmade features as part of its integrity of setting and feeling. A variety of materials and design elements are present within the district, including concrete, metal, and glass. Key elements to maintain include the rural setting and lack of modern intrusions, such as large power or communication infrastructure that is not associated with the operation of the property.

If the district requires changes, these modifications should be done in the least obtrusive way possible:

- Little or no negative impact to the locations where the instruments are sited.
- Minimal changes to the overall design of instrumentation.
- Minimal exterior changes to key administrative buildings.
- Limited development of presently open land.

Changes to architectural resources that are noncontributing to the historic district is appropriate if those changes do not impact the feeling, setting, or association of contributing resources. If possible, all changes should be reversible.

Under this Plan, the overall design of the district should be preserved, which includes its form, plan, space, structure, and style. These characteristics are contained in the contributing resources within the district. Many of the contributing resources are buildings or structures with utilitarian designs. Architectural resources such as these buildings and structures have well-known solutions and references. The Standards and the NPS Preservation Briefs may be referenced to address preservation concerns for architectural resources. Instrumentation, however, has limited technical guidelines that are readily available for reference. Much of the existing information is focused on instrumentation that predates the district. Instrumentation is an emerging preservation challenge that requires special consideration.

Technology often gains its importance through modifications and improvements that enable better listening, data processing, etc. This Plan seeks to maintain scientific tools such as telescopes with an expectation that applied technology will change without restriction. Historic properties must convey their significance to the public. The specifics of the instrumentation applied to the telescope structures is not common knowledge. Instrumentation is changed depending on the project and available technology. The applied technology, as long as it is theoretically reversible, does not have the potential to cause an adverse effect to the district. Moreover, changes in technology are well documented by detailed schematics. No further documentation is necessary to show how scientific advancements evolved, but archival consideration is recommended to ensure that this information may be accessed by scholars in the future.

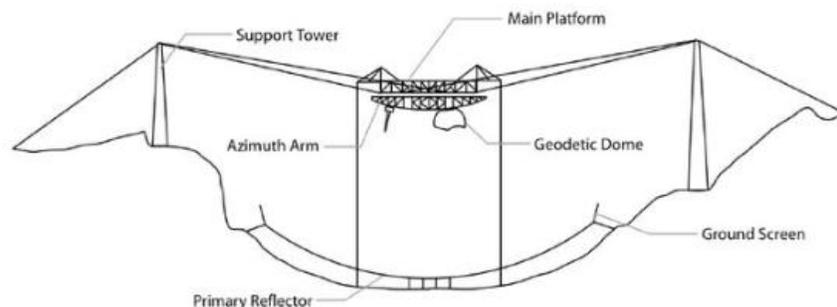
Furthermore, historic materials, or the physical elements combined in a particular pattern or configuration to form the instrument during a period in the past, may be modified as long as the modification is like-for-like and does not impede the original design. The William E. Gordon Radio Telescope demonstrates how

material changes have improved its viability as a research tool (Figures 5-1 and 5-2). The proposed sketch shows the telescope before its design was finalized. The first upgrades changed mesh for metal panels. This material change occurred during the period of significance and contributed to the historic context. Similar changes to the panels would not negatively impact the overall understanding of the district, and therefore, no adverse effect is anticipated. If the historic form of a radio telescope remains reasonably similar to its historic appearance, then changes to its historic characteristics are deemed appropriate when necessary for its ongoing use and viability as a research tool.



Source: Cornell University College of Engineering Photographs, #16-2-2378. Division of Rare and Manuscript Collections, Cornell University Library.

Figure 5-1. William E. Gordon Radio Telescope, Proposed Design, facing west



Source: J.E.G. Peek 2008

Figure 5-2. William E. Gordon Radio Telescope, Current Configuration, showing key elements of design, including primary aspects of structural form

Table 5-1. Examples of Contributing Resources Types and Character-Defining Features

Contributing Resource Types—Function—Example	Character-Defining Features	
<p>District—Scientific—NAIC Historic District</p>	<p>The historic district possesses a significant concentration of buildings, structures, and objects united historically and aesthetically by plan and physical development associated with the advancement of radio astronomy and related sciences. All of the contributing resources within the historic district’s boundaries contain character-defining features that qualify the district for listing in the NRHP. Buildings and structures are identified on the NRHP nomination form and addendum as contributing resources (Table 3-1). Original roads, pathways, and landscape features contribute to the overall setting but otherwise are not eligible for listing in the NRHP. These elements are considered part of the setting, including the landscape, specifically the topography specific to the Karst region, native plants and trees, and other spatial features of the site. Architectural styles or periods include Cold War era and contemporary. Engineering achievements include the William E. Gordon Telescope and Support Towers (305-meter-diameter radio telescope and three support towers). Materials include concrete block, poured concrete, glass, and metal.</p>	 <p>Aerial image of Arecibo Observatory - the National Ionosphere and Atmospheric Historic District, circa 2000. Image provided by Arecibo Observatory.</p>
<p>Structure—Scientific—William E. Gordon Radio Telescope and Support Towers (305-meter-diameter radio telescope and three support towers)</p>	<p>The William E. Gordon Radio Telescope and Support Towers (305-meter-diameter radio telescope and three support towers) together are an example of a contributing structure to the district, which is also individually eligible for listing in the NRHP. Instrumentation is part of this category. Contributing structures should be prioritized for preservation. Materials include concrete and metal.</p>	 <p>William E. Gordon Radio Telescope and Support Towers (305-meter-diameter radio telescope and three support towers) and Visitor Center, 2018, facing west.</p>

Contributing Resource Types—Function—Example	Character-Defining Features	
<p>Building—Scientific and Facility Operations—Operations Building (Building 1) and the Shielded Trailer (Building 65)</p>	<p>The Operations Building (Building 1) and the Shielded Trailer (Building 65) are examples of contributing buildings to the district. The buildings contain spaces where research activities and discoveries occurred. Actively used for science and facility operation. Architectural styles or periods include Cold War era and contemporary. Design elements include flat roofs with modest cantilevered overhangs above entrances, and rectilinear plans with modular additions. Materials commonly used in this period include prefabricated panels, concrete, glass, and metal.</p>	 <p>Operations Building (Building 1) and Shielded Trailer (Building 65), 2018, facing northwest.</p>
<p>Building—Facility Support—Cable Car House (Building 5)</p>	<p>The Cable Car Building (Building 5) is an example of a contributing building to the district. Facility support resources were actively used in the direct operation of the facility and significant instrumentation. The Cable Car Building provides access of the William E. Gordon Radio Telescope, and it was built during the original construction of the site. The building's architectural style is utilitarian, and its period is the Cold War era with design elements that include a flat roof with modest overhangs and a cantilever awning above its entrance. Materials commonly used during this period include concrete block and metal.</p>	 <p>Cable Car Building (Building 5), 2018, facing northeast.</p>

5.2 Treatment Approach

Arecibo Observatory, a NRHP-listed historic district, remains part of an operable scientific and educational property. This Plan was prepared to ensure that the current or future operators consider actions that may adversely affect the property, and the Plan makes recommendations on how to avoid or minimize such effects. Previous sections provided information on why the district qualifies as a historic property, the aspects of historic integrity, and character-defining features of the district. This section explains the Secretary of the Interior's Standards for the Treatment of Historic Properties (the Standards) (36 CFR Part 68), commonsense historic preservation principles that must be considered to help protect irreplaceable cultural resources such as Arecibo Observatory.

The Standards were developed by the Secretary of the Interior, who is responsible for establishing standards for all programs under the Department of the Interior and also advises federal agencies on the preservation of historic properties listed or eligible for listing in the NRHP. The Standards were originally developed for the management of activities under the Historic Preservation Fund, a grant program managed by the Department, but they were soon adopted for use in rehabilitation projects for federal tax purposes and other preservation activities (NPS 2019). In particular, the Standards are used by federal agencies in carrying out their historic preservation responsibilities for federally owned historic properties. State and local historic preservation bodies also commonly use the Standards for their reviews and guidance.

This chapter defines the Standards and the four approaches for treatment of historic properties: preservation, rehabilitation, restoration, and reconstruction. Because of the size and complex nature of

the Arecibo Observatory historic district, the recommendations in this Plan are suggestive and should not be considered all inclusive. A case-by-case review of changes within the district that applies the following recommended approaches is best practice. The Standards provide a foundation for how to evaluate proposed changes within the district that cause the least amount of harm to its historic characteristics. The Standards seek to align necessary changes with preservation principles by providing a framework for decision making.

The four approaches, as defined under 36 CFR Part 68, are as follows:

- **Preservation:** the act or process of applying measures necessary to sustain the existing form, integrity, and materials of a historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses on the ongoing maintenance and repair of historic materials and features instead of extensive replacement and new construction. New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project.
- **Rehabilitation:** the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features that convey its historical, cultural, or architectural values.
- **Restoration:** the act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make the properties functional is appropriate within a restoration project.
- **Reconstruction:** the act or process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location (NPS 2019).

Each approach has a set of standards and guidelines for implementation. The Standards are publicly available for reference in *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings* (Grimmer 2017; <https://www.nps.gov/tps/standards/treatment-guidelines-2017.pdf>). The reference includes recommended and not recommended treatments, guidelines for new construction, and a section on building codes and energy efficiency.

Because the Arecibo Observatory historic district remains in good integrity and condition, preservation is generally the most appropriate approach for keeping the property in its current condition. No substantial rehabilitation or restoration activities appear necessary. Most historic elements remain in place, and the district continues to reflect its period of significance in all contributing resources. Rehabilitation may be required in the future, when replacement of deteriorated features is necessary, when new additions are needed for a new or continued use, or when the removal and replacement of a noncontributing element with a new element is needed. The difference between preservation and rehabilitation is mainly that rehabilitation replaces historic materials with contemporary materials to bring the property into usable condition.

It is unlikely that restoration or reconstruction will occur at the property because it is in good condition and all significant historic characteristics remain intact; however, in the event of a catastrophic event, restoration or reconstruction may be required. For reference, restoration is an appropriate approach when there is adequate documentation and sufficient materials, features, spaces, and finishes to restore the property to its original appearance or a period deemed most significant. Reconstruction is a contemporary depiction of a historic property that is reproduced from new materials when no other property with the same associative value has survived. Care must be taken when reconstructing a historic property to produce an accurate reproduction and make sure the reproduction is recognizable as a duplicate (NPS 2019).

Table 5-2. Standards for Treatment of Historic Properties (36 CFR Part 68)

Approach	Standards
Preservation	<ol style="list-style-type: none"> 1. A property will be used as it was historically or be given a new use that maximizes the retention of distinctive materials, features, spaces and spatial relationships. Where a treatment and use have not been identified, a property will be protected and, if necessary, stabilized until additional work may be undertaken. 2. The historic character of a property will be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces and spatial relationships that characterize a property will be avoided. 3. Each property will be recognized as a physical record of its time, place and use. Work needed to stabilize, consolidate and conserve existing historic materials and features will be physically and visually compatible, identifiable upon close inspection and properly documented for future research. 4. Changes to a property that have acquired historic significance in their own right will be retained and preserved. 5. Distinctive materials, features, finishes and construction techniques or examples of craftsmanship that characterize a property will be preserved. 6. The existing condition of historic features will be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new material will match the old in composition, design, color and texture. 7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used. 8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken. 9. A property will be used as it was historically or be given a new use that maximizes the retention of distinctive materials, features, spaces and spatial relationships. Where a treatment and use have not been identified, a property will be protected and, if necessary, stabilized until additional work may be undertaken. 10. The historic character of a property will be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces and spatial relationships that characterize a property will be avoided. 11. Each property will be recognized as a physical record of its time, place and use. Work needed to stabilize, consolidate and conserve existing historic materials and features will be physically and visually compatible, identifiable upon close inspection and properly documented for future research. 12. Changes to a property that have acquired historic significance in their own right will be retained and preserved. 13. Distinctive materials, features, finishes and construction techniques or examples of craftsmanship that characterize a property will be preserved. 14. The existing condition of historic features will be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new material will match the old in composition, design, color and texture. 15. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used. 16. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
Rehabilitation	<ol style="list-style-type: none"> 1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces and spatial relationships. 2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces and spatial relationships that characterize a property will be avoided. 3. Each property will be recognized as a physical record of its time, place and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken. 4. Changes to a property that have acquired historic significance in their own right will be retained and preserved. 5. Distinctive materials, features, finishes and construction techniques or examples of craftsmanship that characterize a property will be preserved. 6. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.

Approach	Standards
	<ol style="list-style-type: none"> 7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used. 8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken. 9. New additions, exterior alterations or related new construction will not destroy historic materials, features and spatial relationships that characterize the property. The new work will be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment. 10. New additions and adjacent or related new construction will be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.
Restoration	<ol style="list-style-type: none"> 1. A property will be used as it was historically or be given a new use that interprets the property and its restoration period. 2. Materials and features from the restoration period will be retained and preserved. The removal of materials or alteration of features, spaces and spatial relationships that characterize the period will not be undertaken. 3. Each property will be recognized as a physical record of its time, place and use. Work needed to stabilize, consolidate and conserve materials and features from the restoration period will be physically and visually compatible, identifiable upon close inspection and properly documented for future research. 4. Materials, features, spaces and finishes that characterize other historical periods will be documented prior to their alteration or removal. 5. Distinctive materials, features, finishes and construction techniques or examples of craftsmanship that characterize the restoration period will be preserved. 6. Deteriorated features from the restoration period will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture and, where possible, materials. 7. Replacement of missing features from the restoration period will be substantiated by documentary and physical evidence. A false sense of history will not be created by adding conjectural features, features from other properties, or by combining features that never existed together historically. 8. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used. 9. Archeological resources affected by a project will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken. 10. Designs that were never executed historically will not be constructed.
Reconstruction	<ol style="list-style-type: none"> 1. Reconstruction will be used to depict vanished or non-surviving portions of a property when documentary and physical evidence is available to permit accurate reconstruction with minimal conjecture, and such reconstruction is essential to the public understanding of the property. 2. Reconstruction of a landscape, building, structure or object in its historic location will be preceded by a thorough archeological investigation to identify and evaluate those features and artifacts that are essential to an accurate reconstruction. If such resources must be disturbed, mitigation measures will be undertaken. 3. Reconstruction will include measures to preserve any remaining historic materials, features and spatial relationships. 4. Reconstruction will be based on the accurate duplication of historic features and elements substantiated by documentary or physical evidence rather than on conjectural designs or the availability of different features from other historic properties. A reconstructed property will re-create the appearance of the non-surviving historic property in materials, design, color and texture. 5. A reconstruction will be clearly identified as a contemporary re-creation. 6. Designs that were never executed historically will not be constructed.

5.3 Summary of Preservation Approach

Following the Standards will help with the long-term care of the property's significance through the preservation of historic materials and features. The Standards pertain to architectural resources of all materials, construction types, sizes, and functions. The exteriors of contributing resources should be considered when planning activities that may affect the district's historic characteristics. The exterior of contributing resources contributes to the most publicly accessible areas of the district. Lack of

preservation of the exterior of contributing resources would have the most detrimental effect overall on the integrity of the district. The Standards also encompass related landscape features and the built environment, as well as attached, adjacent, or related new construction. In summary, preservation is recommended with the following key principles:

- Adequately train staff about the character-defining features of the district and its historic context.
- Review projects on a case-by-case basis, recognizing that contributing resources within the district have differing levels of significance and that historic integrity may vary.
- Prioritize preservation of the exterior of contributing resources, or do as little harm to their appearance as possible when making repairs.
- Keep adequate documentation to show condition and changes over time.

If preservation is prioritized and implemented as part of the care of Arecibo Observatory, the historic district will continue to retain its integrity and historic context into the foreseeable future. Public access to the district is anticipated, so ADA requirements and safety codes may need to be addressed with local code officials. For guidance on how to incorporate accessibility into historic properties, refer to the NPS's *Technical Preservation Brief 32: Making Historic Properties Accessible* (Jester and Park 1998). For guidance on how to maintain the exterior of contributing resources, refer to the NPS's *Technical Preservation Brief 47: Maintaining the Exterior of Small and Medium Size Historic Building*. For guidance on how to preserve historic corridors, refer to *Preservation Tech Notes for Historic Interior Spaces 1 and 2* (Park 2007; Henry 1985; Keohan 1989). In addition, preservation briefs and tech notes covering topics such as masonry, mechanical systems, and temporary protection are available from the NPS at <https://www.nps.gov/tps/how-to-preserve/briefs.htm>.

5.4 Professional Qualification Standards

The *Secretary of the Interior's Historic Preservation Professional Qualification Standards* (36 CFR Part 61; Table 5-3) are the federal measures for determining minimum requirements for professionals who carry out specific historic preservation roles. A professional qualification standard exists for each of the 12 historic preservation disciplines. The qualification standards define the required level of academic degrees or comparable training, professional experience, and products and activities that demonstrate proficiency in historic preservation. The qualification standards do not define an entry-level position; instead, they provide a flexible framework to evaluate whether a professional will be able to perform competently for the specific job.

It is important to review the qualification standards when hiring for, or supervising, the completion of historic preservation tasks. Many federal historic programs also require that employees or consultants meet or exceed these qualification standards. Specifically, the PA requires that its stipulations be carried out by, or under the direct supervision of, a person or persons meeting or exceeding the minimum professional qualifications, appropriate to the affected resources, listed in the *Secretary of the Interior's Historic Preservation Professional Qualification Standards*. Table 5-3 details the minimum professional qualification standards required for five of the most common preservation disciplines for the care of historic properties. However, in some cases, additional areas or levels of expertise may be needed, depending on the complexity of the task and the nature of the historic properties involved.

Table 5-3. Secretary of the Interior's Professional Qualification Standards

Discipline	Minimum Professional Qualifications
History	<p>A graduate degree in history or closely related field; or a bachelor's degree in history or closely related field <i>plus</i> one of the following:</p> <ul style="list-style-type: none"> • At least 2 years of full-time experience in research, writing, teaching, interpretation, or other demonstrated professional activities with an academic institution, historic organization or agency, museum, or other professional institution; or • Substantial contribution through research and publication to the body of scholarly knowledge in the field of history.
Archaeology	<p>A graduate degree in archaeology, anthropology, or closely related field <i>plus</i>:</p> <ul style="list-style-type: none"> • At least 1 year of full-time professional experience or equivalent specialized training in archeological research, administration or management; • At least 4 months of supervised field and analytic experience in general North American archaeology; and • Demonstrated ability to carry research to completion. <p>In addition to these minimum qualifications, a professional in prehistoric archaeology shall have at least 1 year of full-time professional experience at a supervisory level in the study of archaeological resources of the prehistoric period. A professional in historic archaeology shall have at least 1 year of full-time professional experience at a supervisory level in the study of archaeological resources of the historic period.</p>
Architectural History	<p>A graduate degree in architectural history, art history, historic preservation, or a closely related field, with coursework in American architectural history, or a bachelor's degree in architectural history, art history, historic preservation or closely related field <i>plus</i> one of the following:</p> <ul style="list-style-type: none"> • At least 2 years of full-time experience in research, writing, or teaching in American architectural history or restoration architecture with an academic institution, historical organization or agency, museum, or other professional institution; or • Substantial contribution through research and publication to the body of scholarly knowledge in the field of American architectural history.
Architecture	<p>A professional degree in architecture plus at least 2 years of full-time experience in architecture, or a state license to practice architecture.</p>
Historic Architecture	<p>A professional degree in architecture or a state license to practice architecture, <i>plus</i> one of the following:</p> <ul style="list-style-type: none"> • At least 1 year of graduate study in architectural preservation, American architectural history, preservation planning, or closely related field; or • At least 1 year of full-time professional experience on historic preservation projects. <p>Such graduate study or experience shall include detailed investigations of historic structures, preparation of historic structures research reports, and preparation of plans and specifications for preservation projects.</p>

6. Work Plan

NSF and the Arecibo Observatory operators may undertake a variety of projects in the operation and management of the Arecibo Observatory that require adherence to preservation principles. This Plan addresses how to accomplish the PA stipulations in a manner that complies with preservation principles (Table 3-2 and Appendix B). Arecibo Observatory qualifies as a historic property and, therefore, may be subject to additional Section 106 reviews if new undertakings occur in the future. It is important to communicate to the appropriate staff and thereby notify the FPO as soon as possible when proposed activities have the potential to meet the definition of a new undertaking; only the federal agency charged with historic preservation responsibilities under the NHPA may determine whether a proposed program or activity meets the definition of an undertaking. Table 6-1 provides examples of activities that may need to be considered for their potential to meet the definition of an undertaking.

In addition to the ongoing review of activities to determine whether adherence to preservation principles is required, the HPO must keep the FPO apprised of such activities and review the appropriateness of this Plan on an ongoing basis. A periodic review of facility management plans to integrate preservation principles is crucial to federal compliance and the long-term care of the historic property. Ensuring that the necessary documentation occurs wherever necessary will support the successful implementation of the PA. Providing historic preservation training to appropriate staff and providing access to this Plan will encourage historic stewardship at all levels of staffing.

Table 6-1. Examples of Activities That May Requiring Adherence to Preservation Principles

Activity (PA Stipulation)	Actions	Next Steps
Building/equipment maintenance and/or minor repair without removal of original materials or changes in the exterior design of contributing resources (I.A.1)	<ul style="list-style-type: none"> • Roof repair • Painting • Equipment maintenance • Equipment updates • Water/sewer system/electrical repairs without trenching 	No further review required. Proceed with appropriate treatment (Section 5.2).
Noncontributing resources: building/equipment modification, closure, or demolition (I.A.5[b]).	<ul style="list-style-type: none"> • Any change • Demolition without ground disturbance 	No further review required.
Changes necessary to the operation of telescopes or other scientific equipment (I.A.8[b])	<ul style="list-style-type: none"> • Maintenance • Repair • Upgrades that do not change the aesthetics (aspects of design, feeling) of a contributing resource • Change in instrumentation only that does not affect the structure 	No further review required.
Closure or abandonment of contributing resources (I.A.1)	Puts building or equipment out of use for the foreseeable future	Explore all potential opportunities to keep the resource in use. If no options are viable, proceed with FPO notification, and follow best practices recommended for mothballing in accordance with Preservation Brief 31: Mothballing Historic Buildings
Major upgrades to telescopes or other scientific equipment (I.A.7)	<ul style="list-style-type: none"> • Large addition to structure or equipment • Removal of original structural material • Relocation • Major modification 	Refer to Section 1. Proceed with FPO notification to determine if actions require new Section 106 consultation.

Activity (PA Stipulation)	Actions	Next Steps
Major exterior modification and/or major repair with removal or destruction of original materials or changes in the exterior design of contributing resources (I.A.7)	<ul style="list-style-type: none"> • Roof reconfiguration that changes the aesthetics or design (for example, from flat to gable) • Rehabilitation that alters original material or design • Major repair • Accessibility improvement to the exterior of main elevations (front or primary) • Large addition 	Section 106 review may be required (Section 1). Proceed with FPO notification to determine if actions require new Section 106 consultation.
Demolition of Contributing Resources (I.A.5[a])	Any demolition	Documentation must occur. Appropriate level of documentation will be dependent on proposed change and significance of the proposed resource to be demolished. Documentation requirements will be determined during review (Section 3.2). Proceed with FPO notification to determine next steps.
New Construction (I.A.7)	Any new construction within the historic district boundary	Section 106 review may be required. Proceed with FPO notification to determine if action requires new Section 106 consultation.
Ground-disturbing activities that exceed previous depth of disturbance by more than 2 feet	<ul style="list-style-type: none"> • Trenching • Excavation • New foundation • Demolition that includes the removal of existing foundation • Any other ground-penetrating action that exceeds the previous depth of disturbance • Does not apply to landscaping, other common ground-penetrating activities that do not exceed previous disturbance, or areas where existing utilities are installed and maintained 	While intact cultural deposits are not likely due to the heavy ground disturbance that occurred during the initial construction activities at the site and the karst nature of the ground, archaeological review is recommended when planned disturbance exceeds the previous depth of disturbance by more than 2 feet. Proceed with FPO notification to determine if further actions are necessary.
Post-agreement Discoveries (V)	If any post-agreement discoveries are found during demolition activities	<p>The contractor or collaborator will stop work and notify NSF, who will then determine, in consultation with SHPO, if the discovery is eligible for listing in the NRHP, and a new Section 106 consultation will be initiated.</p> <p>If human or burial remains are found, the contractor or collaborator will cease work and adhere to applicable state and federal laws regarding the treatment of human or burial remains.</p>

7. Conclusion

Because the Arecibo Observatory contains historic properties within a dynamic, operating facility, this Plan explains preservation principles to maintain the Arecibo Observatory historic district as a historic property, with flexible options to allow the Observatory to meet its educational and scientific functions. This Plan must be considered a generalized plan that requires the appropriate reviews of future activities within the historic district. The Plan is applicable to all Arecibo Observatory personnel, including tenants, contractors, grantees, licensees, and other parties operating under the auspices of Arecibo Observatory.

Personnel who perform the work should be trained in proper preservation techniques and should display respect for the historic district and its resources at all times. This is a nationally significant historic district with irreplaceable contributing resources that demonstrate the history of radio astronomy. The built environment and landscape must be considered part of the setting, an important aspect of historic integrity.

The different elements of the historic district—contributing versus noncontributing resources—and what makes each resource integral to the district are explained in this Plan. Case-by-case review is the key to long-term care of the property, and an annual review of all planned projects or activities is recommended. Also, the reasons why each resource is important to the district's history, how to approach the different types of activities to ensure that the resources continue to convey their historic significance, and how to apply preservation principles to the daily management of the facility are discussed in this Plan.

8. Glossary

Advisory Council on Historic Preservation is the independent federal agency that advises the President, U.S. Congress, and federal agencies on historic preservation under the NHPA.

Agreement Document is a document that resolves effects under Section 106 of the NHPA by defining a federal undertaking, specifying adverse effects that may occur, prescribing a set of activities to resolve effects, assigning responsibilities, and establishing a timeline when activities must occur. It is a legally binding document, and it can be either a Memorandum of Agreement or Programmatic Agreement (36 CFR Section 800.6). Arecibo Observatory has a Programmatic Agreement.

Archaeological Resources are cultural artefacts or features that demonstrate human activities important to history and prehistory.

Consultation is the process of seeking, discussing, and considering the views of other participants, and where feasible, seeking agreement with them regarding matters arising in the Section 106 process. It is a reasonable and good faith effort to involve interested parties in Section 106. May include local officials, the public, and government-to-government consultation with federally recognized tribes.

Consulting Parties are interested groups or individuals who have a role in the Section 106 process, such as SHPOs or THPOs (36 CFR Section 800.2), applicants for federal funds or permits, local officials, Native Americans, and other interested parties. May be invited to sign Section 106 agreement documents as invited signatories or concurring parties. An invited signatory has the authority to amend and terminate the agreement, while a concurring party does not have the authority to amend or terminate the agreement (36 CFR Section 800.6[c][3]).

Contributing Resource is a building, site, structure, or object that adds to the historic significance of a district. A contributing resource may or may not be individually eligible for listing in the NRHP. A contributing resource will have been constructed or achieved its significance within the period of significance of a district; it will be associated with the district; and it must retain sufficient aspects of historic integrity.

Cultural Resources is a broad term for historic or culturally important buildings, districts, objects, structures or sites that may include naturally occurring or built environments. This term is commonly used for assessments under NEPA. These resources may or may not be listed in the NRHP, local or state registers.

Effects are any alterations to the characteristics of a historic property that qualify it for inclusion in, or eligibility for, the NRHP. Effects may be direct, indirect, or cumulative. Direct effects are caused by the undertaking and occur at the same time and place. Indirect effects are caused by the undertaking but occur later in time or are farther removed in distance, such as changes in the pattern of land use and population density. Cumulative effects result from the incremental impact of the undertaking when added to other past, present, and reasonably foreseeable future actions. Cumulative effects can result from individually minor, but collectively significant, actions taking place over a period of time.

Federal Preservation Officer is the federal agency official who coordinates historic preservation activities under the NHPA. The responsible party who directs all interactions with other agencies, states, Native Americans, NPS, and the ACHP.

Historic Integrity is comprised of seven aspects: design, material, association, location, setting, feeling, and workmanship. These aspects convey the significance of a historic property.

Historic Property is a prehistoric or historic district, site, building, structure, or object either listed or eligible for listing in the NRHP. Historic properties are subject to Section 106 of the NHPA.

Historic Preservation is the process of sustaining a historic property's form, integrity, and materials by an approach that includes identification, evaluation, recordation, documentation, curation, acquisition, protection, management, rehabilitation, restoration, stabilization, maintenance, research, interpretation, conservation, and/or education and training (Section 301.8 of the NHPA).

Instrumentation is the removable, or applied, technology that frequently changes based on project specifications. Changes in instrumentation do not have the potential to cause adverse effects.

National Historic Landmark is designated by the Secretary of the Interior because the property possesses exceptional value or quality in illustrating or interpreting the heritage of the United States.

National Park Service is the federal agency within the U.S. Department of the Interior that oversees the NRHP and National Historic Landmark programs, as well as the Federal Archaeology Program coordinated by the Departmental Consulting Archaeologist.

National Register of Historic Places is the official federal list of buildings, structures, districts, sites, and objects that are significant in American history, architecture, archeology, engineering, and culture that must be considered for preservation. The NRHP is administrated by the NPS.

Noncontributing Resource is a building, site, structure, or object that does not add to the historic significance of a district. The resource may have been constructed after the district's period of significance, it may not be associated with the district, or it may lack sufficient historic integrity to convey the district's significance.

State Historic Preservation Officer is the official appointed by each state or territory's Governor to carry out and administer the state historic preservation program under NHPA and other applicable statutes.

Tribal Historic Preservation Officer is the official appointed by a federally recognized Native American tribe who carries out and administers a tribal historic preservation program under NHPA and other applicable statutes.

Undertaking is project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a federal agency, including those carried out by or on behalf of a federal agency; those carried out with federal financial assistance; and those requiring a federal permit, license or approval. Undertakings may occur on private or public land. Federal undertakings require consideration of effects to historic properties under NHPA and other applicable laws.

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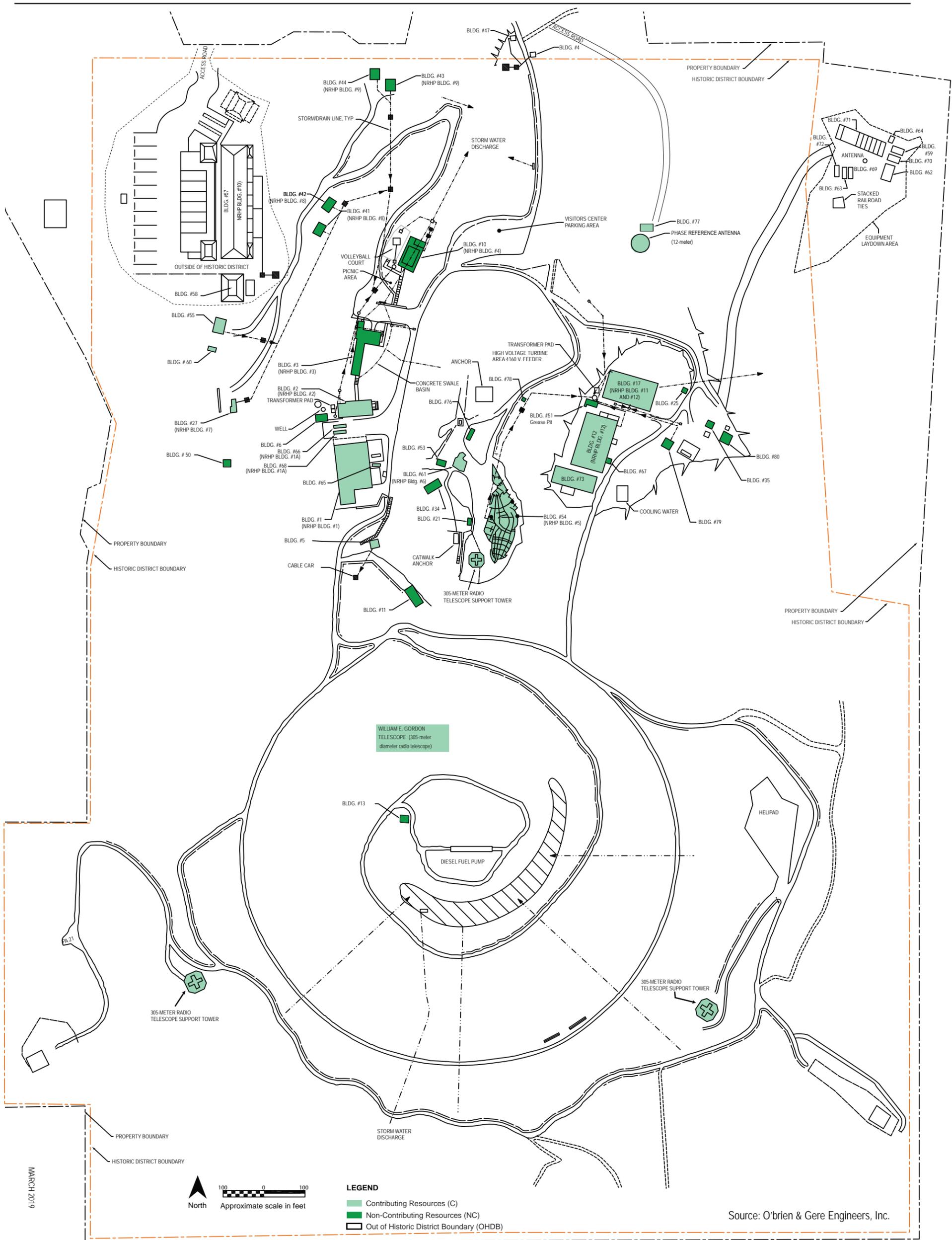
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Appendix A Site Layout

Appendix B
Programmatic Agreement

Appendix A Site Layout



Source: O'Brien & Gere Engineers, Inc.

BUILDING NO. DESCRIPTION

WILLIAM E. GORDON TELESCOPE AND SUPPORT TOWERS (305M diameter radio telescope) (1963) - C
 1. OPERATIONS BUILDING (1963) - C
 2. ADMINISTRATION BUILDING (1963) - C
 3. VISITING SCIENTIST QUARTERS AND CAFETERIA (1963) - NC
 4. ENTRANCE GUARD HOUSE (1963) - OHDB
 5. CABLE CAR HOUSE (1963) - C
 6. PUMP HOUSE/WATER TREATMENT BLDG. (1963) - NC
 10. SWIMMING POOL/RESTROOMS (ca. 1965) - NC
 11. LEWIS BUILDING-RIGGING LOFT (ca. 1965) - NC
 12. MAINTENANCE BUILDING (1967) - C
 13. BOWL SHACK (1963) - NC
 17. WAREHOUSE (1967) - C
 21. ANTENNA TESTING RANGE (ca. 1985) - NC
 25. PAINT STORAGE BUILDING (ca. 2010) - NC

27. OPTICAL LABS (1985/1997) - C
 34. HIGH VOLTAGE POWER SUPPLY BLDG. (1973) - NC
 35. CUMMINGS GENERATOR CONTROL BLDG. (2010) - NC
 41. WEST HILL V.S.Q. BACHELOR UNIT NO. 1 (ca. 1970s) - NC
 42. WEST HILL V.S.Q. BACHELOR UNIT NO. 2 (ca. 1970s) - NC
 43. WEST HILL V.S.Q. FAMILY UNIT NO. 1 (ca. 1970s) - NC
 44. WEST HILL V.S.Q. FAMILY UNIT NO. 2 (ca. 1970s) - NC
 47. MAIN GATE RESTROOM (1963) - OHDB
 50. INTERFERENCE MONITORING SHACK (1992) - NC
 51. GREASE PIT (n.d.) - NC
 53. EMERGENCY GENERATOR BLDG. (1993) - NC
 54. VISITOR CENTER BLDG. (2001) - C
 55. LIDAR LABORATORY BLDG. (1996) - C
 57. NORTH V.S.Q. BLDG. (2002) - OHDB
 58. NORTH V.S.Q. UTILITY BLDG. (2002) - OHDB
 59. VISITOR CENTER TRAILER (2016) - OHDB

60. ANT. RECE. TESTING BLDG. (ca. 1995) - C
 61. LEARNING CENTER (2001) - C
 62. HFF STORAGE TRAILER (2007) - OHDB
 63. IONOSONDE TRAILER (2007) - OHDB
 64. ELECTRONIC TRAILER (1990) - OHDB
 65. SHIELDED TRAILER (1983) - C
 66. ATMOSPHERIC SCIENCE TRAILER (n.d.) - C
 67. CRYOGENICS LAB TRAILER (1967) - NC
 68. SCIENTIFIC OFFICES TRAILER (n.d.) - C
 69. ELECTRONIC TRAILER (WAVEGUIDE) (2007) - OHDB
 70. COMPUTER TRAILER (2005) - OHDB
 71. ELECTRONICS CABLE TRAILER (2005) - OHDB
 72. ELECTRONIC TRAILER (CRYOGENICS) (2005) - OHDB
 73. HF TRANSMITTER BUILDING (2009) - C
 76. INSPIRATION FOR SCIENCE TRAILER (2016) - NC
 77. PHASE REFERENCE ANTENNA (12M) AND BUILDING 77 (2010) - C

78. COFFEE HUT (2002) - NC
 79. ENGINEERING OFFICE BUILDING (2010) - NC
 80. CUMMINGS DIESEL GENERATOR BUILDING (2010) - NC

Figure 1
National Astronomy and Ionosphere Center Historic District
 Arecibo Observatory, Puerto Rico

Appendix B
Programmatic Agreement

PROGRAMMATIC AGREEMENT
AMONG
THE NATIONAL SCIENCE FOUNDATION,
THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, AND
THE PUERTO RICO STATE HISTORIC PRESERVATION OFFICER
REGARDING
POTENTIAL CHANGES TO
ARECIBO OBSERVATORY OPERATIONS
IN THE VICINITY OF ARECIBO, PUERTO RICO

WHEREAS, the Arecibo Observatory is a federal facility owned and funded by the National Science Foundation (NSF), a federal agency. As of the date of this agreement, SRI International with Universities Space Research Association (USRA) and Universidad Metropolitana (UMET) receives funding from NSF via a Cooperative Agreement to operate and maintain the Arecibo Observatory for the benefit of research communities;

WHEREAS, the Arecibo Observatory was listed in the National Register of Historic Places (NRHP) in 2008 as the National Astronomy and Ionosphere Center (NAIC) Historic District 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 it represents a significant work of engineering;

WHEREAS, the NRHP Registration Form describes 13 buildings and a structure, of which eight buildings and one structure have been identified as contributing resources to the NAIC Historic District based on consultation with the Puerto Rico State Historic Preservation Officer (PR SHPO) (see Attachment A for a map of the historic district and Attachment B for a list of contributing resources);

WHEREAS, NSF acknowledges that the Arecibo Observatory holds significant cultural importance to the people of Puerto Rico as a source of inspiration and pride; in addition, it is culturally and scientifically iconic, both nationally and internationally;

WHEREAS, NSF relies on formal processes within the scientific community (e.g., decadal surveys, senior-level reviews, and other advisory committees subject to the Federal Advisory Committee Act), to provide input on science priorities, and these formal reviews have repeatedly recommended divestment from Arecibo Observatory. The Portfolio Review Committee, a subcommittee of NSF Mathematical and Physical Sciences Advisory Committee composed solely of external members of the scientific community, was charged with recommending a balanced portfolio to maximize the science recommended by National Academy of Sciences surveys of the field, which are carried out every decade. To enable NSF to better address decadal survey science, the resulting Portfolio Review Committee Report (NSF AST, 2012), released in August 2012, recommended the divestment of a number of telescopes from the federal portfolio. With respect to the Arecibo Observatory, the report recommended NSF reevaluate its participation in Arecibo in consideration of the science opportunities and budget forecasts. This followed a recommendation made by the Division of Astronomical Sciences Senior Review Committee in 2006 (NSF AST, 2006), that the NAIC should seek partners to contribute personnel or financial support to the operation of Arecibo by 2011 or else these facilities should be closed. The National Academy of Sciences Mid-Decadal review (NASEM, 2016) in August 2016 reiterated these earlier recommendations. The Geospace Section of the NSF Division of Atmospheric and Geospace Sciences in the Directorate for Geosciences (GEO) was an early co-funder of Arecibo Observatory operations and now provides approximately half of the current NSF funding for Arecibo. In 2016, a subcommittee of the GEO Advisory Committee concluded its own community-based portfolio review, which recommended a significant funding reduction (NSF AGS, 2016a). This finding was reinforced by a National Academy of Sciences review in early 2017;

WHEREAS, some members of the public have submitted additional perspectives from the scientific community that expressed support for continued operations at Arecibo Observatory;

WHEREAS, in the fall of 2015, NSF sought viable concepts of operation from the scientific community via a Dear Colleague Letter (Ulvestad and Shepson, 2015);

WHEREAS, based on the input NSF relied upon from the scientific community, NSF developed preliminary alternatives to address changes to operations from reduced NSF funding for Arecibo Observatory. The proposed changes to Arecibo Observatory operations constitute a federal undertaking subject to Section 106 (54 U.S.C. Section [§] 306108) of the National Historic Preservation Act of 1966, as amended (54 U.S.C. § 300101 *et seq.*) (NHPA) and the NHPA's implementing regulations, "Protection of Historic Properties" (Title 36 *Code of Federal Regulations* [C.F.R.] Part 800).

WHEREAS, this Programmatic Agreement (PA) has been prepared in compliance with 36 CFR 800.14(b)(1)(ii) of Section 106 of the NHPA, and technical terms related to the NHPA are included in Attachment C, "References and Definitions," along with references for citations in the PA and links to those references;

WHEREAS, NSF's preliminary alternatives were published in the *Federal Register* on May 23, 2016, as part of NSF's scoping process under the National Environmental Policy Act (42 United States Code [U.S.C.] §§ 4321, *et seq.*) (NEPA). The *Federal Register* notice also stated NSF's intention to initiate consultation under Section 106 of the NHPA and to evaluate potential effects to the Arecibo Observatory, and provided dates to specifically initiate public involvement under Section 106 per 36 CFR 800.2(d). Letters to potentially interested parties, agencies, and Puerto Rican elected officials were also sent. Notification of NSF's NEPA and Section 106 processes was also given through social media announcements, website updates on the NSF Division of Astronomical Sciences website, scientific digests and blogs, and newspaper public notices (in both English and Spanish). Public meetings were held in Arecibo and San Juan, Puerto Rico on June 7 and 8, 2016, to discuss the preliminary alternatives and NSF's compliance with both NEPA and the NHPA, seek input from the public on the preliminary alternatives, and identify consulting parties to participate in NSF's Section 106 consultation process under the NHPA. Six individuals informed NSF that they wished to participate in NSF's Section 106 consultation process as consulting parties at that time;

WHEREAS, the proposed action under NEPA review specifically includes five possible Action Alternatives for consideration: Alternative 1 – *Collaboration with Interested Parties for Continued Science-focused Operations with Reduced NSF Funding*, Alternative 2 – *Collaboration with Interested Parties for Transition to Education-focused Operations*, Alternative 3 – *Mothballing Facilities*, Alternative 4 – *Partial Demolition and Site Restoration*, and Alternative 5 – *Complete Demolition and Site Restoration*;

WHEREAS, on July 5, 2016, NSF initiated its Section 106 consultation process pursuant to the NHPA; NSF has conducted its Section 106 consultation process concurrently with, but separate from, its NEPA review process;

WHEREAS, because of the presence of the NAIC Historic District, NSF has determined, in consultation with PR SHPO and the Advisory Council on Historic Preservation (ACHP), that all five Action Alternatives, including the Preferred Alternative, have the potential to result in adverse effects on historic properties due to the potential demolition or mothballing of some components of the NAIC Historic District under all five Action Alternatives;

WHEREAS, NSF has identified Alternative 1 as NSF's Preferred Alternative in its NEPA process and recognizes that Alternative 1 can only be implemented if a collaborator(s) comes forward with viable plans to provide additional non-NSF funding in support of their science-focused operations; because Alternative 1 has been identified as NSF's Preferred Alternative, this PA addresses potential adverse effects only from Alternative 1; if implementation of Alternative 1 is ultimately not feasible, NSF will resume Section 106 consultation focusing on Alternatives 2-5;

WHEREAS, on September 30, 2016, NSF provided to the scientific community its intent to release a solicitation regarding future continued operations of the Arecibo Observatory via a Dear Colleague Letter (Ulvestad and Shepson, 2016);

WHEREAS, NSF, in consultation with the PR SHPO, has established that the area of potential effects (APE) (as defined at 36 C.F.R. § 800.16(d)) includes the Arecibo Observatory (see Attachment D);

WHEREAS, on October 19, 2016, NSF provided to PR SHPO a letter setting forth NSF's assessment of effects and attached the document, "Proposed Changes to Arecibo Observatory Operations: Historic Properties Assessment of Effects," which was also sent to the Consulting Parties;

WHEREAS, on November 17, 2016, NSF held a consultation meeting in San Juan, Puerto Rico, with the Consulting Parties pursuant to Section 106 of the NHPA and also invited the public. At that meeting four more individuals informed NSF that they wished to participate in NSF's Section 106 consultation process as Consulting Parties. Subsequently on June 28, 2017, an additional individual requested to be a Consulting Party. The following individuals, whose affiliations are noted in the accompanying parenthetical, are collectively referred to herein as "Consulting Parties" – Anthony van Eyken, Ph.D. (SRI International), Brett Isham, Ph.D. (Interamerican University-Bayamon), Xavier Siemens, Ph.D. (American Nanohertz Observatory for Gravitational Waves), Nicholas White, Ph.D. (Universities Space Research Association), Qihou Zhou, Ph.D. (Miami University), Ms. Luisa Zambrano-Marin (Arecibo Observatory), Daniel R. Altschuler, Ph.D. (University of Puerto Rico), Mr. Miguel Babilonia (Puerto Rican Karzo Speleological Research Foundation (FIEKP)), Carmen Pantoja, Ph.D. (University of Puerto Rico), Joan Schmelz, Ph.D. (Universities Space Research Association), and Mr. Ramon Lugo (University of Central Florida);

WHEREAS, on January 25, 2017, NSF released a solicitation requesting proposals to manage and operate the Arecibo Observatory in a reduced funding environment (NSF, 2017); this solicitation, including review of any proposals received, proceeded in parallel with, and separate from, NSF's Section 106 consultation process;

WHEREAS, NSF provided updates to the scientific community on divestment of Arecibo Observatory via a Dear Colleague Letter in April, 2017 (Gaume and Ulvestad, 2017);

WHEREAS, the majority of Consulting Parties and members of the public who submitted comments during the Section 106 and NEPA processes described the cultural and scientific importance of Arecibo Observatory and emphasized a strong preference for continued science-focused operations, which is consistent with Alternative 1, NSF's Preferred Alternative;

WHEREAS, under Alternative 1., any new collaborator(s) must retain the following contributing resources: the 305-meter Reflector (including the Support Towers), NRHP Building #1 (Visitors Offices, Electronics/Digital Lab, Control Room/Operators Office, Facilities/Maintenance (2nd level)), NRHP Building #5 (Visitors Center), NRHP Building #6 (Learning Center), NRHP Building #7 (Atmospheric and Optical Labs), and NRHP Building #13 (Machine Shop). The following contributing resources may be retained or demolished depending on the needs of any collaborator(s): NRHP Building #1A (Visitors Offices, Electronics/Digital Lab, Control Room/Operators Office, Facilities/Maintenance (2nd level); and Safety/Security Office, PC Network Office, Visiting Scientists Offices), NRHP Building #2 (1st floor: Scientific Services, Human Resources, TV/Conference Room; 2nd floor: Director and Administration, Library, Mail Room; 3rd floor: Palomar Room, Scientific Staff Offices; 4th floor: Scientific Staff Offices), and NRHP Buildings #11 and #12 (Warehouse and Business/Purchasing) (see Attachment E);

WHEREAS, under Alternative 1, an additional 17 buildings that have not been designated as either contributing or non-contributing, and are therefore considered to be unevaluated, may be retained or demolished depending on the needs of any collaborator(s) (see Attachment E);

WHEREAS, under Alternative 1, NSF may retain or transfer ownership, depending, in part, on the needs of any new collaborator(s);

WHEREAS, NSF has consulted with PR SHPO and the ACHP and determined that, under Alternative 1, adverse effects to historic properties would result if contributing resources of the NAIC Historic District were demolished, as this would be a permanent removal of historic fabric, or if ownership was transferred from NSF to a nonfederal entity, as the federal consultation process under Section 106 would no longer be applicable to future actions by such a new owner;

WHEREAS, in accordance with 36 C.F.R. § 800.6(a)(1)(i)(C), NSF has provided the ACHP the required documentation and invited it to participate in this PA; the ACHP notified NSF that it would participate in the consultation via a letter dated May 30, 2017;

WHEREAS, NSF has consulted with PR SHPO, the ACHP, and Consulting Parties on ways to avoid, minimize, and/or mitigate the adverse effects that the proposed undertaking could have on historic properties pursuant to the regulations implementing Section 106 of the NHPA, 36 C.F.R. Part 800;

WHEREAS, NSF provided the public an opportunity to express their views on resolving potential adverse effects during a telephonic consultation meeting on June 21, 2017, a public meeting on July 6, 2017, a 30-day public comment period on a draft PA commencing on June 23, 2017, and a telephonic consultation meeting on July 13, 2017; a revised draft PA, incorporating comments made during the July 6, 2017 and July 13 consultation meetings and comments received during the public comment period, was prepared and distributed to the Consulting Parties and the public on August 17, 2017 for review and comment; notification for public involvement opportunities was provided via email to potentially interested parties, updates to the NSF Division of Astronomical Sciences website, and notices in *El Nuevo Dia* newspaper on June 28, 2017, and *El Norte* newspaper on July 6, 2017; the draft PA was emailed to the Consulting Parties and other interested members of the public, posted to the AST website, and provided (hard copies) to the following libraries: Biblioteca Electrónica Pública Municipal Nicolás Nadal Barreto and the Archivo General y Biblioteca Nacional de Puerto Rico;

WHEREAS, NSF has determined, in consultation with PR SHPO and the ACHP, that circumstances are present (undetermined result of the solicitation and uncertainty regarding the specific needs of any new collaborator) that warrant the development of a PA, in accordance with 36 C.F.R. § 800.14(b)(1)ii, is appropriate;

WHEREAS, during the review of the final draft of this PA, Hurricanes Irma (September 6, 2017) and Maria (September 20, 2017) struck the Commonwealth of Puerto Rico resulting in catastrophic damage, including the loss of electrical power and telecommunications. Some damage to the Arecibo Observatory was sustained during Hurricane Maria. Because, as of October 11, 2017, 80% of the island did not have access to consistent and reliable communications, NSF was unable to communicate with the Consulting Parties located in Puerto Rico; therefore, NSF consulted with the ACHP to determine next steps for finalizing this PA.

WHEREAS, in accordance with an October 6, 2017 notification from the ACHP to Federal Preservation Officers regarding post-hurricane Section 106 consultations and related matters, the ACHP concluded and communicated to NSF that it would increase its involvement to facilitate the finalization of this PA;

WHEREAS, to keep the Consulting Parties informed and to communicate the process for implementing the Stipulations in this PA, NSF has committed to provide the Consulting Parties with a final copy of this PA for their records;

WHEREAS, PR SHPO, the ACHP, and the Consulting Parties participated in the development of this PA; PR SHPO and ACHP are Signatories herein; despite the logistical challenges resulting from Hurricanes Irma and Maria, the Consulting Parties have been asked, if available, to execute this PA as Concurring Parties;

WHEREAS, because the Director of the Arecibo Observatory, Francisco Córdova, oversees the operations and administration of the Arecibo Observatory and because he has actively participated in NSF's Section 106

consultation process, NSF invites Director Francisco Córdova to sign this PA as an Invited Signatory to demonstrate his awareness of the terms of this PA;

WHEREAS, if provided supplemental appropriations for hurricane relief and if feasible, NSF intends to fund the repairs of the Arecibo Observatory to its pre-hurricane condition; and

NOW, THEREFORE, NSF, PR SHPO, and the ACHP agree that NSF will ensure that, if Alternative I (*Collaboration with Interested Parties for Continued Science-focused Operations with Reduced NSF Funding*) is selected, the following Stipulations are implemented to address adverse effects of the proposed undertaking on historic properties under Alternative 1 and agree that these Stipulations will govern the undertaking and all of its parts.

STIPULATIONS

NSF will ensure that the following measures are carried out:

The following Stipulations address adverse effects to historic properties associated with implementation of Alternative 1 under the following two scenarios: a) NSF retains ownership of Arecibo Observatory with reduced NSF funding (Stipulation I.A., below); and b) NSF transfers ownership of Arecibo Observatory to a non-federal entity (Stipulation I.B., below).

I. Preservation Provisions

- A. **NSF Retains Ownership of Arecibo Observatory.** In the event NSF retains ownership of Arecibo Observatory and a new collaborator(s) begins operations at and management of Arecibo Observatory with reduced NSF funding, the following provisions shall apply:
1. **Avoidance of Adverse Effects.** NSF will make every effort to avoid adverse effects on contributing buildings by encouraging any collaborator(s) to use as many contributing buildings as practicable, provided that such use facilitates science-focused operations. If the collaborator(s) recommends demolition, NSF will consider mothballing in accordance with Preservation Brief 31: Mothballing Historic Buildings, issued by the U.S. Department of the Interior, National Park Service, for possible future use prior to demolition.
 2. **Support of National Historic Landmark Nomination.** If PR SHPO nominates Arecibo Observatory as a National Historic Landmark, a designation that it currently does not have, NSF will support that nomination, subject to the consent of the collaborator(s).
 3. **Survey.** NSF will conduct a survey of the NAIC Historic District to evaluate the eligibility of any buildings or structures that were not previously surveyed during preparation of the 2008 NRHP nomination, and also those built between 2008 and 2015. NSF will invite PR SHPO staff to participate in the survey. If additional contributing resources are identified, NSF, in consultation with PR SHPO, will prepare and submit an updated NRHP nomination form to include them in the NAIC Historic District.
 4. **Preparation of a NAIC Historic District Preservation and Management Plan.** NSF, in consultation with the ACHP, PR SHPO, and the collaborator(s), will prepare a NAIC Historic District Preservation and Management Plan, consistent with the results of the survey completed in Stipulation I.A.3. and with *The*

Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings (2017), as appropriate. The plan will define roles for NSF, as the federal owner of the historic district, and for the collaborator(s) as operator of the historic property. NSF will implement applicable measures of the plan, as appropriate (see also Stipulation 1.A.8.b. for collaborator(s) implementation).

5. **Required Documentation Prior to Demolition of any Building/Structure Listed on Attachment E.** If the collaborator(s) identifies a building(s) or structure(s) listed on Attachment E that is no longer needed to support science-focused operations and recommends demolition, NSF will first consider mothballing for possible future use. In the case that demolition is to occur, NSF will ensure that the appropriate documentation is prepared prior to any NSF-approved demolition as follows:
 - a. For those buildings/structures identified as contributing to the NAIC Historic District (including any newly identified contributing resources resulting from the survey described in Stipulation I.A.3., above), NSF will ensure that any such contributing resources are documented in accordance with National Park Service (NPS) Historic American Buildings Survey (HABS) and Historic American Engineering Record (HAER) standards prior to demolition, unless PR SHPO recommends against such HABS/HAER documentation.
 - b. For those buildings/structures that are identified as non-contributing to the NAIC Historic District (as updated by the survey conducted pursuant to Stipulation I.A.3., above), no additional documentation will be required.
6. **Process Required Prior to Demolition of any Building/Structure Not Listed on Attachment E.** If the collaborator(s) identifies a building(s) or structure(s) not listed on Attachment E that is no longer needed to support science-focused operations and recommends demolition, NSF will conduct, as appropriate, a new Section 106 consultation prior to any NSF-approved demolition.
7. **New Construction.** If the collaborator(s) identifies new construction or other changes needed to the NAIC Historic District, NSF will conduct, as appropriate, a new Section 106 consultation prior to any NSF-approved new construction or modifications.
8. **Preservation Provisions.** NSF will require that any collaborator(s) adhere to the following preservation provisions:
 - a. **Training.** Key facility staff of the collaborator(s) will attend historic preservation awareness training to encourage awareness of the historic and cultural significance of Arecibo Observatory and to minimize the potential for adverse effects to historic properties. Such training, which will be provided by NSF via a qualified historic preservation professional who is familiar with and knowledgeable about the Arecibo Observatory and its importance to Puerto Rico and the local community, will occur within 180 days (or as soon as practicable thereafter) of the commencement of operations by the collaborator(s). The training will address applicable elements of the

NAIC Historic District Preservation and Management Plan described in Stipulation I.A.4. NSF will provide PR SHPO an opportunity to comment on the content of such training.

- b. **NAIC Historic District Preservation and Management Plan.** The collaborator(s) will incorporate, where practicable, appropriate elements of the NAIC Historic District Preservation and Management Plan (see Stipulation 1.A.3) into the management and operations of Arecibo Observatory in a manner that does not interfere with the ability of the collaborator(s) to conduct science-focused operations at Arecibo Observatory.
 - c. **Public Access.** The collaborator(s) will allow reasonable public access to the Arecibo Observatory site provided that such access does not unduly interfere with the collaborator's use of the property for science-focused operations and is consistent with health, safety, and security guidelines.
- B. **NSF Transfers Ownership of Arecibo Observatory.** In the event NSF issues an award to a collaborator to operate and manage Arecibo Observatory with reduced NSF funding, and that award includes provisions reflecting the collaborator's intent to seek a transfer of ownership of Arecibo Observatory from NSF to the collaborator, the following provisions shall apply:
- 1. **Survey.** Prior to the transfer, NSF will conduct a survey of the NAIC Historic District to evaluate the eligibility of any buildings or structures that were not previously surveyed during preparation of the 2008 NRHP nomination, and also those built between 2008 and 2015. NSF will invite PR SHPO staff to participate in the survey. If additional contributing resources are identified, NSF, in consultation with PR SHPO, will prepare and submit an updated NRHP nomination form to include them in the NAIC Historic District. This provision shall not apply, however, if a survey has already been conducted pursuant to Stipulation I.A.3.
 - 2. **Required Documentation.** Prior to transfer, or as soon as practicable thereafter, NSF will ensure that all contributing resources (including those identified in the survey conducted pursuant to Stipulation I.B.2., above) are documented in accordance with NPS HABS/HAER standards unless PR SHPO recommends against such HABS/HAER documentation.
 - 3. **Training.** NSF will ensure that the key facility staff of any new owner will receive an initial, one-time historic preservation awareness training to encourage awareness of the historic and cultural significance of Arecibo Observatory and to minimize the potential for adverse effects to historic properties. Such training, which will be funded by NSF, will be administered by a qualified historic preservation professional who is familiar with and knowledgeable about the Arecibo Observatory and its importance to Puerto Rico and the local community, and will occur within 180 days (or as soon as practicable thereafter) of the transfer. NSF will provide PR SHPO an opportunity to comment on the content of such training.
 - 4. **Consultation on Preservation Principles and Management Strategies for the**

new Collaborator(s). Within nine months of selection of a new collaborator(s), NSF will consult with the ACHP, PR SHPO, and the new collaborator(s) to discuss the development and implementation of future preservation principles and management strategies that permit continued science-focused operations at Arecibo Observatory while preserving its historic integrity.

5. **Public Access.** NSF will encourage the collaborator(s) to allow reasonable public access to the Arecibo Observatory site provided that such access does not unduly interfere with the collaborator's use of the property for science-focused operations and is consistent with health, safety, and security guidelines.
6. **NSF-Funded Program for the Visually- and Hearing-Impaired.** Within one year of the transfer of Arecibo Observatory to a new owner, NSF will fund the development and installation of a program for the visually- and hearing-impaired in the Arecibo Observatory Visitor's Center. The purpose of this program is to help convey the cultural and scientific significance of Arecibo Observatory to a broader audience. The cost for the program will not exceed \$50,000. Signatories to this PA will have a 30-day period to review a written draft of the proposed program and its components, and NSF will consider any comments received before developing and installing the final program.

C. Documentation of Actions Demonstrating Compliance with this PA

So long as NSF remains the owner of Arecibo Observatory and provided this PA remains in effect, NSF will submit updates every six months, beginning with six months following the effective date of this PA, regarding the progress of compliance with this PA to PR SHPO and the ACHP. If PR SHPO has any concerns regarding the implementation of this PA, Section VII. Dispute Resolution, herein, may be used to address those concerns.

II. DELAYED TRANSFER OF OWNERSHIP

In the event NSF issues an award to a collaborator(s) to manage and operate Arecibo Observatory, and plans to transfer ownership of Arecibo Observatory to the collaborator(s) (a non-federal entity), only Stipulation I.B., above, shall apply, notwithstanding any limited temporal delay.

III. ALTERNATIVE 1 is selected by NSF in its Record of Decision and implementation is not feasible

If Alternative 1 is selected by NSF in its Record of Decision and implementation is not feasible, NSF will notify PR SHPO, the ACHP, and Consulting Parties and will resume Section 106 consultation on Alternatives 2-5 and seek to amend this PA.

IV. UNANTICIPATED EFFECTS

If unanticipated effects on historic properties occur during implementation of the undertaking under Stipulation I.A., NSF will, in compliance with 36 C.F.R. § 800.13(b)(3), determine actions that it can take to resolve potential adverse effects and notify via phone and email PR SHPO and other Consulting Parties, as appropriate, within 48 hours of NSF's awareness of the effects. The notification will describe the eligibility of the property and proposed actions to resolve any adverse effects. PR SHPO and other Consulting Parties will respond with any comments within 48 hours of the notification by phone or email. NSF will take into account the Consulting Parties' recommendations regarding NRHP eligibility and proposed actions, and then carry out appropriate actions. NSF will provide PR SHPO and other Consulting Parties, as appropriate, with a report of the actions when they are completed. This Stipulation (Stipulation IV.) shall not apply if NSF is no longer the owner of Arecibo Observatory.

V. POST-AGREEMENT DISCOVERIES

If NSF continues to own Arecibo Observatory and it is managed by a collaborator(s), all unanticipated discoveries of historic properties and human or burial remains within the APE revealed during any activity associated with implementation of the proposed undertaking under Stipulation I.A., the proposed undertaking will be addressed in the following manner:

- A. The contractor/collaborator(s) carrying out any such demolition will promptly notify NSF, who will notify PR SHPO of the discovery.
- B. If NSF determines, in consultation with PR SHPO, that the discovery is eligible for listing in the NRHP, NSF will initiate consultation with the Consulting Parties to draft a plan with measures that will avoid, minimize, and/or mitigate adverse effects. If agreement is reached regarding such a plan, NSF will implement the plan. If the discovery is made during demolition activities (if any), demolition in the affected area must cease until the discovery process in this Stipulation has been concluded either through a finding that the property is not eligible for listing in the NRHP or through finalization of the plan referenced herein.
- C. If the Consulting Parties cannot reach agreement regarding the development of a treatment or mitigation plan, then the matter will be referred to the ACHP for guidance. NSF will address the ACHP's guidance in reaching a final decision regarding implementation of the plan.
- D. If any previously unidentified human or burial remains are discovered during implementation of the undertaking, the contractor/collaborator(s) will immediately cease any demolition work and adhere to applicable state and federal laws regarding the treatment of human or burial remains.

VI. REPORTING

- A. To keep the public and Consulting Parties apprised of the status of the implementation of the Stipulations in this PA, NSF will maintain a status report on the NSF Division of Astronomical Sciences website with relevant information.
- B. Meetings or conference calls regarding the undertaking and/or implementation of the Stipulations in this PA may be requested at any time by the Signatories for the duration of this PA.
- C. If Arecibo Observatory is transferred out of NSF ownership, the terms of this Stipulation shall not apply after transfer.

VII. DISPUTE RESOLUTION

A. Signatories

In the event one of the Signatories objects to the manner in which any term of this PA is implemented, the following dispute resolution process will be followed:

1. The objecting Signatory will notify all other Signatories to this PA, in writing, of the objection or disagreement, request written comments on the objection or disagreement within ten (10) business days following receipt of such notification, and then proceed to consult with the Signatories to resolve the objection. If at any time during consultation, NSF determines that the objection or disagreement cannot be resolved through consultation, NSF will forward all documentation relevant to the dispute to PR SHPO, or if the objection is raised by PR SHPO, NSF will forward all documentation relevant to the dispute to the ACHP. Within 30 days after receipt of all pertinent documentation, PR SHPO or, as appropriate, the ACHP, will provide NSF with comments and recommendations, which NSF will take into account in reaching a final decision regarding the dispute. Any comment provided by PR SHPO or, as

appropriate, the ACHP, will be understood to pertain only to the subject of the dispute. All other actions under this PA that are not the subject of the dispute will remain unchanged.

2. Unless all Signatories agree that the dispute warrants a cessation of work, neither NSF nor its collaborator(s) will be required to cease work on the proposed undertaking while the dispute is being reviewed.

B. Continued Participation by the Public and Concurring Parties

At any time during the implementation of the Stipulations set forth in this PA, any member of the public, including any Consulting Party who has decided not to sign this PA as a Concurring Party, and any Concurring Party may continue to participate in the Section 106 consultation process as follows:

1. Any member of the public may raise an objection to NSF pertaining to the treatment of an historic property associated with implementation of the proposed undertaking, provided that title to Arecibo Observatory is retained by NSF. In the event such an objection is raised, NSF will consult with PR SHPO regarding the objection, and following such consultation, will provide the objecting member of the public with a decision on the objection.
2. Any Concurring Party may raise an objection to NSF and PR SHPO pertaining to the treatment of an historic property associated with implementation of the proposed undertaking. In the event such an objection is raised by a Concurring Party, NSF and PR SHPO will consult regarding how to resolve the objection. If NSF and PR SHPO are unable to resolve the objection, they will consult with the ACHP. NSF will consider any recommendation on the objection provided by the ACHP before making a final decision on the matter. NSF will communicate such a final decision to the objecting Concurring Party and PR SHPO.

If an objection is made pursuant to either Stipulation VII.B.1. or VII.B.2., NSF, in consultation with PR SHPO, will determine whether the objection warrants a cessation of work (if any) on the proposed undertaking while the objection is being reviewed.

- C.** This Stipulation (Stipulation VII.) shall not apply if NSF is no longer the owner of Arecibo Observatory.

VIII. PROFESSIONAL QUALIFICATIONS

All work carried out pursuant to this PA will be developed and/or implemented by or under the direct supervision of a person or persons meeting or exceeding the minimum professional qualifications, appropriate to the affected resource(s), listed in the *Secretary of the Interior's Professional Qualification Standards* (36 CFR Part 61, Appendix A) and amended in 1992.

IX. PRINCIPLES AND STANDARDS

The Signatories agree that the surveys referred to in Stipulations I.A.3. and I.B.1. will be conducted in a manner consistent with the principles and standards contained in the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (36 CFR Part 68), *Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation* (1983, as amended), *Recommended Approach for Consultation on Recovery of Significant Information from Archaeological Sites* (ACHP, May 18, 1999, 64 FR 27085-27087), and any Puerto Rico guidelines, as appropriate.

X. ELECTRONIC COPIES

NSF will provide PR SHPO, the ACHP, and each Consulting Party with one legible, full-color, electronic copy of the fully executed PA and its Attachments no more than 30 days after execution. If the electronic copy is too large to send via email, NSF will provide each Consulting Party with a copy of the executed PA via a CD.

XI. AMENDMENT

Any Signatory may request that this PA be amended by informing NSF in writing of the reason for the request and the proposed amendment language. After receiving the request, NSF will notify all Consulting Parties of the proposed amendment and consult to reach agreement. The amendment will be effective on the date a copy signed by all the Signatories and Invited Signatories is filed by NSF with the ACHP.

XII. EXPIRATION

If NSF retains ownership of Arecibo Observatory, this PA will expire ten years from the Effective Date of this PA as defined in Stipulation XV., herein. If ownership of Arecibo Observatory is transferred to a non-federal entity, upon completion of the terms in Stipulation I.B., this PA shall expire. Prior to such expiration date, NSF may consult with PR SHPO and the ACHP to reconsider the terms of this PA and amend it in accordance with Stipulation XI. If unresolved issues remain within two years of the expiration date of this PA, NSF will, at that time, consult with PR SHPO and the ACHP regarding the progress of implementation of this PA and consider the appropriateness of developing a subsequent agreement or amendment to the PA.

XIII. COMPLIANCE WITH APPLICABLE LAW AND ANTI-DEFICIENCY ACT PROVISION

This PA will be carried out consistent with all applicable federal and state laws. No provision of this PA will be implemented in a manner that would violate the Anti-Deficiency Act. NSF shall make reasonable and good faith efforts to secure the necessary funds to implement this PA in its entirety. All obligations on the part of NSF will be subject to the availability and allocation of appropriated funds for such purposes. Nothing in this PA may be construed to obligate NSF to any current or future expenditure of resources in advance of the availability of appropriations. Should NSF be unable to fulfill the terms of this PA due to funding constraints or priorities, NSF will immediately notify and consult with PR SHPO and the ACHP to determine whether to amend or terminate this PA pending the availability of resources.

XIV. TERMINATION

If any Signatory to this PA determines that the terms of this PA will not or cannot be carried out, that Signatory will immediately consult with the other Signatories to develop an amendment to this PA pursuant to Section XI., above. If this PA is not amended following that consultation, then it may be terminated by any Signatory through written notice to the other Signatories. Within 30 days following any such termination and prior to work continuing on the undertaking, NSF will notify PR SHPO and the ACHP whether it will initiate consultation to execute a new PA under 36 C.F.R. § 800.14(b)(1)(ii) or request and consider the comments of the ACHP under 36 C.F.R. § 800.7 and proceed accordingly.

XV. EFFECTIVE DATE

This PA will be executed in counterparts, with a separate page for each Signatory, and NSF will ensure that each Signatory is provided with a fully executed copy. This PA will become effective upon obtaining the signatures of NSF, PR SHPO, and the ACHP.

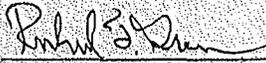
Execution of this PA by NSF, PR SHPO, and the ACHP evidences that NSF has taken into account the effects of this proposed undertaking on historic properties, and has afforded the ACHP an opportunity to comment on the proposed undertaking.

SIGNATORY PAGE

**PROGRAMMATIC AGREEMENT
AMONG
THE NATIONAL SCIENCE FOUNDATION,
THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, AND
THE PUERTO RICO STATE HISTORIC PRESERVATION OFFICER
REGARDING
POTENTIAL CHANGES TO
ARECIBO OBSERVATORY OPERATIONS
IN THE VICINITY OF ARECIBO, PUERTO RICO**

Signatory:

National Science Foundation



Richard F. Green, Ph.D., Division Director, Astronomical Sciences

Date 15 Nov, 2017

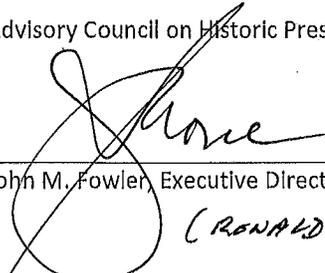


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IN THE VICINITY OF ARECIBO, PUERTO RICO

Signatory:

Advisory Council on Historic Preservation



John M. Fowler, Executive Director
(RONALD D. ANZALONE, ACTG.)

Date

11/15/2017

REC

SIGNATORY PAGE

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Signatory:

Puerto Rico State Historic Preservation Office



Carlos Rubio Cancela, Executive Director

Date

November 14, 2017

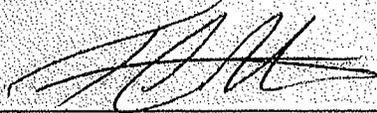


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INVITED SIGNATORY PAGE
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Invited Signatory:

Arecibo Observatory



Francisco Córdova, Director

Date

11/13/17



CONCURRING PARTY SIGNATURE PAGE

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Concurring Party:

SRI International

Anthony van Eyken, Ph.D.

Date _____

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Concurring Party:

Interamerican University-Bayamon

Brett Isham, Ph.D.

Date _____

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Concurring Party:

Miami University

Qihou Zhou, Ph.D.

Date _____

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Concurring Party:

Universities Space Research Association

Date

Nicholas White, Ph.D.

CONCURRING PARTY SIGNATURE PAGE

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Concurring Party:

American Nanohertz Observatory for Gravitational Waves

Xavier Siemens, Ph.D.

Date _____

CONCURRING PARTY SIGNATURE PAGE

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Concurring Party:

Ms. Luisa Zambrano-Marin

Date _____

CONCURRING PARTY SIGNATURE PAGE

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Concurring Party:

Carmen Pantoja, Ph.D.

Date _____

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Concurring Party:

Puerto Rican Karzo Speleological Research Foundation (FIEKP)

Mr. Miguel Babilonia

Date _____

CONCURRING PARTY SIGNATURE PAGE

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Concurring Party:

Universities Space Research Association

Joan Schmelz, Ph.D.

Date _____

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Concurring Party:

University of Central Florida

Mr. Ramon Lugo

Date _____

CONCURRING PARTY SIGNATURE PAGE

PROGRAMMATIC AGREEMENT
AMONG
THE NATIONAL SCIENCE FOUNDATION,
THE ADVISORY COUNCIL ON HISTORIC PRESERVATION, AND
THE PUERTO RICO STATE HISTORIC PRESERVATION OFFICER
REGARDING
POTENTIAL CHANGES TO
ARECIBO OBSERVATORY OPERATIONS
IN THE VICINITY OF ARECIBO, PUERTO RICO

Concurring Party:

University of Puerto Rico

Daniel R. Altschuler, Ph.D.

Date _____

Attachment A
NAIC Historic District Map

Attachment B
Table of Historic Properties in
NAIC Historic District

Contributing Resources to the National Astronomy and Ionosphere Center Historic District

Structure/Building Number	Building Name	Year of Construction
National Register of Historic Places designation (NRHP)*: N/A	305-meter Reflector	1963
Arecibo Observatory designation (AO): N/A	305-meter Radio Telescope and Support Towers	
NRHP: Buildings #1 and #1A	Visitors Offices, Electronics/Digital Lab, Control Room/Operators Office, Facilities/Maintenance (2 nd level); and Safety/Security Office, PC Network Office, Visiting Scientists Offices	1963 (addition in 1983) Year of construction for trailers unknown.
AO: Building #1 (and Trailers #66 and #68)	Operations Building (with Atmospheric Science Trailer and Scientific Offices Trailer)	
NRHP: Building #2	1st floor: Scientific Services, Human Resources, TV/Conference Room; 2 nd floor: Director and Administration, Library, Mail Room; 3 rd floor: Palomar Room, Scientific Staff Offices; 4 th floor: Scientific Staff Offices	1963
AO: Building #2	Administration Building	
NRHP: Building #5	Visitors Center	1997 (addition 2015)
AO: Building #54	Visitor Center Building (Fundación Angel Ramos Visitor and Educational Facility)	
NRHP: Building #6	Learning Center	2001
AO: Building #61	Learning Center	
NRHP: Building #7	Atmospheric and Optical Labs	1985/1997
AO: Building #27	Optical Labs	
NRHP: Buildings #11 and #12	Warehouse and Business/Purchasing	1967
AO: Building #17	Warehouse	
NRHP: Building #13	Machine Shop	1967
AO: Building #12	Maintenance Shops	

** The National Register of Historic Places Registration Form, which was completed in 2007, provides building numbers and names that do not always correspond to the current Arecibo Observatory facility designations. For this reason, the current NRHP Registration Form building designations are provided along with the Arecibo Observatory designations that are provided in Attachment A. Also note that the Registration Form does not indicate which of the 13 described buildings/structures are contributing resources to the NAIC Historic District. The above 8 buildings/structures were identified as contributing resources based on correspondence with the Puerto Rico SHPO on May 20, 2016.*

Attachment C

References and Definitions

PA References:

- Gaume, Ralph A. and James S. Ulvestad. 2017. National Science Foundation NSF 17-079 Dear Colleague Letter: MPS-AST Facility Divestment Activity. April 27.
<https://www.nsf.gov/pubs/2017/nsf17079/nsf17079.jsp>
- National Academies of Sciences, Engineering, and Medicine (NASEM). 2016. *New Worlds, New Horizons: A Midterm Assessment*. Washington, DC: The National Academies Press.
<https://doi.org/10.17226/23560>
- National Science Foundation (NSF) Directorate for Mathematical & Physical Sciences Division of Astronomical Sciences and Directorate for Geosciences Division of Atmospheric and Geospace Sciences. 2017. Program Solicitation NSF 17-538 Management and Operations of the Arecibo Observatory. January 25. <https://www.nsf.gov/pubs/2017/nsf17538/nsf17538.htm>
- National Science Foundation (NSF) Division of Astronomical Sciences (AST). 2006. *From the Ground Up: Balancing the NSF Astronomy Program* (Senior Review Committee Report). Prepared by the Senior Review Committee. October 22.
https://www.nsf.gov/mps/ast/seniorreview/sr_report_mpsac_updated_12-1-06.pdf
- National Science Foundation (NSF) Division of Astronomical Sciences (AST). 2012. *Advancing Astronomy in the Coming Decade: Opportunities and Challenges* (Portfolio Review Committee Report). Prepared by the Portfolio Review Committee. August 14.
https://www.nsf.gov/mps/ast/portfolioreview/reports/ast_portfolio_review_report.pdf
- National Science Foundation (NSF) Division of Atmospheric and Geospace Science (AGS). 2016. *Investments in Critical Capabilities for Geospace Science 2016 to 2025 - A Portfolio Review of the Geospace Section of the Division of Atmospheric and Geospace Science*. Prepared by the Portfolio Review Committee: Daniel N. Baker, Jorge Chau, Christina Cohen, Sarah Gibson, Joseph Huba, Mona Kessel, Delores Knipp, Louis Lanzerotti, William Lotko (*Chair*), Patricia Reiff, Alan Rodger, Joshua Semeter (*GEO/Advisory Committee Liaison*), Howard Singer. April 14.
<https://www.nsf.gov/geo/adgeo/geospace-review/geospace-portfolio-review-final-rpt-2016.pdf>
- Ulvestad, James S. and Paul B. Shepson. 2015. National Science Foundation NSF 16-005 Dear Colleague Letter: Concepts for Future Operation of the Arecibo Observatory. October 26.
<https://www.nsf.gov/pubs/2016/nsf16005/nsf16005.pdf>
- Ulvestad, James S. and Paul B. Shepson. 2016. National Science Foundation NSF 16-144 Dear Colleague Letter: Intent to Release a Solicitation Regarding Future Continued Operations of the Arecibo Observatory. September 30. <https://www.nsf.gov/pubs/2016/nsf16144/nsf16144.jsp>

PA Definitions:

Adverse Effect: a change to the characteristics that qualify a historic property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association (36 CFR 800.5(a)).

Area of Potential Effects (APE): the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking (36 CFR 800.16(d)). It is important to understand that the effects

pertain to the effects on physical historic properties (eligible for or listed in the National Register of Historic Places [NRHP]) in a specific area.

Concurring Party: Any consulting party that has been invited by the federal agency (NSF) to concur in the PA. Concurring parties have the same rights with regard to seeking amendment or termination of the PA as other signatories. The refusal of any party invited to concur in the PA does not invalidate the document (36 CFR 800.16(d)).

Consultation: the process of seeking, discussing, and considering the views of other participants, and, where feasible, seeking agreement with them regarding matters arising in the Section 106 process (36 CFR 800.16(f)).

Consulting Party: Section 106 term that refers to organizations and/or individuals with a demonstrated interest in the undertaking due to the nature of their legal or economic relation to the undertaking or affected properties, or their concern with the undertaking's effects on historic properties. The participation of consulting parties is subject to approval by the federal agency (in this case, NSF). Consulting parties are actively informed of and able to participate in the Section 106 process, including consultation meetings. The views of consulting parties are actively sought by NSF during the Section 106 consultation process. (36 CFR 800.2(c)(5))

Effect: an alteration to the characteristics of a historic property qualifying it for inclusion in or eligibility for the NRHP (36 CFR 800.16(i)).

Historic Property: Any resource, such as a building, structure, or historic district, included in or eligible for inclusion in the NRHP, maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the NRHP criteria (36 CFR 800.16(l)).

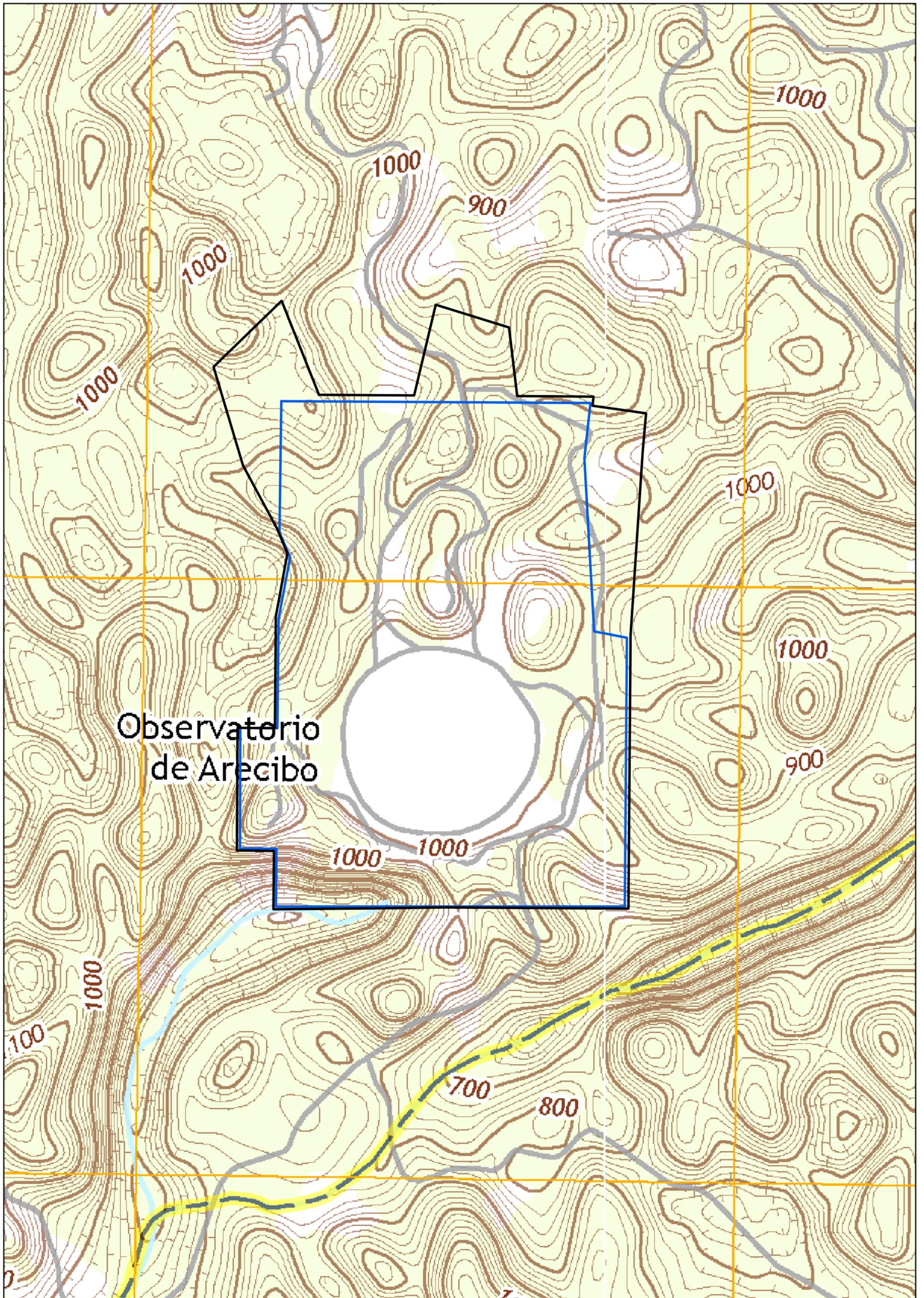
Invited Signatory: Any party that is assigned a responsibility under the PA and is invited by the federal agency (NSF) to sign the PA. Any invited signatory that signs the PA has the same rights with regard to seeking amendment or termination of the PA as other signatories. The refusal of any party invited to become a signatory to a PA does not invalidate the document (36 CFR 800.6(c)(2)).

Signatory: Signatories include the federal agency (NSF), PR SHPO, and ACHP, and they have the sole authority to execute, amend, or terminate the PA (36 CFR 800.6(c)(1)).

Programmatic Agreement (PA): A document that records the terms and conditions agreed upon to resolve the potential adverse effects of a federal agency program or complex undertaking. For this undertaking, a PA is used to document the ways in which adverse effects are addressed because the result of the 2017 solicitation for new collaborators is undetermined and the needs of any new collaborator(s) are unknown (36 CFR 800.14(b)).

Undertaking: A project, activity, or program funded in whole or in part by a federal agency (36 CFR 800.16(y)).

Attachment D
Area of Potential Effects



<ul style="list-style-type: none"> Property Boundary and Area of Potential Effects (APE) Historic District Boundary 	<p>1 inch = 500 feet 0 250 500 Feet</p>	<p>Cultural Resources Area of Potential Effects Arecibo Observatory Puerto Rico</p>
<p>USGS Topographic Quads Bayaney NE (2013) and Utuado NW (2013)</p>		

Attachment E

Buildings and structures that may be retained or demolished based on the needs of any collaborator(s) under Alternative 1- *Collaboration with Interested Parties for Continued Science-focused Operations*

Buildings and structures that may be retained or demolished based on the needs of any collaborator(s) under Alternative 1, *Collaboration with Interested Parties for Continued Science-focused Operations*

Structure/Building Number	Building Name	Year of Construction, if known
National Register of Historic Places designation (NRHP)*: #1A	Visitors Offices, Electronics/Digital Lab, Control Room/Operators Office, Facilities/Maintenance (2 nd level); and Safety/Security Office, PC Network Office, Visiting Scientists Offices	1963 (addition in 1983)
Arecibo Observatory designation (AO): Trailers #66 and #68	Atmospheric Science Trailer and Scientific Offices Trailer	Year of construction for trailers unknown.
NRHP: Building #2	1st floor: Scientific Services, Human Resources, TV/Conference Room; 2 nd floor: Director and Administration, Library, Mail Room; 3 rd floor: Palomar Room, Scientific Staff Offices; 4 th floor: Scientific Staff Offices	1963
AO: Building #2	Administration Building	
NRHP: Buildings #11 and #12	Warehouse and Business/Purchasing	1967
AO: Building #17	Warehouse	
NRHP: #4	Recreation Area	
AO: #10	Swimming Pool/Restrooms (with additional recreation areas)	mid 1960s
NRHP: #8 (B1-B2)	VSQ Bachelor Units (B1-B2)	1990s
AO: #41	West Hill V.S.Q. Bachelor Unit 1	
NRHP: #8 (B3-B4)	VSQ Bachelor Units (B3-B4)	1990s
AO: #42	West Hill V.S.Q. Bachelor Unit 2	
NRHP: #9 (F1)	VSQ Family Units F1	1990s
AO: #43	West Hill V.S.Q. Family Unit 1	
NRHP: #9 (F2)	VSQ Family Units F2	1990s
AO: #44	West Hill V.S.Q. Family Unit 2	
NRHP: N/A	N/A	mid 1960s
AO: #11	Lewis Building-Rigging Loft	
NRHP: N/A	N/A	1963
AO: #13	Bowl Shack	
NRHP: N/A	N/A	
AO: #21	Antenna Testing Range	
NRHP: N/A	N/A	2010
AO: #25	Paint Storage Building	
NRHP: N/A	N/A	1973
AO: #34	High Voltage Power Supply Building	

NRHP: N/A	N/A	Late 1990s
AO: #60	Antenna Receiving Testing Building	
NRHP: N/A	N/A	1983
AO: #65	Shielded Trailer	
NRHP: N/A	N/A	2000s
AO: #73	HF Transmitter Building	
NRHP: N/A	N/A	2000s
AO: #78	Coffee Hut	
NRHP: N/A	N/A	
AO: #62	HFF Storage Trailer	
NRHP: N/A	N/A	
AO: #71	Electronics Cable Trailer	
NRHP: N/A	N/A	
AO: #64	Electronic Trailer	
NRHP: N/A	N/A	
AO: #59	Visitor Center Trailer	
NRHP: N/A	N/A	
AO: #70	Computer Trailer	
NRHP: N/A	N/A	
AO: #63	Ionosonde Trailer	
NRHP: N/A	N/A	
AO: #69	Electronic Trailer (Waveguide)	
NRHP: N/A	N/A	
AO: #72	Electronic Trailer (Cryogenics)	

Key:

 **Contributing Resources:** described in the National Register of Historic Places Registration Form, which was completed in 2007, and identified as contributing to the NAIC Historic District Historic District based on correspondence with the Puerto Rico SHPO on May 20, 2016.

 **Non-Contributing Resources:** described in the National Register of Historic Places Registration Form, which was completed in 2007, and identified as non-contributing to the NAIC Historic District Historic District based on correspondence with the Puerto Rico SHPO on May 20, 2016.

 **Unevaluated:** buildings/structures not designated as contributing or non-contributing resources and considered to be unevaluated at this time.

** The National Register of Historic Places Registration Form provides building numbers and names that do not always correspond to the current Arecibo Observatory facility designations. For this reason, the current NRHP Registration Form building designations are provided along with the Arecibo Observatory designations that are provided in Attachment A.*