NATIONAL SCIENCE FOUNDATION

RECORD OF DECISION

I. INTRODUCTION

Arecibo Observatory is a National Science Foundation (NSF)-owned scientific research and education facility. In 2011, NSF awarded a Cooperative Agreement to SRI International, which together with the Universities Space Research Association (USRA) and Universidad Metropolitana formed the Arecibo Management Team to operate and maintain Arecibo Observatory for the benefit of scientific research communities. Arecibo Observatory enables research in three scientific disciplines: space and atmospheric sciences, radio astronomy, and solar system radar studies; the last of these is largely funded through a research award to USRA from the National Aeronautics and Space Administration (NASA). An education and public outreach program complements the Arecibo Observatory scientific program.

A key component of Arecibo Observatory's research facility is a 305-meter-diameter, fixed, spherical reflector. Arecibo Observatory infrastructure includes instrumentation for radio and radar astronomy and ionospheric physics, office and laboratory buildings, a visitor and education facility, and lodging facilities for visiting scientists.

NSF acknowledges that valuable science and education activities are conducted at Arecibo Observatory, as evidenced by decades of substantial NSF funding of both the facility and research grants. However, the purpose of the current proposal is to reduce NSF funding in light of a constrained budgetary environment.

PURPOSE & NEED

NSF's Division of Astronomical Sciences (AST) is the federal steward for ground-based astronomy in the United States, funding research with awards to individual investigators and small research groups, and via cooperative agreements for the operation of large telescope facilities. These national and international telescope facilities provide world-leading, one-of-a-kind observational capabilities on a competitive basis to thousands of astronomers per year. These facilities also enable scientific advances by making archived data products available to researchers. Along with funding telescope facilities and research awards, AST supports the development of advanced technologies and instrumentation and manages the allocation and assignment of specific frequencies in the radio spectrum for scientific use by the entire NSF community.

NSF relies on the scientific community, via decadal surveys and senior-level reviews, to provide input on priorities, and this community has repeatedly recommended divestment from AO, as well as from other observatories under similar review.

In 2010, the National Research Council (NRC) conducted its sixth decadal survey in astronomy and astrophysics. In their report, *New Worlds, New Horizons in Astronomy and Astrophysics*, the NRC committee recommended the following:

> "NSF-Astronomy should complete its next senior review before the mid-decade independent review that is recommended in this report, so as to determine which, if any, facilities NSF-AST should cease to support in order to release funds for (1) the construction and ongoing operation of new telescopes and instruments and (2) the science analysis needed to capitalize on the results from existing and future facilities."

In response to this recommendation, the NSF Directorate for Mathematical and Physical Sciences (MPS) commissioned a subcommittee of the MPS Advisory Committee to assess the portfolio of the AST within MPS. This subcommittee, 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 under constrained budget scenarios. The resulting Portfolio Review Committee Report (PRC Report), *Advancing Astronomy in the Coming Decade: Opportunities and Challenges*, was released in August 2012.

The PRC Report recommended the divestment of a number of telescopes from the federal portfolio in order to maintain a balance of small-, medium-, and large-scale programs that would best address decadal survey science. With respect to Arecibo Observatory, the PRC Report made the following recommendation (Recommendation 10.4): "AST should reevaluate its participation in Arecibo and SOAR later in the decade in light of the science opportunities and budget forecasts at that time."

This follows from a recommendation made by the AST Senior Review Committee in 2006 in its report entitled *From the Ground Up: Balancing the NSF Astronomy Program* (Recommendation 6): "The National Astronomy and Ionosphere Center [former name for Arecibo Observatory] ...should seek partners who will contribute personnel or financial support to the operation of Arecibo...by 2011 or else these facilities should be closed." The Senior Review Report also noted that "If Arecibo is kept operating beyond 2011, it is expected that this will only be a limited-term extension, pending the deliberations of the next decadal survey".

While AST was the primary funder of Arecibo for over a decade (funding $10.6M annually in 2006, reducing over the years to $4.1M in 2016), the Geospace Section (GS) of the NSF Division of Atmospheric and Geospace Sciences (AGS) 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 ($4.1 million annually from GS) for Arecibo Observatory. As a result, AGS has also taken a lead role in making recommendations about the future of Arecibo Observatory. In 2016, the GEO Advisory Committee concluded its own community-based portfolio review, which recommended a significant and specific funding reduction. The report written by AGS and delivered in April 2016, entitled *Investments in Critical Capabilities for Geospace Science: 2016 to 2025*, gave the following recommendation (Recommendation 9.11): "The GS should reduce its M&O [Management and Operations] support for Arecibo Observatory to $1.1M by 2020, i.e., to a proportional *pro rata* level approximately commensurate with its fractional NSF GS proposal pressure and usage for frontier research." The NSF/GEO Directorate commissioned a review from a second panel assembled by the National Academy of Sciences that was given the charge of assessing the process by which PRC findings and recommendations were reached; this panel agrees with Recommendation 9.11.

The continued importance of the NSF response to the PRC Report was highlighted by the annual report of the Congressionally chartered Astronomy and Astrophysics Advisory Committee

(AAAC) in March 2016, which recommended that "[s]trong efforts by NSF for facility divestment should continue as fast as is possible." More recently, in August 2016, the National Academies of Sciences, Engineering, and Medicine (NAS) mid-decadal report, *New Worlds, New Horizons: A Midterm Assessment*, provided their Recommendation 3-1: "The National Science Foundation (NSF) should proceed with divestment from ground-based facilities which have a lower scientific impact, implementing the recommendations of the NSF Portfolio Review that is essential to sustaining the scientific vitality of the U.S. ground-based astronomy program as new facilities come into operation."

At present, Arecibo Observatory serves a variety of scientific user communities in astronomy, aeronomy, and planetary science, and it is funded for all three activities as well as an active education and public outreach program. However, the scientific community evaluations cited previously indicate that the scientific capability of Arecibo Observatory is lower in priority than other scientific capabilities NSF funds. In a funding-constrained environment, NSF must maintain a balanced research portfolio with the largest science return for the taxpayer dollar. Therefore, the purpose of this Proposed Action is to substantially reduce NSF's contribution to the funding of Arecibo Observatory.

IDENTIFICATION OF POTENTIAL ALTERNATIVES

NSF has defined options for the future state of Arecibo Observatory, given the need to significantly decrease or eliminate NSF funding of the Observatory. NSF has sought viable concepts of operations from the scientific community via an October 26, 2015 Dear Colleague Letter NSF 16–005. Preliminary proposed Alternatives were developed based on this input and were included in the Notice of Intent (NOI) published in the *Federal Register* on May 23, 2016.

A public scoping process was initiated upon publication of the NOI and was completed in June 2016. Details of this process can be found in Section 5 of the Final Environmental Impact Statement (FEIS) for the Arecibo Observatory, dated July 27, 2017, and noticed in the Federal Register on August 4, 2017. Input received during scoping was used to vet the alternatives presented in the NOI and to provide focus on the issues to be evaluated.

Alternatives Considered

As detailed in the FEIS, five Action Alternatives, in addition to the No-Action Alternative, were considered for the proposed change in operations of Arecibo Observatory:

- Alternative 1: Collaboration with Interested Parties for Continued Science-focused Operations (Agency-preferred Alternative)
- Alternative 2: Collaboration with Interested Parties for Transition to Education-focused Operations
- Alternative 3: Mothballing of Facilities
- Alternative 4: Partial Demolition and Site Restoration
- Alternative 5: Complete Demolition and Site Restoration
- No-Action Alternative: Continued NSF Investment for Science-focused Operations

Under each Action Alternative described herein, there could be some level of demolition of buildings and structures; buildings/structures that could be demolished are identified for analysis purposes only, but these buildings/structures would not necessarily be demolished. Alternatives 1 and 2 are defined by the reduction of NSF funding and the continuance of science-focused (under Alternative 1) or education-focused (under Alternative 2) operations and not the disposition of any one facility or structure. Use or demolition of any particular building/structure or instrument cannot be determined unless or until a viable collaboration option is under consideration. Because reduction of NSF funding may require the safe-abandonment, mothballing, or demolition of facilities, the FEIS described these Alternatives under the most conservative (highest environmental impact) scenario in terms of NSF's analysis of potential changes to facilities, so that it may be inclusive of the full range of potential environmental impacts. The analysis approach is consistent with National Environmnetal Policy Act (NEPA) requirements and is sufficiently broad to allow NSF to complete the analysis during planning and without regard to the specifics of a future collaboration.

The Action Alternatives are described below.

Alternative 1 – Collaboration with Interested Parties for Continued Science-focused Operations (Identified in the FEIS as the Agency-preferred Alternative):

Alternative 1 would involve collaborations with new stakeholder(s) who would use and maintain Arecibo Observatory for continued science-focused operations. NSF would reduce its funding of the Observatory and the new stakeholder(s) would be responsible for future maintenance and upgrades. Under this Alternative, NSF could transfer or retain the property. Alternative 1 would involve the least change to the current facility and would retain the 305-meter telescope, the 12-meter telescope, and the supporting facilities for research.

This Alternative might include demolition activities that could remove up to 26 buildings/structures from the site. It is unknown whether specific buildings would be demolished as a collaborative agreement is not yet in place and the needs of any future collaborator(s) are not known at this time. Based on communications with the scientific community, NSF identified the 26 buildings/structures that may be likely candidates for removal, which are provided in Table 2.3-1 of the FEIS. Onsite housing, recreation facilities, and other buildings that could be determined unnecessary would be demolished. Paved roads serving areas that would no longer be used would be removed. The analysis assumes that 26 buildings/structures would be demolished and no new construction would occur, which represents the maximum amount of disturbance that could result under this Alternative.

Demolition of buildings and infrastructure would include the physical dismantling of buildings/structures and use of heavy equipment to break up and remove concrete material. Demolition debris would be recycled and reused to the extent possible, and any remaining materials would be properly disposed of in a commercial landfill. Haul trucks would transport the demolition debris from Arecibo Observatory to recycle/reuse centers in nearby municipalities and the remaining debris to a landfill in Poncé.

Equipment, tools, machinery, furniture, and ancillary items with salvage value that are no longer needed for the Observatory to operate would be disposed of in accordance with federal law. Gates and fencing would be evaluated to determine whether upgrades are needed to provide

appropriate security and access around portions of the site that would require protection. Existing utilities would be maintained and site restoration would occur. Site restoration would include reestablishing landscaping in areas where buildings/structures were demolished and may involve transporting soil to the site to support landscaping in areas where building foundations or excavated bedrock would prevent vegetation establishment.

The anticipated activities to implement demolition under Alternative 1 include the following:

- Conduct a hazardous materials assessment for asbestos-containing material (ACM), lead-based paint (LBP), and other conditions of concern for structures to be demolished. Remediate as necessary.
- Demolish buildings and structures that are no longer needed. Concrete buildings would be removed using hammerhoes, jackhammers, and other heavy equipment.
- Segregate, load, and transport waste materials to appropriate offsite landfills and recycling centers.
- Establish soil in areas where buildings/structures were removed from bedrock. Landscape areas of bare soil.

The demolition period for Alternative 1 is expected to take 12 weeks; depending on the availability of funds, activities may be spread out over multiple fiscal years. All demolition work would be conducted within developed areas of Arecibo Observatory, so there would be no need to construct new access routes to haul debris away and no widening or other improvements to existing roads would occur.

Landscaped areas would be maintained during operations. All infrastructure related to the 12-meter and 305-meter telescopes would be maintained during operations to prevent the degradation of the instruments and to keep vegetation from overgrowing near or on the dishes.

Operations would be expected to continue during demolition activities. Demolition activities that could interfere with the experimental use of the 12-meter and 305-meter telescopes and data collection would be coordinated with Observatory staff to minimize the potential for disrupting scientific work.

Operations after demolition activities would be comparable to current operations with regard to the number of employees and their commuting activities. Specific scientific research, research programs, and educational activities may change.

Alternative 1 was identified as NSF's Preferred Alternative in the FEIS. The reason for identifying it as such is that it meets the Purpose and Need of reducing the amount of funding required from NSF, while allowing continued benefits to the scientific and educational communities. The desire to continue both scientific research and the educational programs that occur at Arecibo Observatory was repeatedly mentioned by members of the public during the NEPA public comment periods. Implementation of Alternative 1, however, is contingent upon the existence of collaborators who come forward with viable proposed plans to provide non-NSF funding in support of their science-focused operations.

Alternative 2 – Collaboration with Interested Parties for Transition to Education-focused Operations:

Alternative 2 would involve collaborating with outside entities to operate and maintain Arecibo Observatory as an education-focused operation. An official collaboration would be created to keep the science center open for students and visitors. New collaborators could include Commonwealth agencies, educational institutions, industrial or commercial ventures, or private individuals. Under this Alternative, NSF could transfer or retain the property.

The visitor center, learning center, and 12-meter telescope would remain operational. The 305-meter telescope would be made inoperable but retained for visual/historical interest. Retaining the 305-meter telescope dish would require that it be secured and regularly maintained so that structural elements would not degrade and the area would not be overgrown by vegetation.

Buildings/structures not needed to meet the anticipated operations-related goals would be safe-abandoned[1] or demolished. The majority of residential housing and recreational facilities would not be retained. See Table 2.3-1 in the FEIS for a list of building/structure dispotision as analyzed in the FEIS.

Equipment, tools, machinery, furniture, and ancillary items with salvage value that are no longer needed for the education-based facility to operate would be disposed of in accordance with federal law. Existing utilities would be maintained. There would be site restoration to establish landscaping where buildings/structures were previously located.

The anticipated activities to implement demolition activities associated with Alternative 2 include the following:

- Conduct hazardous materials assessment for ACM, LBP, and other conditions of concern for structures to be demolished. Remediate as necessary.
- Demolish or safe-abandon buildings, structures, and infrastructure that are no longer needed. Concrete buildings would be removed using hammerhoes, jackhammers, and other heavy equipment.
- Segregate, load, and transport waste materials to appropriate offsite landfills and recycling centers.
- Establish soil in areas where buildings/structures were removed from bedrock. Landscape areas of bare soil.

The demolition period for Alternative 2 would be expected to take 12 weeks; depending on the availability of funds, activities may be spread out over multiple fiscal years. All demolition work would be conducted within developed areas of Arecibo Observatory, so there would be no need to construct new access routes to haul debris away and no widening or other improvements to existing roads would occur.

[1] Safe Abandonment: To remove a building or facility from service without demolishing it. This includes removing furnishings, disconnecting utilities, and isolating the building/structure from public access by fencing or other means to reduce fall and tripping hazards and preclude vandalism. The building/structure is also made secure from environmental damage due to wind, rain, humidity, and temperature extremes. Pest and insect damage must also be taken into account and biodegradable items must be removed to the maximum extent practicable. Under safe abandonment, there is no intention that buildings/structures would be brought back to operational status.

Landscaped areas would be maintained during operations. All infrastructure related to the 12-meter and the 305-meter telescopes would be maintained during operations to prevent the degradation of the instruments and to keep vegetation from overgrowing near or on the dishes.

Operations associated with education would be expected to continue during removal of unnecessary buildings/structures. Demolition activities that could interfere with experimental use of the 12-meter telescope and data collection would be coordinated with Observatory staff to minimize the potential for disrupting scientific work.

Operations after demolition would be comparable to current operations with regard to the number of employees and their commuting activities. The specific job make-up would change, as scientific research would no longer continue. It is anticipated that a staff comparable in size to current operations would work onsite under this Alternative.

Alternative 3 – Mothballing of Facilities:

Alternative 3 would involve mothballing[2] (preservation of) essential buildings, telescopes, and other equipment, with periodic maintenance to keep them in working order. This method would allow the facility to suspend operations in a manner that permits operations to resume efficiently at some time in the future. It is not known what type of operations would be implemented when the mothball phase ends. Operations at the time of resumption could be similar to current operations, other science-based operations, education-based operations, or some other type of operations. Because of this uncertainty, the resumption of operations is not considered as part of this Alternative.

Supporting structures would be evaluated to determine whether they are critical to the operation of the 12-meter and 305-meter telescopes. Buildings/structures that are obsolete and not needed would be removed.

A maintenance program would be required to protect the facilities from deterioration, vandalism, and other damage. Regular security patrols would be performed to monitor the site. Common mothballing measures, such as providing proper ventilation, keeping roofs and gutters cleaned of debris, and performing ground maintenance and pest control, would be implemented. Lubrication and other deterioration-preventing measures would be required on the 305-meter telescope dish, the Gregorian dome, and the support cables for the 305-meter telescope dish and the platform.

Visitor housing and recreational areas would be closed indefinitely, with water lines drained and electricity turned off. All supplies, books, photographs, furnishings, and other items not needed for periodic maintenance would be removed from the site. Equipment, tools, machinery, furniture, and ancillary items that would not be needed for resumption of operations and that have salvage value would be would be disposed of in accordance with federal law.

Site restoration to establish landscaping where buildings/structures were previously located would occur. Gates and fencing would be evaluated to determine whether upgrades would be needed to provide appropriate security and access around portions of the site that would require protection.

The anticipated activities to implement the demolition components of Alternative 3 include the following:

[2] Mothball: Remove a building or structure from daily use while maintaining the general condition for a defined period. Equipment and structures are kept in working order but are not used.

- Prepare buildings and structures to be mothballed and turn off nonessential utilities.
- Conduct hazardous materials assessment for ACM, LBP, and other conditions of concern for structures to be demolished. Remediate as necessary.
- Demolish structures and buildings that are no longer needed. Concrete buildings would be removed using hammerhoes, jackhammers, and other heavy equipment.
- Segregate, load, and transport waste materials to appropriate offsite landfills and recycling centers.
- Establish soil in disturbed areas where buildings/structures were removed from bedrock. Landscape areas of bare soil.
- Complete other limited site restoration activities.
- Establish site security and facilities maintenance.

The demolition period for Alternative 3 would be expected to take 15 weeks; depending on the availability of funds, activities may be spread out over multiple fiscal years. All demolition work would be conducted within developed areas of Arecibo Observatory, so there would be no need to construct new access routes to haul debris away and no widening or other improvements to existing roads would occur.

Landscaped areas would be maintained during the mothball period. All infrastructure related to the 12-meter and 305-meter telescopes would be conditioned for safe storage to prevent the degradation of the equipment and allow operations to be restarted. Regular vegetation maintenance would be implemented to keep vegetation from overgrowing the dishes.

For purposes of the analysis in the FEIS, it was assumed that operations would be suspended for an indefinite time and then resumed at some point in the future. It is anticipated that technical staff responsible for operating the 12-meter and 305-meter telescopes, scientific support staff, and cafeteria workers would not be retained. However, it is expected that current staffing levels for facilities maintenance would remain the same under this Alternative due to the level of maintenance required to keep the infrastructure operable.

Alternative 4 – Partial Demolition and Site Restoration:

Alternative 4 involves the demolition of all above-grade structures, except the large concrete structures (that is, towers, tower and catwalk anchors, and rim wall infrastructure). All below-grade foundations would be stabilized and filled in.

Equipment, tools, machinery, furniture, and ancillary items with salvage value would be disposed of in accordance with federal law. Demolition of the telescopes and other structures would be conducted during the same timeframe. If another use is identified for the 12-meter telescope, it would be repurposed and relocated rather than demolished.

The anticipated activities to implement the demolition activities of Alternative 4 include the following:

- Conduct hazardous materials assessment for ACM, LBP, and other conditions of concern for structures to be demolished. Remediate as necessary.
- Turn off and cap utilities.

- Remove the 305-meter telescope ground screen and reflector dish.
- Remove the platform, all instrumentation, and support structures suspended above the 305-meter reflector dish.
- Sequentially demolish concrete structures using hammerhoes, jackhammers, and other heavy equipment.
- Demolish structures other than those retained on the site.
- Segregate, load, and transport waste materials to appropriate offsite landfills and recycling centers.
- Conduct site restoration work: re-grade affected areas to desired elevations and contours; use available concrete rubble as necessary; bring in fill as needed to establish grade.
- Install soil and vegetation: place soil where needed to support growth of desired vegetation; seed and transplant native species; install temporary erosion control (biodegradable fiber mats) where needed; maintain (appropriate watering as needed and weed control) until desired vegetation is established.
- Install security fencing around the three towers and the anchors for the southeastern and southwestern towers and conduct measures appropriate to secure the site.

The demolition period for Alternative 4 would be expected to take 28 weeks; depending on the availability of funds, activities may be spread out over multiple fiscal years. All demolition work would be conducted within developed areas of Arecibo Observatory, so there would be no need to construct new access routes to haul debris away and no widening or other improvements to existing roads would occur.

Areas revegetated following demolition activities would be maintained for a period of 18 months, less if target revegetation (80 percent cover by desired species) is achieved sooner. A vegetation maintenance staff would be retained through this period.

Operations at Arecibo Observatory would cease under Alternative 4; therefore, it is anticipated that staffing levels would not be maintained.

Alternative 5 – Complete Demolition and Site Restoration:

Alternative 5 involves the demolition of all above-grade structures, including the large concrete structures (that is, towers, anchors, and rim wall infrastructure). Below-grade foundations would be removed and the areas backfilled. Explosives may be used to demolish the three towers, six tower anchors, catwalk anchor, and rim wall infrastructure supporting the 305-meter telescope dish. Explosives, if used, would be limited to low-force charges designed to transfer the explosive force only to the structure designated for removal.

Equipment, tools, machinery, furniture, and ancillary items with salvage value would be disposed of in accordance with federal law. Facilities and structures would be demolished. Demolition of the radio telescopes and other structures would be conducted during the same timeframe. If another use is identified for the 12-meter telescope, it would be repurposed and relocated rather than demolished.

The anticipated activities to implement Alternative 5 include the following:

- Turn off and cap utilities.
- Conduct hazardous materials assessment for ACM, LBP, and other conditions of concern for structures to be demolished. Remediate as necessary.
- Remove the 305-meter telescope ground screen and reflector dish.
- Remove the platform, all instrumentation, and support structures suspended above the 305-meter reflector dish.
- Sequentially demolish the smaller concrete structures by using hammerhoes, jackhammers, and other heavy equipment.
- Remove below-grade structures by using hammerhoes, jackhammers, and other heavy equipment.
- Remove 305-meter telescope dish foundation and rim wall infrastructure, which may entail the use of explosives in addition to hammerhoes, jackhammers, and other heavy equipment.
- Demolish towers, which may entail the use of large cranes and explosives in addition to hammerhoes, jackhammers, and other heavy equipment.
- Demolish tower and catwalk anchors, which may entail the use of large cranes and explosives in addition to hammerhoes, jackhammers, and other heavy equipment.
- Fill and safe-abandon concrete foundations that cannot be removed.
- Segregate, load, and transport waste materials to appropriate offsite landfills and recycling centers.
- Conduct site restoration work: re-grade affected areas to desired elevations and contours; use available concrete rubble as necessary; bring in fill as needed to establish grade.
- Install soil and vegetation: place soil where needed to support the growth of desired vegetation; seed and transplant native species; install temporary erosion control (biodegradable fiber mats) where needed; maintain (appropriate watering as needed and weed control) until desired vegetation is established.
- Conduct measures appropriate to secure the site.

The demolition period for Alternative 5 would be expected to take 38 weeks; depending on the availability of funds, activities may be spread out over multiple fiscal years. All demolition work would be conducted within developed areas of Arecibo Observatory, so there would be no need to construct new access routes to haul debris away and no widening or other improvements to existing roads would occur.

Areas revegetated following demolition activities would be maintained for a period of 18 months, less if target revegetation (80 percent cover by desired species) is achieved sooner. A vegetation maintenance staff would be retained through this period.

Operations at Arecibo Observatory would cease under Alternative 5; therefore, it is anticipated that staffing levels would not be maintained.

No-Action Alternative: Continued NSF Investment for Science-focused Operations

Under the No-Action Alternative, NSF would continue funding Arecibo Observatory at current levels. None of the Action Alternatives would be implemented.

II. ENVIRONMENTAL COMPLIANCE

COMPLIANCE WITH NEPA

The FEIS was prepared pursuant to the NEPA, 42 U.S.C. § 4321, *et seq*, to analyze the potential environmental impacts associated with NSF's proposed changes to operations at Arecibo Observatory in a reduced funding environment. NSF conducted a public processes that informed preparation of a Draft Environmental Impact Statement (DEIS) and FEIS. Due to its funding role in near-Earth objects observations, NASA served as a Cooperating Agency throughout NSF's NEPA process. A more detailed description of NSF's NEPA process is set forth below.

NSF notified, contacted, and/or consulted with agencies, individuals, and organizations during development of its DEIS and FEIS. Public disclosure and involvement regarding the Proposed Action included pre-assessment notification letters to agencies and stakeholders, social media announcements, website updates, scientific digests and blogs, newspaper public notices, public scoping meetings (conducted on June 7, 2016, in San Juan and Arecibo) and a 30-day public comment period to provide input on viable alternatives and resource areas of concern. After NSF's review and consideration of all comments received during the public scoping period, the DEIS was prepared. Public meetings on the DEIS were conducted on November 16, 2016, in Arecibo and on November 17, 2016, in San Juan. Both English and Spanish versions of media notifications and the materials distributed during the meetings were made available to the public. An English/Spanish interpreter was present during all public meetings and interpretation was provided to the public. The public was encouraged to comment during the requisite comment period of the scoping process and after publication of the DEIS. The DEIS was published and distributed to federal, state, local, and private agencies, organizations, and a stakeholder list of over 400 individuals for review and comment during a 45-day public comment period, and it was filed with the United States Environmental Protection Agency (EPA). A Notice of Availability of the DEIS was announced in the *Federal Register* on October 28, 2016. A detailed summary of comments received during the public comment periods is presented in Section 5 of the FEIS. Following the close of the public comment period on the DEIS, NSF reviewed and considered all comments received. The final result of NSF's review and consideration of the public comments is reflected in the FEIS. The FEIS is available on NSF's website, www.nsf.gov/ast, as well as on EPA's Environmental Impact Statement Database.

ENVIRONMENTAL IMPACTS

The FEIS contains a detailed analysis of the environmental impacts associated with each Action Alternative and the No-Action Alternative. A summary of the impacts for each of the considered Alternatives is presented below. Because none of the Action Alternatives would have the potential for measurable impacts on air quality, climate change, land use, surface waters, an analysis of impacts on those resource areas was not carried out further.

The FEIS includes the methodology used for determining impact thresholds and the factors considered in assessing the impact threshold for those resource areas analyzed under each Action Alternative and the No-Action Alternative. The designated impact level under Alternatives 1 through 5 assumes that Best Management Practices (BMPs) and mitigation measures identified in the FEIS would be implemented. See Section 4 of the FEIS for BMPs and mitigation measures associated with each Action Alternative. The BMPs and mitigation measures applicable to the selected Alternative are provided in Section V. DECISION, below. The FEIS also includes a full analysis of impacts, which is incorporated herein.

Alternative 1: Collaboration with Interested Parties for Continued Science-focused Operations (Identified in the FEIS as the Agency-preferred Alternative)

Biological Resources: During demolition under Alternative 1, impacts on biological resources would include direct minor, adverse, and short-term impacts on common vegetation and wildlife, and direct, negligible, adverse, and short-term impacts on migratory birds and the endangered Puerto Rican boa. There would be indirect negligible, adverse, and short-term impacts on offsite wetlands and protected plant species. There would be no impacts on biological resources during operations.

Cultural Resources: Demolition would result in a major, adverse, and long-term impacts on known historic properties that would be considered an adverse effect on historic properties under Section 106 of the National Historic Preservation Act (NHPA). There would be no impacts on known historic properties during operations and no impacts to archaeological resources would be expected during either demolition or operation activities. Major, adverse, and long-term impacts on known historic properties would result if, under this Alternative, Arecibo Observatory were transferred to a non-federal entity. This would occur because Section 106 of the NHPA would not apply to activities carried out by a non-federal entity.

Geology and Soils: Demolition impacts on geological features and soils would include negligible adverse, and short-term impacts on topography and soils and minor, adverse, and long-term impacts on karst features. There would be no impacts on geological features or soils during operations.

Groundwater: Demolition would result in minor, adverse, and short-term impacts from runoff and negligible, adverse, and long-term impacts to underlying groundwater. There would be no impacts on groundwater during operations.

Hazardous Materials: A minor to moderate, long-term benefit resulting from remediation of site contamination could occur during demolition, depending on the level of contamination that must be addressed. A minor, adverse, and short-term impact would result from increased use of hazardous materials during demolition. A minor, long-term benefit would likely occur post-demolition due to the reduced use of hazardous materials during operations.

Solid Waste: Minor, adverse, and short-term impacts on the level of solid waste would occur during demolition due to disposal of the debris from demolished buildings/structures that could not be reused or recycled. There would be no solid waste impacts during operations.

Health and Safety: Negligible, adverse, and short-term impacts on public safety and protection of children during demolition would be expected. Minor, adverse, and short-term impacts on occupational health during demolition may occur. Negligible, adverse, and long-term impacts on

public safety could occur during operations, primarily resulting from the possible reduced capability to observe potentially hazardous near-Earth objects (PHOs).

Noise: Negligible, adverse, and short-term noise impacts from construction equipment and increased traffic would be expected during demolition. There would be no noise impacts during operations.

Socioeconomics: Demolition activities would result in negligible, adverse, and short-term impacts on housing and minor, adverse, and short-term impacts on education and tourism in the Municipality of Arecibo. There would be negligible, short-term benefits on employment, income, and the economy. There would be no socioeconomic impacts during operations.

Traffic and Transportation: Minor, adverse, and short-term impacts on traffic and transportation would be expected during demolition. There would be a minor, adverse, and long-term impact from road damage during demolition activities. No traffic impacts would be expected during operations.

Visual Resources: Impacts to visual resources during demolition would be minor, adverse, and short-term. No impacts on visual resources would occur during operations.

No adverse cumulative impacts on resources would occur under Alternative 1.

Alternative 2: Collaboration with Interested Parties for Transition to Education-focused Operations

Biological Resources: During demolition, impacts on biological resources would include direct, minor, adverse, and short-term impacts on common vegetation and wildlife and direct, negligible, adverse short-term impacts on migratory birds and the endangered Puerto Rican boa. There would be indirect, negligible, adverse, and short-term impacts on offsite wetlands and protected plant species. There would be no impacts on biological resources during operations.

Cultural Resources: Demolition and operations activities would result in major, adverse, and long-term impacts on known historic properties that would be considered an adverse effect on historic properties under Section 106 of the NHPA. Major, adverse, and long-term impacts on known historic properties would result if, under this Alternative, Arecibo Observatory were transferred to a non-federal entity. This would occur because Section 106 of the NHPA would not apply to activities carried out by a non-federal entity. There would be no impacts on archaeological resources expected during either demolition or operations activities.

Geology and Soils: Demolition impacts on geological features and soils would include negligible adverse, and short-term impacts on topography and soils and minor, adverse, and long-term impacts on karst features. There would be no impacts on geological features or soils during operations.

Groundwater: Demolition would result in minor, adverse, and short-term groundwater impacts from runoff and negligible, adverse, and long-term impacts on underlying groundwater. There would be no impacts on groundwater during operations.

Hazardous Materials: A minor to moderate, long-term beneficial impact on the level of site contamination would be expected during demolition, depending on the level of contamination that must be addressed. A minor, adverse, and short-term impact would result from increased use

of hazardous materials during demolition. A minor, long-term benefit would occur from the reduced use of hazardous materials during operations.

Solid Waste: Minor, adverse, and short-term solid waste impacts would occur during demolition due to disposal of the debris from demolished structures that could not be reused or recycled. There would be no solid waste impacts during operations.

Health and Safety: Negligible, adverse, and short-term impacts on public safety and protection of children during demolition would be expected. Minor, adverse, and short-term impacts on occupational health during demolition may occur. Negligible, adverse, and long-term impacts on public safety could occur during operations, primarily resulting from the possible reduced capability to observe PHOs.

Noise: Negligible, adverse, and short-term noise impacts from construction equipment and increased traffic would be expected during demolition. There would be no noise impacts during operations.

Socioeconomics: Demolition activities would result in negligible, adverse, and short-term impacts on housing, and minor, adverse, and short-term impacts on education and tourism in the Municipality of Arecibo. There would be negligible, short-term benefits on employment, income, and the economy. Impacts during operations would include negligible, adverse impacts on population, housing, the economy, employment and income. Moderate, adverse, and long-term socioeconomic impacts would result from fewer regional education activities and science, technology, education, and math (STEM) opportunities. In addition, minor, beneficial, long-term impacts on education would be expected from new STEM programs.

Traffic and Transportation: Minor, adverse, and short-term impacts on traffic and transportation would be expected during demolition. There would be a minor, adverse, and long-term impact from road damage during demolition activities. No traffic impacts would be expected during operations.

Visual Resources: Impacts on visual resources during demolition would be moderate, adverse, and long-term. Minor, adverse, long-term impacts would be expected from operations.

No adverse cumulative impacts to resources would occur under Alternative 2.

Alternative 3: Mothballing of Facilities

Biological Resources: During demolition, impacts on biological resources would include direct, minor, adverse, and short-term impacts on common vegetation and wildlife and direct, negligible, adverse, and short-term impacts on migratory birds and the endangered Puerto Rican boa. There would be indirect, negligible, adverse, and short-term impacts on offsite wetlands and protected plant species. There would be a minor, long-term benefit on migratory birds during the mothball period.

Cultural Resources: Under this Alternative, the mothballing of historic district-contributing contributing resources would result in major, adverse, and short-term impacts on cultural resources due to the loss of association and feeling, and an adverse effect under Section 106. This is because those resources would not be in use, and their use is the primary component of their significance. There would be no impacts to archaeological resources expected during either the demolition or mothball period.

Geology and Soils: Demolition impacts to geological features and soils would include negligible, adverse, and short-term impacts on topography and soils, and minor, adverse, and long-term impacts on karst features. There would be no impacts on geological features or soils during the mothball period.

Groundwater: Demolition would result in minor, adverse, and short-term impacts from runoff and negligible, adverse, and long-term impacts to underlying groundwater. A minor, long-term benefit on groundwater would be expected during the mothball period.

Hazardous Materials: A minor to moderate, long-term benefit on the level of site contamination would be expected during demolition, depending on the level of contamination that must be addressed. A minor, adverse, and short-term impact would result from increased use of hazardous materials during demolition. A minor, long-term benefit would occur from the reduced use of hazardous materials during the mothball period.

Solid Waste: Minor, adverse, and short-term impacts on the level of solid waste would occur during demolition due to disposal of the debris from demolished structures that could not be reused or recycled. A minor, long-term benefit due to reduced solid waste would be expected during the mothball period.

Health and Safety: Negligible, adverse, and short-term impacts on public safety and protection of children during demolition would be expected. Minor, adverse, and short-term impacts on occupational health during demolition may occur. Negligible, adverse, and long-term impacts on public safety could occur during the mothball period, primarily resulting from the possible reduced capability to observe PHOs.

Noise: Negligible, adverse, and short-term noise impacts from construction equipment and increased traffic would be expected during demolition. There would be no noise impacts during the mothball period.

Socioeconomics: Demolition activities would result in negligible, adverse, and short-term impacts on housing in the Municipality of Arecibo. There would be minor, short-term benefits on employment, income, and the economy during demolition. Impacts during the mothball period would include negligible, adverse, and long-term impacts on population and housing, and minor, adverse, long-term impacts on the economy, employment, and income. A moderate, adverse, and long-term impact would result from less regional educational activities. A major, adverse, and long-term impact would be expected from reduced STEM opportunities and tourism in Arecibo and the Commonwealth of Puerto Rico.

Traffic and Transportation: Minor, adverse, and short-term impacts on traffic and transportation would be expected during demolition. There would be a minor, adverse, and long-term impact from road damage during demolition activities. A minor, long-term benefit would be expected during the mothball period.

Visual Resources: Impacts on visual resources during demolition would be moderate, adverse, and short-term. Visual impacts during the mothball period would be minor, adverse, and long-term.

No adverse cumulative impacts on resources would occur under Alternative 3.

Alternative 4: Partial Demolition and Site Restoration

Biological Resources: Under this Alternative, there would be moderate, adverse, and long-term impacts on vegetation as a result of demolition activities. Impacts on wildlife from demolition activities would be moderate, adverse, and short-term. There would be negligible, adverse, and short-term impacts on wetlands, the broad-winged hawk, Puerto Rican boa, listed plant species, and migratory birds during demolition. A minor, long-term benefit would occur on wildlife, listed species, and migratory birds from increased habitat after demolition.

Cultural Resources: Demolition would result in a major, adverse, and long-term impact on known historic properties that would be considered an adverse effect on historic properties under Section 106 of the NHPA. There would be no impacts on known historic properties after demolition and no impacts on archaeological resources would be expected during or after demolition.

Geology and Soils: Demolition impacts on geological features and soils would include minor, adverse, and short-term impacts on topography, minor, adverse, and long-term impacts on karst features and moderate, adverse, and long-term impacts on soils. There would be no impacts after demolition.

Groundwater: Demolition would result in minor, adverse, and short-term impacts from runoff and negligible, adverse, and short-term impacts on underlying groundwater. There would be a minor, long-term benefit due to a reduced lack of groundwater consumption after demolition.

Hazardous Materials: A minor to moderate, long-term benefit to the level of site contamination would be expected during demolition, depending on the level of contamination that must be addressed. A minor, adverse, and short-term impact would result from increased use of hazardous materials during demolition. A moderate, long-term benefit would occur from the reduced use of hazardous materials after demolition.

Solid Waste: Minor, adverse, and short-term impacts on the level of solid waste would occur during demolition due to disposal of the debris from demolished structures that could not be reused or recycled. There would be a minor, long-term benefit after demolition due to reduced solid waste generation.

Health and Safety: Negligible, adverse, and short-term impacts on the protection of children during demolition would be expected. Minor, adverse, and short-term impacts on occupational health and public safety during demolition may occur. Negligible, adverse, and long-term impacts on public safety could occur after demolition, primarily resulting from the possible reduced capability to observe PHOs.

Noise: Negligible, adverse, and short-term noise impacts from construction equipment and increased traffic would be expected during demolition. There would be no noise impacts after demolition.

Socioeconomics: Demolition activities would result in negligible, adverse, and short-term impacts on housing in the Municipality of Arecibo. There would be minor, short-term benefits on employment, income, and the economy during demolition. Impacts after demolition would include negligible, adverse, and long-term impacts on population, and housing, and minor, adverse, and long-term impacts on the economy, employment, and income. Major, adverse, and

long-term impacts would be expected from reduced regional education activities, STEM opportunities, and tourism in Arecibo and the Commonwealth of Puerto Rico.

Traffic and Transportation: Minor, adverse, and short-term impacts to traffic and transportation would be expected during demolition. There would be a moderate, adverse, and long-term impact on traffic and transportation from road damage during demolition activities. A moderate, long-term benefit would be expected from reduced traffic after demolition.

Visual Resources: Impacts on visual resources during demolition would be major, adverse, and short-term. No impacts would occur after demolition.

No adverse cumulative impacts on resources would occur under Alternative 4.

Alternative 5: Complete Demolition and Site Restoration

Biological Resources: There would be major, adverse, and long-term impacts on the Puerto Rican boa and Puerto Rican broad-winged hawk from demolition. There would be moderate, adverse, and short-term impacts on wildlife and wetlands, as well as moderate, adverse, and long-term impacts on vegetation, from demolition. Minor, adverse, short-term impacts on listed plant species and other listed wildlife species would be expected from weeds. A minor, long-term benefit would occur to wildlife, listed species and migratory birds after demolition.

Cultural Resources: Demolition would result in a major, adverse, and long-term impact on known historic properties that would be considered an adverse effect to historic properties under Section 106 of the NHPA. There would be no impacts on known historic properties after demolition and no impacts on archaeological resources would be expected during or after demolition.

Geology and Soils: Demolition impacts on geological features and soils would include moderate, adverse, and short-term impacts on topography, karst features, and soils. There would be no impacts after demolition.

Groundwater: Demolition would result in minor, adverse, and short-term impacts from runoff and moderate, adverse, and long-term impacts on underlying groundwater. There would be a minor, long term benefit on groundwater after demolition.

Hazardous Materials: A minor to moderate, long-term benefit to the level of site contamination would be expected during demolition, depending on the level of contamination that must be addressed. A moderate, adverse, and short-term impact would result from increased use of hazardous materials during demolition. A moderate, long-term benefit on the level of site contamination would occur from the reduced use of hazardous materials after demolition.

Solid Waste: Minor, adverse, and short-term impacts on the level of solid waste would occur during demolition due to disposal of the debris from demolished structures that could not be reused or recycled. There would be a minor, long-term benefit after demolition due to reduced solid waste generation.

Health and Safety: Negligible, adverse, and short-term impacts on the protection of children during demolition would be expected. Minor, adverse, and short-term impacts on occupational health and public safety during demolition may occur. Negligible, adverse, and long-term impacts on public safety could occur after demolition, primarily resulting from the possible reduced capability to observe PHOs.

Noise: Moderate, adverse, and short-term noise impacts from construction equipment would be expected during demolition. Negligible, adverse, short-term noise impacts from demolition traffic would occur. There would be no noise impacts after demolition.

Socioeconomics: Demolition activities would result in negligible, adverse, and short-term impacts on housing in the Municipality of Arecibo. There would be minor, short-term benefits to employment, income, and the economy during demolition. Impacts after demolition would include negligible, adverse short- and long-term impacts on population, and housing; and minor, long-term, and adverse impacts on the economy, employment, and income. Major, adverse long-term impacts would be expected from reduced regional education activities, STEM opportunities, and tourism in Arecibo after demolition.

Traffic and Transportation: Minor, adverse, and short-term impacts on traffic and transportation would be expected during demolition. There would be a moderate, adverse, and long-term impact from road damage during demolition activities. A moderate, long-term benefit on local traffic would be expected from reduced traffic after demolition.

Visual Resources: Impacts on visual resources during demolition would be moderate, adverse, and short-term. No impacts on visual resources would occur after demolition.

Potential cumulative impacts could occur on biological resources under Alternative 5. These impacts involve potential cumulative effects on threatened and endangered species.

No-Action Alternative: Continued NSF Investment for Science-focused Operations

Under the No-Action Alternative, current operations of Arecibo Observatory would continue. No demolition would occur and no change from current conditions would result. There would be no impacts on resources under the No-Action Alternative.

Under the No-Action Alternative, a Puerto Rican boa standard operating procedure for normal operations would be developed and implemented.

ENVIRONMENTALLY PREFERABLE ALTERNATIVE

The determination of the Environmentally Preferable Alternative is based on the analysis of environmental impacts presented in Section 4 of the FEIS and summarized under Environmental Impacts in this Record of Decision. Also considered were the net differences in impacts among the Alternatives after applying all mitigation and monitoring measures. Based on this analysis and a comparison between the net differences in impacts among all of the Alternatives, the No-Action Alternative would have the least potential for adverse impacts and is, therefore, the Environmentally Preferable Alternative. Because, however, the No-Action Alternative does not meet the purpose and need of the Proposed Action, NSF has completed a comparison of the net impacts anticipated from the five Action Alternatives. The net impacts associated with Action Alternative 1 would include no moderate adverse impacts and no major adverse impacts, other than major adverse and long-term impacts on cultural resources resulting from the potential demolition of any historic resources deemed necessary by a future collaborator(s) and from the potential transfer of the facility to a non-federal entity (in which the protections of the NHPA would be lost). However, the character of the use of the property would not change, resulting in less net adverse impacts on cultural resources than would occur under the other Action

Alternatives. Accordingly, NSF has determined that Alternative 1 is the Environmentally Preferable Action Alternative.

SECTION 106 COMPLIANCE

NSF engaged parties interested in potentially affected historic properties in accordance with Section 106 of the NHPA (addressed in Sections 3.2 and 4.2 of the FEIS). NSF conducted an initial teleconference with the Puerto Rico State Historic Preservation Officer (SHPO) on May 19, 2016, to introduce the preliminary proposed Alternatives. A NOI, which included language announcing the commencement of the Section 106 consultation process, was published in the *Federal Register* on May 23, 2016, and a copy of the NOI was provided to the Puerto Rico SHPO via email during the week of May 23, 2016. On June 6, 2016, representatives of NSF met with the Puerto Rico SHPO to discuss the Proposed Action and the preliminary proposed Alternatives.

A formal Section 106 initiation letter and associated materials were submitted to the Puerto Rico SHPO on July 5, 2016, and included an invitation for representatives of the SHPO to attend a site visit at Arecibo Observatory, scheduled for July 19 and 20, 2016. On July 19, 2016, NSF forwarded its Section 106 initiation letter to the ACHP and inquired as to whether the ACHP wished to participate in NSF's Section 106 consultation process. On September 15, 2016, NSF conducted a follow-up teleconference with the Puerto Rico SHPO regarding the status of its Section 106 consultation process.

On October 6, 2016, NSF contacted the ACHP to request confirmation of the ACHP's decision not to participate in NSF's Section 106 process. This request was made because NSF had not heard from the ACHP regarding NSF's invitation to the ACHP to participate in its Section 106 process. On October 7, 2016, the ACHP responded to NSF stating that it would review the material provided by NSF.

In October 2016, NSF provided a copy of the *Proposed Changes to Arecibo Observatory Operations: Historic Properties Assessment of Effects* technical report to the Puerto Rico SHPO and Consulting Parties for review and comment. The document was discussed during an in-person meeting with the SHPO and in a Consulting Party meeting in Puerto Rico in November 2016.

On November 4, 2016, NSF sent an email to the ACHP following-up on NSF's invitation to the ACHP to participate in NSF's Section 106 process. In that email, NSF also notified the ACHP of the publication of the DEIS and provided a link to the document. Later that day, the ACHP informed NSF that it would review the DEIS and then send out a response to NSF's invitation to participate in its Section 106 process. The ACHP further indicated that, if NSF had not heard back from the ACHP within 15 days, NSF should move forward with its Section 106 process and assume that the ACHP will not likely want to participate. On December 15, 2016, NSF again emailed the ACHP to provide clarification about the Proposed Action and inquire as to whether the ACHP would like to participate in NSF's Section 106 process. The ACHP responded the same day with questions about whether NSF saw a need for the ACHP to participate. NSF responded saying that the process had been working well to date, although there are people who work at or live near Arecibo Observatory who are concerned about potential reduced operations or demolition of the facility. NSF also informed the ACHP that, after conversations with the Puerto Rico SHPO, it was determined that a Programmatic Agreement (PA) should be developed

to address potential adverse effects on historic properties. NSF further informed the ACHP that it would circulate any draft PA to the ACHP for input.

A teleconference occurred between NSF and the Puerto Rico SHPO on April 27, 2017, to discuss the preliminary draft PA. During that teleconference, the Puerto Rico SHPO requested that NSF reach out again to the ACHP and urge its participation in the consultation process. On April 28, 2017, NSF provided the ACHP with a formal invitation to participate in NSF's Section 106 consultation process and a preliminary draft PA for informal review and comment. The ACHP responded by email the same day, confirming receipt of the preliminary draft PA and notifying NSF of the the staff person from the ACHP who would be handling further coordination for the proposed undertaking. During a teleconference held on May 5, 2017, the ACHP agreed to participate in the Section 106 consultation process. A follow up call was conducted with the ACHP and the Puerto Rico SHPO on June 1, 2017. A draft of the PA was provided to the Puerto Rico SHPO, the ACHP, and the Consulting Parties on June 23, 2017, for review and comment (during a 31-day public review and comment period), and NSF held a meeting in Arecibo, Puerto Rico on July 6, 2017 to discuss the draft PA. A second consultation meeting was held telephonically on July 13, 2017, to discuss the draft PA. After the review and comment period ended (on July 24, 2017), NSF reviewed and considered all written and oral comments received during the comment period, including all comments made during the July 6th and July 13th, 2017 consultation meetings. Following additional input by the ACHP in mid-August, 2017, NSF prepared a revised draft PA. The revised draft PA was submitted to the Puerto Rico SHPO, the ACHP, and the Consulting Parties, and made available to the public, on August 17, 2017. No comments on the revised draft PA were received as of September 6, 2017.[3] A follow-up teleconference call had been scheduled for September 5, 2017 but was cancelled due to emergency weather related issues associated with Hurricane Irma, which struck Puerto Rico on September 6, 2017. Shortly after Hurricane Irma, Hurricane Maria, on September 20, 2017, made landfall on Puerto Rico resulting in catastrophic damage, including the loss of electrical power and telecommunications. 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 and, therefore, NSF consulted with the ACHP to determine next steps for finalizing the PA. 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 facilitate finalization of the PA. NSF and the ACHP, with input from the Puerto Rico SHPO, finalized the PA and provided it to the Puerto Rico SHPO and the ACHP for signature. NSF also reached out to the Consulting Parties to invite them to sign the PA as Concurring Parties, if available. To demonstrate the awareness and acceptance of the terms of the PA, NSF also asked the Director of Arecibo Observatory, Francisco Córdova, who oversees the operations and the administration of Arecibo Observatory and who actively participated in NSF's Section 106 consultation process, to sign the PA as an Invited Signatory The PA was fully executed by the Signatories on November 15, 2017, and filed with the ACHP; the final execution of the Signatories constitutes NSF's completion of its compliance obligations with the NHPA.

[3] Drafts of the PA were provided in both English and Spanish, and translation services were used at the November 2016 Section 106 meeting, and available upon request at the July 6, 2017 and July 13, 2017 meetings.

ENDANGERED SPECIES ACT COMPLIANCE

In May 2016, NSF began its informal consultation with the U. S. Fish and Wildlife Sevice (USFWS) via a telephone call identifying the general project and discussing preliminary options for alternatives. On June 17, 2016, NSF submitted a data request to USFWS regarding the project area. On June 24, 2016, USFWS responded to the data request and also requested a site visit, which was conducted on July 20, 2016. The site visit included a walk-through of the undeveloped areas on the Observatory property and a discussion of potential impacts to listed species from the potential demolition of the large concrete infrastructure (towers and towers anchors). The endangered Puerto Rican boa and the endangered fern *Tectaria estremerana* were known to occur at Arecibo Observatory and, during the site visit, USFWS confirmed the use of Arecibo Observatory grounds by the endangered Puerto Rican broad-winged hawk.

During the discussions at the site visit, USFWS recommended that NSF adopt procedures for working in areas of Arecibo Observatory where the Puerto Rican boa may occur that would be consistent with those developed and implemented by the U.S. Army at Fort Buchanan. USFWS provided the Fort Buchanan boa procedures and NSF's environmental services contractor worked with NSF to develop protocols to ensure that neither routine operations nor demolition activities would result in an inadvertent take of a Puerto Rico boa.

Additional teleconferences were held on September 27, 2016, and October 18, 2016, to discuss surveys for listed plant species, Endangered Species Act Section 7 compliance, potential mitigation activities that could be implemented to reduce the potential for a take of a listed species, and to set the date of the meeting at the USFWS office in Boquerón for November 16, 2016. On October 20, 2016, USFWS requested information on property ownership, the size of the property, the ultimate disposition of the property if the Observatory were closed, and the responsible party for ensuring that any mitigation would be implemented. USFWS also requested that the Puerto Rico Department of Natural and Environmental Resources (DNER) be invited to the November 16, 2016 meeting. NSF responded with the requested information and agreed to invite the DNER to the November 16 meeting.

On November 18, 2016, a meeting was held with USFWS, DNER, and NSF at the USFWS office in Boquerón. Attendees discussed vegetation surveys planned for December 2016, potential direct, indirect, and cumulative impacts of the Alternatives on listed species, and potential avoidance and other mitigation measures. It also was decided that informal consultation could adequately address Alternatives 1, 2, and 3, regardless of which of those Alternatives were selected. Formal consultation was likely to be needed if Alternative 4 were selected, and formal consultation would be required if Alternative 5 were selected.

On November 22, 2016, NSF informed USFWS and DNER that the vegetation surveys would be delayed until January 2017, because of a conflict with operation of the 305-meter-diameter radio telescope. On December 14, 2016, NSF confirmed the dates of January 9 through 11, 2017, for the vegetation survey with USFWS and DNER. On December 16, 2016, USFWS confirmed it would attend the surveys on January 10, 2017. On December 21, 2016, NSF informed USFWS of potential issues with using a global positioning system receiver to record locations beneath the 305-meter-diameter dish and offered an alternate mapping method should signal interference be encountered. USFW agreed with the proposed approach.

On January 13, 2017, USFWS emailed NSF with an update on the vegetation survey and requested information on the areas around the buildings/structures that were analyzed for

demolition. NSF confirmed receipt of this email on January 18, 2017. On February 17, 2017, NSF provided USFWS with the preliminary results of the vegetation surveys, confirming there were no listed plants in areas with suitable habitat where demolition could occur. NSF noted the vegetation survey report would be sent to USFWS. On February 23, 2017, NSF requested a teleconference with USFWS to discuss moving forward based on the findings of the vegetation survey and March 3, 2017, was set as the date for the teleconference.

On March 3, 2017, NSF, USFWS, and DNER discussed NSF's ESA consultation and the NEPA analysis for the proposed NSF action. No impacts on listed plant species were anticipated based on the expected areas of disturbance, the lack of plant species in areas with potentially suitable habitat, and the lack of suitability for listed plant species in developed and maintained areas. The expected areas of disturbance would be provided to any collaborator(s) under Alternatives 1 or 2. If a collaborator(s) were selected and additional areas, including additional or widened roads, would be needed for continued science-focused (Alternative 1) or educational-focused (Alternative 2) operations, NSF agreed that it would engage in additional consultation with USFWS and complete any additional surveys deemed necessary. During consultations with USFWS and DNER, NSF also clarified that some vegetation would be removed under all Alternatives. NSF also indicated that implementation of either Alternative 1 or Alternative 2 might include a transfer of the land. Under these two Alternatives, if a land transfer were included, the land transfer would be assessed during a separate consultation that would address the appropriate conservation measures.

There was a discussion of potential impacts on the Puerto Rican broad-winged hawk, including the potential for overlapping territories on the Observatory site. NSF provided a copy of the BO issued for construction of Puerto Rico Highway 10, which included conservation measures for the hawk. It was agreed that the approach should be to minimize the impacts on individuals, determine the number of nests, and then mitigate any impacts. This would include protection of the species during breeding season and, as a last resort, perform compensatory mitigation for the habitat lost. NSF committed to performing potentially impactful work outside of the breeding period for the Puerto Rican broad-winged hawk. DNER requested that the Puerto Rican Boa Protocol be updated to include DNER points of contact and NSF agreed. DNER reiterated that, prior to using explosives (i.e., under Alternative 5), the area within 100 feet (30 meters) of the detonation site should be inspected for the presence of boas and birds and the detonation would need to be delayed until no animals were present. NSF agreed with this approach.

During the same meeting, NSF conveyed to USFWS that a BA would be submitted to USFWS to request informal consultation for all Alternatives. In addition, NSF agreed that, if Alternative 5 were ultimately selected, NSF would conduct hawk surveys and additional formal consultation with USFWS, with implementation of appropriate mitigation, prior to any demolition activities.

On May 4, 2017, NSF submitted its BA and a request for consultation to USFWS. NSF also conveyed this information via email. USFWS responded, acknowledging receipt of the email and stating that the BA would be assigned for review upon receipt of the hard copy request.

On May 22, 2017, NSF informed USFWS that NSF may entertain land transfer as an option under Alternatives 1 and 2, but that any potential transfer would remain speculative. As such, NSF would commit to additional consultation with the USFWS prior to a transfer, consistent with language in the BA and did not expect that the BA would need to be modified. USFWS

responded, identifying the assigned reviewers of the BA and indicating they would review the document to determine whether any modifications would be required.

USFWS concurred with the findings of the NSF BA in a letter dated June 23, 2017 (FEIS Appendix 4.1-A). USFWS agreed that the measures proposed by NSF to avoid and minimize impacts to species were appropriate and noted that additional consultation would be required if Alternative 5 were selected. In the letter, USFWS indicated that additional consultation would be required if land transfer would occur under the selected alternative.

III. IMPACT OF HURRICANES IRMA AND MARIA

On September 6, 2017, Hurricane Irma struck Puerto Rico causing a loss of electrical power and other damage. On September 20, 2017, while still recovering from Hurricane Irma, Puerto Rico and Arecibo Observatory, suffered a direct hit by Hurricane Maria, a Category 4 hurricane. The Commonwealth suffered devastating damage to almost all of its infrastructure. Communications were impossible in the first several days after the Hurricane. When communications were reestablished, NSF learned that the Observatory, though receiving some damage, escaped significant damage. In particular, the damage to structures in the historic district is reparable, and, as a result, NSF determined that no additional NEPA analysis would be needed. If feasible, either through supplemental appropriations for hurricane relief or through normal appropriated funds, NSF intends to fund the repairs of Arecibo Observatory to its pre-hurricane condition.

IV. NSF'S SOLICITATION REQUESTING PROPOSALS TO MANAGE AND OPERATE ARECIBO OBSERVATORY WITH REDUCED NSF FUNDING

On January 25, 2017, NSF released a solicitation requesting proposals to manage and operate Arecibo Observatory. The solicitation specified a reduced level of NSF funding and the inclusion of voluntary committed cost sharing. If a proposer intended to maintain the current operations (at a level of approximately $12 million per year, including the current NASA funding of $3.6 million/year), the proposer was required to present a plan to supplement NSF funding with external support. The solicitation was also designed to allow potential collaborators the freedom to propose highly creative approaches to the management and operations of Arecibo Observatory. The broad latitude given in the solicitation enabled potential collaborators to respond with proposals that could support either Alternative 1 (Collaboration with interested parties for science-focused operations) or Alternative 2 (Collaboration with interested parties for education-focused operations). The response to the solicitation was critical to determining the viability of implementing Alternative 1, NSF's Preferred Alternative. NSF ultimately received responses that primarily took the approach of emphasizing the science-focused operations, while retaining significant education components as well. Accordingly, at this juncture, it appears as though implementation of Alternative 1 is viable.

V. DECISION

NSF has determined that it must change operations at Arecibo Observatory in light of funding constraints. The scientific community's recommendations to reduce NSF's contributions to operations at Arecibo Observatory, and to ensure a balanced portfolio for both the AST and AGS

Divisions, led to NSF's determination that changes to operations at Arecibo Observatory at a reduced funding level were necessary.

In its March 2016 report, the AAAC noted: "the NSF/AST division continues to make progress in responding to the PRC recommendations…[by] partnering of some facilities while limiting the negative impact on the scientific community." Moreover, in their March 2017 report, the AAAC noted: "it is recognized by the Portfolio Review Committee, NSF/AST, and the AAAC that complete removal of funding from a facility/telescope might remove productive and sometimes unique assets from being available for astronomical research. For this reason, the preferred divestment alternative being pursued by the NSF has involved forming partnerships that enable valuable observing capabilities (the combination of telescope and instrumentation) to be used for astronomical research. This approach could and should reduce costs to NSF/AST without as severe an impact (on research) as closure."

Confronted with funding constraints, NSF pursued a path forward to address ways in which a change in operations could be accomplished, coupled with a full understanding of the environmental consequences that would result from implementation of the Action Alternatives and No-Action Alternative. This path forward also included consideration of associated demolition activities that could, potentially, be needed. The completion of this path, culminating in this decision, has taken place over several years. Engagement with the scientific community to seek alternative ways to continue operations at Arecibo Observatory has occurred for the past two years. NSF conducted a feasibility study to help inform the scope of necessary environmental reviews for any operational changes. The feasibility study was followed by an extensive 16-month environmental review process with significant public involvement. Substantial public outreach efforts were made through a wide variety of modalities, and several public meetings and comment periods were held throughout NSF's process. All public comments NSF received during this process were considered and factored into this decision. During this environmental review process, and consistent with the recommendations from the scientific community, NSF identified Alternative 1 as the Preferred Alternative, rather than closure of of the Observatory. Of the six Alternatives analyzed in the FEIS (Science-focused, Education-focused, Mothballing, Closure with Partial Demolition, Closure with Full Demolition, and the No-Action Alternative), NSF now issues its decision selecting Alternative 1. This Alternative, which is also the environmentally-preferable Action Alternative (see Section II), was selected after considering the viability of the proposals received in response to NSF's solicitation to operate and manage Arecibo Observatory (see Section IV). In addition, this decision is further supported by the following factors:

- Arecibo Observatory generates significant contributions to science.
- The astronomical and aeronomy communities have indicated their desire to continue operations at Arecibo Observatory, despite lower funding levels, rather than close it completely.
- Continuation of operations at Arecibo Observatory will allow the important science-based educational programs to continue; these programs were identified during the public comment periods as being of very high value to the people of Puerto Rico.
- Arecibo Observatory is an important cultural icon to the Puerto Rican people, and is listed on the National Register of Historic Places for its scientific and engineering merit.

NSF also acknowledges that continuing operations of Arecibo Observatory will support NASA's congressional mandate to discover, characterize, and catalog potentially hazardous near-Earth objects.

Although identified as the environmentally-preferable Action Alternative, Alternative 1, as explained above and more thoroughly set forth in the FEIS, could result in several adverse impacts on various resources. To reduce those impacts, which largely stem from any demolition activities deemed necessary by a collaborator(s), NSF has committed to implement mitigation measures. The following is a list of those mitigation measures:

Air Quality

- Contracts for any demolition work will require idle reduction and proper equipment maintenance to reduce emissions during demolition.

Biological Resources

- The expected areas of disturbance that were analyzed to determine potential impacts to protected species will be provided to prospective bidders that propose to provide demolition services. If a bidder indicates that additional areas, including additional or widened roads, will be needed to complete work, NSF will delay the award until additional consutations with USFWS, including additional surveys, have been completed.
- Worksites will be clearly marked and workers will be instructed to stay within the marked areas.
- Staging areas will be placed in disturbed areas whenever possible.
- If offsite soil is needed to backfill an excavated area, the minimum amount of soil needed will be brought onto the site.
- Landscaped areas will be maintained to avoid the propagation of weed species.
- As appropriate, soil used for planting will be augmented with nutrients, organic matter, or bulking agents to provide an appropriate medium for root establishment and subsequent growth of the species selected for planting.
- Re-landscaping will use non-invasive species and will incorporate native vegetation, if feasible.
- If offsite soil is needed to backfill an excavated area, the minimum amount of soil needed will be brought onto the site.
- A site-specific stormwater pollution prevention plan (SWPPP) will be developed to support the National Pollutant Discharge Elimination System stormwater permit.
- Erosion control measures such as riprap, check-dams, and compost filter berms will be used to protect exposed soil and minimize erosion, scouring, and sedimentation. Good housekeeping measures will be practiced during demolition and the disturbed areas will be revegetated. Steep slopes that are disturbed will be protected with biodegradable erosion control measures. Pre-demolition runoff patterns will be restored upon completion of demolition activities.

- Standard operating procedures for the capture and relocation of Puerto Rican boas (FEIS Appendix 4.1-A) will be used during demolition and/or site restoration activities will be implemented as follows:
  - Key onsite personnel will be trained in the identification of boas and the value of boas and boa conservation by qualified personnel.
  - Daily pre-work surveys of equipment and work areas, including buildings/structures and karst features, will be completed by qualified personnel trained in boa identification and location.
  - Any Puerto Rico boas found on equipment or within the day's work area will be relocated to the designated relocation area south of the staging yard on the eastern side of Arecibo Observatory; this should be done by an individual authorized by the USFWS and trained in handling Puerto Rican boas.
  - If a Puerto Rico boa is observed in the day's work area, work will be stopped until a qualified wildlife biologist trained in handling Puerto Rican boas can relocate the snake to the designated relocation area or the Puerto Rico boa voluntarily vacates the work area.
- While it is unknown at this time whether Arecibo Observatory will be transferred out of federal control, should Areceibo Observatory property be transferred out of federal control in the future, NSF will consult with USFWS, as appropriate, to meet Section 7 consultation requirements and to determine whether any mitigation measures are necessary.
- A pre-demolition survey for active bird nests will be conducted. Any identified active nests will be protected from disturbance by a 100-foot nesting buffer, which will remain in place until the young have fledged from the nest.

Cultural Resources

- Stipulations specified in the Section 106 PA (see Attachment A) will be implemented, subject to available appropriations and funding priorities. These stipulations, which were reached through consultation with the Puerto Rico SHPO, the ACHP, and the Consulting Parties, as well as input from the public, were developed to address adverse effects to historic properties. These stipulations also provide the necessary mitigation to address major impacts to cultural resources under NEPA.
- An unanticipated discovery plan will be developed prior to any demolition activities under Alternative 1 being carried out.

Geology and Soils

- Construction stormwater controls will be implemented and maintained to prevent scour and soil loss from runoff.
- Before any demolition begins, a geophysical survey will be conducted to inspect designated work areas and note any suspected karst features, including sinkholes, solution cavities, and areas of soil subsidence that could be affected by demolition work. The survey will also evaluate soil stability and the vertical and horizontal projection of sinkholes. These features will be avoided when possible and protected with sandbags, nets, and filter fabric. They will be monitored during the work for changes such as soil subsidence, collapse, water infiltration, and clogging.

- A site-specific SWPPP will be prepared and implemented prior to starting any demolition activities.
- Disturbed areas, if any, will be stabilized and revegetated with native plant species to minimize the potential for erosion after any demolition is completed. Native species will, to the extent possible, be used for any necessary revegetation; if the use of non-native species is necessary, only non-invasive species will be planted.
- Earth-disturbing activities, if any, will be conducted in a manner that minimizes alteration of the existing grade and the hydrology of existing surficial karst features.
- Previously unknown karst features that are identified during any invasive work activities, including blasting and removal of foundations, anchors, towers, and below-grade structures, will be addressed as follows:
  - Work will stop within a 100-foot radius of the feature and the feature will be assessed to identify its potential to impact other karst features such as groundwater conduits, surface water conduits, and caves. The assessment method could include visual assessment, geophysical survey, or other techniques for subsurface characterization of karst features.
  - The karst feature will be either isolated or temporarily sealed to minimize impacts during demolition work (e.g., blocked with sandbags, protected with baskets, nets, or filter fabric).

Groundwater

- A site-specific SWPPP will be prepared and implemented prior to starting any demolition activities.
- Construction stormwater controls will be implemented and maintained to prevent scour and soil loss from runoff anticipated to result from any demolition activities.
- Disturbed areas, if any, will be stabilized and revegetated to minimize the potential for erosion after any demolition is completed. Any necessary revegetation will use native species to the extent possible; if non-native species are needed, only non-invasive species will be planted.
- Before any demolition begins, a geophysical survey will be conducted to inspect designated work areas and note any suspected karst features, including sinkholes, solution cavities, and areas of soil subsidence that could be affected by demolition work. The survey will also evaluate soil stability and the vertical and horizontal projection of sinkholes. These features will be avoided when possible and protected with sandbags, nets, and filter fabric. They will be monitored during the work for changes, such as soil subsidence, collapse, water infiltration, and clogging.
- A spill prevention, control, and countermeasures (SPCC) plan will be developed to address risks to groundwater from potential spills. The SPCC plan will include equipment inspections, equipment refueling, equipment servicing and maintenance, equipment washing, and the use and storage of any hazardous materials, chemicals, fuels, lubricating oils, and tther petroleum products.
- Any earth-disturbing activities will be conducted in a manner that minimizes alteration of the existing grade and the hydrology of existing surficial karst features.

- Previously unknown karst features that are identified during any invasive work activities, including blasting and removal of foundations, anchors, towers, and below-grade structures, will be addressed as follows:
  - Work will stop within a 100-foot radius of the feature and the feature will be assessed to identify its potential to impact other karst features such as groundwater conduits, surface water conduits, and caves. The assessment method could include visual assessment, geophysical survey, or other techniques for subsurface characterization of karst features.
  - The karst feature will be either isolated or temporarily sealed to minimize impacts during demolition work (e.g., blocked with sandbags, protected with baskets, nets, or filter fabric).

Hazardous Materials

- Complete site characterization and removal or remediation of contamination will be completed prior to any demolition activities.
- Hazardous materials and wastes will be used, stored, disposed of, and transported during any demolition activities in compliance with all applicable laws and regulations.
- Demolition contractors will create and implement a spill response plan.
- NSF will require all demolition contractors to create and implement a demolition management plan, including hazardous materials discovery protocols. The demolition management plan will include, at a minimum, a list of persons to contact in case of a possible encounter with undocumented contamination; provisions for immediate notification of the observation to demolition management; and notification of the regulatory agency with jurisdiction. If previously unknown contamination is found, demolition will halt in the vicinity of the find and the next steps will be decided in consultation with the regulatory agency.

Solid Waste

- Whenever possible, any demolition debris (such as soil) will be used onsite.
- Demolition debris, if any, will be diverted from landfills through reuse and recycling to the extent practicable.

Health and Safety

- Any demolition contractor will develop and implement a demolition Health and Safety Plan.
- Arecibo Observatory personnel will comply with OSHA safety protocols.
- Fencing and signage will be installed around any demolition sites.

Noise

- Demolition areas, if any, will be fenced to keep personnel as far away as possible from heavy equipment.

Traffic and Transportation

- Transport of materials and demolition vehicles will occur during off-peak hours when practicable.

- Delivery truck personnel and demolition workers will be notified of all potential height restrictions and overhead obstructions.
- Vehicles used for material transport will be required to comply with local standards for height, width, and length of vehicles, when practicable. If at any time vehicles of excessive size and weight are required on local roads and bridges, NSF will coordinate with the appropriate transportation authority to obtain the necessary permits.
- NSF will coordinate with the appropriate transportation authority to determine the appropriate mitigation measures to implement in response to road damage.
- Further detailed waste haul routes and concerns will be addressed during the detailed design phase of the Proposed Action, including verification that all bridge crossings on the delivery routes have adequate strength and capacity.
- To minimize the impacts of any demolition on local residents, the demolition contractor will coordinate with local public schools to ensure demolition and haul routes do not adversely affect school bus traffic.

Perhaps the most significant major, adverse impact that the change in operations, under Action Alternative 1, at Arecibo Observatory could have is the impact on historic properties associated with the historic use of the Observatory. Although mitigation measures will be implemented to avoid impacts, the potential for major adverse impacts – if demolition is requested by a future collaborator(s) for continued operations – remains. Therefore, and in compliance with Section 106 of the NHPA, the PA was developed and implementation of it is designed to address those impacts. (See Attachment A)

NSF prepared a BA to assess the potential impacts to listed species with the potential to occur on or adjacent to Arecibo Observatory. The BA was submitted to USFWS as part of the informal consultation for the Proposed Action. USFWS concurred with the findings of the BA and the proposed mitigation measures identified above, in a letter dated June 23, 2017 (FEIS Appendix 4.1-A).

A member of the public submitted a concern to the USFWS Migratory Bird Lead for Puerto Rico after the FEIS was issued, indicating that NSF's use of a web-based report on wildlife was not sufficient. NSF considered this issue, and concluded that, because it used the web-based report as a starting point then coordinated directly with USFWS on the analysis of potential impacts to migratory birds during the development of the EIS, no change to the analysis is needed.

Alternatives Not Selected

The No-Action Alternative was not selected because it would not meet the purpose and need for the action, which is to substantially reduce NSF's contribution to the funding of Arecibo Observatory. Under the No-Action Alternative, the level of funding provided by NSF would remain unchanged.

Alternative 2 was not selected because no proposals for educational operations were received in response to NSF's solicition and, therefore, this Action Alternative was determined not to be viable. Moreover, while the general environmental impacts and costs associated with implementation of Alternative 2 would be comparable to Alternative 1, the impacts to cultural resources would be greater than under Alternative 1. The reason for this is because Arecibo Observatory would no longer be used to conduct scientific research, which is one of the two

main reasons why buildings/structures within Arecibo Observatory are deemed historically significant. Also, the ultimate outcome of Alternative 2 would be less in line with the mission and goals of NSF because Alternative 2 would not continue the scientific research currently conducted at Arecibo Observatory.

Alternative 3 was not selected because, while the general environmental impacts and costs associated with implementation of Alternative 3 would be comparable to Alternative 1, the impacts to cultural resources would be greater than under Alternative 1. This is because Arecibo Observatory would no longer be used for the purpose that forms the basis for its historical significance. In addition, Alternative 3 would remove the scientific and educational opportunities supportable under Alternative 1, and these opportunities are, according to the public comments received, very important to both the scientists and the Puerto Rican people.

Alternative 4 was not selected because the environmental impacts, public concerns, and costs associated with implementation of Alternative 4 would be greater than that for Alternative 1. Also, Alternative 4 would not allow scientific research to continue at Arecibo Observatory.

Alternative 5 was not selected for multiple reasons. The environmental impacts associated with demolition of the towers and cable anchors would be greater than any of the other Alternatives. The cost to implement Alternative 5 would be much greater than any other considered Alternative. Alternative 5 also would result in demolition of the iconic 305-meter radio telescope dish, which is one of the main reasons why Arecibo Observatory is an historically significant facility on the National Register of Historic Places. Also, Alternative 5 would not allow the continuance of scientific research or educational programs, both of which are, according to public comments received, very important to the scientists and Puerto Rican people.

It is important to note that Alternative 1 could be implemented in a manner in which NSF would retain ownership of Arecibo Observatory, or in which NSF would transfer its ownership interest to a non-federal entity. If such a transfer were to take place, consultation with the USFWS would resume to address concerns associated with the property being owned and managed by a non-federal entity, including the consequences associated with the inapplicability of Section 7 consultation under the ESA to non-federal actions conducted at the site. Similarly, a non-federal entity would not be required to comply with Section 106 of the NHPA, leaving significant historic properties without the protections afforded by that statute. For this reason, the transfer scenario is specifically addressed in the PA.

At its November 9, 2017 National Science Board meeting, after reviewing the scientific merit and other considerations related to Alternative 1: Collaboration with Interested Parties for Continued Science-focused Operations, the National Science Board authorized the Director (or her designee) to approve the selection of Alternative 1, contingent upon NSF's completion of its compliance with the NHPA (which subsequently occurred on November 15, 2017). We have considered the scientific merit of Arecibo Observatory, the budgetary constraints faced by NSF, and the environmental consequences and their associated mitigation measures. After thorough consideration of the entire administrative record, we conclude that Alternative 1: Collaboration with Interested Parties for Continued Science-focused Operations represents an opportunity to continue operations at an important and historically significant astronomical facility that provides useful and innovative science and educational activities, with reduced NSF funding contributions. Accordingly, we hereby approve the selection of Alternative 1 as the path forward for the future of Arecibo Observatory.

11/15/17
Date

Dr. Richard F. Green
Division of Astronomical Sciences
National Science Foundation

11/15/17
Date

Dr. Paul Shepson
Division of Atmospheric & Geospace Sciences
National Science Foundation

ATTACHMENT A

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

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;

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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 Día* 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 hereln; 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*

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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 I.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.

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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

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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.

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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

SIGNATORY PAGE

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IN THE VICINITY OF ARECIBO, PUERTO RICO

Signatory:

Advisory Council on Historic Preservation

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

Date 11/15/2017

RFG

SIGNATORY PAGE

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POTENTIAL CHANGES TO
ARECIBO OBSERVATORY OPERATIONS
IN THE VICINITY OF ARECIBO, PUERTO RICO

Signatory:

Puerto Rico State Historic Preservation Office

Carlos A Rubio

Carlos Rubio Cancela, Executive Director

Date November 14, 2017

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INVITED SIGNATORY PAGE

PROGRAMMATIC AGREEMENT
AMONG
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IN THE VICINITY OF ARECIBO, PUERTO RICO

Invited Signatory:

Arecibo Observatory

Francisco Córdova, Director

Date 11/13/17

CONCURRING PARTY SIGNATURE PAGE

PROGRAMMATIC AGREEMENT
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IN THE VICINITY OF ARECIBO, PUERTO RICO

Concurring Party:

SRI International

_____ Date _____

Anthony van Eyken, Ph.D.

CONCURRING PARTY SIGNATURE PAGE

PROGRAMMATIC AGREEMENT
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Concurring Party:

Interamerican University-Bayamon

_____ Date _____

Brett Isham, Ph.D.

CONCURRING PARTY SIGNATURE PAGE

PROGRAMMATIC AGREEMENT
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Concurring Party:

Miami University

_____ Date _____

Qihou Zhou, Ph.D.

CONCURRING PARTY SIGNATURE PAGE

PROGRAMMATIC AGREEMENT
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Concurring Party:

Universities Space Research Association

Date

Nicholas White, Ph.D.

CONCURRING PARTY SIGNATURE PAGE

PROGRAMMATIC AGREEMENT
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Concurring Party:

American Nanohertz Observatory for Gravitational Waves

_____ Date _____

Xavier Siemens, Ph.D.

CONCURRING PARTY SIGNATURE PAGE

PROGRAMMATIC AGREEMENT
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Concurring Party:

_____ Date _____

Ms. Luisa Zambrano-Marln

CONCURRING PARTY SIGNATURE PAGE

PROGRAMMATIC AGREEMENT
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Concurring Party:

_____ Date _____

Carmen Pantoja, Ph.D.

CONCURRING PARTY SIGNATURE PAGE

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IN THE VICINITY OF ARECIBO, PUERTO RICO

Concurring Party:

Puerto Rican Karzo Speleological Research Foundation (FIEKP)

_____ Date _____

Mr. Miguel Babilonia

CONCURRING PARTY SIGNATURE PAGE

PROGRAMMATIC AGREEMENT
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Concurring Party:

Universities Space Research Association

_____ Date _____

Joan Schmelz, Ph.D.

CONCURRING PARTY SIGNATURE PAGE

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Concurring Party:

University of Central Florida

_____ Date _____

Mr. Ramon Lugo

CONCURRING PARTY SIGNATURE PAGE

PROGRAMMATIC AGREEMENT
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Concurring Party:

University of Puerto Rico

_____ Date _____

Daniel R. Altschuler, Ph.D.

Attachment A
NAIC Historic District Map

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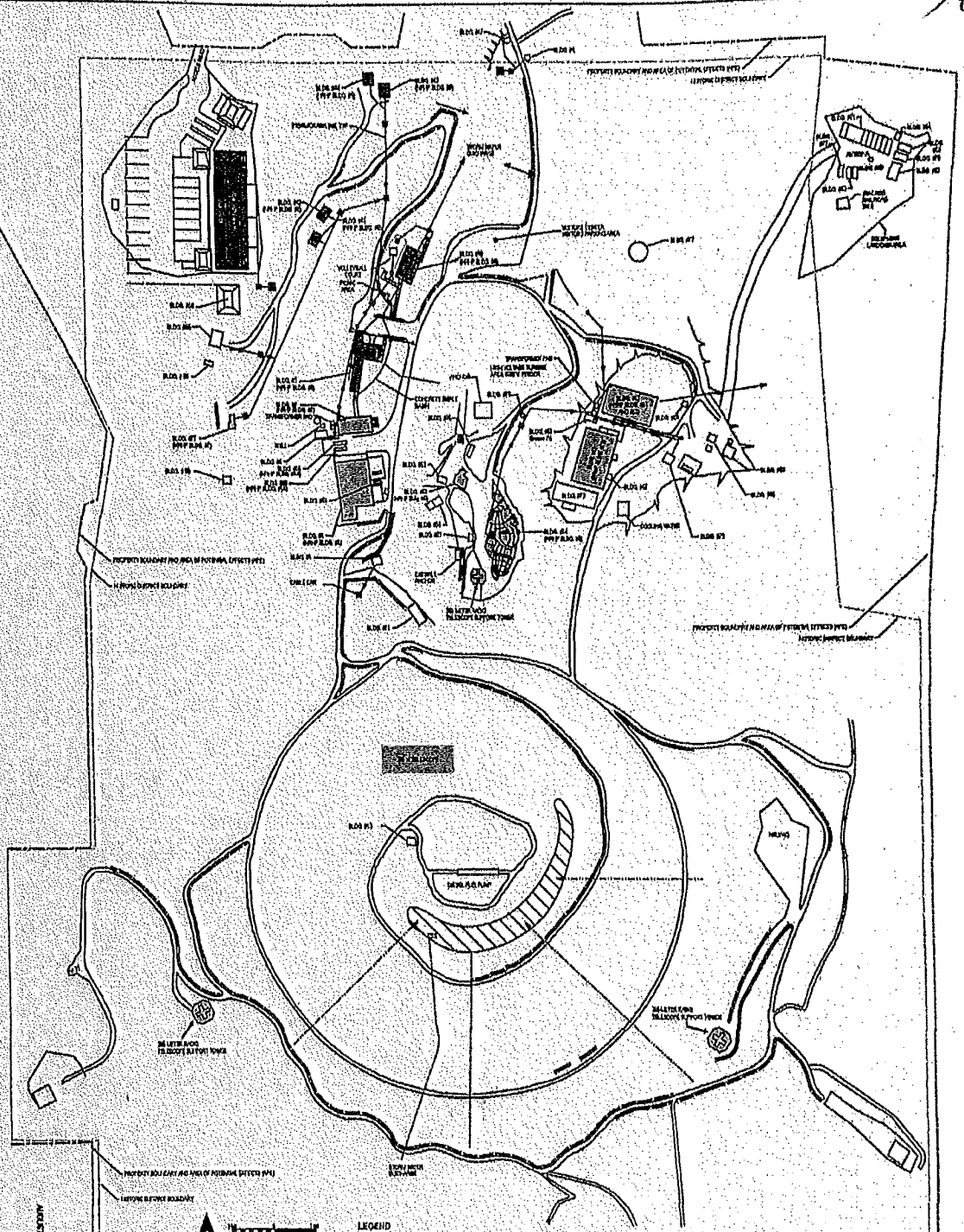

BUILDING NO. DESCRIPTION

1. OPERATIONS BUILDING (NRHP BLDG #1) (1963)
2. ADMINISTRATION BUILDING (NRHP BLDG #2) (1963)
3. VISITING SCIENTIST QUARTERS AND CAFETERIA (NRHP BLDG #3) (1963)
4. ENTRANCE GUARD HOUSE (1963)
5. CABLE CAR HOUSE (1963)
6. PUMP HOUSE/WATER TREATMENT BLDG. (1963)
10. SWIMMING POOL/RESTROOMS (NRHP BLDG #4) (Mid 1960s)
11. LEWIS BUILDING-ROOFING LOFT (Mid 1960s)
12. MAINTENANCE SHOPS (NRHP BLDG #13) (1962)
13. DOME SHACK (1963)
17. WAREHOUSE (NRHP BLDGS #11 AND #17) (1967)
21. ANTENNA TESTING RANGE
25. PAINT STORAGE BUILDING (Circa 2010)
27. OPTICAL LABS (NRHP BLDG #7) (1965/1967)
34. HIGH VOLTAGE POWER SUPPLY BLDG. (1972)
35. CUMMINS GENERATOR CONTROL BLDG. (2010)
41. WEST HILL V.S.Q. BACHELOR UNIT 1 (NRHP BLDG #8) (1960s)
42. WEST HILL V.S.Q. BACHELOR UNIT 2 (NRHP BLDG #9) (1960s)
43. WEST HILL V.S.Q. FAMILY UNIT 1 (NRHP BLDG #5) (1960s)
44. WEST HILL V.S.Q. FAMILY UNIT 2 (NRHP BLDG #6) (1960s)
47. MAIN GATE RESTROOM (1963)
50. INTERFERENCE MONITORING SHACK
51. GREASE TK1
53. EMERGENCY GENERATOR BLDG
54. VISITOR CENTER BLDG. (NRHP BLDG #3) (1997)
55. LOAN LABORATORY BLDG. (1966)
57. NORTH V.S.Q. BLDG. (NRHP BLDG #10) (2002)
58. NORTH V.S.Q. UTILITY BLDG. (2002)
59. VISITOR CENTER TRAILER
60. ANT. RECE. TESTING BLDG. (Late 1960s)
61. LEARNING CENTER (NRHP BLDG #6) (2001)
62. HFF STORAGE TRAILER
63. IONOSONDE TRAILER
64. ELECTRONIC TRAILER
65. SHIELDED TRAILER (1967)
66. ATMOSPHERIC SCIENCE TRAILER (NRHP BLDG #1A)
67. CRYOGENICS LAB TRAILER (1967)
68. SCIENTIFIC DEVICES TRAILER (NRHP BLDG #1A)
69. ELECTRONICS TRAILER (WAVEGUIDE)
70. COMPUTER TRAILER
71. ELECTRONICS CABLE TRAILER
72. ELECTRONIC TRAILER (CRYOGENICS)
73. HF TRANSMITTER BUILDING (2005)
74. SUSPENSION FOR SCIENCE TRAILER (2005)
77. PHASE REFERENCE ANTENNA (12M) (2010)
78. COFFEE HUT (2005)
79. ENGINEERING OFFICE BUILDING (2005)
80. CUMMINS DIESEL GENERATOR BUILDING (2010)

Architectural Resources and Historic Properties within the APE
Arecibo Observatory
Puerto Rico

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ATTACHMENT A

Attachment B
Table of Historic Properties in NAIC Historic District

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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 Arecibo Observatory designation (AO): N/A	305-meter Reflector 305-meter Radio Telescope and Support Towers	1963
NRHP: Buildings #1 and #1A AO: Building #1 (and Trailers #66 and #68)	Visitors Offices, Electronics/Digital Lab, Control Room/Operators Office, Facilities/Maintenance (2nd level); and Safety/Security Office, PC Network Office, Visiting Scientists Offices Operations Building (with Atmospheric Science Trailer and Scientific Offices Trailer)	1963 (addition in 1983) Year of construction for trailers unknown.
NRHP: Building #2 AO: 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 Administration Building	1963
NRHP: Building #5 AO: Building #54	Visitors Center Visitor Center Building (Fundación Angel Ramos Visitor and Educational Facility)	1997 (addition 2015)
NRHP: Building #6 AO: Building #61	Learning Center Learning Center	2001
NRHP: Building #7 AO: Building #27	Atmospheric and Optical Labs Optical Labs	1985/1997
NRHP: Buildings #11 and #12 AO: Building #17	Warehouse and Business/Purchasing Warehouse	1967
NRHP: Building #13 AO: Building #12	Machine Shop Maintenance Shops	1967

** 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 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 B

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)).

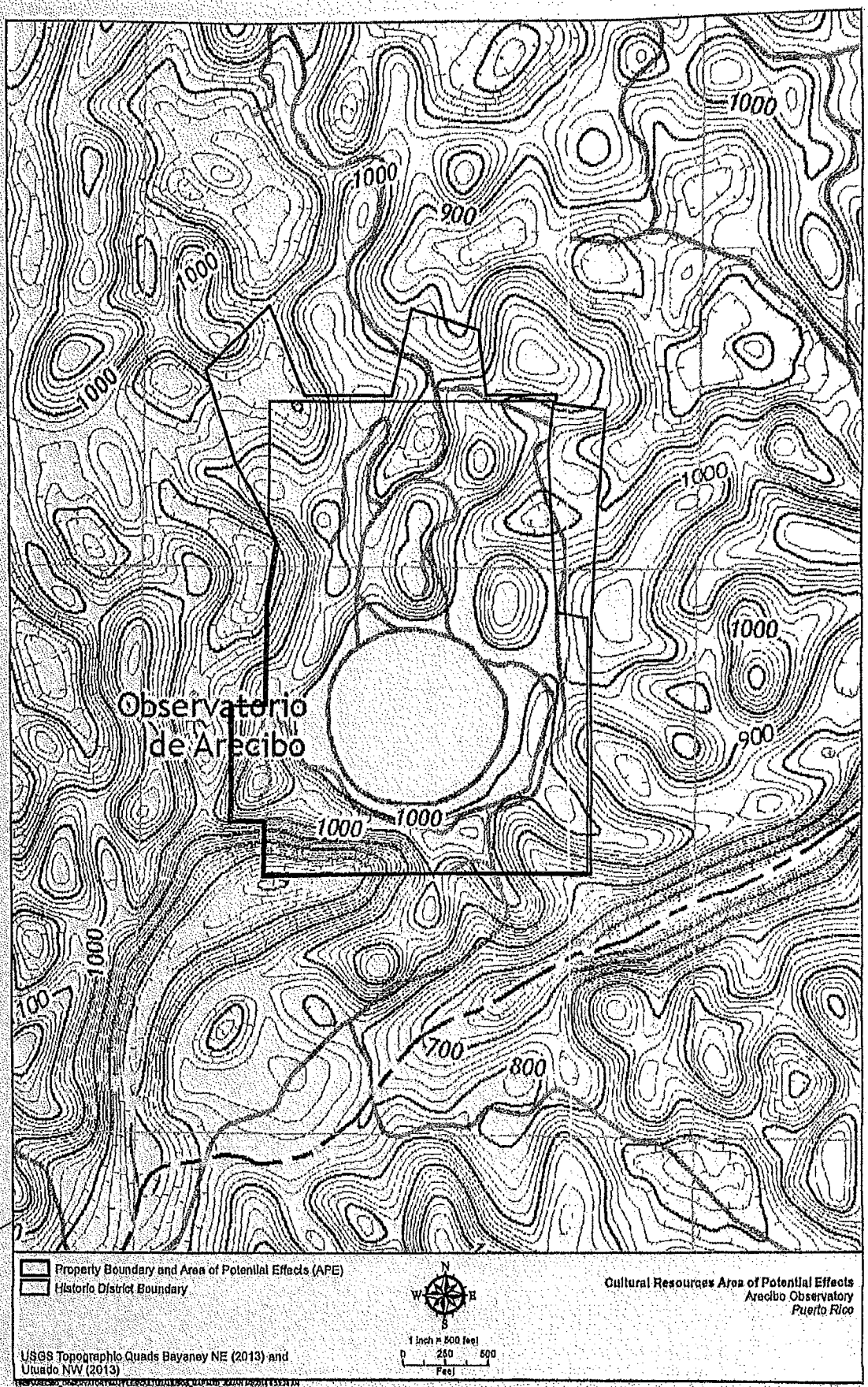
Invited Signatory: Any party that is assigned a responsibility under the PA and is invited by the federal agency (NSF) to sign the PA. Any invited signatory that signs the PA has the same rights with regard to seeking amendment or termination of the PA as other signatories. The refusal of any party invited 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



ATTACHMENT D

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 (2nd 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; 2nd floor: Director and Administration, Library, Mail Room; 3rd floor: Palomar Room, Scientific Staff Offices; 4th 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	mid 1960s
AO: #10	Swimming Pool/Restrooms (with additional recreation areas)	
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	

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