Improving Undergraduate STEM Education: Pathways into the Earth, Ocean, Polar and Atmospheric & Geospace Sciences (IUSE:GEOPAths)

PROGRAM SOLICITATION
NSF 20-516

REPLACES DOCUMENT(S):
NSF 18-583

National Science Foundation

Directorate for Geosciences
Division of Atmospheric and Geospace Sciences
Division of Earth Sciences
Division of Ocean Sciences
Office of Polar Programs

Directorate for Education and Human Resources
Division of Undergraduate Education

Letter of Intent Due Date(s) ***(required)*** (due by 5 p.m. submitter's local time):

December 20, 2019

November 17, 2020

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

February 14, 2020

January 26, 2021

IMPORTANT INFORMATION AND REVISION NOTES

A. While maintaining elements from the legacy tracks of GEOPATHS (EXTRA and IMPACT), this solicitation features three new funding tracks that focus on Geoscience Learning Ecosystems (GLEs):

1. GEOPAths: *Informal Networks* (***IN***). Collaborative projects in this track will support geoscience learning and experiences in informal settings for teachers, pre-college (e.g., upper level high school) students, and early undergraduates in the geosciences.
2. GEOPAths: *Undergraduate Preparation* (***UP***). Projects in this track will engage pre-college and undergraduate students in extra-curricular experiences and training in the geosciences with a focus on service learning [Reference 3 in the Program Description section] and workplace skill building.
3. GEOPAths: *Graduate Opportunities* (***GO***). Projects in this track will improve research and career-related pathways into the geosciences for undergraduate and graduate students through institutional collaborations with a focus on service learning and workplace skill building.

B. The following proposal components should not be included in the 15 page body of the proposal. Instead they should be completed and submitted in the Special Information & Supplementary Documents Section of FastLane:

1. Postdoctoral Researcher Mentoring Plan
2. Data Management Plan
3. Participant Mentoring Plan (required for all projects that propose activities involving student participants) - up to two pages maximum.
4. Sustainability Plan - up to two pages maximum.
5. Evaluation Plan - up to three pages maximum (including figures).

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 19-1), which is effective for proposals submitted, or due, on or after February 25, 2019.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Improving Undergraduate STEM Education: Pathways into the Earth, Ocean, Polar and Atmospheric & Geospace Sciences (IUSE:GEOPAths (GEOPAths)

Synopsis of Program:

The National Science Foundation's (NSF's) Improving Undergraduate STEM Education (IUSE) Initiative is a Foundation-wide effort to accelerate improvements in the quality and effectiveness of undergraduate education in all STEM fields including the learning, social, behavioral, and economic sciences. Undergraduate STEM education is critical for preparing both a diverse STEM workforce and a STEM-literate public that is ready to support and benefit from the progress of science [Reference 1]. The IUSE initiative provides a Foundation-wide framework of investments to support the agency's commitment to the highest caliber undergraduate STEM education. By improving the quality and effectiveness of undergraduate education in all STEM fields, IUSE investments enable NSF to lead national progress toward a diverse and innovative workforce and a STEM-literate public.

Through the IUSE framework, NSF coordinates its investments in undergraduate programs and undergraduate STEM education to maximize impact, and to use shared metrics and appropriate program evaluation approaches. These investments are made across all directorates and address both STEM education in general and specific disciplinary needs. IUSE investments support a variety of activities including the inclusion of inquiry-based and active learning approaches in undergraduate STEM instruction, efforts to increase undergraduate STEM research experiences and courses, and research on the persistence and graduation of students in STEM programs. In addition, specific emerging cross-disciplinary needs include data science preparation for students in all majors, recruitment and retention of women and of students from underrepresented groups in STEM degree programs, incorporation of undergraduate research in STEM fields for STEM majors and non-majors, and re-envisioning of introductory courses in light of new research findings and theories. IUSE also seeks to broaden participation in STEM fields from all sectors and groups in society and proposers are encouraged to establish linkages, as appropriate, with components of the national network of NSF INCLUDES projects [Reference 2 in the Program Description section].

The Directorate for Geosciences (GEO) contributes to the *IUSE* initiative through the *Improving Undergraduate STEM Education: Pathways into the Geosciences - Earth, Ocean, Polar and Atmospheric Sciences (IUSE:GEOPAths)* funding opportunity. IUSE:GEOPAths invites proposals that specifically address the current needs and opportunities related to education within the geosciences community through the formation of STEM Learning Ecosystems that engage students in the study of the Earth, its oceans, polar regions and atmosphere. The primary goal of the IUSE:GEOPAths funding opportunity is to increase the number of students pursuing undergraduate and/or postgraduate degrees through the design and testing of novel approaches that engage students in authentic, career-relevant experiences in geoscience. In order to broaden participation in the geosciences, engaging students from historically excluded groups or from non-geoscience degree programs is a priority. While maintaining elements from the legacy tracks of GEOPATHS, this solicitation features three new funding tracks that focus on Geoscience Learning Ecosystems (GLEs):

1. GEOPAths: *Informal Networks* (***IN***). Collaborative projects in this track will support geoscience learning and experiences in informal settings for teachers, pre-college (e.g., upper level high school) students, and early undergraduates in the geosciences.

2. GEOPAths: *Undergraduate Preparation* (***UP***). Projects in this track will engage pre-college and undergraduate students in extra-curricular experiences and training in the geosciences with a focus on service learning [Reference 3 in the Program Description section] and workplace skill building.

3. GEOPAths: *Graduate Opportunities* (***GO***). Projects in this track will improve research and career-related pathways into the geosciences for undergraduate and graduate students through institutional collaborations with a focus on service learning and workplace skill building.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- M. Brandon Jones, GEO/OAD, telephone: (703) 292-4713, email: mbjones@nsf.gov
- Elizabeth L. Rom, GEO/OCE & GEO/OPP, telephone: (703) 292-7709, email: elrom@nsf.gov
- Amanda (Manda) S. Adams, GEO/AGS, telephone: (703) 292-8521, email: amadams@nsf.gov
- Aisha R. Morris, GEO/EAR, telephone: (703) 292-7081, email: armorris@nsf.gov
- Keith A. Sverdrup, EHR/DUE, telephone: 703-292-4671, email: ksverdru@nsf.gov

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.050 --- Geosciences
- 47.076 --- Education and Human Resources

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 18

NSF expects to make up to 18 awards through this competition, with ~6 awards being made in each of the three tracks.

Anticipated Funding Amount: $6,000,000

NSF anticipates available funding for the IUSE:GEOPAths program to be approximately $6 million total for new awards per fiscal year. See section III below for further information about the anticipated number of awards in the program's three tracks and the average size and duration of awards. The estimated program budget, number of awards, and average award size/duration are subject to the availability of funds.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

An organization may serve as sole submitting organization or as lead organization of a collaborative project on only one submission per competition , regardless of track, but may serve as the non-lead organization of a collaborative project more than once per competition. Additional eligibility requirements are described later in the solicitation.

Potential PIs are advised to contact their institutional office of research regarding processes used to select proposals for submission.

Limit on Number of Proposals per PI or Co-PI:

A Principal Investigator may serve in the role of PI or Co-PI on only one proposal per competition if they are at the sole-submitting organization or the lead organization of a collaborative project, but may serve as the Co-PI for a non-lead organization of a collaborative project more than once per competition.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required. Please see the full text of this solicitation for further information.
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**
  - Full Proposals submitted via FastLane: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
  - Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

  Inclusion of voluntary committed cost sharing is prohibited.

- **Indirect Cost (F&A) Limitations:**

  Not Applicable

- **Other Budgetary Limitations:**

  Not Applicable

C. Due Dates

- **Letter of Intent Due Date(s)** ***(required)*** (due by 5 p.m. submitter's local time):

  December 20, 2019

  November 17, 2020

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

  February 14, 2020

  January 26, 2021

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria. Additional merit review criteria apply. Please see the full text of this solicitation for further information.

Award Administration Information

Award Conditions:

Additional award conditions apply. Please see the full text of this solicitation for further information.

Reporting Requirements:

Standard NSF reporting requirements apply.

TABLE OF CONTENTS

I. INTRODUCTION

Over the past decade, reports developed by the National Science Board, the National Academies, and the President's Council of Advisors on Science and Technology (PCAST) have documented the substantial role played by the science, technology, engineering, and mathematics (STEM) disciplines as drivers of American innovation, prosperity, and global competitiveness [References 4 - 8]. These reports have also noted that the "need for STEM knowledge extends to all Americans," due to the growing role of STEM products in the lives of citizens and the need for our democratic society to make informed decisions on the basis of scientific evidence. Yet, in spite of continually growing demand for STEM expertise and literacy, fewer students are pursuing advanced degrees and careers in STEM disciplines and insufficient progress is made in engaging the full diversity of the Nation's potential talent pool in those

fields.

The *Status of the Geoscience Workforce 2018* report (published by the American Geosciences Institute - AGI) and related efforts [References 9 & 10] assess the educational and employment landscape within the geosciences [References 10-18] and have documented clear evidence of this downward trend. The Bureau of Labor Statistics estimates a higher than average growth rate for the future geoscience workforce (growing at higher-than-average rates and projected turnover resulting from retirements) while AGI predicts that production of new geoscientists at current rates will not be sufficient, resulting in a shortfall of ~118,000 geoscientists by the year 2026. Improving efforts to retain individuals from groups who have traditionally been excluded in the geosciences is important since these students will soon be the majority of college age students in undergraduate programs [Reference 19 & 20].

Relatedly, increasing the recruitment and retention of undergraduate students in geoscience courses and programs might lead to more graduates in the discipline, however there are barriers that will need to be addressed. The geosciences differ from many other STEM disciplines in that 1) there often are not well-defined pathways between high school, college education (both two-year and four-year), and graduate education or career options and 2) lack of exposure to existing, well-defined career pathways could be a barrier if students do not enter the path early enough. AGI found that approximately half of the geoscientists surveyed (at all degree levels) had taken a formal Earth science course while in high school, demonstrating the potential importance of early exposure to the geosciences for career preparation. In fact, in 2017 69% of doctoral graduates in the geosciences reported taking a high school geoscience or environmental science course [Reference 21]. High school exposure to the geosciences is an integral part of the recruitment pipeline for engaging students in geosciences pathways. Yet, fewer than 50% of high school graduates take a high school geoscience course (e.g., Earth science, oceanography, or meteorology) and the lack of an Advanced Placement course/exam in geoscience makes it difficult to elevate the reputation of the discipline, further continuing the lack of exposure and awareness of the geosciences as a career option. Given this lack of visibility in (or even before) high school, geoscience continues to primarily be a discovery major at the undergraduate level, with a few notable exceptions (e.g., meteorology).

The increasing importance of two-year colleges (2YCs) in the higher education landscape [Reference 22] poses a unique challenge for the geoscience's community, given that only ~24% of the nearly 1725 2YC's nationwide offer a geoscience program or course. The greater diversity of students found at 2YCs offers an important, largely untapped opportunity for broadening participation in the geosciences. Degree program opportunities at many minority-serving institutions (MSIs), and especially at Historically Black Colleges and Universities (HBCUs), also are quite limited [Reference 23].

The geosciences are inherently strengthened by the multiple entry points into the field, either as an undergraduate major or as a graduate student from other STEM fields such as chemistry, engineering, computer science, physics, biology, geography, or mathematics. The interdisciplinary nature of the geosciences offers the potential for undertaking more innovative approaches to recruitment and retention of students. The increasing focus of geoscience work on societally relevant issues such as climate, natural hazards, energy resources, etc. also opens the door to engaging a variety of additional students, including those pursuing undergraduate degrees in the social and behavioral sciences. The challenge arises when searching for or developing effective strategies to increase the awareness and access to the geosciences for these students and supporting them at the critical junctures where they might otherwise exit the discipline. An overarching framework that could help in this regard is to encourage the development of *geoscience learning ecosystems (GLEs)* that would unite various stakeholders to develop, enhance or sustain learning opportunities in STEM and the geosciences in particular.

To address these and related matters, the Directorate for Geosciences (GEO) supports the IUSE:GEOPAths program to create and support innovative and inclusive projects to build the future geoscience workforce. This program is one component in the National Science Foundation (NSF) *Improving Undergraduate STEM Education* (IUSE) initiative, which is a comprehensive, Foundation-wide effort to enhance the quality and effectiveness of the education of undergraduates in all of the STEM fields. Several key reports and documents describe the importance of the undergraduate experience as pivotal for preparing both a diverse STEM workforce that is ready and equipped for innovation, and a STEM-aware public ready to support and benefit from the progress of science [e.g., References 5, 7, 24, 25 and 26].

Collectively, projects in the IUSE portfolio are intended to: improve STEM learning and learning environments, broaden participation and institutional capacity for STEM learning, and build the professional STEM workforce for today. IUSE: GEOPAths is not primarily about curricular improvement or research on learning but relates to the IUSE goals of connecting education research to practice, building institutional capacity for preparing the professional geoscience workforce, and broadening participation in the geosciences. More information on the IUSE initiative is available in the core IUSE activity offered by the Education and Human Resources (EHR) directorate: the *EHR Improving Undergraduate STEM Education (IUSE: EHR)* program [https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505082].

II. PROGRAM DESCRIPTION

Improving Pathways into the Earth, Ocean, Polar and Atmospheric & Geospace Sciences

The IUSE:GEOPAths funding opportunity invites creative proposals to identify, broaden, strengthen and sustain the pathways that will engage and retain diverse students in pre-college, undergraduate and graduate geoscience degree programs. Additionally, skill and competency building for a variety of career pathways is of interest. IUSE:GEOPAths projects are expected to utilize effective, evidence-based strategies for improving student engagement, support and retention, and to expose students to meaningful experiences through creation of *geoscience learning ecosystems (GLEs)* that leverage STEM stakeholder networks, academic and/or non-academic research activities and instrumentation infrastructure. The underlying hypothesis for this solicitation is that novel, authentic, career-relevant geoscience experiences for broader student populations will augment existing curricula and increase students' identification with the geosciences that will ultimately increase the students' desire to pursue degrees and geoscience-related careers.

The overarching questions being addressed through this solicitation are:

Which strategies are most effective for creating inclusive environments in the geosciences that are attractive and supportive to students from groups that have been historically excluded in STEM?

Which approaches are most effective in introducing pre-college students to geoscience content?

Which methods are most effective in recruiting and retaining undergraduate students in the geosciences?

Which experiences are most effective in preparing undergraduate geoscience majors and graduate students for the workforce, and smoothing their transition post-graduation?

Which strategies are most effective for increasing the number and diversity of non-geoscience undergraduate majors that pursue post-baccalaureate degrees in geoscience?

IUSE:GEOPAths projects also offer an opportunity to tap the nation's diverse student talent pool and broaden participation in science and engineering. NSF is particularly interested in increasing the numbers of persons who have been historically excluded due to race, gender or ability in professional experiences related to the geosciences. IUSE:GEOPAths projects are strongly encouraged to involve students who are members of the following communities that have been underrepresented in STEM: African Americans, Hispanics, American Indians, Alaska Natives, and Native Hawaiians or other Pacific Islanders. When designing recruitment plans, IUSE:GEOPAths projects are also encouraged to consider students who have disabilities as well as veterans of the U.S. Armed Services. Proposers seeking to engage students at MSIs and two-year institutions through IUSE:GEOPAths are reminded of some of the specific barriers to attainment that these students must confront [e.g., References 5, 19, 20, 22, 23, 27-28]. These include: limited knowledge about college navigation; financial concerns; insufficient academic preparation, especially in math; misalignment of core courses across community colleges and four-year schools; limited advising, orientation, and mentoring; constraints affecting the academic and social integration of working students; and lack of self-efficacy.

This solicitation seeks to adapt the STEM Ecosystem concept outlined in the current White House STEM Strategic Plan to a *geoscience learning ecosystem* model for education, training and workforce development (GLEs). GLEs are formed through the relationships, collaborations and connections of various institutions, entities and groups with an eye towards creating supportive and fertile educational environments for students. **All IUSE:GEOPAths projects are expected to include a GLE framework with clearly defined goals and activities**. For further guidance on the development of learning ecosystem models, please reference the following section of the current White House STEM Strategic Plan (Pathways to Success - Develop and Enrich Strategic Partnerships and Foster STEM Ecosystems that Unite Communities).

This solicitation offers three funding tracks that focus on Geoscience Learning Ecosystems (GLEs).

1. GEOPAths: *Informal Networks* (***IN***). Collaborative projects in this track will support geoscience learning and experiences in informal settings for teachers, pre-college or community college students.
2. GEOPAths: *Undergraduate Preparation* (***UP***). Projects in this track will engage students in extracurricular research experiences and training in the geosciences with a focus on service learning and workplace skill building.
3. GEOPAths: *Graduate Opportunities* (***GO***). Projects in this track will improve research and career-related pathways into the geosciences for undergraduate and graduate students through institutional and employer collaborations with a focus on workplace learning and workforce skill building.

GEOPAths: Informal Networks (IN)

GEOPAths:IN projects will focus on activities and efforts that will extend the reach of STEM content for use in informal settings to teachers and pre-college or community college students who might otherwise not encounter geoscience before deciding on a major or completing a degree. Learning ecosystem collaborations involving academic and nonprofit organizations will emphasize educational outreach experiences in the geosciences that will leverage the expertise of partner organizations and broaden the reach and impact of the activities.

Activities that might be supported through the *GEOPAths:IN* track include, but are not limited to, the following:

Providing experiences that help pre-college students transition more successfully into undergraduate geoscience programs.

Creating mechanisms to engage students with sensory, physical, or intellectual disabilities, including “less apparent” disabilities in accessible field and research experiences.

Creating summer bridge programs that expose incoming undergraduate freshmen to the geosciences.

Leveraging science centers, museums, aquaria, etc. to expose home-schooled pre-college students to geoscience content and opportunities.

Creating mechanisms to engage upper level high school or community college students in experiences that demonstrate the geosciences as a viable career path before applying for college admission or transfer to a 4-year program.

Providing experiences for teachers to gain geoscience content for use in the classroom.

Competitive proposals submitted to the GEOPAths:IN will show evidence that all organizational partners are committed to and have been engaged intellectually in the design and execution of the proposed work. It is also important that proposals not only include details on the targeted geoscience content, but also demonstrate that the proposed learning ecosystem model is designed to increase the interests of participants post activity. Proposals seeking funds to support an existing organizational collaboration must clearly demonstrate the effectiveness of current activities being implemented through the partnership and identify the gaps that would be addressed if additional resources were made available. Lead organizations must demonstrate appropriate relationships and connections with local schools, school districts, other institutions of higher learning, etc. Proposals will also build on the evidence base for effective strategies for engagement and recruitment, particularly among underrepresented student populations. Similarly, they will be designed to contribute to the evidence base through formative and summative assessment and documenting the impact of the experiences on attitudes and learning outcomes. Competitive proposals will clearly articulate how the proposed activities scaffold to, and integrate with, the academic program(s); carefully describe methods for developing partnerships; and outline detailed models for recruitment and selection of participants.

GEOPAths: Undergraduate Preparation (UP)

GEOPAths:UP projects are focused on providing students with sustained or catalytic experiences that develop their expertise in geoscience, enhance their professional skills, increase their access to professional networks, and demonstrably deepen their interest in, and knowledge of, geoscience career pathways. Introducing students to the geosciences through extra-curricular experiential learning, internships, field excursions, service learning activities, and culturally-relevant or problem-based learning scenarios, are well-documented as successful approaches for recruitment. Increasing the number and types of opportunities that provide individual undergraduate students with authentic, career-relevant experiences – across all employment sectors – may increase both student engagement and retention in the geosciences. Many academic, private sector and government-managed facilities within the geosciences community could be leveraged to provide such experiences.

GEOPAths:UP proposals can be submitted by institutions of higher education that offer undergraduate courses or bachelor's degrees in any of the geoscience fields, with some restrictions (see eligibility criteria). *GEOPAths:UP* projects are expected to focus on the needs of individual students, primarily by offering cohort-based, extra- or co-curricular experiences that complement the submitting institution's existing curriculum. Each cohort should involve a minimum of six students per institution. Learning ecosystem models are encouraged that describe how new or existing collaborations with other academic or non-academic institutions might create opportunities that expose participating students to a variety of supportive learning or working environments, as are collaborations that engage diverse undergraduate students from local 2YR colleges and MSIs. While requests to support academic year undergraduate research as one component of a *GEOPAths:UP* project will be considered, they must not duplicate the types of undergraduate research experiences that can be supported through the International Research Experience for Students (IRES) or the Research Experiences for Undergraduates (REU) Site and Supplement program solicitations. General field courses will not be supported. However, development of new field experiences for students who are historically disadvantaged and at institutions that provide evidence of a strong commitment to continue the field course after the grant period ends will be considered.

Activities that might be supported through the *GEOPAths:UP* track include, but are not limited to, the following:

Providing students with service-learning or community-based opportunities related to the geosciences.

Establishing and conducting novel support programs aimed at retaining diverse students in geosciences.

Partnering with large research facilities, to provide students with hands-on training and experience using sophisticated geoscience instrumentation, large data sets, and/or models.

Engaging students in large, ongoing, and separately funded field-based research campaigns and subsequent data analysis and synthesis.

Creating competitions and prizes that offer capstone experiences at large or unique geoscience research facilities.

Leveraging large research infrastructure (e.g., ships, geophysical facilities) to expose students from high schools, community colleges and non-geoscience majors to geoscience content and opportunities.

Establishing new multi-year, academic-year geoscience research opportunities for cohorts of undergraduate students at the awardee institution.

Creating summer bridge programs that expose incoming undergraduate freshmen to the geosciences.

Offering accessible field research experiences for students with sensory, physical, or intellectual disabilities; this includes intentional engagement of students with "less apparent" disabilities, high functioning undergraduate students on the autism spectrum and students in STEP-like transition programs [Reference 26].

Supporting research experiences for individuals (e.g., veterans) at the undergraduate level who want to enter or re-enter the geosciences after an interruption in their academic training.

Competitive proposals submitted to this track will build on the evidence base for effective strategies for undergraduate engagement, recruitment and retention, particularly among underrepresented student populations. Similarly, they will be designed to contribute to the evidence base through formative and summative assessment and documenting the impact of the experiences on student attitudes, learning outcomes, and persistence in the pipeline. Competitive proposals will clearly articulate how the proposed activities scaffold to, and integrate with, the academic program(s); carefully describe methods for recruitment and selection of students; and, discuss professional development activities that better prepare faculty and other professional participants for their roles as mentors/supervisors.

Additionally, proposers seeking to develop institutional collaborations between two-year colleges and four-year programs that involve geoscience technician training are directed to NSF's Advanced Technological Education (ATE) program.

GEOPAths:Graduate Opportunities

GEOPAths:GO projects are expected to establish new, or strengthen existing, institutional partnerships and collaborations that provide and or improve sustainable support mechanisms for undergraduate and graduate students to transition into research or career related pathways in the geosciences. Emphasis will be on the connections between academic institutions and the private sector to support students at critical transition points as they move from baccalaureate and graduate degrees into other areas of geoscience and the geoscience workforce. *GEOPAths:GO* projects are expected to focus less on the engagement of individual students in the geosciences and focus more on implementing systemic and sustainable approaches that can increase access to geoscience training, research opportunities and skill building which can open doors to research and career pathways over time. The emphasis is on employing a learning ecosystem model to establish programs, structures, and collaborations that can have lasting impact. Providing reliable and current information about career paths and opportunities, as well as improving methods to sustain mentoring, networking, and professional development are also important strategies in helping students make the transition into research positions, careers and beyond.

Activities that might be supported through the *GEOPAths:GO* track include, but are not limited to, the following:

Creating mentored geoscience-related internships, externships, certificate or apprenticeship programs in collaboration with the private sector.

Convening small conferences or strategic planning activities to establish new organizational collaborations.

Designing and testing novel bridge programs that help post-undergraduate students from non-geoscience fields transition into geoscience graduate programs.

Creating enrichment programs that develop skills required by the evolving job market for geoscientists and increase their entry into jobs classified as geoscience.

Fostering career-aligned collaborations between academia and the local private sector or state/local government that facilitate transitions between undergraduate/graduate programs and the geoscience workforce.

Developing content for virtual research experiences that link to the evolving nature of the modern work environment.

Competitive proposals submitted to the GEOPAths:GO track will show evidence that all organizational partners are committed to and have been engaged intellectually in the design and execution of the proposed work. It is also important that proposals not only include details on the transition that the project would enhance, but also demonstrate that the proposed learning ecosystem model is also designed to foster the success of students once they transition to the new academic or professional stage. Proposals seeking funds to support an existing organizational collaboration must clearly demonstrate the effectiveness of current activities being implemented through the partnership and identify the gaps that would be addressed if additional resources were made available.

Important Note: Proposals seeking to support student transitions between Tribal Colleges and four-year geoscience degree programs should be submitted through the *Tribal Colleges and Universities Program (TCUP) Partnerships for Geoscience Education (PAGE)* track (see https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5483).

REFERENCES

[1] *Building the Future Investing in Innovation and Discovery: NSF Strategic Plan 2018-2022.* https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf18045

[2] NSF's Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES) program. https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505289

[3] National Academies of Sciences, Engineering and Medicine, Service-Learning in Undergraduate Geosciences: Proceedings of a Workshop (2017). Washington, DC: National Academies Press, https://www.nap.edu/download/24621

[4] National Research Council (2010) Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5. Washington, DC: National Academies Press, www.nap.edu/catalog.php?record_id=12999.

[5] National Research Council (2011) Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads. Washington, DC: National Academies Press, www.nap.edu/catalog.php?record_id=12984.

[6] President's Council of Advisors on Science and Technology (2012) Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics, https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf.

[7] National Research Council (2012) Discipline-based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering. Washington, DC: National Academies Press, www.nap.edu/catalog.php?record_id=13362.

[8] National Science and Technology Council, Committee on STEM Education (2018). Charting a Course for Success: America's Strategy for STEM Education. https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf .

[9] Zeigler, K., S.A. Camarota (2014) Is there a STEM worker shortage? A look at employment and wages in science, technology, engineering, and math, Center for Immigration Studies, http://cis.org/no-stem-shortage.

[10] Wilson, C. (2018) Status of the Geoscience Workforce 2018, American Geosciences Institute, https://store.americangeosciences.org/status-of-the-geoscience-workforce-report-2018-digital-edition.html .

[11] Emerging Workforce Trends in the U.S. Energy and Mining Industries: A Call to Action (2013), National Academy of Science Board on Earth Sciences and Resources, http://dels.nas.edu/Report/Report/18250.

[12] Preparing the Next Generation of Earth Scientists: An Examination of Federal Education and Training Programs (2013) National Academy of Science Board on Earth Sciences and Resources, http://dels.nas.edu/Report/Preparing-Next-Generation-Earth/18369.

[13] Mascarelli, A. (2013) Sustainability: Environmental puzzle solvers, Nature 494, 507-509. doi:10.1038/nj7438-507a. Published online February 27, 2013.

[14] Perkins, Sid (2011) Geosciences: Earth works, Nature 473, 243-244. doi:10.1038/nj7346-243a. Published online May 11, 2011.

[15] Issues Affecting the Future of the U.S. Space Science and Engineering Workforce: Interim Report (2006) http://www.nap.edu/catalog.php?record_id=11642.

[16] National Oceanic and Atmospheric Administration Strategic Human Capital Management Plan: Developing, Valuing, and Sustaining a World-Class Workforce FY 2006-FY 2011, http://www.wfm.noaa.gov/pdfs/Strategic_Human_Capital_Management_Plan.pdf.

[17] Educational Competencies for Marine Science and Technology Occupations. Marine Advanced Technology Education Center, Monterey, CA, 55 pp.; Geospatial Workforce Development White Paper (2012) National Geospatial Advisory Committee (NGAC) http://www.fgdc.gov/ngac/ngac-geospatial-workforce-development-paper-final.pdf.

[18] Workshop on "Geoscience and the 21st Century Workforce" (2013) Convened by InTeGrate, AGI, and AWG,

http://serc.carleton.edu/integrate/workshops/workforce2013/index.html.

[19] Starks, B.C. and Matthaeus, W.H (2018) STEM Recruitment and Beyond: The Messenger is the Medium, Journal of STEM Education, volume 19 (4), 27-33.

[20] Bernard, Rachel & Cooperdock, Emily. (2018). No progress on diversity in 40 years. Nature Geoscience. 11. 10.1038/s41561-018-0116-6.

[21] Wilson, C. (2016) Status of Recent Geoscience Graduates, American Geosciences Institute, https://www.americangeosciences.org/sites/default/files/ExitSurvey_2017_Online_041018.pdf.

[22] National Academy of Engineering and National Research Council report, "Community Colleges in the Evolving STEM Education Landscape: Summary of a Summit" (2102) Washington, DC: The National Academies Press.

[23] National Academies of Sciences, Engineering, and Medicine (2019) Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce. Washington, DC: National Academy Press, https://doi.org/10.17226/25257

[24] Thiry, H., T.J. Weston, S.L. Laursen, and A.B. Hunter (2012) The benefits of multi-year research experiences: Differences in novice and experienced students' reported gains from undergraduate research, CBE Life Sciences Education, 11 (Fall), 260-272.

[25] Russell, S.H., M.P. Hancock, and J. McCullough (2007) Benefits of undergraduate research experiences, Science, 316, 548-549.

[26] Atchison, C.L. and B.H. Gilley (2015) Geology for everyone: making the field accessible, Earth Magazine, https://www.earthmagazine.org/article/geology-everyone-making-field-accessible

[27] Hurtado, S., C.B. Newman, M.C. Tran, and M.J. Chang (2010) Improving the rate of success for underrepresented racial minorities in STEM fields: Insights from a national project, New Directions for Institutional Research, Volume 148, 5-15.

[28] Chang, M.J., J. Sharkness, S. Hurtado, and C.B. Newman (2014), What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups, Journal of Research in Science Teaching, volume 51 (5), 555-580.

III. AWARD INFORMATION

Regardless of which track is selected, the program expects to offer approximately 18 awards, with the average total award size expected to be in the $300,000 to $350,000 range. The duration of awards for all tracks will be up to 36 months. Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

An organization may serve as sole submitting organization or as lead organization of a collaborative project on only one submission per competition , regardless of track, but may serve as the non-lead organization of a collaborative project more than once per competition. Additional eligibility requirements are described later in the solicitation.

Potential PIs are advised to contact their institutional office of research regarding processes used to select proposals for submission.

Limit on Number of Proposals per PI or Co-PI:

A Principal Investigator may serve in the role of PI or Co-PI on only one proposal per competition if they are at the sole-submitting organization or the lead organization of a collaborative project, but may serve as the Co-PI for a non-lead organization of a collaborative project more than once per competition.

Additional Eligibility Info:

The limitation on eligible organizations noted above applies only to sole submitting organizations or lead organizations of a collaborative proposal. All other eligible organizations identified in the PAPPG are eligible to participate as the non-lead institution of a collaborative proposal. In addition, the following eligibility limitations apply:

GEOPAths:Informal Network (IN) proposals: The following institutions and organizations are eligible to submit proposals as the sole submitting organization or lead institution in a collaborative proposal:

1. Institutions of higher education (as defined in section 101 (a) of the Higher Education Act of 1965) in the United States and its territories that grant associate, baccalaureate, or graduate degrees in the disciplines listed in the National Center for Education Statistics' Classification of Instructional Programs.
2. Nonprofit, non-academic organizations (independent museums, observatories, research laboratories, professional societies and similar organizations) located in the U.S. that are directly associated with educational or research activities.

GEOPAths:Undergraduate Preparation (UP) proposals: NSF is restricting the eligibility of institutions that may serve as the sole submitting institution or the lead institution in a collaborative proposal in order to increase opportunities for smaller and/or primarily undergraduate institutions that have less access to significant Federal funding for STEM research and related infrastructure. The following institutions are eligible to submit proposals as the sole submitting organization or lead institution in a collaborative proposal:

Only institutions of higher education (as defined in section 101 (a) of the Higher Education Act of 1965) in the United States and its territories that grant associate, baccalaureate, or graduate degrees in the disciplines listed in the National Center for Education Statistics' Classification of Instructional Programs database are eligible to submit proposals, with the following restrictions: institutions identified by the Carnegie Classification in effect at the time of this solicitation's submission deadline as "Doctoral Universities: Very High Research Activity" may not serve as the lead institution and may only submit proposals as the non-lead institution of a collaborative ***GEOPAths:UP*** proposal.

GEOPAths:Graduate Opportunities (GO) proposals: The following institutions are eligible to submit proposals as the sole submitting organization or lead institution in a collaborative proposal:

Only institutions of higher education (as defined in section 101 (a) of the Higher Education Act of 1965) in the United States and its territories that grant associate, baccalaureate, or graduate degrees in the disciplines listed in the National Center for Education Statistics' Classification of Instructional Programs database are eligible to submit proposals as the sole submitting organization or lead institution in a collaborative proposal, with no restrictions on institution type.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Letters of Intent *(required)*:

Letters of Intent (submitted through FastLane) are required for all tracks. Any full proposals received for projects that did not submit a Letter of Intent by the required deadline will be returned without review. The Letter of Intent should identify the track to which the proposal is being submitted to and the name and organizations of the PI, Co-PIs and other key personnel who will be involved with the project. If the project will be leveraging a named research facility or program (e.g., NCAR, LSAMP), this facility/program should be identified. The Letter of Intent should also identify which geoscience sub-fields (e.g., oceanography) or employment sectors (e.g., mining) are being addressed, if relevant. A brief synopsis (**less than 2,500 characters**) of the project design and activities to be undertaken should be provided. If more than one Letter of Intent is received from an organization in which they are the lead of a collaborative project, they will be asked to make a decision as to which proposal will move forward. Letters of Intent are not binding but are used by NSF program staff to gauge the number of proposals likely to be submitted and to identify the types of reviewer expertise that will be required.

Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through FastLane in response to this Program Solicitation please note the conditions outlined below:

- Submission by an Authorized Organizational Representative (AOR) is required when submitting Letters of Intent.
- A Minimum of 0 and Maximum of 4 Other Senior Project Personnel are permitted
- A Minimum of 0 and Maximum of 5 Other Participating Organizations are permitted
- Submission of multiple Letters of Intent is permitted

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via FastLane or Grants.gov.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: (https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

See PAPPG Chapter II.C.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

The following requirements generally apply to all tracks. Specific requirements that are unique to one of the tracks are clearly identified.

Proposal Title : The proposal title established in FastLane should clearly indicate which track is being supported by the proposed project, using the relevant format here:

- For **GEOPAths:IN** projects, the title should read as "**GP-IN:** rest of the title…."
- For **GEOPAths:UP** projects, the title should read as "**GP-UP:** rest of the title…."
- For **GEOPAths:GO** projects, the title should read as "**GP-GO:** rest of the title…."

Project Description :

a. *Overview*. Provide a brief description of the goals and objectives of the proposed *IUSE:GEOPAths* project, the intellectual focus, organizational structure, timetable, and any participating organizations' commitment to the activity. Information should be provided about the specific student population being targeted (e.g., demographics, grade level, critical juncture), as well as a justification as to why this particular population was chosen.
b. *Institutional Profile(s)*. Provide a brief description of the submitting organization and any other organizational partners in the project. Proposals should describe the current status of undergraduate or related geoscience education, research, and/or training opportunities at each organization, including the demographics and expertise of the faculty, staff, and the number, demographics, and expertise of the undergraduate or other targeted student population participating in these geoscience opportunities. If more than one organization is involved in the project, the proposal should describe the goals of the collaboration and the anticipated outcomes for students who will benefit from that collaboration. The roles of each organization and a management plan should be clearly defined.
c. *Project Design*. Proposals should describe the specific activities that will be undertaken to achieve the goals outlined in this solicitation, appropriate for the specific track being addressed. Details on the learning ecosystem model that will be applied during the project should be discussed here.
d. *Project Personnel*. This subsection should describe any relevant experience and the record of involvement with research, training, and/or education of undergraduates, graduates, high school teachers, etc. by the PI, the faculty or other professionals who may serve as mentors for the proposed activities. The description should include information on the record of faculty/mentors in publishing work involving undergraduate and graduate authors and/or in providing professional development opportunities for student researchers/trainees. For all projects, this section should also discuss the diversity of the mentor pool; strategies for recruiting and selecting additional mentors; any training, mentoring, or monitoring that mentors have received or will receive to help them mentor students effectively during the extra- or co-curricular experience; and any plans by which mentoring relationships will be sustained after students leave the *IUSE:GEOPAths*-supported activity.

   Supplemental Documents :

e. *Participant Recruitment and Selection and Mentoring (to be uploaded as a supplemental document in FastLane)*. The overall quality of the student recruitment and selection processes and criteria will be an important element in the evaluation of *IUSE:GEOPAths* proposals. This criterion is most relevant for ***GEOPAths:UP*** projects, but will also be important for ***GEOPAths:IN and GO*** projects that are designed to engage students in specific activities. The student recruitment plan should be described with as much specificity as possible, including the types and/or names of academic institutions or other partners where students will be recruited and the efforts that will be made to attract members of traditionally excluded groups. The names of any ongoing programs to engage underrepresented minorities in STEM disciplines (e.g., LSAMP, SOARS) that may be leveraged for recruitment should be identified. The number of participants engaged in GEOPAths activities should be appropriate to the institutional or organizational setting, as well as the project design. This section should also describe the mentoring strategy for participants and specific mentoring trainings for project staff who will serve in a mentoring role.
f. *Project Evaluation and Reporting (to be uploaded as a supplemental document in FastLane)*. Each project should include a description of formative and summative evaluation activities that will be undertaken to improve implementation and document progress toward achieving major goals and objectives. This section should describe efforts to measure qualitatively and quantitatively the success of the project in achieving its goals, particularly with regard to the degree to which students have gained geoscience content knowledge and skills, have changed their perspectives and attitudes toward geoscience education and career paths, and/or have been successfully retained at critical junctures in the pathway. Evaluation may involve periodic measures throughout the project to ensure that it is progressing satisfactorily according to the project plan and may involve pre-project and post-project measures aimed at determining the degree of student learning that has been achieved. In addition, it is highly desirable to have a structured means of tracking participating students beyond graduation, with the aim of gauging the degree to which the *IUSE:GEOPAths* experience has been a lasting influence in the students' career paths. Proposers may wish to consult The 2010 User-Friendly Handbook for Project Evaluation (https://www.purdue.edu/research/docs/pdf/2010NSFuser-friendlyhandbookforprojectevaluation.pdf) for guidance on the elements in a good evaluation plan. PIs must engage specialists in program evaluation (from their organization or another one) in planning and implementing the project evaluation. Unless a case is made, it is preferable that engaged specialists are not members of the core project team (e.g., PI, CoPI, etc.).

g. *Sustainability Plan (to be uploaded as a supplemental document in FastLane)*. The proposal should describe plans for sustaining programs, activities and/or collaborations that have been developed through the project once NSF funding has ended. If the sustainability plan involves continuing organizational support, a letter of commitment from senior administration official(s) confirming that support should be included in the Supplementary Documents section of the proposal.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

It is expected that most of the funding being requested will be used to support participants or programs/mechanism/experiences that would directly impact participants. Proposers should consult with their Sponsored Research Office as to whether institutional policies require that this support be in the form of *Participant Support Costs* or through some other budget category (e.g., Salaries). Participants serve a different role on the project because their involvement is aimed at developing research skills or providing practical educational experiences.

The PI is expected to attend a meeting of *IUSE:GEOPAths* Principal Investigators during the first year of the project, likely to be held in the Washington, DC metro area, or an alternative location (e.g., professional society meeting), and should include funding to support travel and per diem for this two-day meeting in the budget.

C. Due Dates

- **Letter of Intent Due Date(s) *(required)*** (due by 5 p.m. submitter's local time):

  December 20, 2019

  November 17, 2020

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

  February 14, 2020

  January 26, 2021

D. FastLane/Research.gov/Grants.gov Requirements

For Proposals Submitted Via FastLane.gov:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: https://www.fastlane.nsf.gov/a1/newstan.htm. .html. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: https://www.grants.gov/web/grants/applicants.html. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

Proposers that submitted via FastLane may use Research.gov to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.C.2.d(i). contains additional information for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.C.2.d(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they

plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
    a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
    b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

Additional Solicitation Specific Review Criteria

- Participant Recruitment: Is the recruitment and selection process described with sufficient detail? Is the recruitment plan likely to attract a diverse population of students that would benefit from the proposed activities?
- PI Team: Does the project team have sufficient experience in supporting students in the types of activities being proposed?
- Organizational Commitment: Is organizational commitment outlined well in the proposal and is the evidence of support for the project sufficient to achieve the goals and objectives?
- Connection to Research on Geoscience Education: How well informed are the vision and execution plan by the literature and prior attempts, if applicable, to implement change. Is the expectation of success well-justified?
- Connection to Careers: Is there a sufficient connection in the proposed project to viable workforce paths in the geosciences?
- Student Recruitment/Mentoring Plan: Is there a mentoring plan in place for student participants? The plan should emphasize strategies to ensure inclusive environments, programming and experiences with a focus on retention and movement of participants to the next appropriate level of education and research acumen (including but not limited to sufficient training for faculty and staff to successfully undertake their roles as mentors and supervisors of the student participants).
- Project Evaluation and Reporting: Will the evaluation and monitoring plan provide sufficient documentation that project goals and outcomes have been realized?
- Potential for Sustainability: What is the potential for sustaining project activities and/or institutional collaborations after funding ends?

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any

reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)*; or Research Terms and Conditions* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

Special Award Conditions:

All IUSE:GEOPAths projects should expect to participate in data collection and evaluation at the level of the national program as well as at least one Principal Investigator meeting. As such, proposals should include planning for this work in management structures and in budgets.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- M. Brandon Jones, GEO/OAD, telephone: (703) 292-4713, email: mbjones@nsf.gov
- Elizabeth L. Rom, GEO/OCE & GEO/OPP, telephone: (703) 292-7709, email: elrom@nsf.gov
- Amanda (Manda) S. Adams, GEO/AGS, telephone: (703) 292-8521, email: amadams@nsf.gov
- Aisha R. Morris, GEO/EAR, telephone: (703) 292-7081, email: armorris@nsf.gov
- Keith A. Sverdrup, EHR/DUE, telephone: 703-292-4671, email: ksverdru@nsf.gov

For questions related to the use of FastLane or Research.gov, contact:

- FastLane and Research.gov Help Desk: 1-800-673-6188

  FastLane Help Desk e-mail: fastlane@nsf.gov.

  Research.gov Help Desk e-mail: rgov@nsf.gov

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

IX. OTHER INFORMATION

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF Grants Conferences. Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on NSF's website.

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at https://www.grants.gov.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.E.6 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at https://www.nsf.gov

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314

- **For General Information** (NSF Information Center)**:** (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**

  Send an e-mail to: nsfpubs@nsf.gov

  or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See System of Record Notices, NSF-50, "Principal Investigator/Proposal File and Associated Records," and NSF-51, "Reviewer/Proposal File and Associated Records." Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton
Reports Clearance Officer
Office of the General Counsel
National Science Foundation
Alexandria, VA 22314