

THE NATIONAL ECOLOGICAL OBSERVATORY NETWORK

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No MREFC funds are requested for the National Ecological Observatory Network (NEON) in the FY 2018 Request. Construction funding totals an estimated \$469.30 million, which reflects a \$35.58 million increase in the Total Project Cost (TPC) in conjunction with the change in the managing organization. The increase in the TPC is being funded via transfers of Research and Related Activities (R&RA) funds from the Directorate for Biological Sciences (BIO). Construction is expected to be complete by the spring of 2018. NEON operations and maintenance will be funded through the R&RA account.

Appropriated and Requested MREFC Funds for the National Ecological Observatory Network

(Dollars in Millions)

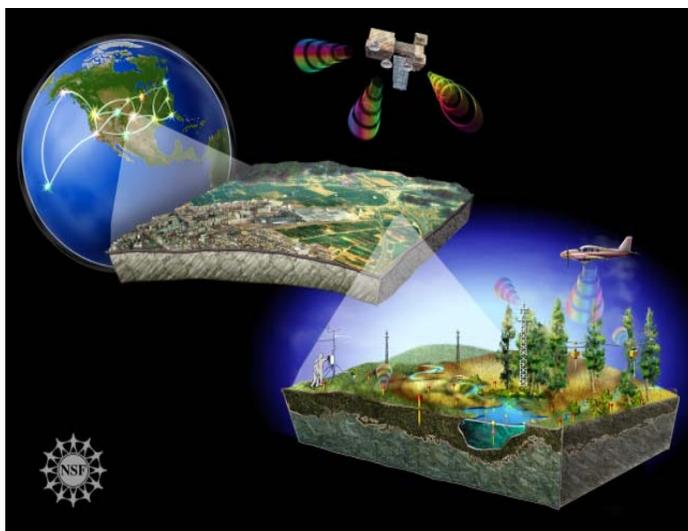
	Prior Years	FY 2012 Actual	FY 2013 Actual	FY 2014 Actual	FY 2015 Actual	FY 2016 Actual	FY 2017 Estimate	FY 2018 Request	Total Project Cost ¹
Previous Funding Profile	\$12.59	\$60.30	\$91.00	\$93.20	\$96.00	\$80.64	-	-	\$433.72
Revised Funding Profile	12.59	60.30	91.00	93.20	96.00	100.64	15.58	-	469.30
<i>Change from Previous Profile</i>	-	-	-	-	-	20.00	15.58	-	35.58

¹ In June 2016, the National Science Board (NSB) approved an increase in NEON's Total Project Cost from \$433.72 million to \$469.30 million. The \$35.58 million increase is provided through transfers from the R&RA account to the MREFC account of \$20.0 million from FY 2016 funds (completed) and up to \$15.58 million from FY 2017 funds (expected).

NEON consists of geographically distributed field and lab infrastructure networked into an integrated research platform for regional to continental scale ecological research. Cutting-edge sensor networks, instrumentation, experimental infrastructure, natural history archive facilities, and remote sensing will be linked via the internet to computational, analytical, and modeling capabilities to create NEON's integrated infrastructure.

Baseline History

In 2004, the National Research Council evaluated the original NEON design of loosely confederated observatories and recommended that it be reshaped into a single integrated platform for regional to continental scale ecological research. Congress appropriated initial funding in FY 2007. A Preliminary Design Review was completed in June 2009 and a Final Design Review (FDR) was completed in November 2009. The FDR also included a formal construction baseline review and cost review; an additional baseline review was conducted in April 2011 prior to initiation of construction that confirmed the baseline scope, cost, and schedule. Project planning continued through FY 2011 until construction began in August 2011.



NEON will be a collaborative research platform of geographically distributed infrastructure connected via the latest information technology. By combining in-situ sensing with remote sensing observations, NEON will address pressing environmental questions on regional to continental scales. *Credit: NSF.*

Major Research Equipment and Facilities Construction

Total Funding Requirements for NEON

(Dollars in Millions)

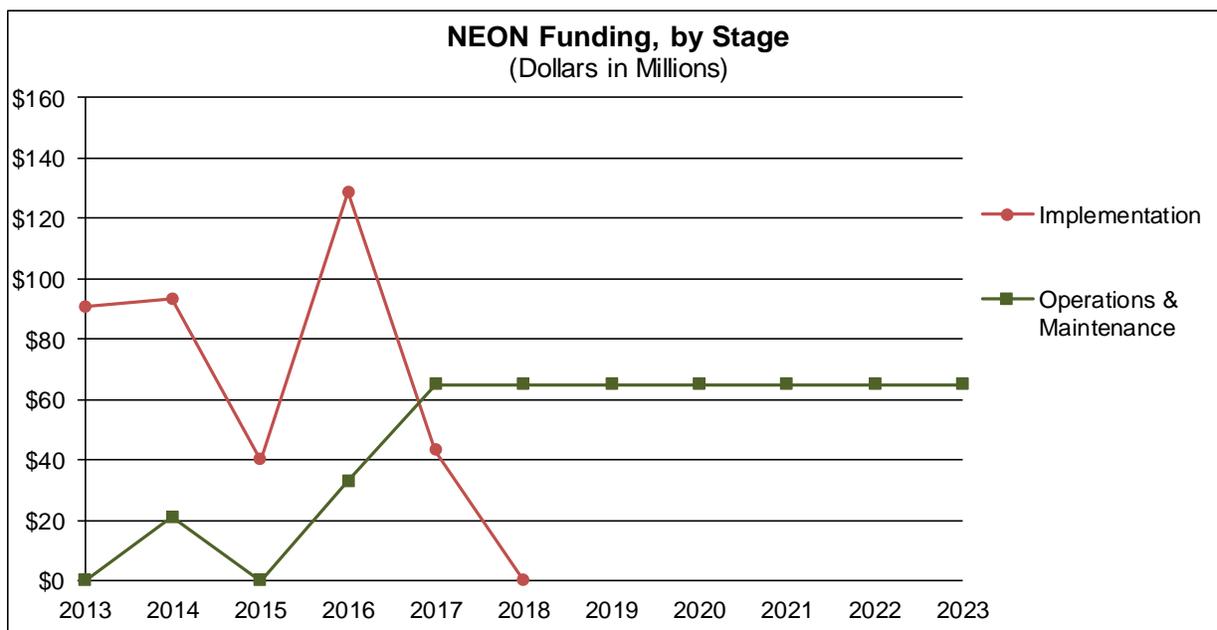
	Prior Years ¹	FY 2016 Actual	FY 2017 Estimate	FY 2018 Request	ESTIMATES				
					FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
R&RA:									
Concept & Development	\$104.85	-	-	-	-	-	-	-	-
Operations & Maintenance ^{2,3}	21.00	32.97	65.00	65.00	65.00	65.00	65.00	65.00	65.00
ARRA	9.96	-	-	-	-	-	-	-	-
Subtotal, R&RA	\$135.81	\$32.97	\$65.00	\$65.00	\$65.00	\$65.00	\$65.00	\$65.00	\$65.00
MREFC:									
Implementation ^{3,4}	296.88	128.51	43.91	-	-	-	-	-	-
TOTAL REQUIREMENTS	\$432.69	\$161.48	\$108.91	\$65.00	\$65.00	\$65.00	\$65.00	\$65.00	\$65.00

¹ Concept & Development funding and Implementation funding are cumulative of all prior years; Operations & Maintenance (O&M) funding reflects prior year actual obligations only.

² Funding for O&M is currently capped at \$65.0 million per year for planning purposes, pending the results from an initial period of operations under Battelle management. Future O&M requests will be based on a more thorough analysis of science capabilities and affordability.

³ Consistent with revised TPC plans, \$20.0 million of FY 2016 R&RA appropriated funding was transferred to the MREFC account and carried forward into FY 2017. Up to \$15.58 million of FY 2017 R&RA requested funding is expected to be transferred into the MREFC account.

⁴ \$56.0 million of FY 2015 MREFC funding for NEON was carried over into FY 2016. A total of \$28.41 million of FY 2016 MREFC funding was carried over into FY 2017 of which \$8.40 million is being held as part of NSF's strengthened oversight of budget contingency as well as NSF-held management reserve. These funds will be made available to the project based on bona fide need and recipient performance.



Note: In FY 2016, \$20.0 million was transferred from the R&RA account to the MREFC account for NEON Implementation. In FY 2017, a transfer of up to \$15.58 million from the R&RA account to the MREFC account is expected.

MREFC Project Plan

NEON is the first research platform and the only national experimental facility specifically designed to collect consistent and standardized sensor and biological measurements across 81 sites nationwide; reduced from 106 sites following NSF's decision in FY 2015 to de-scope the project in order to prevent a potential \$80.0 million cost overrun. Measurements will enable basic research on complex phenomena driving ecological change and at the scales appropriate for studying many grand challenge questions in ecology.

NEON allows researchers to expand the scale of their research to understand continental-scale dynamics affecting ecosystems.

A NEON cyberinfrastructure gateway provides resources to support formal and informal public education and provide opportunities for citizens to participate in scientific investigations. NEON data is open-access via web portals and available as soon as possible, once basic quality assurance and quality control procedures have been applied. Private organizations including the Heinz Center, National Geographic Society, Nature Serve, and the Ecological Society of America are assisting Battelle Memorial Institute, Inc. to broaden the impact of NEON science and education to the next generation of scientists and educators.

The 2009 United States Global Change Research Program assessments⁴ indicate that U.S. ecosystems will experience abrupt and unpredictable changes from a suite of human-driven processes in the near future. NEON enables research on the impacts of climate and land use change, water use, and invasive species on the Nation's living ecosystems at temporal and spatial scales that are relevant to human well-being. NEON's unique statistically-determined, continental-scale design, with data products, data management, and standardization supports research on the dynamics of complex coupled systems needed for modeling and understanding rates of change on regional and continental scales. No other standalone system – federal or private – can provide the scientifically validated suite of data measurements that NEON will provide.

The scientific techniques, sensor data, and basic research knowledge gained through NEON will inform federal resource management decisions necessitated by climate and land use change, water use, and invasive species. They will contribute to societal benefits as identified by the 2014 U.S. National Plan for Civil Earth Observations⁵ and the international Group on Earth Observations 2005 Framework Document.⁶ The science that NEON supports is not bound by national boundaries, with regard to environmental change, invasive species, and the ecological processes they affect. The repurposing of NEON data and information and establishing interoperability among all earth observations is important to enable the research on continental to global scales. Domestic and international memorandums of understanding focus on meeting NEON's Strategic Plan and the U.S. National Plan for Civil Earth Observations² both of which call for strengthening international collaboration in earth observations, and to improve data access, management, and interoperability. Formal agreements have been signed with the European Union, including the Integrated Carbon Observing System (ICOS) Ecosystem Thematic Center, Infrastructure for Analysis and Experimentation on Ecosystems (AnaEE), Czech Climate Change Research Center (CzechGlobe), and Australia's Terrestrial Ecosystem Research Network (TERN). Areas of coordination include planning, design, construction, deployment, environmental assessment, data management, geospatial data exchange, cyberinfrastructure, research, and modeling.

Management and Oversight

- NSF Structure: The NEON program is managed by the Division of Biological Infrastructure (DBI) within BIO. Managing the NEON program in DBI helps foster its associations with other BIO facilities and infrastructure investments and its connections to broader biological and interdisciplinary science activities. Within BIO/DBI, a Science Advisor (working with the Deputy Division Director) provides

⁴ Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (Eds.). (2009). *Global Climate Change Impacts in the United States*. Retrieved from <https://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf>

⁵ The U.S. National Plan, states '...to coordinate, plan, and assess Federal Earth observation activities in cooperation with domestic stakeholders; to foster improved Earth system data management and interoperability throughout the Federal Government; and to engage international stakeholders by formulating the U.S. position for, and coordinating U.S. participation in the intergovernmental Group on Earth Observations.' National Science and Technology Council, Executive Office of the President. (2014). *National Plan for Civil Earth Observations*. (p. 71). Retrieved from www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/2014_national_plan_for_civil_earth_observations.pdf

⁶ Group on Earth Observations. (2005, February). *Global Earth Observation System of Systems (GEOSS): 10-Year Implementation Plan*. Retrieved from www.earthobservations.org/documents/10-Year%20Plan%20Reference%20Document.pdf

overall programmatic oversight for BIO's mid- and large-scale research infrastructure, while the day-to-day program management is done by dedicated cognizant program officers with assistance from a program manager experienced with other MREFC projects. The cognizant program officers for construction and operations coordinate the direct oversight of NEON construction, operations and maintenance, and science utilization. An NSF Integrated Project Team (IPT) chaired by the NEON program officers, with representatives from the Office of Budget, Finance, and Award Management which includes the Large Facility Office, the Office of Legislative and Public Affairs, the Office of the Director, and program representatives from other NSF large facilities, helps ensure coordinated agency oversight to the project. The Office of the General Counsel provides ongoing technical advice on the National Environmental Policy Act (NEPA) compliance and NSF environmental policy and also has representation on the IPT.

- External Structure: NEON, Inc., the company previously managing the NEON project, was notified in December 2015 of NSF's intent to transfer responsibility for construction and initial operations to a new management entity. In 2016, NSF used an expedited process to select a new managing entity for the NEON construction and initial observatory operations. As of June 2016, the NEON project is now fully managed by Battelle Memorial Institute, Inc. (Battelle), a non-profit, membership-governed corporation with extensive experience managing large research projects, government contracts, and related activities.

Reviews

- Technical reviews: The NEON Observatory Design Review (including site selection and deployment design) was successfully completed in February 2009.
- Environmental review: The NEPA environmental assessment was completed in November 2009. NSF signed a "Finding of No Significant Impact" in December 2009; the U.S. Fish and Wildlife Service concurred with this finding, as well as with NSF's compliance with the Endangered Species Act. In July 2011, the NSF Record of Decision was signed.
- NSF conducted a Readiness Review to assess Battelle's competence to assume management of the NEON project in June of 2016.
- Construction, Cost, and Schedule reviews:
 - A third Baseline Review was held in August 2014 to evaluate re-planned schedule and cost.
 - NEON, Inc. was notified in May 2015 of non-compliance with terms and conditions of the cooperative support agreement, NSF's concerns over increasing schedule slippage, required delivery of a new estimate to complete the project, and NSF's intent to conduct strategic assistive site visits.
 - In June 2015 the NEON, Inc. estimate to complete included a projected cost overrun of \$80.0 million above the approved budget. A baseline Re-Scope Review was held in July 2015 to assess reductions in scope to bring the costs within the approved budget in accordance with NSF's "No Cost Overrun" policy.
 - In July 2015, NSF directed NEON, Inc. to reduce the project scope and deliver revised project documents, construction schedule, and cost proposal to reflect the scope reduction.
 - A revised proposal was submitted December 2015 which indicated the potential for an additional \$19 million cost overrun and further schedule slip leading NSF to make its decision to transfer management responsibility.
 - An independent cost estimate (ICE) was obtained by NSF to support its internal cost analysis and award to the new managing organization.
 - In June 2016 NSF conducted a site visit in order to review Battelle's readiness to assume full responsibility for the remaining construction and initial operations of the NEON Observatory.
 - A Construction and Transition to Operations Review will be conducted in 2017.
- National Science Board (NSB) Review: The NSB reviewed and authorized NEON construction in May 2010 and authorized initial NEON Operations and Maintenance (O&M) in February 2013. In

September 2015, it established an ad hoc Task Force on NEON Performance and Plans to review and monitor NSF's oversight of the project. In 2016, after review of a new construction cost proposal (including the ICE), Battelle's successful management of the project to-date, and the remaining project risks, the NSB authorized an increase in the total project cost from \$433.72 million to \$469.30 million.

- Management, Business, and Operations Reviews:
 - NSF conducted a Business Systems Review and issued a final report in November 2011.
 - An Operations Review of the project's operating plan and costs for the first three years of operations was held in January 2012.
 - Beginning in May 2015, NSF has conducted a series of site visits to work with NEON, Inc., on improving business systems including reporting capabilities, cost sufficiency and estimation, and supply chain issues including procurement and contracting.
 - Delays in construction have impacted rollout of operations by one year. With the transition to Battelle, an extension of the initial operations award is anticipated to allow the project to stabilize. A focused, external review of annual operations costs is planned for March 2017. A pre-award cost review prior to full observatory operations funding is expected in FY 2018.
 - Annual Operations Reviews will continue once construction is complete.

Project Status

Eighty-five percent of the Observatory research capabilities have been achieved with one hundred percent capability planned to be completed by the spring of 2018. This includes construction for the remaining terrestrial locations, aquatic sites, and airborne observation platforms (AOP).

In FY 2017, MREFC funds will support completion of the NEON cyberinfrastructure hardware and software deployments for various sites as well as domain facilities acceptance. This includes completion of the management system for assets, configuration, inventory, and data algorithms and related data release via NEON's web portal.

Scope Management and De-scoping: Delays in permitting of selected sites, cyberinfrastructure development, and procurements signaled the potential for significant construction cost overruns. Estimates received in June 2015 prompted NSF to assemble leaders from the science community to assess possible scoping strategies for maintaining the project with the approved budget in accordance with NSF's no cost overrun policy. A major objective of the meeting was to ensure the delivered Observatory would still enable the transformative regional to continental science as framed in the original NEON Science Strategy. This decision to de-scope was confirmed by the NSF/BIO Advisory Committee. De-scoping decisions were finalized and implemented in late July 2015.

For FY 2017, \$65.0 million was requested from the R&RA account to support initial operations and maintenance. This represents the final increment from the original three-year O&M award as well as a partial increment for a proposed two-year extension while future costs are evaluated by NSF. The additional two years in O&M will allow time for a more complete understanding of the science capabilities and costs proposed, identification of management efficiencies under Battelle, and to prepare for a re-competition for a longer term award. This includes management and technical support, seasonal biological sampling, analytical and archival costs, and domain facilities cost. Funds will also support the calibration and validation laboratories and headquarters functions, such as maintenance of the data center, Observatory monitoring, quality assurance and control, and O&M of the AOP.

In FY 2018, NSF will explore options for O&M of the full NEON Observatory after construction. As noted above, NSF expects to extend the initial operations award that began in FY 2014 for 24 months to allow Battelle time to identify project efficiencies, minimize costs, and maximize science delivery. Final costs for observatory O&M will be determined on the basis of these management efforts and analyses.

Cost and Schedule

The original projected length of the construction stage was six fiscal years, with six-months of schedule contingency included. Project performance under NEON, Inc., was running well behind the original plan. Under Battelle's management, the planned project end date has shifted back to mid-FY 2018 and the TPC has been re-established as described above. Roughly 80 percent of the approved project funds for construction have been spent, with Observatory capability at approximately 85 percent complete. Focused management by Battelle and oversight by NSF is now required to remain within budget and on schedule.

Risks

Technical: While the bulk of NEON's infrastructure and instrumentation will be "commercial off-the-shelf," NEON's scientific and networking design required certain technological innovations for a small number of components. Consequently, BIO has provided R&RA funds for advanced research and development activities in the areas of sensors, cyberinfrastructure, and remote sensing technology. These development activities are progressing and risks to schedule are being monitored. Technical risk is considered low at this point in construction. The remaining technical hurdle is deployment of the cyberinfrastructure architecture for full integration of the NEON observatory sites and mobile platforms for delivery of data to the science community.

Deployment: Environmental assessment and permitting continues to have a potential impact on schedule. Risk mitigation strategies include the direct contracting of the environmental assessments by NSF, the hiring of experienced, national firms by Battelle for engineering and permitting, and the identification of alternative sites if primary sites still hold significant risk. The selection of alternative sites for other high-risk sites is nearing completion and environmental compliance activities are actively underway.

Management: Management risk has been partially mitigated by NSF based on the decision to replace NEON, Inc. with Battelle. The transition to new management is an inherently risky proposition but was necessary in this case. Battelle continues to work closely with NSF oversight personnel to clearly communicate process, standards, timelines, costs, and expectations.

Future Operations Costs

NEON is the first research observatory that will maintain and operate in-situ instrumentation and conduct biological sampling in 20 domains (81 locations) including three airborne observatories, a central operating facility, and a cyberinfrastructure center. Field support will be provided to monitor the sensors, and receive, process, and archive data from all measurement systems. NEON operations include significant labor costs due to the manual processes still required for biological sampling and data collection in some fields. NEON is reliant on sensors and cyberinfrastructure that have a defined lifecycle, so operations costs include scheduled replacement and refreshing of sensor, instrumentation, and cyberinfrastructure technology. Operations activities and associated costs will ramp up as sites are commissioned. Battelle is accelerating the transition of infrastructure to operations whenever possible to appropriately manage construction costs.

A three-year initial award for O&M began September 2014 to allow NEON, Inc. to explore opportunities for schedule and cost efficiencies and provide a basis for funding the full Observatory operations during out-years. The delay in construction has extended this activity from FY 2016 through early FY 2018. An extension of the initial operating period through FY 2019 is now planned under Battelle to allow the project to stabilize. For FY 2018, O&M costs are capped at \$65.0 million for planning purposes with final costs to be determined after Battelle's assessment of management efforts and analyses.