Written Testimony of Dr. Anthony Beasley, Chief Operating Officer and Project Manager, National Ecological Observatory Network (NEON), Inc. before the UNITED STATES HOUSE OF REPRESENTATIVES Subcommittee on Research and Science Education hearing entitled "NSF Major Research Equipment and Facilities Management: Ensuring Fiscal Responsibility and Accountability", March 08, 2012.

Chairman Brooks, Ranking member Lipinski, and distinguished members of the Subcommittee, thank you for the opportunity to testify. My name is Dr. Tony Beasley, and I am Project Manager for the National Ecological Observatory Network (NEON), and Chief Operating Officer of NEON, Inc. I appreciate the opportunity to provide you an overview of the NEON MREFC Project from its inception to the construction underway today. My written testimony specifically addresses questions about NEON and the National Science Foundation Major Research Equipment and Facilities program directed to me by the committee, with a few general observations on the issues included.

I would like to begin with an introduction to the scientific motivation for NEON. Living systems are experiencing some of the greatest rates of change in the history of life on Earth. A suite of human-driven processes (climate and land use change, invasive species) are collectively affecting living systems by altering the fundamental relationships between life and the non-living environment that sustains it. Our current understanding of these changes is based on knowledge obtained either from small plot (less than 1 hectare) research, operational monitoring and assessments, or from satellite-scale remote sensing. The basic scientific knowledge needed to understand the biosphere at human scales (regional to continental scales), to quantify the strong and weak forces regulating the biosphere, and to predict the consequences of climate and land use change on living systems cannot be extrapolated from studies at these extreme scales.

NEON was designed by the ecological research community to address this gap in hypothesis-driven research capability – functioning as a fully integrated, multi-scale sensor to detect, understand, and forecast changes in the biosphere at regional to continental scales. The scientific and technical requirements that led to the Observatory's design were specifically derived to address these fundamental hypothesis driven questions about the forces driving biosphere change while concurrently assessing the biosphere responses and feedbacks. The NEON experimental design calls for in-situ infrastructure that will measure drivers and biological responses at the meter scale, couple these to simultaneous biological/physical measurements at the meter to kilometer scale (i.e., airborne remote sensing), and join these estimates to biological/physical measurements at multiple kilometer scale (i.e., satellite remote sensing). It is the coupling across scales that provides the unique capability required to understand the multi-scale processes driving living systems and evaluate the fundamental theories of how living systems operate, respond, and adapt. The sensitivity and ability of the Observatory to address the fundamental theories derives from the scientific and statistical underpinnings of the infrastructure deployment and integration via cyberinfrastructure into a single in situ sensor of the biosphere. Testing these theories about the biosphere cannot be accomplished by only integrating data from existing monitoring networks, infrastructure, assessments, or remote sensing.

I will now specifically address the following questions received from the Subcommittee:

How and why was NEON identified and selected as a worthy large facilities construction project?

All NSF large facilities projects arise initially from analysis and collaboration in the research community to identify important scientific opportunities that might best be addressed by a new large-scale facility. The overarching scientific motivation for NEON is discussed above; in 1998, the National Science Board's Task Force on the Environment (TFE) identified NEON as a potential large-infrastructure project. Subsequently, there were NSF-funded workshops organized by the research community to further explore the needs of such an infrastructure. In addition, the NSB TFE held a public hearing, a symposium, and a town hall at various locations throughout the country. These community engagement activities informed the NSB's decision to qualify NEON as a potential MREFC project in August 1999. In 2003, a National Academy of Sciences study "NEON: Addressing the Nation's Environmental Challenges" was completed, recommending the establishment of a national observatory.

Following these recommendations, proposals for design and development efforts were requested and awarded by NSF, and work began in the research community and at NSF to define the facility. In 2006, a Conceptual Design Review for NEON took place, followed by a Preliminary Design Review in mid 2009 and Final Design Review in late 2010. All these reviews were successful and indicated a facility ready for consideration. Subsequently, the National Science Board approved NEON Construction in May 2010, and upon enactment of the requisite appropriations and concurrence by Congress, NSF awarded construction funding in August 2011.

What was the MREFC approval process experience for NEON?

The approval process included mandatory NSF-organized reviews as required by the NSF Large Facilities Office Manual for MREFC projects (NSF 07-38), including Conceptual, Preliminary and Final Design Reviews. In addition, a NSF-led Blue Ribbon Science Review of NEON was held in February 2009. Based on the recommendations from NSF review panels and significant input from the research community, NEON identified areas of risk that required an active risk-retirement strategy and conducted its own prototyping and reviews, and in some cases, commissioned external expert groups to address identified risks. In total, between late 2006 and early 2010, more than sixteen separate major reviews of NEON design, project structure and planning took place, involving more than a hundred scientists, engineers, project managers and administrators from the research and facility communities in assessing NEON's plans. The result of this input was to improve and refine the design of the facility, to reinforce and guide best practices in project management and planning, and to ensure NEON was being implemented as an engineering-oriented initiative which would be built on the basis of measurable and incremental

progress. This process engendered an outcome and deliverable-oriented culture that aligned with the major approval stages required of any such large project.

The design/development and MREFC approval efforts were significant and important. Producing a facility design which would meet the science requirements that initiated the program, and a project plan including a credible budget and schedule for construction in a safe and cost-effective way, was an important requirement for both the NSF and NEON, Inc.

How do you work with NSF to ensure that the American taxpayer is getting a return on this investment?

At the program level, NSF is cognizant of the need to establish a clear linkage between fundamental research and societal needs and has reinforced that attitude with the NEON development team. To this end, NSF has established formal relationships with other Federal agencies via Memoranda of Understanding that include stipulations on potential collaborative activities based on NEON. Two examples are highlighted: an MOU between NSF and the United States Geological Survey and another between NSF and the United States Environmental Protection Agency. NEON utilizes these relationships established by NSF as a framework for structuring our interactions with executive and middle-level Federal science managers. We do this in order to identify opportunities for using NEON data and information for resource management and other relevant purposes. These types of interactions are also facilitated by NSF's interagency forums that highlight NEON's complementarity with initiatives undertaken by other Federal agencies. Avoiding duplication of effort or waste by coordinating efforts with other agencies has been a priority during NEON design and development.

At the project level, daily-weekly interactions with the NSF reporting progress, issues and opportunities are used to guide development, and formal monthly reporting allows performance monitoring. Annual reviews of project progress by external experts are mandated; during these reviews, performance of the project is examined to ensure that resources are being used effectively, progress is on track, risks are being monitored, etc. During facility design, appropriate design practices to minimize cost and environmental impact were followed, and some consideration of the life-cycle costs were undertaken, e.g., designing the facility to lower long-term operating costs.

What were the strengths and weaknesses of the process?

The NSF MREFC process has become a well-defined framework within which a project can be conceived, designed, planned, reviewed and constructed. The general approach used is highly consistent with similar processes used by the Department of Energy, NASA and other large organizations to construct major facilities and experiments. The documentation and other data deliverables required as part of the process provide key stakeholders (e.g., the design/development team, the NSF, Congress and taxpayers) with objective information about the facility's plans and progress, and there are many evaluation points

and gates for the program to pass through before construction funding is awarded. This is done to ensure the best possible scientific return for the research dollars invested, and provide opportunities for oversight to ensure that cost-effective progress is being made. Both at the project level and at the NSF, regular evaluations of the processes are conducted to seek improvements.

I have some familiarity with the management processes that are used by similar science organizations in other countries (e.g., CSIRO in Australia and the STFC in the United Kingdom), and it is my opinion that the MREFC process in use by NSF is typically more rigorous and more effective (in an administrative sense) than the processes used for facility construction in those countries. It has engendered a professional project management mindset in the scientific community which was less obvious before the NSF Large Facilities Office began the early 2000s.

I cannot identify major intrinsic weaknesses in the process; it is a reasonable framework, in my opinion. Individual outcomes in the process will vary; facility projects sit differently inside the framework, and are subject to different risks and sensitivities to external circumstances. It could be that further development of the MREFC process to address project-to-project differences could provide better interface performance between NSF and the projects, addressing issues more readily. It is generally the case that funding a project more slowly than originally planned over a series of years will lead to "marching army" and other increases in the total cost of a project, and careful planning and negotiation between the project, NSF and Congress is required to avoid these issues.

The scale of scientific research (and therefore the facilities to address the burning issues) has grown rapidly over the past two decades, and it is increasingly apparent that large international facilities may be the only way to address the important scientific issues of tomorrow. Successfully merging national facility development processes like the MREFC framework with those used by foreign partners to produce effective international collaborations has been, and will continue to be, a challenge. The Large Facilities Office has recently spearheaded an effort to improve community understanding of those challenges and gather input on how to address them; over time, I expect that the MREFC processes will be expanded and refined to include clear interfaces to international analogs.

What have been the biggest challenges you have faced with the project thus far and how were they rectified?

During my time with NEON, the initial challenge faced was to help our scientists understand the formal project management techniques needed to produce a facility design and operations model on the scale being considered, and understand the importance of a systems engineering approach to development. Formal and informal training helped address this concern, including attendance at the "Large Facilities" and "Project Science" Workshops supported by the NSF.

As an ecological observatory with multiple sites, environmental review and permitting were significant challenges identified as a risk to the development schedule during our early reviews. We responded by

significantly increasing staff in this area, and expanding our outreach and coordination efforts both with the land owners (including federal agencies) and the research community.

How is NEON currently managed?

The NEON construction project is managed by NEON, Inc. under a cooperative agreement with the NSF. NEON, Inc. is a non-profit 501(c)(3) company established to undertake the design, development and construction of the NEON facility. NEON, Inc. is a membership organization, comprised of more than 55 university and commercial partners interested in the facility. A Board of Directors elected from the member institutions and from the broader community provides oversight. The Chief Executive Officer of NEON, Inc. is the Principal Investigator on the NSF NEON award. A NEON Project Director and Project Manager (reporting to the NEON, Inc. CEO) manage the day-to-day operations of the construction project. In the next year, a NEON Observatory Director will be hired to oversee the facility operations.

What are the roles and responsibilities of the facility staff and the roles and responsibilities of NSF in the management and oversight of NEON?

Organization of the NEON construction project under the Project Director and Project Manager includes a team of senior managers responsible for key deliverables to the facility (for example, Civil Construction, Computing, Science, Systems Engineering, Safety). NEON, Inc. managers and staff are responsible for the safe, cost effective, timely and high-quality completion of tasks and deliverables associated with the construction and operations of the facility. NEON managers oversee progress, and quantitatively report progress and issues to the Project Manager, who integrates the information and reports to the NEON Project Director, NEON, Inc. Board and the National Science Foundation on a regular basis. I personally aim at a “no surprises, keep informed” relationship with NSF.

Under the cooperative agreement in place with the NSF, significant reporting and change request requirements are in place and being followed. Progress reporting and issue management takes place between the project and key NSF officials (including the BIO Directorate Program Officer and the Large Facilities Office) on a daily-weekly basis, with monthly formal reporting. NEON has a clear responsibility to communicate fully with and request approval from NSF in a wide variety of circumstances. NSF reviews NEON planning, monitors NEON progress, and continuously assesses and advises on management practices and interactions with the research community.

How is the entire life cycle of the project, including management and operations after construction, taken into account in the management and oversight of NEON?

An important deliverable of the MREFC-process Preliminary Design Review is an Operations Plan for the facility under consideration. This plan includes information and estimates concerning the facility

research objectives and products, management structure, planning assumptions, staffing and annual operating costs, risks and interfaces to the research community,. The Operations Plan is reviewed in detail at both the Preliminary and Final Design Reviews, and the maturity of planning and the cost estimate for operations are an important consideration for both the National Science Board and the NSF when approving the facility to move forward into the MREFC queue. In addition to these construction-level reviews, an independent NSF-led Operations Review is mandated to carefully examine the facility operations definition, and ensure safe, cost-effective and high-quality scientific operation of the facility.

One important area examined by the MREFC process is the transition between construction and operations. The nature of this transition varies widely between facilities (e.g. a telescope which is ultimately fully assembled and begins observation at a given time versus a distributed infrastructure like NEON which has substantial components in full operation while other components are still under construction). Minimizing the costs associated with the transition is a particular area of focus in the MREFC process.

Mr. Chairman and Members of the Subcommittee, thank you once again for the opportunity to testify about the National Ecological Observatory Network. I would be happy discuss any issues the Subcommittee may wish to explore with respect to the NSF MREFC process and NEON.

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SUMMARY

- The National Ecological Observatory Network (NEON) construction project began in 2011, as part of the National Science Foundation (NSF) Major Research Equipment & Facilities Construction (MREFC) program. The scientific motivation for NEON arose from the research community in the late 1990s, and the specific design for NEON and plans for operation of the facility were developed in collaboration with the community over the past several years.

- During 2006-2011 NEON followed all required MREFC processes, refining and improving the definition of the program. Expert reviews of all aspects of NEON planning and documentation provided important information to assessment of the facility plans.

- Important challenges faced by NEON include leading the exploration of new technologies and collaboration styles to the ecological community, and the permitting of the field infrastructure sites.

- NEON management is focused on safe and cost-effective execution of the construction program, and providing the NSF and all stakeholders with the information needed to understand project status in a timely and effective manner. NEON management works closely with NSF to stay informed about related activities in other Federal agencies to maximize the utility of the planned infrastructure.

- A detailed Operations Plan is reviewed at both the mandated Preliminary and Final Design reviews. Maturity of planning and the cost estimate for operations are important considerations for both the National Science Board and the NSF when approving the facility to move forward into the MREFC queue.

- Future improvement of the MREFC process may involve consideration of international collaboration complexities and interfaces.