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March 20, 2017

Dr. J. Stephen Binkley
Acting Director
Office of Science
U.S. Department of Energy
1000 Independence Avenue
Washington, D.C. 20585

Dear Dr. Binkley:

On behalf of the Basic Energy Sciences Advisory Committee (BESAC), I am forwarding to you the report of the 2016 Committee of Visitors (COV) for the Office of Workforce Development for Teachers and Scientists (WDTS). The COV met for three days in December 2016 to address the efficacy and quality of the processes used to solicit, review, recommend, monitor, and document application, proposal, and award actions and the quality of the resulting portfolio. Dr. Gordon Brown of Stanford University chaired this committee.

The recommendations of the COV and the contents of this report were unanimously accepted and endorsed by the members of BESAC at our February 2017 meeting.

I would like to thank you for the opportunity to involve BESAC in this very important review process.

Sincerely,

John C Hemminger

Digitally signed by John C. Hemminger
DN: cn=John C. Hemminger, o=UC Irvine, ou=Department of Chemistry, email=jchemmin@uci.edu, c=US
Date: 2017.03.19 20:29:51 -07'00'

John C. Hemminger
Chair
Basic Energy Sciences Advisory Committee

Enclosure

cc: Gordon Brown, Stanford University
Harriet Kung, SC-22
Katie Runkles, SC-22

Final Report of the 2016 Committee of Visitors of the Department of Energy Office of Workforce Development for Teachers and Scientists (WDTS)

December 6-8, 2016

Executive Summary

A Committee of Visitors (COV) review of the Office of Workforce Development for Teachers and Scientists (WDTS) of the DOE Office of Science was undertaken on December 6-8, 2016 at DOE Headquarters in Germantown, MD. The mission of WDTS is *"to help develop the next generation of scientists and engineers to support Department missions, administer its programs, and conduct research that will realize the nation's science and innovation agenda"* (from the DOE Strategic Plan, May 2011).

The 2016 WDTS COV was charged by BESAC Chair John C. Hemminger with assessing (1) the efficacy and quality of the processes used to solicit, review, recommend, monitor, and document application, proposal, and award actions, and (2) the quality of the resulting portfolio, including its breadth and depth and its national and international standing in the following National Laboratory-based programs:

(1) Science Undergraduate Laboratory Internship (SULI) Program
(2) Community College Internship (CCI) Program
(3) Visiting Faculty Program (VFP)
(4) Office of Science Graduate Student Research (SCGSR) Program

These four programs account for about 70% of the WDTS annual budget (~$20M) and involve about 1,100 participants annually. Because much of the systematic data needed to evaluate the effectiveness of these four programs is currently being organized in digital form using a recently developed interactive management software system (WDTS Application and Review System - WARS), the 2016 COV review was primarily a "process evaluation" rather than an "outcome evaluation".

In addition, we were asked to comment on the changes that have taken place since the 2010 COV review, the new directions of WDTS, including development and implementation of an integrated on-line application, review, evaluation, and data management system, and the new operational baselines established for the four Laboratory-based WDTS programs listed above.

The COV members listed below were selected by Chair Gordon E. Brown, Jr. for their technical expertise in areas relevant to the mission of the DOE Office of Science, for their experience in STEM-related education, and for their many years of experience in both research university and National Laboratory settings.

COV Members

Dr. Gordon E. Brown, Jr. (Chair), D.W. Kirby Professor of Geological Sciences in the School of Earth, Energy & Environmental Sciences, Stanford University, Stanford, CA; Professor of Photon Science, SLAC National Accelerator Laboratory, Menlo Park, CA

Dr. Vicki H. Grassian, Distinguished Professor and Distinguished Chair of Physical Chemistry, Departments of Chemistry & Biochemistry, Nanoengineering, and Scripps Institution of Oceanography and Associate Dean, Division of Physical Sciences, U.C. San Diego, La Jolla, CA

Dr. Stephen T. Pratt, Senior Chemist and Leader of the Gas-Phase Chemical Dynamics Group, Chemical Sciences and Engineering Division, Argonne National Laboratory, Argonne, IL

Dr. Nancy L. Ross, Professor and Head of the Department of Geosciences, Virginia Tech, Blacksburg, VA

Dr. Nan N. Sauer, Associate Director for Chemistry, Life, and Earth Sciences, Los Alamos National Laboratory, Los Alamos, NM

The mission of WDTS continues to be vitally important as major demographic changes in the workforce will take place over the next 10-15 years that will impact the DOE complex. There will be key retirements and an overturn of the workforce in skilled positions throughout the government Laboratories. Efforts to recruit and train a future workforce must reflect the changes in the ethnic composition of the workforce that will vary substantially by region of the country.

Since the 2010 COV review, WDTS has successfully implemented most of the recommendations made by that committee. With the addition of three new Ph.D.-level staff positions and the development of the WARS online management system, WDTS is on a strong trajectory to make the program stronger and to gather the data needed to access the impact of the program, with the recognition that the timescale for assessment will range from years (VFP, CCI, and SCGSR) to decades (SULI). Another positive step is the enhanced communication among the DOE Laboratories that form the core of the WDTS program and which show a great range in geographical location and size. WDTS should be encouraged to leverage their outreach efforts with the workforce development and outreach activities at the Laboratories. This effort should be closely coordinated with the Laboratory Education Directors, who expressed very strong satisfaction with the WDTS management team and programs as part of the 2016 COV review.

The COV reached a number of important conclusions about the WDTS programs it reviewed and has offered a number of recommendations in this report (see pages 15-17) for improving the undergraduate intern, visiting faculty, and graduate student research programs. ***One of our major recommendations is to increase the number of participants in the SULI, CCI, and VFP programs. This will require an increase in the FY 2018 budget as well as in future budgets, which we strongly support.*** Our discussions with Laboratory Education Directors from six of the National Laboratories participating in these programs indicate that these (and potentially other) National Labs have the capacity to increase the number of participants in these programs. ***The COV also strongly recommends extending the SCGSR program period to better match a typical Ph.D. timescale (3-5 years). In addition, the COV urges WDTS to consider the suggestion by the LEDs that the outcomes of the VFP might be significantly enhanced by extending the allowable term of these appointments. The COV also recommends the development of a SULI-like program for early Ph.D./M.S. students that would be combined with the existing SULI program. We further recommend that the name of this expanded program be changed from Science Undergraduate Laboratory Internship to Science Laboratory Internship (SLI).***

Based on our detailed review of the four major Laboratory-based WDTS programs, the COV ranks two of the programs (SULI and SCGSR) as Excellent, and two of the programs (CCI and VFP) as Very Good with the potential to be Excellent. Our rankings indicate that the processes used to solicit, review, recommend, monitor, and document application, proposal, and award actions in two of the four WDTS programs (SULI and SCGSR) and the quality of the resulting WDTS program portfolios are judged to be Excellent. The other two programs (CCI and VFP) could be improved in various ways as indicated by the recommendations of the COV.

Although the COV recognizes that there may be constraints that limit the ability of WDTS to increase diversity among program *participants* directly, one way to address this goal would be to increase the diversity in the *applicant* pools. This goal could be accomplished by increasing awareness of WDTS programs at historically minority colleges, or smaller colleges in neighboring urban communities. Targeted outreach by the Laboratory Education Directors and public affairs offices could help bring these programs to the attention of a more diverse set of potential applicants. While the WDTS sponsors research and training opportunities within the DOE complex for undergraduates (SULI and CCI), graduate students (SCGSR), and visiting faculty from institutions historically underrepresented in the research community (VFP) and has implemented significant outreach efforts to attract applicants to these programs, the COV questions whether these efforts are sufficient to significantly increase the ethnic and gender diversity of the future science and engineering workforce and whether efforts can be made to engage students from underrepresented minorities at an earlier stage of their career (*e.g.*, high school). ***We challenge WDTS management and the DOE Office of Science to develop a more integrated, holistic national program that would involve the DOE Office of Science, the National Science Foundation, and other STEM-related federal agencies that would be charged with developing a more ethnically diverse science and engineering workforce by addressing the pipeline problem at an earlier stage in STEM education.***

We wish to thank the WDTS staff and Dr. Jim Glownia in particular for their commitment to these important programs, their hospitality and informative presentations during the COV review, and their patience with the many interruptions by COV members during their presentations for questions and comments.

The two days of the COV review left no doubt about the commitment of the WDTS staff to their programs. They care deeply about their program participants and radiate an impressive level of enthusiasm. While this is true for all of the programs, the National Science Bowl seemed to be the pinnacle, bringing everyone together to enjoy the products of their efforts.

Overview of the 2016 COV Review Process

The COV review consisted of a working dinner on December 6 and two days (December 7-8) of presentations by WDTS staff members to the COV and discussions of the four WDTS programs we were charged with reviewing. Dr. John Hemminger (Chair of BESAC and Distinguished Professor of Chemistry, U.C. Irvine, Irvine, CA) attended the COV working dinner and the COV review on the morning of December 7. WDTS staff present during all or part of the review included Dr. James Glownia (Director of the Office of WDTS), Dr. Julie Carruthers (Senior Science and

Technology Advisor, Office of the Deputy Director for Science Programs), Dr. Ping Ge (SCGSR Program Manager), Dr. Karen Skubal (WDTS Program Manager), Dr. Jan Tyler (NSB and Einstein Fellows Program Manager), Ms. Karen Talamini (Program Analyst), and Ms. Yolanda White (Program Coordinator).

The report of the 2010 COV for the Office of Workforce Development for Teachers and Scientists and the response to the report of the 2010 COV by WDTS staff were reviewed by each member of the 2016 COV prior to arrival in Germantown. At the working dinner on December 6, 2016, WDTS Director Jim Glownia welcomed the COV and BESAC Chair John Hemminger gave the COV its charge.

The COV review began at 8:30 am on December 7 with an overview of and retrospective on the Office of WDTS by Dr. Glownia and presentations by Dr. Karen Skubal on the Science Undergraduate Laboratory Internships (SULI), Community College Internships (CCI), and the Visiting Faculty Program (VFP), by Dr. Ping Ge on the Office of Science Graduate Student Research Program (SCGSR), and by Dr. Glownia on the WDTS Application Review System (WARS). In addition, Dr. Jan Tyler gave a brief presentation on the National Science Bowl and the Albert Einstein Fellowship Program for high school teachers, although these programs were not reviewed by the 2016 COV. This was followed by a presentation of the WDTS Program Peer Review by Drs. Skubal and Glownia and a summary of the WDTS budget by Dr. Glownia.

On December 8, 2017, the COV review began at 8:30 am with a detailed presentation on evaluation of WDTS Laboratory-based STEM training programs by Dr. Julie Carruthers, which was followed by additional presentations on the VFP, SULI, CCI, and SCGSR programs by Drs. Skubal and Ge. During the afternoon COV session, Drs. Skubal, Ge, Tyler, and Glownia discussed the WDTS outreach program. In addition, the COV participated in a virtual town hall meeting via telephone conference with six Laboratory Education Directors (LEDs), including Meridith Bruozas from Argonne National Laboratory, Linda Lung from the National Renewable Energy Laboratory, Julie Malicoat from Oak Ridge Institute for Science and Engineering, Spencer Pasero from Fermi National Accelerator Laboratory, Scott Robbins from Los Alamos National Laboratory, and Ken White from Brookhaven National Laboratory. No WDTS staff members were present during this teleconference with the LEDs. The purpose of the virtual town hall meeting was to hear directly from some of the National Laboratory customers of the WDTS about the effectiveness of WDTS programs. The next section summarizes the main points of this discussion. A copy of the COV review agenda is attached to this report.

The COV carved out time during the busy two-day schedule for private discussions about the material presented and for question and answer sessions with WDTS staff members. We were provided with hard copies as well as digital copies of all presentations, which greatly facilitated our review of the various WDTS programs.

Summary of Virtual Town Hall Meeting with National Laboratory Education Directors

The COV participated in a teleconference with the Laboratory Education Directors (LEDs) from ANL, BNL, FNAL, LANL, NREL, and ORISE on the afternoon of December 8, 2016. This 1.5 hour teleconference was very informative and provided strong support for a number of points made by the WDTS Program Managers. In particular, all of the LEDs expressed strong support for the WARS software system, and believed that it will be a powerful tool with which to address a number of longstanding issues, specifically the question of "longitudinal tracking," that is, the ability to track applicants and alumni of the WDTS programs, which has not been done in a systematic fashion in the past. This ability will allow users to assess both the short- and long-term goals of the programs and to determine what programs really work (*i.e.* achieve their stated goals) and where improvements can be made. In the past, the assessment and evaluation of WDTS programs has been difficult due to the lack of quantitative information, and assessments relied heavily on anecdotal evidence. The new system appears to be a major leap forward and should allow a wide range of questions to be addressed that will provide much needed information on the effectiveness of WDTS programs and the demographics of students and faculty involved in these programs. The WARS effort was initiated about 5 years ago to address issues raised by the 2010 COV review and appears to be a major success.

Discussion of the WARS system with the LEDs revealed another important finding: the LEDs interact very well both among themselves and with the WDTS staff. The COV has the impression that the LEDs and WDTS staff view themselves as being part of the same team. The perspectives of the LEDs on many programs, issues, and desires had significant common threads, and there was considerable optimism about the direction the WDTS programs are going and the leadership provided by the WDTS office, particularly the leadership of Director Glownia. This attitude appears to be a notable improvement since the previous review. Indeed, the 2010 COV report was seen as "a kick in the butt to improve the way an SC project should be administered." The increasing coordination among the DOE National Laboratories is already having a significant impact on determining best practices, unifying procedures, etc.

When the LEDs were asked about specific programs, there was particular support for the SULI and VFP programs, and one LED strongly endorsed the CCI program. (The SCGSR program is fairly new and is administered by WDTS directly, so the LEDs had less to say about this program.) There was a general consensus that five of the six Laboratories participating in the teleconference had more capacity for SULI and VFP participants. (WDTS management noted, however, that last year VFP "left money on the table.") In particular, in the view of the LEDs, the number and willingness of high-quality mentors is not a limitation for these programs. Aside from growing the existing programs at the Laboratories, the LEDs had two suggestions for possible improvements that resonated with the COV. First, given the success of the SULI program, the LEDs suggested the development of a SULI-like program for early Ph.D./M.S. students. This program would provide a National Laboratory experience at a time when the students were still assessing potential directions for their research careers. In addition, this would enhance the pipeline from disciplines that more traditionally focus on MS programs, such as computer science. Second, it was suggested that the term of the VFP beyond the current limitation of up to three summers should be increased. The LEDs felt that the development of productive collaborations and the background necessary to

generate new external funding might take more than three summers. Along these lines, the COV also felt that the time limitations for the SCGSR program could be relaxed to allow the development of a more extensive research collaboration between graduate student (and her/his university advisor) and National Lab mentor. In particular, the integrated 12-month limitation of the SCGSR program and the need to reapply each year until the 12-month limitation was reached, place unnecessary restrictions on the participants and add considerable uncertainty for the student. For example, it would be a great improvement if the student/faculty member and Laboratory staff member could develop their collaboration at the start of a graduate program and then allow it to evolve over the next three to four years of a typical graduate-student career without introducing the uncertainty of reapplying each year. Such a longer-term model is currently used by many of the DOE National Scientific User Facilities, such as the Advanced Light Source at Lawrence Berkeley National Laboratory and the Stanford Synchrotron Radiation Lightsource at SLAC National Accelerator Laboratory, which typically grant beam time initially for a two-year period, following successful peer review of a beam time proposal, with the possibility of an additional two-year period of beam time without the need to prepare a new proposal.

Finally, when asked about their dreams and desires, several of the LEDs talked about the importance of STEM experiences for K-12 and of building programs aimed at those students. The COV supports this idea, particularly in the context of building diversity, but we recognize that K-12 students are outside the allowable scope of WDTS programs.

Our teleconference with the six LEDs left the COV with the strong feeling that an energetic group of LEDs has been assembled, and monthly meetings with WDTS staff members have clearly been effective. There is a great sense of common goals and teamwork among the LEDs, and this will ultimately result in more uniformity and effectiveness of training programs across the DOE Laboratory system.

Changes in WDTS Programs Since the 2010 COV Review

The 2016 COV was impressed with the changes made by WDTS management since the 2010 COV review. Most of the recommendations suggested by the 2010 COV have been implemented. For example, a number of WDTS student and educator programs (Academies Creating Teacher Scientists (ACTS), Pre-Service Teachers (PST), Real World Design Challenge (RWDC), Undergraduate Research Journal, and College Guide) were judged to be weak by the 2010 COV, who recommended that they be eliminated and their funding redirected to the strongly rated WDTS programs (Science Undergraduate Laboratory Internship (SULI), Community College Internship (CCI), National Science Bowl (NSB), Einstein Fellows, Lindau Awards). These recommended changes have been made by WDTS. In addition, the Faculty and Student Teams (FaST) program was revamped following the 2010 review into the Visiting Faculty Program (VFP). The Office of Science Graduate Fellows (SCGF) Program was eliminated in 2009 and replaced by the Office of Science Graduate Student Research Program in response to OMB recommendations. After one year of operation, this new SCGSR program was judged to be excellent by the 2010 COV. The recently expanded WDTS leadership team, including several new Ph.D.-level Program Managers, is excellent. The Program Managers have taken ownership of their individual programs and are enthusiastic and appear to care deeply about them. The development of close relationships and

monthly teleconferences with the LEDs is an important improvement that will ultimately lead to more unified standards and improved "best practices" for the programs across the Laboratory system. One of the more notable developments since the 2010 COV is the WDTS Application and Review System (WARS), an online management system that is an excellent addition to the WDTS program and to the DOE. The proactive development of this system by the WDTS leadership is impressive and will have a long-term impact for WDTS. The WARS system has several excellent features that benefit the application and review processes and analysis of the application and participant pools in various ways (demographics, geographics, etc.). The ability to quickly assemble and analyze these data will enable data-driven decisions in the future and will allow future COV reviews to readily determine what works and what doesn't work within the programs and to assess the effectiveness of various programs using the available data instead of anecdotal stories that often provide the basis of assessment. Overall, the Office of WDTS has done an excellent job of addressing the recommendations of the 2010 COV Report. One of the stated goals of WDTS was to bring the administration and review of WDTS programs more in line with the rest of the Office of Science programs. This goal has now been largely met under the current WDTS management team.

WDTS actions that are ongoing include (1) use of the findings from the Office of Science assessment of workforce development needs to prioritize programmatic research topics in the solicitation and selection of applications to the Graduate Research Program, (2) work diligently and strategically in all programs to increase the participation of student and faculty from underrepresented groups, and (3) use of program assessments on a regular basis to improve/modify existing programs.

WDTS Program Overviews and Evaluations

1. Science Undergraduate Laboratory Internship (SULI) Program Overview and Evaluation

Mission. The SULI program, with $8.3M in funding in FY 2016, provides undergraduate students from 2- and 4-year undergraduate institutions with paid internships in science and engineering activities within DOE National Laboratories. Students work with National Laboratory staff scientists and engineers on projects related to ongoing research programs. Internships are intended to encourage students to pursue careers in STEM-related areas.

Nature of Internships. There are two types of internship appointments: a 10-week summer program and a 16-week fall and spring program. Approximately 2/3 of the 750 students participating in the SULI program during the past year participated in the summer program. Student participants are paid $500 weekly stipends and received travel costs to and from the Laboratory and possible housing allowances.

Although the COV understands the distinction between the two types of internships, several questions about the internships were raised during our review. *Is the applicant pool of similar quality for the two types of internships? Is the acceptance rate similar for the two types of internships? Does the longer period of the fall and spring internships result in higher completion*

rates of research projects and more in-depth projects? Which of the two types of internships is more favored by National Laboratory mentors? These questions should be addressed by WDTS.

Eligibility Requirements. Participants must be 18-years of age or older, US citizen or legal permanent resident, have a minimum GPA of 3.0, and one-year of university/college course-work are required. There is also an opportunity for recent graduates to apply as long as they are within their first year since graduation (graduating seniors). Additionally, BS/MS students are eligible to apply.

Following a discussion of eligibility requirements by the COV, we agree that the current requirements are reasonable.

Evaluation of Applicants. The current evaluation procedure determines the eligibility of student applicants first, then sends student applications to first-choice Laboratories for review and selection. Evaluation is based on (1) course work performance (especially in STEM courses), (2) recommendation letters, (3) expressed scientific interests, (4) applicant's background and experience, and (5) accomplishments. Applicants not selected for first-choice Laboratory assignments are subsequently released to second-choice Labs.

There was a lot of discussion by the COV about the evaluation process and evaluation criteria. It isn't clear if the evaluation process differs from one DOE Laboratory to another. There should be some common criteria used for applicant evaluation by the different Laboratories and by the science and engineering mentors, although the COV recognizes that the same approach cannot be applied in evaluating all applicants. The COV also recognizes that there is often only one or two SULI or CCI applicants at a given Laboratory in a given specialty area, which limits choices. The COV also discussed the need to require a webinar on implicit bias for all national lab staff involved in the evaluation process.

In both the SULI and CCI programs, applications appear to be driven by proximity and specific school efforts. *Should efforts be focused on enhancing applications beyond these current drivers? The COV feels that further outreach efforts are needed to increase applications from other populations, with particular attention to attracting a more diverse group of applicants.*

Deliverables. Research report oral/poster presentation, peer review, general audience abstract, and pre-/post-participation surveys.

Although the COV did not see examples of these program deliverables, we agree that this is an appropriate set of deliverables for participants. From a professional development standpoint, students will gain experience writing a technical document (research report), conveying the essence of their research to a general audience in the form of an abstract, and preparing and delivering an oral or poster presentation. The pre-/post-participation surveys are also important in evaluating the SULI program from a participant perspective.

Capacity of the National Laboratories To Take More Students with an Increase in WDTS Funding for the SULI Program. During the period 2013-2016, 2,872 undergraduate students

pave participated in the SULI program, and 12.7% of these participants have participated in the SULI program more than once. *Could more SULI undergraduates be accommodated by the National Labs?* The capacity question was discussed with the WDTS leadership team and separately with the Laboratory Education Directors during the teleconference. The WDTS leadership team was not sure if the different DOE National Laboratories could increase capacity in the various programs. The LEDs who participated in the teleconference with the COV indicated that there were growth opportunities in all of the WDTS programs. Many of the LEDs thought the VFP program was a particularly important program to grow as it represented an important program for engaging faculty in colleges that had little connection to the National Laboratories. Nearly all of the LEDs felt there was capacity to grow the SULI program as well. Some National Laboratory LEDs closer to highly populated areas (*e.g.*, LBNL) thought the CCI program also had room for growth. Because the SCGSR program is relatively new, there was not a strong consensus about potential growth of this program among the LEDS. Based on the input from LED's about the capacity question, ***the COV strongly recommends that WDTS leadership develop a strategic plan for growing the SULI, CCI, and VFP programs as well as for increasing the funding needed to implement this growth***.

A graduate student program that is SULI-like for first- or second-year graduate students was discussed with the LED's and is something for WDTS leadership to consider in the future. Increased funding that would more directly tie research to workforce development is another potential consideration in the future.

COV Recommendations for the SULI Program. While the COV has some suggestions, as noted above, the COV is convinced that for the most part the SULI program is an excellent, well-run program by WDTS that provides unique National Laboratory research experiences to students at universities and colleges throughout the nation. ***The COV strongly agrees with the mission of the SULI program and strongly recommends that the WDTS carry out a detailed evaluation of this program to determine if the desired outcome of encouraging students to pursue careers in STEM is being achieved***. The WARS online management system should make this task much easier than in the past, when information of this type was not carefully tracked. We appreciate the efforts being made in evaluating the WDTS programs in general as described during the COV review.

With development of the necessary evaluation tools (WARS) nearing completion and with the recently expanded WDTS leadership team in place, ***the COV strongly recommends that a strategic plan for growth of the SULI program be developed and implemented in collaboration with the National Laboratory LEDs***. *The plan should include the steps needed for growing of the program consistent with the capacity of the National Laboratories to host additional students. The plan should also couple with outreach programs of the DOE Labs designed to attract a larger and more diverse applicant pool and to increase public awareness of the SULI program. Future connections between the SULI program and the SCGSR program should be explored as a way to grow the SCGSR applicant pool.* The National Laboratory LED's strongly recommended to the COV during our telephone conference that the SULI program be modified so that 1st and 2nd year graduate students are eligible for this program. ***The COV agrees with this recommendation and further recommends that the name of the program be modified from Science Undergraduate***

Laboratory Internship (SULI) to Science Laboratory Internship (SLI) to reflect the expansion of this program to include graduate students early in their careers.

Overall Program Quality. ***The overall quality of the SULI program was judged to be excellent by the COV.*** Some questions on program evaluation, program improvement, and program expansion were brought up by the COV, but these issues were not considered to be significant problems, especially in light of efforts to enhance program evaluation using the new WARS system, which will help inform WDTS leadership and future COV reviews.

2. Community College Internship (CCI) Program Overview and Evaluation

Mission. The Community College Internship (CCI) program is aimed at providing students from community colleges with the opportunity for technical internships in science and engineering at DOE National Laboratories. In contrast with the SULI program, which is focused on research experiences for scientists and engineers, the CCI program is aimed more at providing National Laboratory experiences for potential technicians, technologists, etc. Training experiences for this fraction of the workforce are of considerable importance for the scientific enterprise.

Student participants are paid $500 weekly stipends and received travel costs to and from the Laboratory and possible housing allowances. The CCI program remains relatively small compared to the SULI program, but it has grown from ~50 students in 2009 to ~90 students/year at present, with a FY 2016 budget of $1.0M. Fifteen National Laboratories currently participate in this program, and appointments are for 10 weeks during the summer, fall, or spring terms.

Eligibility Requirements. The applicant must be 18-years of age or older, a US citizen or legal permanent resident, have a minimum GPA of 3.0, and have one-semester of course-work, including 6 credit hours in STEM courses. Some flexibility is provided to allow participation by interns with challenging schedules.

Deliverables. The training experience includes the requirement that the participant gives an oral/poster presentation about their work.

Diversity. As pointed out in the 2010 COV review, the CCI program participants have a higher degree of diversity than the national science and engineering undergraduate population. Although it might be assumed that CCI participants would most likely be drawn from community colleges local to the National Laboratory, the COV heard examples of participants who travelled substantial distances from their institutions to a National Laboratory. Nevertheless, for participating Laboratories near large urban centers, *increased outreach to local community colleges might result in additional increases in the number of under-represented minorities in the program, and ultimately lead to increased diversity in the technological workforce.*

Overall Program Quality. The COV believes that this is a valuable program providing an important segment of the potential technological workforce with a unique training opportunity within the DOE Laboratory system. Such experiences could ultimately add considerably to the

diversity of the technological workforce. As discussed above in the section on the capacity of National Labs to take more SULI students, there is also the potential to grow the CCI program. ***The COV strongly recommends that WDTS leadership work with National Lab LED's to seek additional funding to grow this program. We rank this program as Very Good, with the potential to be Excellent.***

3. Visiting Faculty Program (VFP) Overview and Evaluation

Mission. The goal of the Visiting Faculty Program, formerly known as the Faculty and Student Teams (FaST), is "to increase the research competitiveness of faculty members and students from institutions of higher education that are historically underrepresented in the research community in order to expand the workforce that addresses DOE mission areas." In this program, university or college faculty members carry out collaborative projects with researchers at DOE Laboratories. The faculty members can invite up to two students to participate in the project, and the appointments are for 10 weeks in the summer term. Through such collaborations, the program aims to improve the quality of the research program at the participants' home institutions, allowing them to develop more competitive proposals for future research. The program also provides unique research opportunities to participating faculty and students, and the COV heard evidence of some notable successes of the program. For example, a former VFP faculty participant at BNL was awarded a $2M grant from the Department of Homeland Security to develop new STEM programs at Alabama A&M University.

The current VFP program, which was created in 2003, is relatively small, with a budget of $1.7M in FY 2016 that supported ~60 faculty members and ~25 students. Participating faculty receive a $13K stipend plus travel and housing allowances. More than half of the 158 VFP projects funded by the Office of Science from 2013 to 2016 were affiliated with Basic Energy Sciences

The COV recognizes that the VFP can help develop a pipeline to train the next-generation, ethnically diverse workforce because each VFP faculty may invite up to 2 students to participate in the program. If not already in place, ***The COV recommends that students accompanying VFP faculty to National Labs should be offered career advice and mentoring to keep them engaged in Laboratory activities.***

The COV views the VFP as undersubscribed. ***The COV recommends that efforts be made to increase the breadth and impact of the program as well as the number of participants.*** *Can the successful VFP faculty be used as ambassadors (with stipends) to help expand the program?*

Overall Program Quality. The VFP is another beneficial program with substantial potential for increasing workforce diversity. The challenge is to develop connections between Laboratory researchers and prospective faculty members. While the program has been successful, the number of applicants does not appear to be as high as it might be. ***The COV recommends that WDTS staff work with the LEDs to develop and implement more active outreach programs that would bring the VFP program to the attention of more potential participants.*** In addition, ***the COV urges WDTS to consider the suggestion by the LEDs that the outcomes of the VFP might be***

significantly enhanced by extending the allowable term of these appointments. This change might significantly enhance the long-term outcomes of the program. The COV understands that such an extension could limit the number of faculty participating in the program, so further discussion between WDTS management and the LED's is needed before a final decision is made on this suggestion. ***The COV ranks the VFP program as Very Good, with the potential to be Excellent.***

4. Office of Science Graduate Student Research (SCGSR) Program Overview and Evaluation

Mission. The mission of the Office of Science Graduate Student Research (SCGSR) program is to prepare graduate students for STEM careers critically important to the DOE Office of Science mission. This program provides outstanding graduate students with opportunities to conduct research in collaboration with DOE Laboratory scientists and engineers in areas that address scientific challenges central to the Office of Science mission. The award period for the proposed research project at DOE Laboratories may range from 3 to 12 consecutive months. A monthly stipend of up to $3,000/month is provided to the graduate student participants for general living expenses and travel expenses of up to $2,000 are provided for travel to and from the DOE National Lab.

The SCGSR program is sponsored and managed by the WDTS, in collaboration with the six Office of Science research program offices (ASCR, BES, BER, FES, HEP, NP) and the 17 participating DOE National Laboratories. The research opportunity is expected to advance a graduate student's overall doctoral thesis while providing access to the expertise, resources, and capabilities available at the DOE Laboratories.

Since the SCGSR program was initiated in 2014, 207 SCGSR awards have been made to graduate students in SCGSR priority research areas, with another 50 awards expected to be made for the second solicitation of 2016. The FY 2016 budget for the SCGSR program was $2.5M. Graduate student proposals for SCGSR awards are reviewed and scored on the basis of scientific and/or technical merit of the proposed research and relevance of the proposed research to their graduate thesis research and training. To date, graduate student awardees, approximately one-third of whom are female, have come from 86 different Ph.D. granting universities in the physical sciences.

Evolution of the DOE Graduate Fellowship Program. In 2010, an Office of Science COV completed a review of all existing Workforce Development Programs. The assessment of the fledgling Graduate Student Program was quite positive, reflecting the enthusiasm of the staff and the importance of developing technical talent for the DOE. The COV judged that this new program was important and had the potential for high impact. Their rating was "Very Good with potential for Excellence". The 2010 COV report provided a number of suggestions for improvement of the program. It was clear that the 2010 COV endorsed this effort, which recognized the need to attract early career scientists to the DOE National Laboratories and the unique nature of many technical careers within the DOE.

The current SCGSR program is the result of significant changes to the original Graduate Fellowship Program resulting from the 2010 COV review and a negative 2014 OMB assessment. Both assessments provided input that the WDTS graduate program be an evidence-based effort with an emphasis on graduate student training at DOE National Laboratories. Consequently, the program is now focused a research experience for Graduate Students. The nature of the current program and the processes for executing the program were described in detail to the 2016 COV and are the focus of this assessment.

The SCGSR Program. During several presentations and discussions, the COV was provided with a picture of the SCGSR program that was highly favorable. The components of the program include:

- Development and annual review of Program Priority Research Areas
- Student outreach and solicitation of applications through the WARS online system
- Eligibility and compliance review
- Relevance Review
- Merit-based review
- Selection of awardees

The COV received a detailed description of all elements of the SCGSR program including the steps required to (1) define priority research areas, (2) execute the solicitation and selection processes, and (3) evaluate the applications, including the metrics used, and the impact of the program to the DOE Office of Science. In addition to a detailed description of the SCGSR program from the Program Manager, the COV received extensive background material on the program model and the processes and procedures used to assess applications and select candidates for participation in the SCGSR program. The COV was very impressed with the systematic approach used in all aspects of the program and the detailed tracking done to support solicitation and selection of the funded graduate students. In addition, it was clear to the COV that the SCGSR team that manages this effort is committed to the success of the program and has taken significant steps to develop a rigorous system to support all aspects of the program. Of particular note is the WARS online system, which now provides beginning-to-end management of the program and documents all elements of the program. The vision for this tool and its development and implementation over the last 5 years has been a substantial endeavor and a significant accomplishment for the broader WDTS program. This tool allows best-in-class management of the program and will allow tracking of the impact of the program over time, which is critical for defending the program to oversight entities.

General Observations. The COV was shown data from four cycles of the SCGSR program, which indicate it is well organized and effectively executed. The Priority Research Areas are systematically identified based on long-term research areas and projected workforce needs within the DOE and the DOE Laboratories. The team works closely with SC Program Managers to assess and modify the priorities annually and thus ensures that they are able to address emerging workforce pipeline needs. The ability to add or remove focus areas as workforce needs develop or change is important and enhances the responsiveness of the program. This approach makes the program highly valuable to the National Laboratories, well aligned with projected needs, and appreciated by SC program offices.

A significant component of the SCGSR program is appropriately focused on the review of application packages submitted by prospective graduate student participants. The review process is systematic and based on clear metrics and thoroughly documented using the WARS online system. The SCGSR Program Manager presented success exemplars during the presentations that were valuable and interesting to the COV.

In discussions with the Laboratory Education Directors during our virtual town hall meeting, it was clear to the COV that while the network between the Laboratories and WDTS is strong, each organization used a different approach to identify mentors who assist with placement of the graduate research students. It was evident that Laboratories with smaller programs had the ability to be more engaged in the placement process, and they have developed strong lessons learned that should be shared with other Labs. Overall, all approaches seemed effective, but it is our assessment that additional structure would benefit the program.

All Laboratory Education Directors shared ideas on the continuing education element of the student experiences and the use of WDTS and National Laboratory tools to enhance the student experience. Overall, the exchange between WDTS and the Laboratories is dynamic and forward looking. Webinars, which could be used by all sites and offered multiple times, represent just one example of the positive interactions between the Labs and the WDTS. This engagement was specifically called out as a need in the 2010 COV report, and it is apparent that this weakness has been addressed.

Opportunities for Improvement.

Diversity. Like other WDST programs, SCGSR needs to incorporate additional elements to enhance diversity in the applicant pool. The COV appreciates the rules governing information and the need to have a merit-based program. It is our assessment that the most effective approach for enhancing diversity is through active efforts that impact the incoming applicant pool. The new effort to solicit and fund efforts at the Labs to enhance diversity represents a good start. The program should consider other mechanisms to enhance outreach. A strength that should be tapped is the expertise at the individual Laboratories as well as personal contacts between National Laboratory scientists and engineers and faculty and students at colleges and universities that serve primarily minority students. Establishing these expectations clearly and working with the Labs to share concepts and ideas should yield large dividends.

Longer Laboratory Engagement Opportunities. One interesting set of data provided to the COV was the distribution of project durations. For all projects funded in each of the four solicitations, a large fraction of the projects lasted 10-12 months. The COV believes that this reflects the added value of longer stays at the Laboratories. The current program limits the length of the graduate student's National Laboratory experience to 3 to 12 months. However, when a graduate student and advisor develop a thesis project, the research plan typically extends over 3 – 5 years, and National Laboratories provide unique research capabilities that could be important throughout the course of a thesis project, particularly at its inception when proof-of-principal or proof-of-approach data are of vital importance. The opportunity to have access to unique National Laboratory capabilities and infrastructure for a larger fraction of a graduate student’s career is extremely valuable. Currently, graduate students need to re-apply and compete for a slot for each

year they would like to be at a National Laboratory. The COV feels that the 3- to 12-month limitation needlessly restricts the potential benefits of the collaboration with the National Laboratory. ***The COV strongly recommends extending the program period to better match a typical Ph.D. timescale.*** The program should consider alternatives that allow graduate students in good standing with strong support from the Labs to automatically be eligible for renewal for up to 3 years. ***The COV also recommends that the SCGSR program assess the potential impact of multi-year awards to the program and to increase the budgets to the programs to accommodate some multi-year awards.***

Eligibility of Students in Master's Degree Programs. In discussions with the Laboratory Education Directors, the COV asked about the interest from students in Master's degree programs in the SCGSR program. In particular, we were interested in engaging researchers in fields where the terminal degree is often an M.S. degree (*e.g.*, engineering and computer science) and not a Ph.D. degree. These fields and the capabilities at the Labs that utilize them are important to the DOE mission. The LEDs strongly welcomed participation of such students in their programs. ***The COV recommends that SCGSR evaluate the interest and potential impact of inclusion of Master's degree students from a targeted set of disciplines.***

Overall Program Quality. The SCGCR program is viewed by the COV as a very important means of attracting graduate students to careers at the National Labs, of providing research opportunities using facilities that are often unique, and of increasing the science and engineering workforce who has an appreciation of the missions of the National Labs. ***The COV ranks this program as Excellent.***

Summary of COV Program Rankings and Recommendations

Science Undergraduate Laboratory Intern (SULI) Program (Ranked Excellent)

(1) The COV strongly recommends that the WDTS carry out a detailed evaluation of the SULI program to determine if the desired outcome of encouraging students to pursue careers in STEM is being achieved. This effort could be greatly facilitated by contacting the National Lab mentors of the undergraduates who participated in the SULI program to find out what career path each student took.

(2) The COV recommends that the number of internships in the SULI program available to the National Labs be increased, consistent with the capacity of the National Lab staff to mentor an increased number of undergraduate interns. The six LEDs who participated in the virtual town hall meeting stated that there is additional capacity at each of their Laboratories for SULI students.

(3) The COV also recommends the development of a SULI-like program for early Ph.D./M.S. students that would be combined with the existing SULI program. We further recommend that the name of this expanded program be changed from Science Undergraduate Laboratory Internship to Science Laboratory Internship (SLI).

(4) The COV recommends that all National Lab staff involved in the evaluation process of applicants for the SULI program be required to view an appropriate webinar on implicit bias.

Community College Intern (CCI) Program (Ranked Very Good with the potential to be Excellent)

(1) The COV strongly recommends that WDTS leadership, in consultation with National Laboratory Education Directors, seek additional funding to grow this program. The CCI program is viewed by the COV as one means of increasing an ethnically diverse, technologically savvy workforce within the DOE complex due to the fact that CCI program participants have a higher degree of diversity than the national science and engineering undergraduate population.

(2) The COV recommends that the Laboratories increase their outreach to local community colleges as a means of increasing the number of under-represented minorities in the program.

Visiting Faculty Program (VFP) (Ranked Very Good with the potential to be Excellent)

(1) The COV recommends that WDTS staff work with the LEDs to develop and implement more active outreach programs that would bring the VFP to the attention of more potential participants. This objective is particularly important because the VFP is designed to attract faculty and students from institutions historically underrepresented in the research community and thus could result in an increase in ethnic diversity within the science and engineering workforce.

(2) The COV recommends that efforts be made to increase the breadth and impact of the program as well as the number of program participants. Can successful VFP faculty be used as ambassadors (with stipends) to help expand the program?

(3) The COV recommends that students accompanying VFP faculty to National Labs should be offered career advice and mentoring to keep them engaged in Laboratory activities.

(4) The COV urges WDTS to consider the suggestion by the LEDs that the outcomes of the VFP might be significantly enhanced by extending the allowable term of these appointments. We understand, however, that such an extension could limit the number of faculty participants in the program, so further discussion about this possible extension is needed between WDTS and the LED's.

Office of Science Graduate Student Research (SCGSR) Program (Ranked Excellent)

(1) ***The COV strongly recommends extending the SCGSR program period to better match a typical Ph.D. timescale (3-5 years).*** The program should consider alternatives that allow graduate students in good standing with strong support from the Labs to automatically be eligible for renewal for up to 3 years.

(2) ***The COV also recommends that the SCGSR program assess the potential impact of multi-year awards on the program and to increase the program budget to accommodate some multi-year awards.***

(3) ***The COV recommends that SCGSR evaluate the interest and potential impact of***

including Master's degree students from a targeted set of disciplines.

(4) ***The COV recommends that additional structure be put in place in the SCGSR program that would result in a more standardized approach to identifying National Lab mentors for graduate student researchers.***

(5) ***The COV recommends that staff scientists and engineers at the National Labs who have mentored and collaborated with graduate student researchers in the SCGSR program be asked to provide any information they might have on the professional activities of the graduate students, including place of employment, once they have received their M.S. or Ph.D. degrees.*** This information is critical for building a database on SCGSR participants that can be used to evaluate the effectiveness of the SCGSR program.

Equipment Donation Program (EDP). Although the COV did not hear about this program during the review, it is administered by the WDTS Office and received a ranking of Good by the 2010 COV. One member of the 2016 COV who is a long-time National Laboratory staff member expressed surprise at the existence of this program, as it had long been his understanding that donating excess equipment to outside institutions was extremely difficult to do; his experiences over the years confirmed this belief. Such an equipment donation program could be extremely valuable and provide considerable leverage to the long-term outcomes of programs like the VFP. ***The COV recommends that the EDP program should be better advertised at the National Laboratories and at universities and colleges, particularly those institutions historically underrepresented in the research community.***

WARS (WDTS Application and Review System)

From 2004 to 2011, WDTS relied on a data management system developed at PNNL for all student/faculty applications for the SULI, CCI, and VFP programs. Many problems with the online applications system at PNNL were noted by WDTS staff and upgrades to this system were initiated in 2010. However, use of the PNNL-WDTS Applicant/Participant Data Systems in 2011 revealed additional problems that raised serious doubts about the long-term viability of the PNNL online data management software. A new project was begun with ORISE via a field work proposal in 2012 to develop a WDTS-wide applications and data-management system that would replace the PNNL system. The resulting WARS online management system, which has been developed in collaboration with ORISE over the past five years at a cost of ~$3M, is based on program logic models that utilize program goals and descriptive elements that define program success factors and supports the collection and archiving of applicant information, mentor information, participant information, and outcome data into a long-term database for tracking, assessment, and evaluation of WDTS programs. One particularly important aspect of the WARS online management system is that National Laboratory mentors are required to enter project information. Extensive automated data analytics are available in the WARS system as are visualization capabilities, which save significant staff time in the analysis of data.

Some of the capabilities of the WARS system were presented to the COV by Drs. Glownia and Carruthers during the review, and WARS was used by Dr. Carruthers during the COV review to provide demographic information on ethnicity in the applicant and participant pools for several years in response to questions by the COV. The COV shares the enthusiasm expressed by the six

Laboratory Education Directors about the WARS data management system and considers this development to be a major success, well worth the development cost, that will significantly improve the ability of WDTS management, future COV's, and government oversight agencies, such as OMB, to assess the effectiveness of WDTS programs. We applaud the efforts of the WDTS staff, particularly Jim Glownia, for their role in developing this interactive, automated data management system, which is likely to have applications well beyond those of WDTS.

WDTS Program Peer Reviews

WDTS Program Manager Karen Skubal and WDTS Director Jim Glownia presented to the COV an informative talk on WDTS Program Peer Reviews that occurred in a 2012 Reverse Site Visit and a 2015-2016 Peer Review involving all of the participating National Labs. The reviews were carried out by independent, external subject matter experts. The purpose of the 2012 Reverse Site Visit was to ensure that a standardized set of common core requirements are employed by all of the National Labs for WDTS Lab programs. The areas where common core requirements are needed include: (1) the student/faculty application process, (2) applicant review and selection, (3) student intern/visiting faculty training, (4) program execution, including professional development, and oversight, including self evaluations, (5) tracking to monitor participant progress and to ensure completion of required deliverables, (6) mentor selection, (7) mentor preparation and monitoring, and (8) WDTS funding and maintenance of financial records. The 2015-2016 Peer Review was designed to evaluate whether SULI, CCI, and VFP are being managed and executed in a manner that ensures that program participants receive best-in-class experiences at 15 of the 17 National Labs that increase their preparedness for a STEM career and that the Lab-based programs support the DOE's Office of Science mission. In addition to these two main outcomes, a number of other operational questions were also considered, ranging from *"Do the Labs employ effective outreach and recruitment of participants?"* to *"Do Labs ensure participants have quality projects that expose them to unique DOE Lab competencies and capabilities?"* The outcome of the 2015-2016 Peer Review was generally very positive for all National Laboratories participating in the WDTS programs.

Outreach

The WDTS uses a variety of outreach approaches to inform potential undergraduate and graduate interns and visiting faculty about the SULI, CCI, VFP, and SCGSR programs. WDTS Program Manager Dr. Karen Skubal presented a summary of the methods used to advertise these programs and solicit applicants, including (1) webinars on WDTS programs, (2) participation in regional (DC-based) STEM outreach events, (3) development and hosting of a web-based access portal for DOE Lab-based STEM-related resources and opportunities targeting students and faculty, (4) piloting of outreach proposal solicitation to host National Laboratories, (5) directed e-mail program announcements to institutional Career Service/Placement Offices, and (6) instructions to host Lab and National User Facilities to create/update their website content with current WDTS program information. In addition, in FY 2016 WDTS put out a call to the National Laboratories for outreach proposals for underrepresented groups in WDTS programs designed to improve the diversity of the applicant pools for SULI, CCI, VFP, and SCSGR. WDTS also made a total of

$360,000 in awards to 10 of the National Labs for diversity and outreach pilot programs.

The COV views these outreach efforts as important to achieving an increased number of WDTS program participants from underrepresented groups in the US research community. In spite of these well-intentioned efforts, however, the COV is not convinced that these "standard" approaches to increasing the ethnic and gender diversity of WDTS programs will succeed. ***We strongly recommend that WTDS partner with appropriate STEM-related programs in the National Science Foundation to increase the number of underrepresented students in the STEM pipeline by developing a national campaign aimed at attracting an increased number of high school students to science, technology, engineering, and mathematics programs in college and universities.*** Such an effort should be started as soon as possible and its effectiveness should be reviewed by the next COV for WDTS.