An Evaluation of DOE-EM STEM Education and Workforce Development Programs

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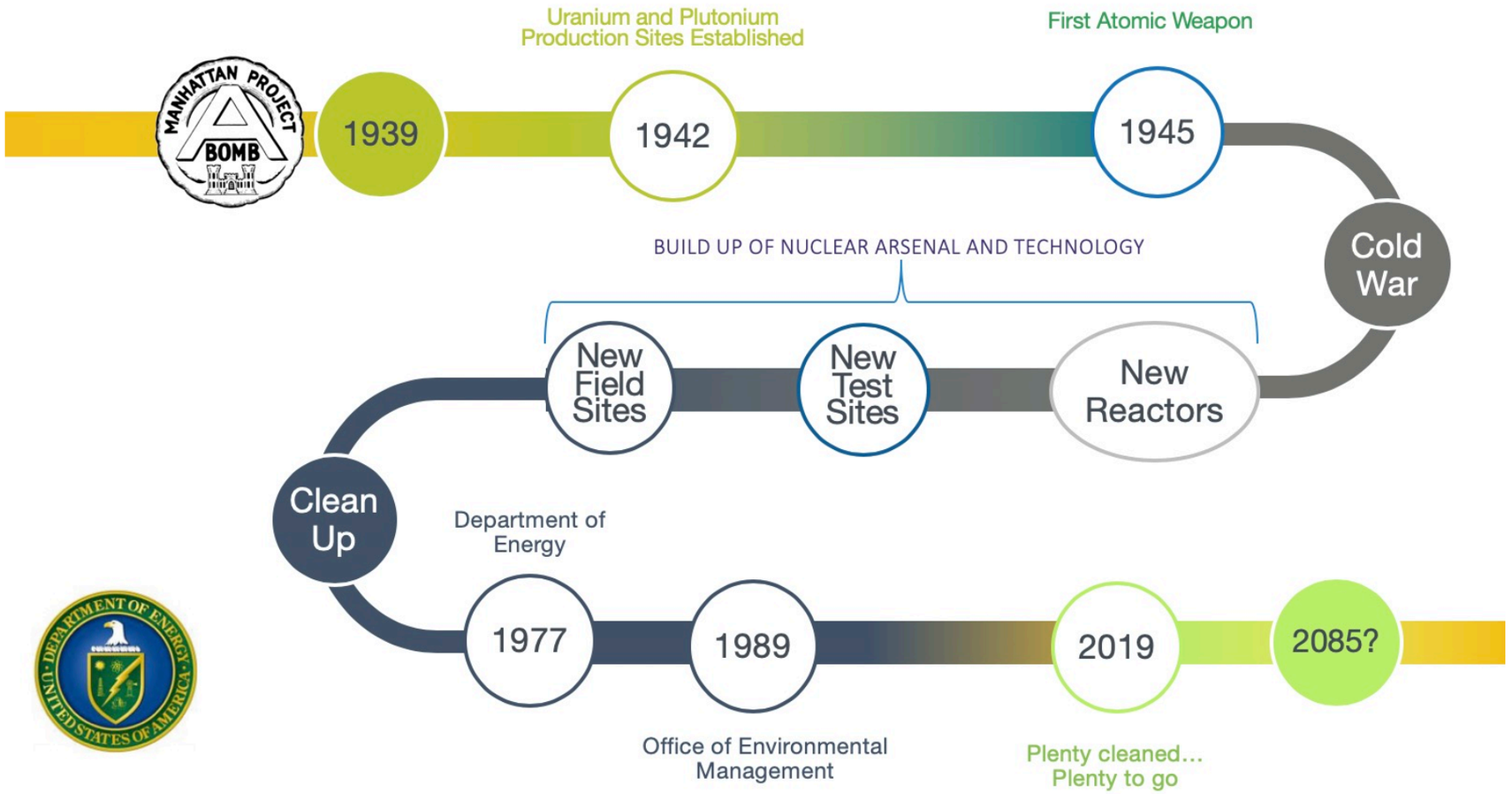
EXECUTIVE SUMMARY



Five decades of government-sponsored nuclear weapons development, production, and testing has resulted in significant environmental impacts. This legacy requires extensive clean-up efforts, led by the Department of Energy's (DOE) Office of Environmental Management (EM). EM is responsible for cleaning up 16 sites in 11 states. This mission will cost an estimated $232 to $274 billion and take more than 70 years to complete. The nuclear cleanup industry must maintain a highly qualified workforce for at least the expected duration of clean up efforts.

EM leadership has growing concerns about the increasing number of aging employees who will soon be eligible for retirement and the small pool of young workers employed by the agency. EM has approximately 1200 employees, whose average age is 52. 38% of the EM workforce is now eligible for retirement. By the year 2025, 51% of EM employees will be eligible to retire. Currently, only 1.8% of EM employees are under the age of 30. The department's success hinges on its ability to continue to staff its positions with high-quality employees.

To meet this staffing need, EM has three research programs which employ graduate students. Additionally, EM supports several summer internship programs, but it is unclear how fruitful these initiatives are in providing EM with a robust, diverse talent pipeline, especially given the agency's dwindling funding. In total, EM spends approximately $7 million dollars on these pipeline programs.

The current study was informed by the concepts of STEM workforce recruitment, STEM employment pipeline development, and workforce diversity. We explored the extant literature related to these three areas to better understand the conditions that will most likely support enhanced STEM recruitment, pipeline development, and workforce diversity.

Guided by our literature review and the specific requests made by EM, we developed the following research questions:

1. **What factors attracted existing young employees to STEM fields and their roles in the Office of Environmental Management?**

2. **What challenges does the Office of Environmental Management face as it recruits young professionals, particularly those of diverse backgrounds?**

3. **To what extent do existing talent pipelines support the Office of Environmental Management's hiring?**

4. **How does EM's practice compare to other agencies/organizations who recruit STEM professionals?**

To address our research questions, we employed a mixed method design which included a qualitative analysis of semi-structured interviews with EM employees, augmented by a quantitative analysis of data comparing specific aspects of DOE-EM with two similar federal agencies. The project team was given access to employees at seven of the sixteen remaining nuclear cleanup sites. Of these, the research team was able to interview employees at six of the seven sites - Hanford, Washington; Savannah River, S.C.; Carlsbad, N.M.; Paducah, KY; Oak Ridge, TN; and Headquarters, Washington, D.C. The team interviewed 33 EM employees, which included eight hiring managers and twenty-five junior staff members. Sixteen interviews were conducted in person, while seventeen were conducted via video conference. Employees served in a range of roles, but were primarily comprised of engineers and physical scientists. Based on the qualitative and quantitative data collected, the team identified the following significant findings:

Research Question 1: *What factors attracted existing young employees to STEM fields and their roles in the Office of Environmental Management?*

1. STEM interest starts early. All interviewees reported an early interest in math and/or science that predated high school. A majority of employees participated in Advanced Placement (AP) math and science courses in high school and many also participated in math and science clubs, STEM summer programs, and other extracurricular STEM activities.

2. Mentoring matters. Study participants consistently reported having a teacher, family member, role model, or mentor who encouraged their interest in STEM. Interviewees reported that STEM mentoring was a crucial support in primary and secondary school, college, and through early career. STEM mentoring matters from cradle to career.

3. We know our mission is important, but does anyone else? Study participants reported that they were initially attracted to EM due to motivations and incentives unrelated to the organization's mission. However, once employed with the agency, most interviewees stated that they bought into the agency's mission and believe that their work is extremely important. Most participants had no knowledge of the organization's mission (and little general knowledge about the organization itself) prior to being hired. Many interviewees noted that the importance of the agency's mission would be a great marketing tool to recruit new, young employees.

Research Question 2: *What challenges does the Office of Environmental Management face as it recruits young professionals, particularly those of diverse backgrounds?*

1. Systemic barriers. Across sites and roles, interviewees expressed concerns with the application and hiring process. Participants repeatedly noted the extremely long and tedious hiring process, a process which can take six months to a year, as a barrier to recruiting new talent. Interviewees also stated that the way positions are advertised on USA JOBS is complex and confusing to those not already in the federal government. Additionally, veteran's preference in hiring tends to skew the demographics of applicants towards older candidates. Employees also recognized that recent political shifts have created hiring barriers as the Trump administration is reducing the federal workforce through attrition.

2. Diverse definitions of diversity. Leadership and staff held imprecise definitions of workplace diversity but generally acknowledge its importance. Some defined workforce diversity in terms of race, age, gender, and socio-economic background, while others defined diversity in terms of life experiences. Most interviewees initially responded that they believed EM was suitably diverse. However, after follow up questions on specific ways in which the office was diverse, most employees acknowledged areas for improvement.

3. Higher the rank, the less diversity. Employees perceived the organization to be less diverse at higher levels than at junior levels. This finding is related to the overall lack of diversity in STEM fields and serves as a clarion call for continued recruitment of diverse candidates for all positions, particularly in leadership.

4. More support and development (on support and development). Across employees of all ages and roles, both field members and leadership yearn for deeper ongoing professional development and career advancement. There seemed to be a demand--both from managers and their direct reports--for more robust support on management and coaching.

Research Question 3: *To what extent do existing talent pipelines support the Office of Environmental Management's hiring?*

1. What pipelines? Pipelines are viewed as the means to hiring for a vacancy, not necessarily an overarching talent strategy, and leadership and staff hold mixed attitudes about the necessity or efficacy of existing pipeline programs. EM staff cannot comment on the effectiveness of pipeline programs because it does not systemically track participation in these opportunities and the number of candidates who convert to full-time employees. Hiring metrics and pipeline output are not DOE-EM key performance indicators and hiring timelines limit pipeline effectiveness. Without clear succession planning, interns placed in field sites often go to work with contractors instead.

2. Let's go to the field! There is a strong desire from leadership and junior staff for field rotations. In the past, EM ran an Environmental Management Professional Development Corps (EMPDC) program through which new hires would work in a series of field placements before accepting a permanent position.

Field based staff believed this program supported recruiting at remote sites. Individuals who had participated in the EMPCD program cited positive experiences with work details and expressed a desire to bring those programs back. Employees who had participated in EMPCD also reported that field rotations enabled them to have a better understanding of EM's work from a broader context, rather than the limitations of their specific field site.

Research Question 4: *How does EM's practice compare to other agencies/ organizations who recruit STEM professionals?*

1. Find the mission-aligned talent. Based on our interviews with ORAU and NNSA, Strong recruiting relies on a clearly articulated value proposition for candidates, the match between candidates and supervisors, and functional staff to recruit. Talent gets snatched up quickly, so hiring processes need to be more nimble. Additionally, high-performing candidates are looking for ongoing support and development in their roles. Consequently, EM should give more thought to the value proposition of why candidates should work for the organization and match candidates with supervisors or mentors to support and develop them in their roles.

2. Start early and begin with the end in mind. There is an emerging interest in K-career STEM pipeline development. Private companies that staff government positions are beginning to invest in STEM education, summer programs, and internships for students in K-college. These organizations also provide STEM fellowships for graduate students and conduct professional development on creating engaging, applied STEM curriculum for K-12 teachers. The cleanup of the 16 remaining nuclear cleanup sites will take more than 70 years to complete. Therefore, it would be wise for EM to invest in early STEM education with an eye towards the organization's long-term goals. As one employee of a comparison organization stated, "It's far harder to invest in efforts that won't come to fruition for ten years, but I believe our K-12 work is some of our most impactful." Based on these findings, we offer the following recommendations to DOE-EM:

1. *Cultivate a pool of STEM candidates.*
2. *Conduct a community outreach program.*
3. *Create field-site partnerships with K-12 schools, districts, community colleges, and universities.*
4. *Create a K-12 mentoring program and prioritize mentoring opportunities for field-site communities and for those demographics which are underrepresented in the STEM pathway.*
5. *Identify strong mentors for new employees and train them to fill this important role.*
6. *Capitalize on a pool STEM candidates.*
7. *Track pipeline participants and identify metrics for hiring, which leadership review cyclically.*
8. *Define key diversity goals and include in hiring and recruiting metrics/strategy.*
9. *Train field site staff on pipeline programs.*
10. *Articulate a value proposition for new hires. Create hiring materials centrally for use by field site staff.*
11. *Provide support for succession planning.*
12. *Conduct interviews with candidates who do not take jobs with EM and use this data to make improvements to the hiring process.*
13. *Consider reinstating field rotation program.*

INTRODUCTION

The Office of Environmental Management

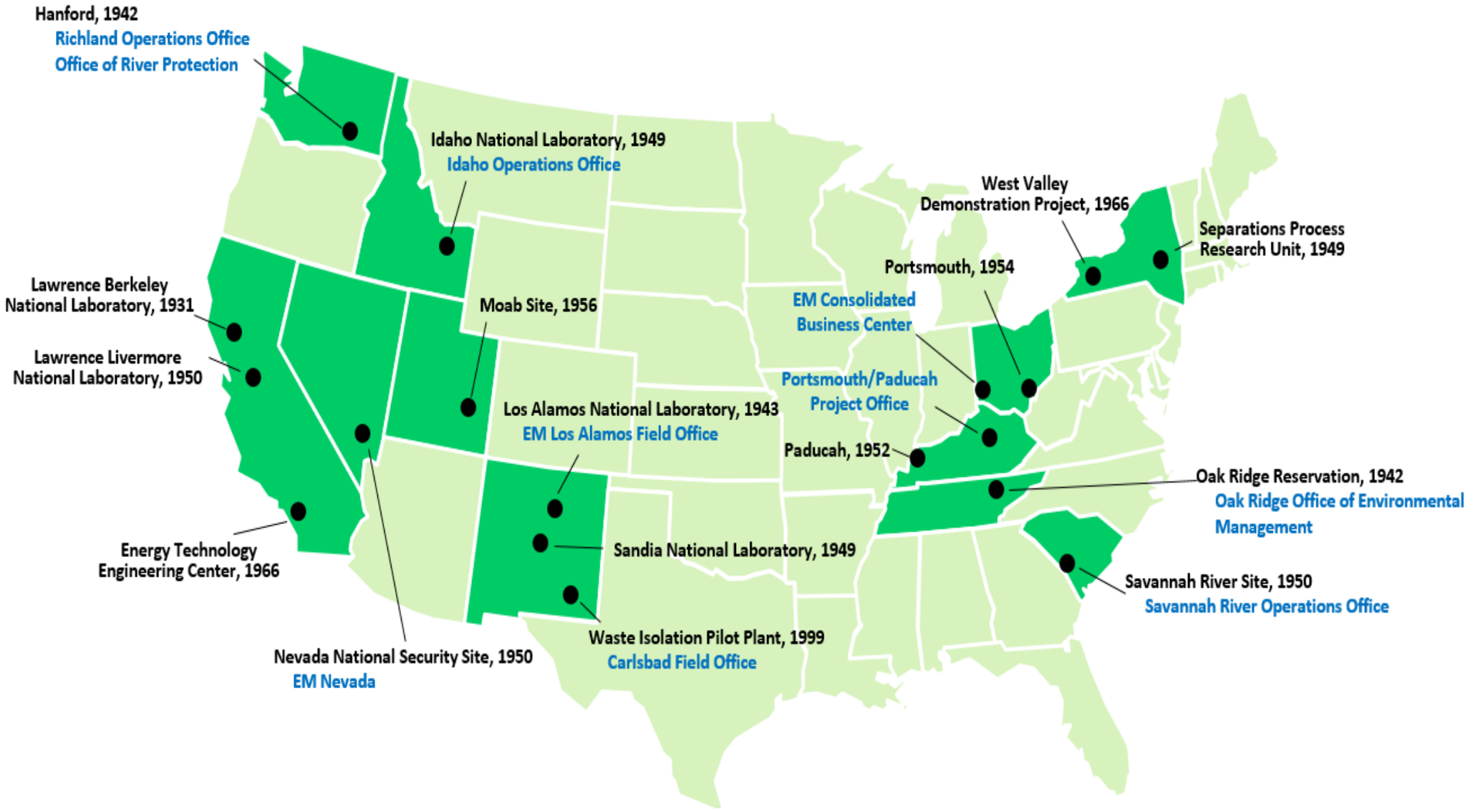
The Office of Environmental Management (EM) leads the federal response to environmental impacts of five decades of government sponsored nuclear weapons development, production, and testing. Through the rapid expansion of the Manhattan project, federal scientists did indeed create a country-wide factory. At its peak, the U.S. nuclear weapons complex relied on operations at 16 large facilities and many smaller sites. As EM's historical archive puts it, "in its diversity, the complex ranged from tracts of isolated desert in Nevada, where weapons were tested, to warehouses in New York that once stored uranium" (Office of Environmental Management, n.d.).

Nuclear weapons projects have resulted in millions of gallons of liquid radioactive waste, millions of cubic meters of solid radioactive waste, thousands of tons of spent nuclear fuel, and vast quantities of contaminated soil and water" (Office of Environmental Management, n.d.). To ensure the safe disposal of this material and the cleanup of land and water, EM currently operates at 16 sites in 11 states and manages more than 1,250 employees and more than 10,000 contractors. Full cleanup of existing nuclear weapons projects is estimated to take more than 70 years to complete and a budget of between $232 to $274 billion. The department's success hinges on its ability to continue to staff its positions (and those of its contractors) with high-quality employees. In the 2018 fiscal year, EM hired 39 staff members to new roles (3.26% accession rate). In the same period, 101 employees left positions with EM (8.44% attrition rate) of which 70 employees retired.

To meet their staffing needs, EM participates in the Federal Pathways Program and ancillary internship programs, including the Department of Energy Scholars Program, the Consortium for Risk Evaluation and Stakeholder Participation, and the Minority Institution Partnership Program.

In 1939, Danish Nobel Prize-winning physicist Niels Bohr argued that building an atomic bomb "can never be done unless you turn the United States into one huge factory." Years later, he told his colleague Edward Teller, "I told you it couldn't be done without turning the whole country into a factory. You have done just that."

SITES



EM BY THE NUMBERS

~1200
Employees

52
Average age of federal employees

38%
Eligible to retire

1.8%
Under 30

51%
Eligible to retire in 2025

The remaining work will take the DOE-EM another 70+ years and $250+ billion.

Request for Assistance and Research Questions

In a Request for Assistance to the Vanderbilt Ed.D. program, EM leadership acknowledged concern about their imbalanced attrition and accession rates. In addition, faced with a mission which will take at least 70 years to complete, the EM team voiced particular worry about the "graying" of their workforce. EM operational sustainability and advancement requires a steady supply of STEM talent. To meet staffing needs, EM has a number of pipeline programs which target students with the aim of eventually hiring them. It is unclear, however, if these initiatives provide EM with a robust, diverse talent pipeline of young professionals. In addition to receiving feedback on the efficacy of existing pipelines, EM leadership expressed a desire to better understand how they might attract young STEM graduates to the current pipeline programs. EM leadership was also open to developing a better understanding of the K-12 to career STEM pathway and what features encourage young people to persist in STEM majors and careers. Our inquiry focuses on the K-12 to federal career pathway with particular focus on K-12 factors as that aligns with our research team's experience base.

To provide assistance, the research team and EM leadership established the following research questions:

1. **What factors attracted existing young employees to STEM fields and their roles in the Office of Environmental Management?**

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Federal Context

The U.S. Federal government employs more than 2.1 million Americans at hundreds of government agencies. Ensuring these positions are staffed with well-qualified individuals is an issue of national security, stability, and sustainability. As the Baby Boomer generation continues to exit the workforce, this issue deserves particular attention. More than 45 percent of current federal employees are over 50 years old (Office of Personnel Management, 2017). Fifteen percent of current federal employees are eligible for retirement now, and in just five years, this figure will increase to more than 30 percent (Office of Personnel Management, 2017). This attrition rate will be most acutely felt in leadership roles where 70 percent of federal senior managers are eligible for retirement in five years. An impending federal brain drain could be particularly acute in science, technology, engineering and math (STEM) fields (National Science Board, 2010). More than 40 percent of federal physical scientists and 32 percent of federal biologists are over the age of 50 (National Science Board, 2010).

Indicators suggest that the federal government will need to compete heavily with private industry for replacement science talent. The percentage of top performing U.S. high school students who intend to major in STEM fields has declined in the last 20 years (National Science Board, 2010). To ensure both steady current federal service levels and innovation of federal agencies, it is imperative that the federal government cultivate, recruit, and retain younger generations of civil servant scientists to fill vacancies left by retirees.

Concerningly though, young people view federal civilian service jobs more unfavorably now than they did in previous decades (Booz Allen Hamilton, 2011; Harvard Kennedy School, 2015). When surveyed, college-educated Americans view private sector jobs as more interesting and challenging than public service positions (Booz Allen Hamilton, 2011). Only 25 percent of young people report an interest in working in public service, down from 33% in 2015 (Harvard Kennedy School, 2015). Ironically, most polls on the subject suggest young employees want to do meaningful work and consider finding a position that aligns with their values to be a top priority. In one survey, more than half of the respondents reported a willingness to take a 15 percent pay cut for a position in an organization that matched their values (Net Impact, 2012). In fact, early research suggests millennials are more likely than previous generations to seek out volunteer experiences or work on social impact ventures (Booz Allen Hamilton, 2011). The federal government is missing a critical opportunity, then, to hire civic-minded young people.

Some critics argue young people avoid federal service because its rigid pay scales limit earning potential. Whether federal employees actually fall short on salary compared to their private sector peers is a hotly contested political debate among think tanks, political scientists, and economists. In 2017, the Congressional Budget Office concluded that on average federal employees are paid 3 percent higher than private sector employees. However, this broad conclusion deserves greater context. When federal employees are compared to private sector peers with similar work experience and education, the Congressional Budget Office found a 34 percent advantage for federal employees with a high school diploma or less and a 24 percent shortfall for federal employees who have graduate degrees (Congressional Budget Office Report, 2017). less than 8 percent of the federal workforce, a figure which is down by 2 percent since 2010.

percent since 2010. Nearly 25 percent of employees are under the age of 30 in the entire US workforce (Yoder, 2018).

The Office of Personnel Management acknowledged this need bluntly in a 2011 report: “The need to promote employment opportunities for students and recent graduates, as part of an overall recruiting strategy, is paramount as an ever-growing number of federal employees nears retirement age” (Office of Personnel Management, 2016). Recent policy reflects this awareness. In 2010, in an effort to address a perceived competitive disadvantage compared to other sectors in recruiting and hiring students and recent graduates, President Obama signed Executive Order 13562, “Recruiting and Hiring Students and Recent Graduates”. This executive order established the federal Pathways Programs to supplement federal hiring pipelines with targeted opportunities for young professionals with additional supports and outreach to veterans.

The Pathways Program includes three specific programs designed to engage three talent pools: current students, recent graduates, and Presidential Management Fellows. The internship program targets current high school, college, or graduate students, allowing them to work in federal agencies, explore federal careers, and receive a salary or stipend for their contributions. Students who successfully complete their internships are eligible for conversion to full time civil service positions, provided positions exist for which they can apply. The recent college graduate program targets individuals who have recently graduated from qualifying educational institutions. Participants must apply for an existing temporary position and are placed in a one-year career development program. The Office of Personnel Management encourages agencies to convert these employees to permanent positions within two years. Finally, the Presidential Management Fellow program targets individuals with an advanced degree who are interested in a managerial role in the federal government. Agencies must sign up to participate in the Presidential Management Fellowship program and budget for a position for multiple years to sustain the fellow.

A 2016 Office of Personnel Management evaluation of the Pathways Program in 17 large federal agencies found mixed results (Office of Personnel Management, 2016). Agencies did use this program as a supplemental hiring authority and appeared to prioritize veteran appointments. However, agencies were less strategic in marketing opportunities to possible talent pools. In addition, federal staff had varying degrees of understanding about the programs, remote federal locations had far fewer applicants for positions, tracking tools to identify Pathways Programs participants onboarding, training, and conversion to hiring were limitedly implemented, and inadequate succession planning had hindered early success of the program.

It does not appear, at least initially, that the Federal Pathways Program has been successful in its goal of recruiting and retaining young applicants. This may be due to the length of the federal hiring process which is a notoriously long and bureaucratic process. The average hiring process in the U.S. is an estimated 23 days, but for federal positions, the process routinely takes more than nine months to complete (Salemi, 2016; Glassdoor, 2015). Hiring for federal positions typically took a long time under presidential administrations which were in favor of expanding the federal workforce or at least

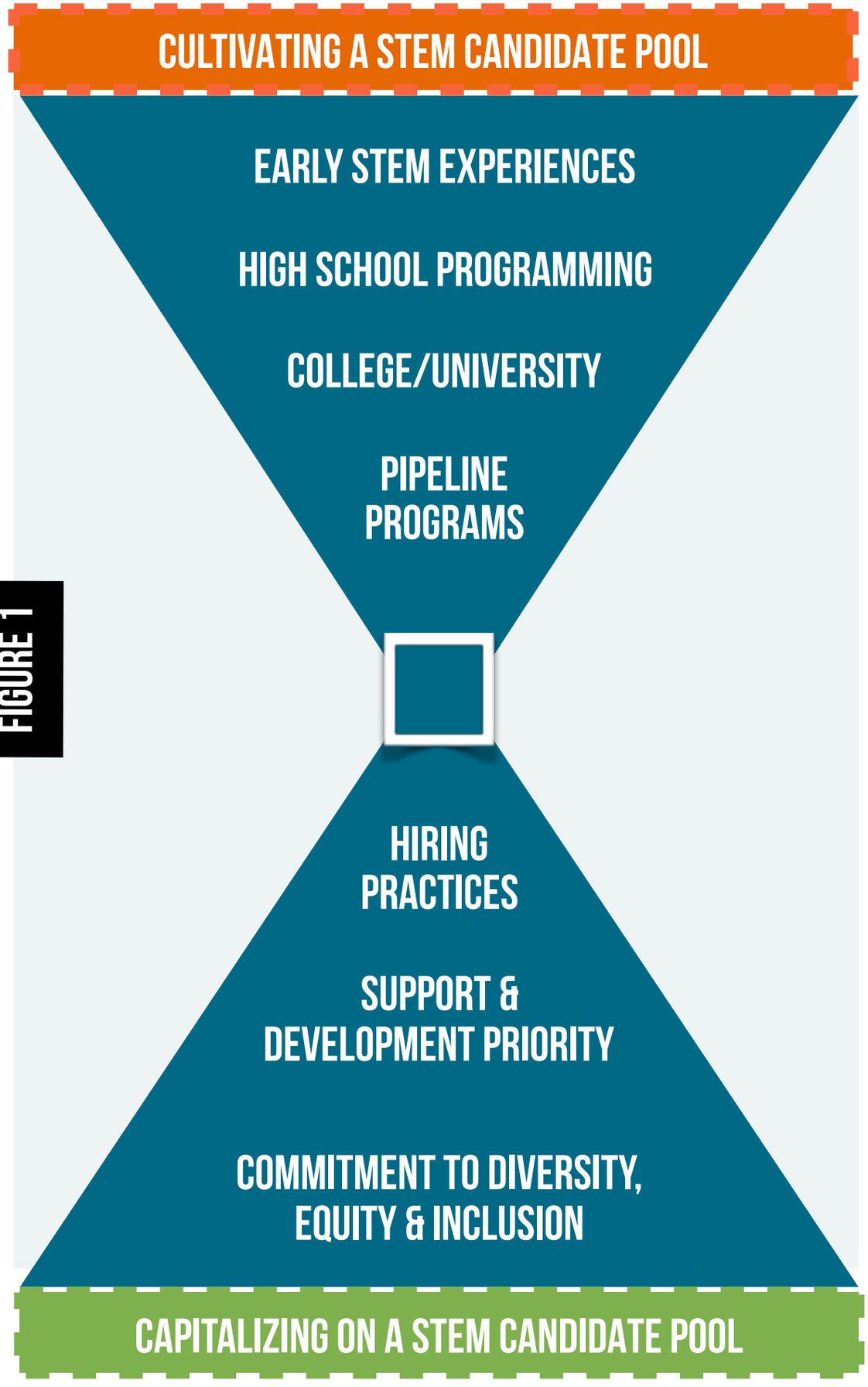
committed to retaining a static workforce. President Trump's administration, however, advocates for a smaller federal workforce and has adopted a policy of shrinking the government's size through attrition. Under such conditions, agencies struggle to fill vacated positions without a lengthy justification for why they require the position they wish to post and fill along with senior official approval of all new positions. These policies result in longer hiring timelines and fewer federal posted positions. It is against this backdrop that the Department of Energy's (DoE) Office of Environmental Management (EM) approaches significant staffing challenges of its own.

Conceptual Framework and Review of Relevant Literature

Our inquiry is concerned with how a public agency can recruit individuals into STEM careers. For the purposes of this investigation, we refer to the journey of young people from childhood to college to a career in a science, technology, engineering, or mathematics field as the STEM pathway. We use the term pipeline or pipeline programs to refer to employer sponsored programs which aim to attract STEM graduates into a job.

In the process of completing this analysis, the research team developed a framework to understand how STEM pipelines and hiring processes interact and can be maximized for a public organization's benefit, represented by Figure 1. We first describe our conceptual framework and then provide a review of relevant literature to support elements contained therein.

FIGURE 1



The goal of a recruiting or pipeline program is to convert highly skilled external job candidates to hired staff within an organization. While simple in concept, many external factors contribute to creating a diverse pool of potential STEM career candidates. The road to hiring in a STEM field at a public organization does not begin with a resume. In early life, pathways to STEM careers exist with multiple junctures at which some candidates persist to graduation with a STEM degree and others leave for opportunities in other content areas or fields of interest (Cannady, Greenwald, & Harris, 2014). A disproportionate amount of women and minorities leave the STEM pathway.

In an effort to create a larger pool of STEM candidates and to ensure this pool is representative of the country's population, understanding the STEM pathway from childhood to job choice and application is important. Research shows that factors throughout the K-12 pathway influence an individual's likelihood of entering a STEM major in college. College experiences similarly influence an individual's likelihood of graduating with a STEM degree. Employer sponsored pipeline programs can support an individual's decision to apply for STEM positions with an employer.

Increasing the number of STEM professionals in a candidate pool does not ensure candidates will take positions with a public agency. Hiring talent in competitive industries requires organizational priorities and corresponding systems and structures that allow for a mission aligned and efficient hiring practices.

These factors combined comprise a model of thinking about maximizing STEM hiring potential in a public organization. A discussion of the components of this conceptual framework follows.

The STEM Pathway from Cradle to Career

Concern about the number of men and women entering science fields is well documented by the science education and workforce development community (Whalen & Shelley, 2010; Rask, 2010). In 2011, President Barack Obama's Jobs and Competitiveness Council announced that the economy needed to produce at least 10,000 additional engineers each year to meet workforce demands and increase innovation (Salzman, 2013). While some scholars disagree about the severity of the STEM employee shortage, research suggests a large share of people who are initially interested in STEM subjects as children do not persist to a STEM career as adults (Salzman, 2013).

In a literature review on the subject, Osbourne, Simon, & Collins (2003) found that most young children hold positive views toward STEM and STEM in school; however, fewer than ten percent of high school students matriculated to college with an intent major in STEM fields in 2008 (Snyder, Dillow, and Hoffman, 2009; Whalen & Shelley, 2010; Shapiro & Sax, 2011). While in college, the number of students who complete a STEM major decreases further (Astin & Astin, 1993; Chen, 2009; Shapiro & Sax, 2011). This is often called the leaky pipeline phenomenon and is particularly acute for women and minority students studying STEM subjects (Shapiro & Sax, 2011; Griffith, 2010; Riegle-Crumb, Moore, & Ramos-Wada, 2010). Organizations that wish to recruit more STEM graduates of greater diversity for jobs should take steps to improve this leaky pipeline.

Early exposure to STEM can be foundational for students.

Elementary and middle school programming

The age at which students first become interested in STEM is a relatively new research subject. Sadler, Sonnert, Hazari, & Tai (2012) found that the strongest predictor of an interest in STEM at the end of high school was an interest in STEM at the beginning of high school. Dabney et. al (2012) examined interviews of STEM professionals and students and found more than 40 percent of them developed an interest in science or mathematics in elementary school. Maltese and Tai (2010) reviewed more than 100 interviews to determine when scientists and physics or chemistry graduate students first become interested in their STEM field. They found most participants became interested in STEM before middle school grades (Maltese & Tai, 2010). Eighth grade students who indicate an interest in a STEM career were at least two times more likely to earn a STEM degree (Tai et al, 2006). These research studies suggest that students who intend to pursue a career in STEM often make this decision for themselves by middle school. The findings highlight the importance of early (pre-high school) experiences, socialization, and characteristics in forming career intentions in STEM. This follows what is known about career aspiration development, as scholars agree that by early to mid adolescence career aspirations have been formed (Seligman & Weinstock, 1991; Bandura, Barbaranelli, Caprara, & Pastorelli, 2001). Sadler et. al (2012) suggest that utilizing initiatives targeted at increasing the interest of students, particularly girls and minorities, at primary and middle school levels may be a promising approach. Additionally, reducing the attrition of students from the STEM pathway and increasing the recruitment of students skilled in math and science who have not previously expressed an interest in STEM may also be beneficial recruitment strategies (Sadler, et al 2012).

Finally, increasing students' experiences with women and minorities who work in STEM fields may also contribute to a more diversified STEM workforce (Blackburn, 2017; Griffith, 2010; Wang & Degol, 2013). This can be accomplished through school based programs, mentoring initiatives, and utilizing public libraries as a source of information and a platform to bridge the knowledge and information gap between secondary and postsecondary institutions (Blackburn, 2017; Hall, et al, 2011; Sahin, Ayar, & Adiguzel, 2014, Raines, 2012).

High school programming

Noting the importance of elementary and middle school experiences on STEM pathways does not suggest, however, that the decisions students make and the experiences they have in high school do not have bearing on future STEM careers. In fact, if student interest in STEM fields begin in middle school, they are crystallized and refined in high school, where students may select specialties and learn about specific degree programs to support their aspirations (Low, Yoon, Roberts & Rounds, 2005). The strongest predictor of entering a STEM major in college is students' academic preparation in high school (Tai, Liu, Maltese, & Fan, 2006).

Researchers suggest content and sequencing of high school courses can affect students' decisions to pursue and persist in STEM majors. Wang (2013) and Tyson et al. (2007) both found student participation in higher levels of high school mathematics predicted student STEM major persistence in college. Students with more AP course experience, for example, are more likely to complete a STEM major in college (Griffith, 2010). In a comparison of international STEM programs, Andreescu et al. (2008) found that educational systems with strong mathematics programs and a high percentage of college STEM majors were built on a foundation of a rigorous national mathematics curriculum.

Curricular organization appears to matter in determining the trajectory of students who complete STEM majors. STEM subject course curriculum is often siloed whereby science teachers teach science classes and math teachers teach math courses with little opportunity for an integrated approach. This is unfortunate as integrated approaches to teaching STEM through which students more fully appreciate subject matter application appear to support the development of higher order reasoning, logic skills, and eventually, STEM persistence (Stone & Lewis, 2012). Gottfried and Bozick (2016) and Gottfried, Bozick, and Srinivasan (2014) found a positive relationship between applied science courses and a student's attending college and enrolling in a STEM major.

High school type may influence student selection into STEM majors and by extension STEM careers. Students who attend STEM focused high schools are more likely to indicate an interest in a STEM career, to matriculate to college in a STEM major, and to complete a STEM major than their peers who attend traditional high schools (Franco, Patel, & Lindsay, 2012; Thomas, 2000). While STEM schools may provide a fruitful recruiting ground for STEM majors and careers, it is important to note that with selection bias in play, it is difficult to determine if STEM high schools create more interest in later STEM careers.

College programming

Not enough college students are enrolled in STEM majors.

Prior et al. (2009) found that just 24 percent of entering college students reported an interest in studying STEM subjects, and within these students, fewer still will complete their STEM degree (Chen & Weko, 2009).

In a longitudinal study of more than 25,000 students, Astin (1993) found a 40 percent drop in the number of students majoring in science, mathematics, and engineering between their freshman and senior years of study. Chen (2009) built on Astin (1993) 16 years later, finding that just 53 percent of STEM major entrants persisted in a STEM field. Chen and Soldner (2013) found similar results when reviewing Beginning Postsecondary Students data from 2004-2009 and the 2009 Postsecondary Education Transcript Study: only 52 percent of undergraduates and 31 percent of community college students remained in STEM fields after four years (Chen & Soldner, 2013).

Researchers have started studying what conditions contribute, or do not, to graduating with a STEM degree. Griffith (2010), for example, found that the environment of the institution and STEM field department had a strong impact on the persistence of students in STEM majors. Students attending selective institutions with large graduate to undergraduate ratios and a significant amount of spending devoted to research had lower persistence in STEM major, while those at selective institutions with large undergrad to grad ratios were more likely to persist in STEM majors (Griffith, 2010). Higher grades in STEM field courses relative to other courses during the first year of college increased the probability of continuing in a STEM major.

Out of school time

Enrichment activities generally have positive effects on student achievement.

Students who participate in non-formal learning activities such as school clubs have stronger academic and social outcomes and are more likely to go to college than peers who do not (Camp, 1990; Eccles & Barber, 1999; Shernoff & Vandell, 2007; Lipscomb, 2007). Gottfried and Williams (2013) tested whether this was the case for STEM specific clubs. Specifically, the researchers were interested in knowing whether students who participated in STEM clubs in high school eventually elected to take STEM courses in college. They found a positive relationship between math and science club participation and high school GPA and a positive relationship between math club participation and STEM college major selection (Gottfried & Williams, 2013).

Students who have role models or mentors in STEM are more likely to pursue STEM careers (Austin & Sax, 1996). The positive effects of STEM mentoring on all students, and particularly women and minority students, are well documented and appear throughout the K16 pathway (MacPhee, Farro, & Cannetto, 2013; Holland, Major & Orvis, 2012; Griffin & Perez, 2010; Gorman, et al., 2010).

Numerous studies have examined the impact of STEM mentoring, as well as innovative ways to accomplish it. Kendricks, Nedunuri, & Arment (2013) found that STEM mentoring at an HBCU was linked to increased academic performance, retention, and graduation of minority students in STEM fields. The study also found that students consistently rated mentoring as having the largest impact on their academic performance. Sahin, Ayar, & Adiguzel (2014) found that STEM based after school programs served the dual purpose of exposing students to both engaging STEM activities and experiences, as well as providing mentors and role models through the instructors and exposure to STEM professionals. Stoeger, et al. (2013) found that girls between eleven and eighteen years old who participated in a one year online STEM mentoring program demonstrated increased STEM activity, knowledge of university studies and jobs in STEM, and STEM elective intentions. Stoeger et al. (2013) posits that e-mentoring of girls by women with a track record of success in STEM can provide more opportunities for mentoring as it removes the barriers of time inflexibility and lack of mobility. In summary, these studies demonstrate that having a STEM mentor is critical for the persistence of many students into STEM career fields.

Self image and STEM

Research confirms a link between self-perceptions and gaps in intention to declare STEM majors (Correll, 2001; Nagy, Trautwein, Baumert, Koller, & Garrett, 2006). As early as elementary school, perceptions of self-efficacy affects career aspiration (Bandura, et al. 2001). Research supports the notion that student self confidence influences academic success in STEM specific disciplines. Eccles and Wigfield (1995) found students succeeded in tasks when they had positive self-ability perception. The authors argued that "adolescents' perceptions of their own abilities were more strongly related to to attainment values and interest in the tasks than perceived utility values" (Subotnik, Tai, Rickoff & Almarode, 2009). This has become known as the expectancy-value model. This framework helps to explain why students often prefer subject areas that come more easily to them and why students dislike subjects in which they perceive themselves to be weaker.

Hannover and Kresels (2004) found that students are more interested in subjects when their perception of a subject practitioner matches how they view themselves. In the study, students viewed a prototype of students who like science as more arrogant and less attractive than students who do not like science. The researchers suggested that a student with strong self image and competing, positive prototypes is more likely to persist into a STEM career. This adds another nuance to existing research on the importance of mentoring and real-world, representative examples of scientists to support persistence in STEM (Lee, 1998; Lee, 2002).

Not everyone has equal access to the K-16 STEM pipeline.

Diversifying the K-16 STEM Pipeline

Women and minorities are much less likely to enter a STEM field than their white male peers (Seymour & Hewitt, 1997; Campbell, Denes, & Morrison, 2000). This is particularly problematic as STEM careers provide paths to economic stability and growth for these demographics (Stadler, et al, 2012). In the last decade, more women and minorities have entered STEM professions, but gaps remain (Huang, Taddeuse, Walter, & Samuel, 2000; Xie and Shauman, Blickenstaff, 2005)

Women in particular appear to decide on a STEM career in middle school (Kinzie, 2007). Women students report that understanding the real life applications of STEM content helped them retain an interest in STEM in middle and high school (Hyde & Gess-Newsome, 2000). Miller et. al (2006) found that female high school students were more interested in people centered careers than their male peers. Their research suggested that physical science courses could better connect science careers to their people impacts (Miller et al., 2006). Shapiro and Sax's (2011) review of the literature on women in STEM concluded "women's experiences with the curriculum as well as interactions with instructors and peers are influential in shaping women's interest in and longer-term commitment to STEM." Factors that improve the recruitment of women in STEM include developing an identity linked to STEM from a young age, having a supportive family, and access to quality advising (Blackburn, 2017).

There are strong gender differences in who declares a STEM major (Xie & Shauman, 2003; National Science Board (2010); Simon & Farkas (2008). Women are 57 percent of college attendees, but among first year college students, only 17 percent of women intend to major in a STEM field compared to 32 percent of men (Shapiro & Sax 2011; Pryor et. al, 2010). Additionally, a smaller share of women persist in STEM majors than their male peers (Blackburn, 2017; Stadler, et al, 2012; Griffith, 2010). When there are more female minority faculty members, the number of female minority STEM graduates increased (Qiam, Zafar, & Xie, 2009). Similarly, Female and minority students were more likely to persist in STEM majors at institutions with higher percentages of female and minority grad students; as the graduate student population in STEM fields becomes more female and minority, so does the undergrad STEM population (Griffith, 2010).

Among the factors that influence the persistence of women and minorities in STEM career fields are a sense of self-efficacy and STEM mentoring (Stadler, et al., 2012; Wang & Degol, 2013; Hall, et al., 2011). Blackburn (2017) found that in creating a smooth STEM Pipeline, formal and informal engaging STEM classroom activities, access to volunteer and mentoring opportunities, and building strong self-efficacy were all significant factors. This was particularly true for women and minorities; developing an early STEM identity, having a supportive family, and confidence in math and science abilities were also critical factors for these subgroups. It stands to reason, then, that confidence in math and science abilities and a sense of self-efficacy are necessary precursors to an interest in and persistence in a STEM career field.

Mentoring may function to increase the persistence of women and minorities in STEM in multiple ways.

In addition to providing guidance and encouragement, when the mentors are also women and minorities, they may also serve as role models in which students can see themselves (Hall, et al, 2011; Stadler, et al, 2012; Kendrick, Nedunuri, & Arment, 2013; Gorman, et al, 2010). Kendricks, Nedunuri, & Arment (2013) found that participants in a STEM mentoring program at an historically black college or university (HBCU) consistently reported that their mentoring relationship was the most significant factor in the academic performance and continuation in a STEM field. In addition to providing guidance, encouragement, and role models, mentoring may also contribute to an individual's social capital through the transmission of "insider knowledge" from mentor to mentee on STEM career development, opportunities, and advancement. The research literature demonstrates that in creating STEM pathways to attract and recruit women and minorities, starting early (elementary and middle school) with engaging curriculum to increase self-efficacy and confidence in math and science, and providing going mentoring and support are critical to retaining women and minorities in the STEM pipeline (Blackburn, 2017; Griffith, 2010; Stadler, et al, 2012; Wang & Degol, 2013; Hall, et al, 2011; Raines, 2012; Kendricks, Nedunuri, & Arment, 2013).

Characteristics of successful K-16 STEM programming

In summary, research suggests the following elements contribute to a strong and inclusive STEM K-16 pipeline.

- Early engagement of students in STEM content and real-world application;
- High-quality STEM curriculum and courses which are appropriately sequenced;
- An emphasis on the integration of STEM content;
- Enrichment opportunities which allow students to further engage in STEM content;
- Access to role models with whom students can develop supportive relationships; and,
- Role models and teachers who are representative of STEM students.

Pipeline Programs

Georgetown's Center on Education and the Workforce suggested that by 2020, 65 percent of jobs will require education or training beyond high school, and the National Conference of State Legislatures predicts that by 2020, the country could see a shortfall of 1.5 million people with the necessary middle and high skill levels to fill jobs, and the U.S. could have 6 million low skilled, likely unemployed, workers (NCSL, 2012). This skills gap, some researchers say, has dire consequences, 'including economic underperformance, social unrest, and individual despair (Laboissiere and Mourshed, 2017).

Students are responding to the need for more education. More than 19 million students attended college in 2018 (NCES, 2018). The number of short program, vocational credentials earned by students at public community colleges more than doubled between 2000 and 2012 (Soliz, 2016), a promising development at a time when skills are more important than ever as determinants of labor market earnings (Holzer, 2008). A question remains as to how the public sector, particularly the federal government, can maximize its resources to create positions for these skilled workers, particularly those in STEM fields. This question is especially relevant at at time in which the United States spends fewer and fewer public federal dollars on workforce development (Holzer, 2008). Promising policies and practices (e.g., pipeline programs that connect recent graduates to federal agencies) are emerging to address these gaps, but there is limited research on them, and very little is currently known about which aspects of workforce training programs are essential for student success and support growth (Soliz, 2016).

There is an emerging precedent for federal and state agency partnerships to start partnerships aimed at local workforce development (RAND, 2018). RAND researchers have been working with the Federal Emergency Management Agency and Puerto Rican agencies to create a workforce development system to train--and retain--workers with the skills they need to compete in the 21st century labor market. Recently, increasing numbers of state legislatures have focused on apprenticeships and other work-based learning, sharing workforce information and data, tailoring job services, aligning K-12 education to job needs thru career pathways, tailored plans for students, and dual credit with postsecondary opportunities (NCSL, 2012). Through these examples, researchers are beginning to codify what makes a strong workforce development program led by government agencies, but more research is needed.

Public Agency Recruiting and Hiring

Much has been made of the differences between today's young people and working Baby Boomers. According to some researchers, members of the X and Millennial generations are more self-absorbed, possibly due to the self-esteem movement which began in the 1980s (Twenge, 2006). This is hardly a decided point, however, as researchers have taken issue with the evidence used to make these claims (Trzeniewski, Donnellan, & Robins, 2008). It is true that how young people in the workforce behave today appears to be different than Boomers remember behaving themselves (Deal, Altman, & Rogelberg, 2010). However, as they say, memory can be a fickle thing. Fifty years ago, then 50 year olds thought very little of their Boomer colleagues (Seligman, 1969).

There are few evidence-based differences in workforce behaviors and attitudes between today's young people and Boomers.

This is due in part because data on the attitudes toward work of previous generations is limited, so empirical research is similarly limited (Twenge, 2010). Furthermore, differences in work based on existing data can oftentimes be explained by larger cultural shifts. For example, young people today work more hours in the day than they did in the 1970s but this is true for the entire U.S. workforce (Family and Work Institute, 2005; Staff & Schulenberg, 2010). While it is true that young people today appear to volunteer more or show interest in social ventures more than previous generations, there are also more social ventures in which young people today can participate. Twenge (2010) showed that young people in the workforce are no more altruistic than their older peers were.

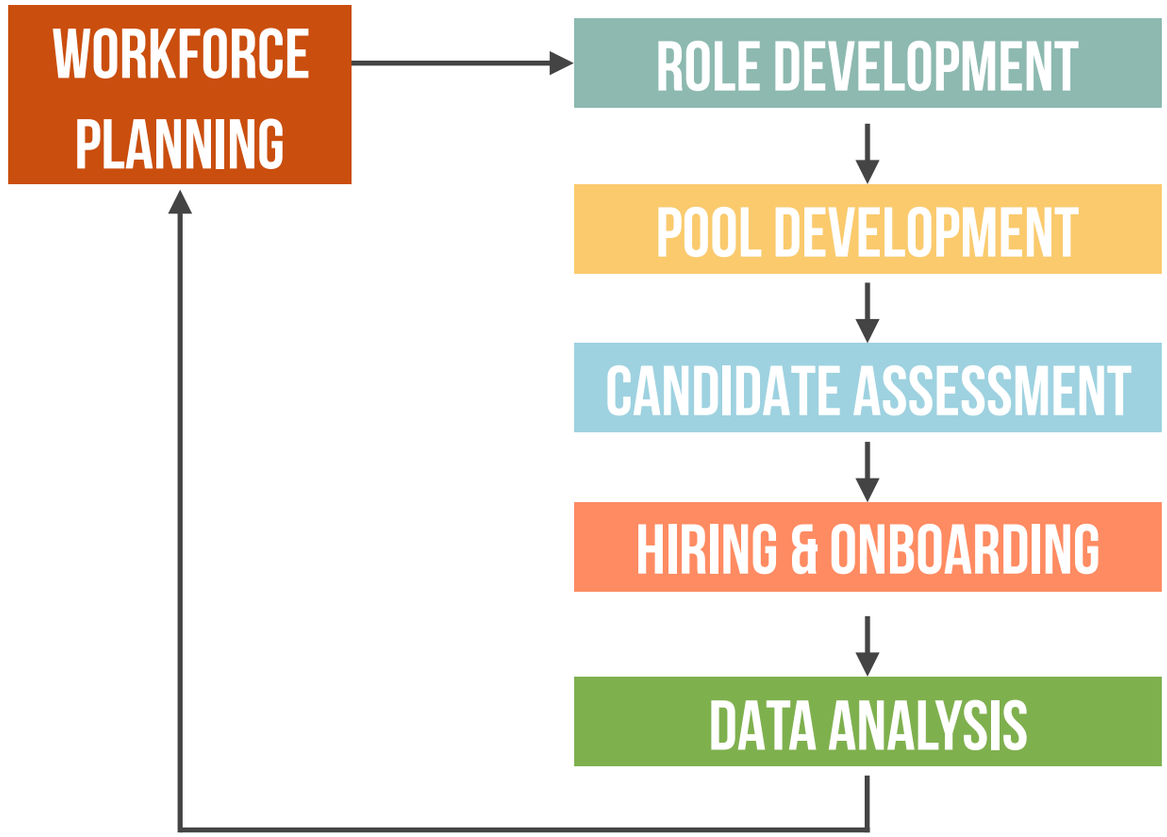
What do we know about documented generational differences in attitudes towards work? More recent generations place less value on work for its own sake (Twenge, 2010). Similarly, Boomers appear to be more work-centric and more recent generations are more family-centric (Cennamo & Gardner, 2008). Levine (2008) suggested that millenials prefered more structured environments and clarity on expectations than their older colleagues. Hershatter and Epstein (2010) built on Levine's work and argued that millennial college graduates seek structures of support, clarity of assignment, and more personal feedback from and relationships with their bosses. Evidence to support this was found in a 2008 survey in which 66 percent of millennial business students agreed with the statement "I prefer personal relationships with my bosses," compared to 52 percent of Gen Xers.

While there may be slight differences between older and younger generations in the workforce today, best practices for establishing workplace culture likely work just as well for today's young employees as they did for Boomers. For this reason, we document general best practices in recruiting, hiring, and supporting workers.

Key Systems for Successful Hiring

Since there is little empirical data on the difference between Boomers and younger generations, hiring agencies should consider implementing general best practices for cultivating, attracting, and hiring strong candidates. Groysberg, Nohria, and Fernandez-Araoz (2009) conducted a mixed methods study of 50 global companies to identify characteristics of organizations that successfully created staffing pipelines for key vacancies. First, the researchers found that companies were more successful when they prioritized resources towards hiring practices. Second, they developed a framework to articulate key features of a successful hiring program (adapted into Figure 2).

FIGURE 2



Strong recruitment efforts begin with clear workforce planning. Workforce planning includes reflections on current staff, planning for separations and retirements, and considerations of major upcoming projects the organization and its departments will undertake in coming years. From there, positions are clarified so that recruiting staff can focus their attention on the most necessary job skills required of a vacancy. Recruiters are most successful when they have a large pool of candidates, cultivated both inside and outside of the hiring organization. Candidate assessment practices should be rigorous. Hiring offers are most effective when they are made by hiring managers and not just HR staff; further offers that emphasize the match of the candidate to the opportunities of the position are the strongest of all. A strong hire is only effective when the onboarding process is solid, and programs through which new hires are matched with mentors are most successful. Finally, organizations which excel in hiring regularly take time to review their hiring practices, analyze hiring data, and conduct interviews with applicants to understand their experiences (Groysberg, Nohria, & Fernandez-Araoz, 2009).

Coaching and Mentoring Support

Over the last four decades, there has been a dramatic increase in organizations' commitment to coaching (International Coach Federation, 2016). Hiring great people is only good if you can keep them, and given this increase in coaching especially in the private sector, it's worth considering how federal agencies can provide the coaching more and more candidates are seeking in an employer. Coaching has been shown to increase job performance (Bozer et al., 2013) and enhance leadership skills in employees (Mackie, 2015).

Despite early returns on coaching, little empirical research exists on the exact coaching components needed within EM's unique context, or more broadly, within the federal government. However, emerging research is beginning to shed light on this topic. Meta-analyses studies by Jones et al.(2016) and Theeboom et al. (2014) found that coaching had a positive impact on job performance and learning. Jones and Zhou (2018)'s built on Mackie's (2014) work and found coaching has positive impacts on well-being, self-efficacy, motivation, and satisfaction.Jones and Zhou (2018) argue that coaching is more effective within highly complex and technical roles, which we propose describes EM's reality.

Diversity in the Federal Government

Research on diversity initiatives in government started to emerge in earnest in the early 1990s, starting with Jamieson and O'Mara (1991)'s work on emerging practices. They could only cite one public sector example, so researchers and federal agencies began to benchmark themselves against initiatives in the corporate sector. In 1995, Eleanor Laudicina conducted an initial assessment of workforce diversity in government. Her findings were promising: federal agencies, she found, are on par, or even ahead, of their corporate counterparts in recruitment, retention, training, development, and benefits programs that aim to enhance workforce diversity (Laudicina, 1995). Laudicina (1995) cites, however, that little is known about diversity initiatives in government, and few exemplar models have been spotlighted.

In the early 1990s, researchers started to predict serious problems in federal agencies' ability to recruit and retain a diverse, viable workforce (Laudicina, 1995).

Hays and Kearney (1992), for example, questioned how the federal government was going to be able to recruit effectively (with an eye towards diversity) in the labor market.

Since the 1970s, federal agencies have been required to increase the representation of women and minorities at all levels (Laudicina, 1995). The U.S. Office of Personnel Management (OPM) requires agencies to develop and implement a "comprehensive, integrated, and strategic focus" on diversity and inclusion (FEORP, 2016). As an organization, OPM supports diversity and inclusion in the Federal Workplace and partners across government agencies to support employee inclusion and team productivity (FEORP, 2016). OPM's 2016 report on diversity indicated that diversity levels have improved slightly, remained flat, or in some cases regressed (FEORP, 2016).

At the turn of the 21st century, a greater focus on diversity within the federal government emerged. In 2000, Al Gore spearheaded the publication "Best Practices in Achieving Workforce Diversity," which argues that federal organizations should align diversity to the core organizational goals and objectives of the agency. One of the first major governmental reports on diversity and inclusion within the federal government, BP claims that workforce diversity should not be viewed as the quantitative representation of groups, but as a systematic application of diversity concepts to the fabric and mission of the federal agency.

However, in his analysis of the FEORP 2016 report, Bill Valdez, president of the Senior Executives Association, claims that there is lack of alignment between mission goals and diversity and inclusion programs in federal government, which has contributed to D&I efforts being stalled within agencies (Davidson, 2018). Valdez also cites a lack of rigorous and analytical research base for D&I programs, a contributing factor to the "perpetuation of federal policies that have contributed to underrepresentation in the federal workforce" (Davidson, 2018).

There is still much to learn about diversity initiatives in government and there is still a need for exemplary models. In analyzing the Department of Defense's initiatives created to align DoD STEM and diversity goals with national priorities, Lim et al. (2013) found that DoD has articulated diversity goals in policy documents, but based on the imprecise definition of diversity it provides, it is not possible to evaluate how DoD is performing against their diversity goals, which echoes Davidson's claim about the lack of analytics and metrics for these initiatives (2018). The imprecise definition of diversity is a major consideration as EM doubles down on diversity initiatives.

METHODS

The project team utilized a mixed methods design to explore and understand the factors impacting EM's recruitment and hiring of a young, diverse workforce. An in-depth qualitative research design was selected as the primary focus of the study to identify the variables that attract millennials to careers in STEM and EM, barriers to recruiting and hiring a young, diverse EM workforce, and to evaluate the effectiveness of current EM recruitment pipeline and pathway career initiatives. Patton (2015) states that "qualitative methods facilitate study of issues in depth and detail. Approaching fieldwork without being constrained by predetermined categories of analysis contributes to the depth, openness, and detail of qualitative inquiry." The qualitative research design was augmented by a subsequent quantitative research methodology which was employed to compare EM's recruitment and hiring data as benchmarked against other federal agencies.

Initial project design began in the fall of 2018 through conversations with our EM point of contact. Our point of contact was on assignment as a visiting scholar at Vanderbilt University. She acted as a liaison for key leadership staff including our project sponsor at in the DOE Office of EM, the Associate Principal Deputy Assistant Secretary. Eventually our research team was connected with an HR management analyst in EM who provided us with data support throughout the duration of our project.

Data collection included conducting relevant interviews, securing necessary documents, and observing work environments at the EM sites. The research team conducted weekly calls to ensure a thorough understanding of project-related work. Documents were housed on a google drive and interview recordings and transcripts were held on a password-protected server.

Interviews

In consultation with EM, the research team determined that the project questions would be best answered through interviews of junior staff and a select group of hiring managers. A group of 10 supervisors were identified by EM leadership and emailed by the Associate Principal Deputy Assistant Secretary who introduced the study and the research team. Members of the research team conducted follow up outreach.

Because of limitations set by certain federal labor unions, EM leadership could not release email addresses for all employees under 35 to us. In conjunction with an EM management analyst, the research team described the project goals and intended methodology to a federal labor manager at the EM Consolidated Business Center. After several follow up conversations over a period of six weeks, the EM leadership team received word that because the employee list was split across several labor unions, obtaining final approval would take several more weeks. At that point in time, the research team and EM staff decided it would be best to move forward with a contact list of non-unionized employees who were under 35 and relatively new to their assignments.

The EM HR management analyst provided a list of 28 individuals who fit the above criteria, located in six of the 16 EM sites. The six sites were located in the southeast and western regions of the United States. Once again, the Associate Principal Deputy Assistant Secretary sent an email to these possible interviewees introducing the study and the research team. The research team followed up with possible interviewees, ultimately scheduling with 20 of these individuals after reiterating the purpose of the study.

Participation was completely voluntary with no benefit nor penalty for participating or not participating. The DOE-EM was not notified of who participated and who did not to protect participant confidentiality and avoid any potential occupational consequences to study participants. All study participants were provided with and signed an informed consent, notifying them of their rights and their ability to discontinue the study at anytime without penalty.

Most participants were interviewed individually, while a small number were interviewed in pairs. Due to the multiple locations in this study, interviews were conducted both in person and remotely via video conference. Interviews were conducted on site at three locations: the Savannah River Site in South Carolina, Washington, DC, and Germantown, Maryland. Remote interviews were conducted with EM employees in Hanford, Washington, Carlsbad, New Mexico, Paducah, Kentucky, Oak Ridge, Tennessee, and Washington, DC. While on site, the research team met with additional individuals who were new EM hires and who were not part of a labor union. This resulted in an additional six interviewees. In total, the research team interviewed 33 EM employees; 8 of these were hiring supervisors and 25 were young EM employees. Sixteen of the interviews were conducted in person, and 17 were conducted via video conference. All interviews were recorded. All participants agreed to allow the interviews to be recorded and no identifying data of the participants was maintained. The interview protocols involve questions about their work in the Department of Energy, their educational experiences and career choices, their connection to STEM, their perceptions of workforce diversity, and their perception about recruiting and hiring.

Documents

EM's website provides an in-depth overview of the organization's mission and history along with semi-current updates on work at its 16 sites around the country. Additionally, the research team requested documents on a range of other topics. Through our EM HR management analyst contact, we received generic job descriptions (e.g. general engineer, information technology specialist, safety officer, etc.), information on federal hiring authorities, and workforce planning templates. Other leadership staff provided employee handbooks, appraisal documents, and diversity and inclusion policies and regulations.

Observations

While onsite, researchers documented work conditions and staff interactions. The research team also spent time navigating USAJOBS to gain the perspective of a candidate applying for a position with EM.

Establishing Benchmark Comparisons

EM leadership expressed a desire to better understand how other agencies approached pipeline programs. EM staff provided the research team with a contact in human resources at the National Nuclear Security Administration (NNSA). In consultation with EM staff, the research team developed a series of interview questions for this contact. Scheduling with NNSA staff proved difficult, but the research team was able to conduct one interview with a member of the NNSA team.

In addition, the research team sought out other models of successful pipeline programs, hoping that observations and conversations with administrators of such programs would yield insights for the EM team. Interviewees from the Oak Ridge site mentioned the Oak Ridge Associated Universities (ORAU) as a model internship program. ORAU is a consortium of 125 national universities who have partnered with the federal government to create STEM pipeline initiatives from K - College. ORAU has worked with the Department of Energy for over 70 years to educate, recruit, and train individuals to meet the STEM needs of the federal workforce through their Oak Ridge Institute for Science and Education (ORISE) program. Annually, ORISE recruits and fills 10,000 internship with K-12, college, and graduate students. In an effort to capture this expertise, the research team conducted three additional interviews with key ORAU staff on K-12 pipelines, recruiting practices, and workforce development.

Quantitative Analysis

In order to test qualitative findings, the research team used large publicly available data sets to compare the Department of Energy to related agencies. We examined survey responses from the 2018 Federal Employee Viewpoint Survey (FEVS) for the Department of Energy, the National Aeronautics and Space Administration, and the Nuclear Regulatory commission. These two other agencies had been recommended by EM leadership because of similarities in job content and function. To examine differences in means, we completed a one-way ANOVA analyses on dependent variables from the survey related to our findings.

We selected the following survey statements to analyze:

- “Policies and programs promote diversity in the workplace (for example, recruiting minorities and women, training in awareness of diversity issues, mentoring).”

- “Supervisors work well with employees of different backgrounds”

- “Work unit is able to recruit people with the right skills.”

In addition, we reviewed aggregate results of the FEVS for EM and attempted to triangulate those results to agency-wide publicly available data. While imprecise, we believe this presents a picture for EM leadership to better understand and address issues related to recruitment and workforce diversity and validates key qualitative findings.

Data Coding and Analysis

Interviews

Data analysis and coding consisted of a listening tour and notes review for all interviews. During this process, research team members reviewed the interview recordings three times; the first time listening to review the interview and gain familiarity, the second time listening for themes, and the third time listening for illustrative quotes. Based on the listening tour of each interview, data matrices were developed. A concept-clustered matrix strategy was selected to analyze the data so that themes identified could be linked to the study’s conceptual framework.

After matrices were created for each interview, a master matrix was created which identified major themes that were seen across the interviews. Organizing categories were based on our conceptual model: STEM recruitment, career choice, systems and structures in hiring practices, and workforce development strategies. Within each category, we utilized illustrative quotes, documentation, and observations based on subcategories developed from our initial analysis of themes. These subcategories were grounded in the literature and based on the research questions. All leadership and staff interviews were subjected to the same data analysis and coding strategy.

Observations and Documents

Observational and document analysis provided a broad understanding of federal approaches to hiring, diversity initiatives, and employee appraisals. Research team members considered this evidence in aggregate and comparison.

Limitations

The project team acknowledges several limitations to the study. First, the interview sample raises several issues of external validity, limiting the generalizability of the findings. EM provided our list of 28 possible interviewees who were under 35 and not part of a labor union. As the project went on, it became clear that this list was not inclusive of all employees who met this criteria; therefore, while the information presented here provides a view into the experiences of a class of employees, it is possible that it misses key experiences of staff who are under 35 and not in a labor union.

Within the constraints of our interviewee list, the research team attempted to ensure regional representation. The list of possible interviewees contained individuals at seven sites. This is due, in part, to the non-union constraint as more EM staff is unionized in certain states than others. Interviews were conducted with staff from six of the seven provided locations. Of possible interviewees, then, the research team has data from a reasonable representation of sites. However, there are 16 EM sites. Moreover, the research team completed more interviews in certain sites than others. As a result, our findings will have limited generalizability (i.e., external validity) to all EM locations.

Because the research team conducted interviews with participants at multiple sites across the nation, interviews were completed both in person and remotely over video conference. The team was aware that remote video conferencing could potentially impact rapport building with interview participants. To mitigate this issue, the research team recorded all online interviews with video technology and audio recorded in-person interviews. Nonetheless, there is still a difference between in person and remote video interview environments. Similarly, for convenience and participant comfort, a few interviews were conducted onsite in pairs as opposed to individually. While the data collected from the remote video interviews and the interviews conducted in pairs do not appear to have resulted in different trends, the research team does acknowledge this difference in interview environment as a potential limitation.

Our sample of young employees included a few individuals who participated in the Environmental Management Professional Development Corps (EMPDC) or Recent College Graduate pipeline programs, but the majority did not. We collected data on the experience of pipeline programming with those candidates who participated. For those individuals who did not participate in such a program, we focused our instead on factors that attracted individuals to their profession and programming they wished they had. We believe this data is still of value to EM leadership as they conduct workforce planning and outreach, but we acknowledge this is not an evaluation of all the pipeline programs EM supports.

Additionally, the research team struggled at times to receive data from the EM team due to competing priorities, political challenges, bureaucracy, and staff capacity. We submitted a request to the EMCBC for interview approval in early fall, but were not made aware until late November that approval would take several additional weeks. At that point in time, the research team made the decision to move forward with a sample of non-unionized employees. Qualitative data collection did not begin in earnest until mid-December.

Similarly, while EM leadership requested a benchmark analysis of other federal agencies, the research team did not receive a contact at NNSA until February. Despite repeated attempts to conduct interviews with the NNSA, the research team was only able to hold one call for information. We present findings from that conversation here but acknowledge that we have an incomplete picture of NNSA's pipeline strategy.

To strengthen our benchmarking effort, the research team sought out industry leaders in cultivating STEM talent and managing a STEM pipeline. ORAU provided a strong fit for both of these criteria. We conducted three interviews with their staff and believe the data collected from those interviews provides some helpful considerations for EM leadership.

However, ORAU is a non-profit organization operating with considerably fewer constraints than a federal agency and it benefits from a large federal contract to conduct workforce development efforts for national laboratories. Information gathered from ORAU interviewees provides insight into how an organization can cultivate STEM pipelines, but the application of this information to the EM context is imperfect.

We did not explicitly collect data on interviewee demographics, including race, socio-economic status, or the region of upbringing. In retrospect, this is a weakness of our work as we are unable to delineate the difference in STEM pathway or hiring experiences by these distinguishing features unless interviewees specifically refer to themselves in such a way during their interviews. While we present findings on the ways in which EM staff consider the organization diverse, we rely on our own perceptions of interviewee diversity rather than self-identification.

Our interview sample is comprised of individuals who persisted through the STEM pathway and into a pipeline to be hired by EM. While these interviews yielded rich data on their experiences in STEM fields, we do not have data on the experiences of candidates who did not persist. This means that we do not know how different the experiences of our interviewees are from people who applied to EM and did not choose to work for the organizations nor students who left the STEM pathway at some point in their educational experience.

FINDINGS

Research Question #1: What factors attract young employees to STEM fields and eventually their roles in the Office of Environmental Management?

Finding 1: STEM Interest starts early.

Most employees reported an interest in math and science in K-12 programming, a clear desire to work in a STEM application field, and had early opinions that they were good at math or science.

All interviewees reported an early interest in math and science that predated high school. EM employees liked STEM subject areas best in school. Most could trace this interest back to middle school, with some able to trace it back to elementary school experiences. This was true regardless of gender, race, or age of interviewee. Even in cases where interviewees did not explicitly acknowledge early STEM schooling experiences as critical to their ultimate career choice, they often said things like “I knew at a young age that I preferred technical things.” Another interviewee stated, “I really liked cars as a kid and thought I wanted to design them when I got older.”

While interviewees indicated their interest in STEM fields began before high school, they reflected more on the content of high school courses than their K-8 schooling. Most interviewees were successful high school students who excelled in STEM fields. A majority reported taking AP or advanced math and science classes in high school. Even without explicit interview questions on the topic, EM interviewees expressed an early interest in the application of their STEM learnings. For example, when asked about his academic background and STEM coursework preferences, one interviewee remarked “I always wanted to do applied math.”

Additionally, EM interviewees had early successes in STEM content areas. Interviewees said things like “I was always good at science” or “building things came easily to me.” Most interviews with young employees were marked by interviewee self-confidence in technical expertise. Other interviewees may not have expressed their technical prowess in terms of absolute strength; rather, they shared comments like “I had an easier time in science class than in reading.”

“I have always been a science nerd. I wanted to change the world with it.”

Finding 2: Mentoring Matters

Many study participants reported having a family member, teacher, role model or mentor who guided/encouraged/ fostered an interest in STEM throughout their educational experience.Interviewees consistently reported having a teacher, family member, role model, or mentor who encouraged their interest in STEM. At times, it was something as subtle as a teacher saying “You know, you’re really good at math and science. You should think about being an engineer.” Others had more active support from the adults in their lives. One interviewee reported that his father kept him and his siblings busy with projects around their home which involved the application of math and science. The importance of teachers, family members and other role models or mentors in STEM cannot be overstated. The role that these critical adults played in the lives of the interviewees when they were youths provided support, encouragement, guidance, and a vision of what was possible for them as adults.

"People cannot achieve what they cannot see. So if you go into rural communities, or underserved communities where they don't have access or role models in STEM, then it's very difficult to keep going towards a STEM career”

-EM Leader

Interviewees reported mentoring as a crucial support in college and early career. Many reported strong relationships with college professors and cited internship experiences as an important reason why they continued into STEM careers. Others mentioned their supervisors in the armed services as encouraging them toward technical careers. Supports provided by mentors in early career stages played a role in the persistence of interviewees within the EM office. Oh this is interesting and a different issue (field persistence) than field entry As one interviewee put it, “One thing that’s kept me here is the ability to learn from so many accomplished people.” Mentoring played a significant role for most study participants, from their earliest experiences and interests within K-12 education through their persistence in STEM once in the career field. However, access to these mentors within EM was varied, an aspect of the finding which will be addressed later in the discussion.

Interviewees were aware of the impact mentoring had on their educational experience and careers, and several suggested mentoring programs as a means through which EM could cultivate goodwill in its communities and in turn a larger pool of possible applicants. Generally, interviewees believed mentoring helped get them where they were, and many people with whom the research team spoke believed it was a duty to provide similar supports to a younger generation.

Finding 3: We Know Our Mission Matters, but Does Anyone Else?

Most participants cited the mission of EM as being an important part of their reason for working with the agency. However, few deeply knew of EM's mission before joining the organization. Interviewees carry a sense of import about their work. Nearly all reported they were driven by EM's mission and motivated by the importance of the office's work. As an engineer in South Carolina noted, "One of the best things about working here is knowing that we are helping to take care of future generations." Another scientist at the same site relay, "the reason that I do what I do is to protect the worker, environment, and the public." While all interviewees discussed the importance of their contributions toward the larger mission, the degree of connection varied by degrees depending on interviewee location. For example, headquarters employees spoke at greater length about how their work connected to EM's larger mission. Field employees certainly saw their work as meaningful, but discussed to a lesser degree how their work contributed to the national mission. This is could be a function of a field placement where work assignments are more functional as opposed to work at headquarters where work assignments tend to be more strategic in nature and directed toward policy.

Despite pride and satisfaction with their work and the organization's mission, most interviewees had no knowledge of EM, its mission, or its work prior to their employment with the agency. Employees repeatedly acknowledged that most of the public has no knowledge about EM, the importance of their work, and the career opportunities available, including a few interviewees who grew up in communities where EM sites are located. As one interviewee stated, "I'm from [the region I work in now]. But I didn't know anything about EM until I was working for a contract organization. And even then, I didn't know much about the actual work of EM until I was hired." The implications of this knowledge gap on recruiting capacity were not lost on EM employees.

> **As one interviewee acknowledged, "Our work is extremely important. I feel like if we could do a better job communicating this to young people, they would be more interested in our work."**

Finding 4: It's More Than Money

Many employees reported that their decision to work for EM was not based on salary, but rather other attractive incentives and opportunities provided by the agency.

Most interviewees acknowledged that outside of the EM headquarters in Washington, DC, the 16 EM cleanup sites are quite remote and far from the social, cultural, and communal elements that would attract most people, particularly young people, to a work location. As discussed in the previous finding, young EM employees knew little about the EM mission before they applied for their positions. Consequently, their choice to work at their EM site was rooted in more personal factors such as having family ties to the area, having completed an internship at the site, or a desire to work in the geographic region of the site.

In discussing how he chose to apply to their current work location, a scientist in Tennessee explained how he came to be at the Oak Ridge site, “I wanted to be in Tennessee. My life was in Tennessee. So I was just looking all the time for jobs in Tennessee near my hometown.” Another engineer in Carlsbad, New Mexico discussed how he wanted to be closer to his roots: “I wanted to be west. We lived on the east coast for a period of time, but our family is in Texas. I was looking for a way to get closer to them.” So, this location was familiar to me and allowed us to be closer to her family.” Statements like these suggest the remoteness of the EM cleanup sites present a challenge for EM’s current approach to recruiting, as the organization relies on interest in remote locations rather than an interest in the organization’s mission.

While pay at EM was a draw for a few interviewees, many of the EM staff we interviewed were motivated by other perceived incentives such as the stability of working in the federal workforce, student loan repayment, and work life balance. An interviewee in Washington D.C. who had four job offers at the time of his hiring with EM said,

> “EM had the lowest pay, but made up for it with other benefits such as student loan repayment, accelerated promotion, opportunities for advanced education, work-life balance and stability. That's why I chose EM.”

Others interviewees reported they sought employment with EM because it provided a more stable career than could be offered in the private sector.

Research Question #2: What challenges does the Office of Environmental Management face as it recruits young professionals, particularly those of diverse backgrounds?

Finding 1: The Waiting Game

Systemic barriers including lengthy hiring processes and ineffective succession planning limit the organization’s ability to hire young and diverse candidates.

Repeatedly, interviewees commented on how they perceive systems and structures related to hiring to be a barrier in the hiring process of any candidate. Interviewees believed these barriers were a particular impediment to hiring younger employees because of the emphasis placed on experience in the application process. Frequently, interviewees contend, applicants have to utilize specific words on their resumes to be considered for further review. Several interviewees suggested that the process of preparing a “screen worthy” resume removed possible candidates who do not have access to the specific supports required to be successful. In describing their experiences applying for their positions, staff--especially those recently hired--cited how intimidating the application process can be.

"You don't even know how to apply because there are specific things you need to do to address all of the questions and write your resume in a way that meets the qualifications for certification. If you're coming from private sector, you think you have to have a one-page resume but my federal government resume right now is 7 pages long. It's different. Unless you're talking to people who are coaching you through that process, a normal person would not

would not normally apply for a job that way."

A few interviewees suggested reconsidering how the agency values employee experience in the process. As one interviewee stated, "One challenge is veteran's preference in hiring. Veteran's preference isn't a bad thing, but it definitely makes it more difficult for a person just out of college to score high enough [in the application process] to be part of the candidate pool." To some extent, interviewees suggested that veterans' preference hiring skews the age of the workforce upward.

Across sites and roles, interviewees expressed concerns with the application and hiring process. "It just feels like the culture is averse to hiring," one interviewee reflected. One of their biggest concerns centered on the length of time of the process to fill a position. Multiple respondents noted that hiring can take more than a year to fill a position. A hiring manager reflected, "The department takes forever to hire people. And if you have a great candidate on the line, there needs to be incentives to try to keep them for the long wait." Multiple interviewees cited recent hiring processes in which they lost a candidate to another job. "If you're young and talented," one respondent noted, "DOE isn't your only job offer and if it takes that long, then it's unlikely that you'll continue in the process if you have a solid offer on the table." Losing candidates to a poor process seemed to be a point of frustration for hiring managers. "I was told that the application process would take months, and it did, and my process was one of the quicker processes," a staff member noted. Leaders and staff suggested that the length of the process can limit their talent pipelines, particularly when it comes to competing with private sector jobs. "You can get hired on the spot in the private sector," one interviewee noted.

"I had a candidate recently knock the cover off the ball during the hiring process. Resume, great. References, great. Interview, great. And he went to work for a different organization at the end because the process was so convoluted. We spent 7 months trying to hire him."

Interviewees perceive recent political shifts as a barrier in the hiring process. Repeatedly, staff and leadership mentioned that President Trump's administration has called for a smaller federal workforce. Interviewees cite new processes for approving positions as overly bureaucratic and a structural impediment to nimble staffing decisions. New positions must be approved by the Secretary of Energy. Reclassifications of positions are not approved by the Secretary, but they still require a number of approvals at headquarters. Even lateral moves for existing employees require a lengthy transfer and approval process. This comment from one interviewee summed up this sentiment, "Every [new position] has to be signed off by the Secretary [of Energy]. And that takes a really long time. Back ten years ago it took 8 months to be hired. Now it's probably double that."

In 2012, EM moved to a shared service human resource model. DOE and EM pay to receive some human resource functions from the Environmental Management Consolidated Business Centers (EMCBC) located in Cincinnati. Multiple interviewees, particularly those at smaller sites, described confusing lines of authority between the EMHQ and EMCBC that hindered the hiring process and suggested that decentralized hiring may contribute to lengthy hiring timelines.

It is difficult to overstate how frustrated interviewees were about the hiring process. The research team noted how this frustration spilled into other areas, including succession planning. For example, if a seasoned employee in a high General Services (GS) grade retires, it may be in the organization's best interest to fill the highly skilled vacancy, or depending on the work of the site, it may be better to create two junior level positions out of the vacancy. A leadership move of this latter type helps ensure young talent in the organization's junior ranks. As those employees learn and grow they can then fill more senior positions.

Workforce planning is a time-intensive task for supervisors, and when when leadership cannot guarantee that junior positions will be filled, they lose an incentive to engage in this process. As a result, EM may lose on the number of junior positions (and in turn younger staff members) if leadership does not complete its succession planning with them in mind. Multiple interviewees cited how, when individuals leave EM, job descriptions have to be turned around quickly, limiting opportunities for evaluation of how the role has evolved and how it may be calling for new knowledge and skills. As one interviewee explains, "Two things make succession planning difficult. First we don't know what staff is going to retire and second the process for bringing in new staff is so lengthy and bureaucratic." Another put it more simply: "succession planning is nonexistent because the role has to be open first." Limited opportunities for succession planning can limit the number of qualified candidates--both internal and external--available for a given position.

Finding 2: What is diversity? How do diversity and experience intersect or work against each other?

Leadership and staff hold imprecise definitions of workplace diversity.

When asked about the diversity of EM, interviewees provided a range of responses. Some defined workforce diversity in terms of race, others in terms of gender, others in terms of age, and still others in terms of socio-economic background and diversity of life experiences. Most interviewees initially responded that they believed EM was suitably diverse. It was only after follow up questions on specific ways in which the office was diverse that employees acknowledged areas for improvement.

A majority of leadership and staff interviewed cited limited diversity in age. Some defined workforce diversity as having different backgrounds. "There are people I worked for who had their college paid for and others who didn't," one staff member explained, "We have people who grew up in different states… some came from the Navy, some with experience with nuclear reactors, some not."

Both staff and leadership noted that racial diversity decreased in higher levels of the agency. This reflection from a Washington, DC leader captures this theme: "In terms of demographics, a lot of minorities are extremely underrepresented and that's unfortunate. A lot of our challenges are technical in nature, and your ability to progress relies on if you have a technical degree; and if those disciplines are underrepresented, that's a challenge."

Only a few interviewees were quick to point out the benefits of workforce diversity:

> **"The strength of your team is how inclusive you are, not just on the outward demographics, but how people think and approach problems. Inclusion is broader than diversity."**

Generally, interviewees who were younger believed the workplace was not especially diverse while older employees and those in leadership saw EM as diverse in a multitude of ways.Comments such as the quote above shine a light on a possible conflict in EM between organizational values around experience (e.g., checking off certain "boxes," or having certain experiences) and a desire to recruit younger and more diverse staff.

A quantitative comparison between DOE, NASA, and NRC suggest the DOE as a whole performs statistically significantly lower than these other agencies on FEVS than its peer agencies (Appendix A). On a FEVS statement which asked if "policies and programs promote diversity in the workplace," an ANOVA test yielded the following results.

	MEAN (SD)
DOE	3.61 (1.08)
NASA	4.11 (0.91)
NRC	3.86 (1.01)
F VALUE	572.06

Just 60 percent of EM employees agree with the statement. Another FEVS statement asked if "Supervisors work well with employees of diverse backgrounds." Against, the DOE underperformed its peer agencies.

	MEAN (SD)
DOE	3.83 (1.01)
NASA	4.21 (0.86)
NRC	3.97 (.97)
F VALUE	394.47

Just 73.5 percent of EM employees agree with this statement. These quantitative analysis appear to validate the qualitative findings that there is a continued need to integrate diversity, equity, and inclusion into hiring practices and workplace culture.

Finding 3: I'm ready, coach!

Employees are looking for deeper coaching and support with career advancement.

Across employees of all ages and roles, field members and leadership yearn for deeper ongoing professional development and career advancement. "Career advancement is not something that is institutionalized…" one interviewee said, with another adding, "Any coaching that happens is accidental."

This theme appeared across interviewee locations and was not limited to younger employees. “There aren’t huge opportunities for growth or advancement of your skills across the sites,” said a field member. Several interviewees cited the lack of a structure designed for personal coaching and development, noting that development occurs based on how much a manager takes an interest in their direct reports, not in any systems and structures that support employees’ development. “I was fortunate to have managers who took an interest in me,” an interviewee reflected, “I really have to be my own advocate for professional development.” There is a performance management framework, but there were mixed attitudes regarding the framework’s efficacy, partially because it seems like there are varying degrees of implementation, particularly the individual development plans.

On a related matter, there seemed to be a demand--both from managers and their direct reports--for more robust support on management and coaching. “In most technical organizations, the people who get promoted are those who are strong technically, but not as strong in soft skills and people skills. I think what would be helpful is some coaching training for managers and help for them with career path planning,” urged one staff member.

Research Question #3: To what extent do existing talent pipelines support the Office of Environmental Management’s hiring?

Finding 1: What pipelines?

Pipelines are viewed as the means to hiring for a vacancy, not necessarily an overarching talent strategy, and leadership and staff hold mixed attitudes about the necessity or efficacy of existing pipeline programs.

Our interviewees were frequently confused by questions related to pipeline programs. Across employees of all ages and roles, the most well known programs were those associated with the federal Pathways Programs. Even as it relates to the Federal Pathways Programs, the depth of employee understanding of the program depended on the employee’s functional assignment and location. Employees with human resources functions held the strongest understanding of the Pathways Programs. Employees located in the Washington D.C. or Germantown offices appeared to understand the programs better than their colleagues in field sites. Pipeline programs which are not included in the federal pathways program (e.g. Department of Energy Scholars and the Minority Educational Institution Student Partnership Program) were the least understood in the field. Interviewees reported receiving little communication regarding these programs nor did they know many participants of these programs. This left the research team with two takeaways: first, it appears that communication regarding these programs could be strengthened in general and particularly to the field; and, second, it does not appear that many of the ancillary pipeline program participants go on to take positions with EM.

Notably, even employees who entered EM through a pipeline program did not consider their program as a component of a pipeline recruiting strategy. Generally, staff communicated about the federal Pathways Program and ancillary internships in transactional terms.

These programs are seen as the means through which hiring managers are able to staff vacancies on their teams. They are not seen as strategic efforts to recruit strong candidates into a career path in EM. This is not to say that hiring managers and staff do not want more holistic pathways into the profession. Indeed, a strong desire for field rotations (discussed in detail below) reflected a yearning for more thoughtful pipeline approaches.

The extent to which interviewees believed pipeline programs were necessary depended on their location and the vacancies held in their departments. Many employees thought they had plenty of candidates for general positions. For example, one interviewee noted, “the issue isn’t enough candidates, it’s whether enough candidates will stay in the queue for as long as the hiring process takes.” Yet other interviewees, particularly those at more remote sites, reported that they do not have enough qualified STEM candidates for any position. As one interviewee put it, “our remoteness is a deterrent.” Across sites and staff levels, there are certain vacancies for which it is always difficult to hire. Interviewees did not believe that existing pipeline programs targeted these positions specifically enough.

In stark contrast to the relative “silence” regarding pipeline programs, many employees talked about the importance of mentoring in their career progression. When leadership staff reflected on their careers, they frequently cited how mentors supported their development in federal service. In fact, several of the leaders felt they should take a more active role in supporting the careers of young or prospective EM employees. As discussed earlier, employees of all levels cite organizational mission as their work motivation. Leaders held a similar attitude toward their role as mentor. They felt it was their duty to support young professionals to learn about the field of environmental management. In turn, young employees talked at length about how they valued relationships with experienced peers or how they wished they had supportive mentors. That said, leaders had mixed reviews of the current internship program (as part of the Federal Pathways Program).

Many leadership level staff raised concerns about their inability to hire interns.

> “We have at least one program that I'm aware of where you can bring folks in who are qualified. And they will intern for a year and then at the end of the year, if everything goes well, it can turn into a job offer. But, most of our interns come in, serve their time, and then they go off to careers elsewhere. But that's not really the fault of someone in a hiring position. I don't have the ability to say, "hey, that intern was amazing, I want to hire them." Instead I have to post the position and go through a whole process and then the candidate is lumped in with the million other people who are looking for a job.”

Frustrations about the return on investment of the intern program emerged. Several leaders said it was hard to justify spending a large portion of time on the internship program when they knew they would not be able to hire interns, either because the positions are not available or because they perceive the process as too much of a barrier.

Opinions on the effectiveness of the internship program varied by staff location. Leaders in Washington D.C. report more positive feedback on the program's effectiveness. In the field, internship placements were more infrequent, and leaders report that when they cannot offer positions to interns in at field sites, it makes the intern program doubly challenging.

In many cases, interns placed at field sites go to work for contractors instead. Leaders hold mixed attitudes on the value and utility of this reality. One manager in South Carolina noted that "On one hand, I'm ok with [my interns working for contractors] because at least they are staying in the industry, but I wish I could hire some of these people to work for our team directly." Another leader framed a similar point: "It's a shame sometimes because we put in good work to groom interns and we teach them about our field, but then contractor organizations get to reap the benefit." More bluntly, this manager added, "I have worked with great people in the intern program. And I can get them jobs with contractors but that's not doing my department much good, is it?"

To some extent, EM staff cannot evaluate authoritatively the effectiveness of pipeline programs because EM does not systemically track participation in these opportunities nor the number of candidates who convert to full-time employees. Certainly the HR analyst who supported this program knew a rough number of FTEs who came through the Federal Pathways Programs, but it was evident in our interviews of leadership and staff that the organization does not frequently review hiring metrics nor pipeline output as part of its key performance indicator review. In fact, our review of the organization's metrics illustrates this point. To a large extent, metrics of success are framed as the number of projects completed or the amount of waste EM removes, and these are extremely important, but operational activities like the number of new hires against the number of vacancies are not reported for review in this way.

Quantitative comparisons between the DOE, NRC, and NASA using the FEVS results on survey item "Work unit is able to recruit people with the right skills" indicate the DOE performs statistically significantly lower than these benchmark agency peers.

	MEAN (SD)
DOE	3.1 (1.2)
NASA	4.52 (1.11)
NRC	3.3 (1.17)
F VALUE	311.41

Similarly, EM employees report concern on this survey item. Just 32 percent of EM employees agree that the organization can recruit the right people. When asking EM field offices this item, the agree rate drops to 30 percent.

Finding 2: Let's go to the field!

There is a strong desire among leadership and junior staff for regular field rotations.

Throughout the findings, we note of how headquarters and field based staff have differing perspectives on hiring pipelines. One uniform finding in many interviews and across staff level and location was a desire for a return to a field rotation program. In the past, EM ran an Environmental Management Professional Development Core (EMPDC) program through which new hires would work in a series of field placements before accepting a permanent position In addition, the EMPCD program provided seminars and professional development opportunities for participants.

Interviewees who participated in this program spoke very positively about it. According to one participant, "had I not had [the EMPCD program], it would have been far more difficult for me because while I had the basic knowledge set and fundamentals, I was not aware of how to apply them in my work tasks." A field-site based supervisor relayed similar observations, "the EMPDC program allowed new employees to understand the work of EM much more, and I believe it made the participants stronger employees." Moreover, field based staff believed this program supported recruiting at remote sites. One participant in the program suggested that she would not have considered a position in the field if it were not for the EMPCD program. Leaders at field sites held similar perspectives; according to one, the EMPCD program "let young employees see the on the groundwork of EM in a way that may have attracted them to come work at field sites they previously would have written off." When asked to describe some meaningful career advancement opportunities, many interviewees noted their time at sites in the field that allowed them to apply their skills in a real world setting. One Washington D.C.-based engineer noted,

> "It was an amazing experience to be able to connect what we did in the headquarters to what we do in the field. At headquarters, you don't get to see the work in action, but in the field you understand the work better and get to know the contractual staff too. It was so valuable."

Research Question #4: How does EM's practice compare to other agencies/organizations who recruit STEM professionals?

Finding 1: Recruiting 101

Strong recruiting relies on a clearly articulated value proposition for candidates, the match between candidates and supervisors, and functional staff to recruit.

Nearly all interviewees found their work to be meaningful and many frequently characterized their role as critical to national safety. As discussed earlier, the importance of the EM mission was an evident motivator for interviewees who linked their work to the legacy of the Manhattan project and a fast ramp up of nuclear weapons in the 1940s and 1950s. As one leader in Washington D.C. put it, "our program manages one of the largest government liabilities" in existence. When asked how the office could do a better job recruiting young people to the field, interviewees repeatedly called for the office to do a better job messaging its mission to potential candidates and the broader community.

This echoes findings from our public agency and non-profit sector comparison points. The recruiting team from our non-profit comparison point, ORAU, staffs more than 10,000 college and graduate students into paid internships at national laboratories around the country. They explained that they are often competing against large and well known businesses for talent and find that a clear value proposition for the candidate goes a long way. They emphasize how potential candidates will be able to learn in their placements and will be conducting important work on issues of national import like national security or environmental sustainability. While their research placements are often at well-known and popular agencies like the Center for Disease Control (CDC) or the National Aeronautics and Space Administration (NASA), they emphasized that they place as many candidates at organizations with less appeal like the Department of Transportation. For less popular agencies, recruiters argued it was essential to have a well documented value proposition for candidates. They enjoy the most success in filling these roles when they emphasize that the work the hire will be completing and the mentoring or learning opportunities the agency will provide. These findings were echoed in our conversation with a leadership developer at NNSA. She reported that NNSA's graduate fellowship opportunities are filled with highly sought-after candidates. To encourage their participation in the NNSA program, recruiting teams pitch the benefits of public agency research and employment to candidates.

Recruiting staff in both comparison points talked about how today's young graduates prioritize their learning and development when selecting new positions. According to these interviewees, STEM graduates want to work in fields where they will have opportunities to grow, and much of this hinges on the placement of young employees with supervisors who are willing to support their development. The recruiters we met with reported that they are careful to review job descriptions with supervisors, push supervisors to clarify responsibilities, and help them think about how they will support their new hires to grow and learn. This finding connects to earlier discussions of mentoring and succession planning.

Relatedly, the research team found that organizations who recruit a number of young people for public agency employment are staffed in a way to facilitate this effort. Currently, EM has one employee responsible for supporting workforce planning and pipeline development. In an agency of more than 1,200 employees, this is a significant workload. The National Nuclear Security Administration has a larger human resource team devoted to supporting talent acquisition. One employee manages the Federal Pathways Program and another manages the NNSA specific intern program. In the ORAU non-profit sector comparison point, our interviewees reported far more full time employees devoted to recruiting efforts.

Unsurprisingly, our non-profit comparison point had a much more nimble hiring process, explicitly oriented towards ensuring a positive candidate experience. According to one recruiter, "young, qualified applicants are looking for a quick application process, and they want to have immediate access to senior staff to provide feedback on their application." This is a notably different application requirement than is currently available through the federal government.

NNSA relies heavily on their Graduate Fellowship Program (GFP) to staff annual vacancies. The GFP recruits roughly 50 participants each year who receive salaried positions while they complete their fellowship. Approximately half of these fellows take full time positions with NNSA at the close of their fellowship. NNSA has two full-time employees who manage a contractor who in turn manages the program.

Finding 2: Start early and begin with the end in mind

There is an emerging interest in K-12 pipeline development.

Our non-profit comparison point is using some of its funding to begin cultivating a K-12 STEM pipeline into public sector interest and potential jobs. This effort is really "It's far harder to invest in efforts that won't come to fruition for ten years, but I believe our K-12 work is some of our most impactful," His team is beginning to offer STEM internships to students in middle and high school and to conduct professional training for teachers in rural communities. It is the mission of ORAU to develop a robust K - Career STEM pipeline programs throughout the Appalachian region. Through its ORISE programming (Oak Ridge Institute for Science and Education), ORAU offers a range of K-12 initiatives which include summer programs, internships, scholarships, and professional development for K-12 STEM educators to help them create more engaging STEM classroom experiences throughout the school year. While the long-term impacts of these efforts remain to be seen, they represent a promising practice for EM to consider.

DISCUSSION

Our findings indicate that the EM is not immune from the leaky STEM pipeline outlined in our literature review. Our findings point to the relevance of the research on the STEM pathway and on recruiting, pipeline programs, and workforce development. For EM, the issue of urgency is – or should be – obvious and compelling. It is estimated that more than 2.5 million jobs in science, engineering, and or technology fields will be created in the next decade (Carnevale et al., 2013). This increase in STEM positions will require qualified candidates. Policymakers should have an interest, then, in understanding what motivates an individual to pursue a STEM career field. We organize our discussion into two sections: 1) reflections on the STEM Pathway and, 2) recruiting, pipeline programs, and workforce development.

The STEM Pathway

The importance of early STEM experiences

Those interviewed have progressed through the pipeline and obtained a career in STEM, so our capstone project provides insights into what factors led them to a career in a STEM field. First, our interviews with EM staff confirm what the extant research established about STEM interests emerging early in a K-12 career. Many of the leaders and staff members spoke glowingly about their interest in science and math beginning in their early upbringing. "I've always had a fascination with energy," a staff member gushed.

When pressed, most interviewees suggested their interest in STEM began before high school, which Tai et al. (2006) suggests make it two times as likely to earn a STEM degree. Interviewees commented on the importance of elementary school math and science curricular experiences with statements like “I liked math even in the first grade.” These findings highlight the importance of developing robust K-12 STEM programs which not only engage students in high school, but more critically in both elementary and middle school.

Most interviewees, though, connect early STEM interest to early personal relationships, including mentors and family members. One interviewee discussed how he entered into the engineering field because it was what everyone in his family did. Another interviewee talked about admiring her teachers in elementary school. This aligns to research findings which connect relationships with adults in STEM fields to the development of interest in STEM fields by youths and adolescents (Austin & Sax, 1996; MacPhee, Farro, & Cannetto, 2013; Holland, Major & Orvis, 2012; Griffin & Perez, 2010; Gorman, et al; 2010). This finding also connects to Hannover and Kressels (2004) theories on the importance of STEM prototypes. Interviewees held positive initial reactions to their role models in STEM, potentially increasing the likelihood that they could see themselves in STEM fields of study.

Interviewees also report a connection between self-perceived strengths and school interests. While most interviewees reported that they had not contemplated a career in Environmental Management, they did know that they wanted to work in a STEM field because of their affinity for and math and science. Several interviewees explained that they liked science or math because they were good at it or it came to them more easily than humanities content areas. This is unsurprising as Bandura et al. (2001)’s research found that perceptions of self-efficacy affected career aspirations. Relatedly, this confirms Eccles and Wigfield (1995)’s research findings which show students achieve more academic success in areas in which they perceive themselves to be proficient. Notably, interviewees indicated that they knew they were good at math or science early in their educational careers. This suggests that early K-12 efforts to increase student perceptions of self-efficacy in STEM fields would pay dividends.

Interviewees also expressed a desire to apply STEM learning in the field working on real-world problems. As one interviewee mentioned, “I always knew I wanted to do applied math.” Another discussed how as a child she wanted to change the world. The research team saw this emerge again in the strong desire for field placements. Even as adults, EM staff members want the opportunity to apply their theory-based knowledge against actual challenges. This affirms Gottfried and Bozick’s (2016) research that opportunities for students to apply their STEM learning can support student persistence to a STEM degree.

The research on early STEM experiences are leading some organizations to begin investment in K-12 STEM pipelines. ORAU’s emphasis on K-12 programming illustrates this nicely. A reasonable theory of action may suggest that if students have the opportunity to engage with STEM content, apply their learning to real-world problems, are provided access to relatable STEM role models and mentors, and can see themselves as successful, they will be more likely to persist into a STEM college major and career.

High School and College

By high school, most of our interviewees had already decided on a STEM or technical career. Interviewee responses confirm Tai, Liu, Maltese, and Fan's (2006) finding that the strongest predictor in STEM at the end of high school was an interest in STEM at the beginning of high school. This was especially evident in our interviews with females, confirming Kinzie's (2007) research that women decided on STEM interest in or before middle school. Given this research and our qualitative data, it would be reasonable to conclude that the bulk of K-12 investments should be made in elementary school programs.

Nearly all of our interviewees reported participation in accelerated math or science courses. This finding connects to research on the importance of rigorous curriculum in fostering STEM persistence (Wang, 2013; Griffith, 2010; Tyson et al., 2007). Our interviewees discussed their enjoyment of STEM courses in high school, but they perceived interactions with teachers or other mentors around STEM content as more important than course content. This finding highlights another point in time in which access to mentoring relationships in STEM fields is important.

Recruitment, Pipeline Programs, and Workforce Development

The research team acknowledges the constraints EM faces as it attempts to build its pipeline strategy and hire young employees. The federal government has strict rules in place for hiring. The EM human resource budget has been reduced over the last five years. The current presidential administration has made clear its strong desire to reduce the federal workforce. Nonetheless, there are connections between our findings on the efficacy of current pipeline initiatives and extant literature which EM should consider even within its current limitations.

Messaging about the importance of the work may also lead to improved young staff retention. This was not the explicit focus of our study, but many interviewees reflected on their perceptions of millennial staff members as less interested in stable long-term employment than peers of older generations. As discussed in the literature review, there is little empirical data to support this claim; however, it was pervasive in young staff, recruiters, and leadership alike. Assuming this perception is legitimate and the model of workplace stability in which an individual stays with an organizations for decades, it is possible that the incentives of federal service (e.g. low turnover) may not appeal to younger generations of employees. For this reason, EM staff is well-served to consider how to create supportive environments which compel staff of all ages to stay in their positions.

Coaching and mentoring programs for new EM staff may be one approach to encouraging their development and increasing job satisfaction. Interviewees commented at length about how they valued the support and guidance of experienced leaders and peers. Others wished they had more of an opportunity to receive this kind of support. A desire for coaching and mentoring aligns with findings of Theeboom et. al (2014) and Jones and Zhou (2018) which suggested workplace mentoring results in benefits on well-being, motivation, and satisfaction. In addition, a strong mentoring program would support onboarding for new employees, as identified in Groysberg et al. (2009)'s work as an important element of a strong hiring system.

Our findings largely confirm the spirit behind Laudicina (1995)'s predictions about federal agencies' ability to recruit and retain a diverse, viable workforce. The 2000 report "Best Practices in Achieving Workforce Diversity" suggests that diversity initiatives hinge on leaders being able to "effectively interact with and manage people in a diverse workplace" (p. 6). The qualitative findings on workforce diversity speaks to both the need to communicate the ways in which EM is diverse and also to expand a broader, shared definition of workforce diversity, especially given continued competition from the private sector.

Repeatedly EM staff acknowledged that the slow federal hiring process caused them to lose out on talented candidates who left the hiring process early for other positions. While this is likely true, a lack of data analysis on this issue makes it unclear if there are elements of this slow hiring process over which EM might have the ability to improve. In other words, it would be easy enough to blame inefficient hiring practices on the federal system at the moment. Groysberg et al. (2009) identified the importance of gathering data on candidate experience in order to improve hiring practices. It would be worthwhile for EM leadership and HR teams to consider conducting a series of interviews with EM candidates who opt for positions with other organizations. This feedback would allow EM to identify ways in which it might improve its hiring functions within an admittedly inefficient, federal system.

RECOMMENDATIONS

We first present recommendations for EM leadership and then include larger policy recommendations for the field. Given EM's budgetary concerns, the research team identified a variety of next steps, some of which could be implemented with little to no additional resources.

1. **Create field-site partnerships with K-12 schools, districts, community colleges, and universities.** Our discussions confirmed many EM employees first became interested in EM work at the point of hire, despite several growing up close to EM field sites. At the same time, interviewees repeatedly discussed the value of STEM educational experiences. Most of our interviewees who attended college either identified a preference for studying a STEM field early on -- at the point of high school --or were members of the military who became interested in STEM fields during their service. This finding suggests that organizations could begin cultivating their talent pipelines much earlier in careers of post-secondary candidates. In consultation with staff at local schools, EM could design programs that allow participants to view real-life application of STEM skills. Such an effort provides double benefit for EM to begin to get knowledge about its important work out to current students. Given that many field site employees wanted to work near their hometowns and given that recruiting appears to be more difficult at remote sites, we recommend EM prioritize this effort in its field-site communities.

2. **Create a K-12 mentoring program and prioritize mentoring opportunities for field-site communities and for those demographics which are underrepresented in the STEM pathway.** The importance of mentoring and STEM persistence emerged in both the research literature and our interviews. In addition, interviewees voiced broad support for becoming mentors themselves. To support a robust and diverse pool of STEM job candidates, EM should consider creating a mentoring program with K-12 schools, districts, community colleges, and universities. To encourage engagement in the field site locations, we recommend prioritizing these communities for mentoring programs first. Similarly, research is clear that mentors are especially beneficial for demographic groups who are underrepresented in the current STEM pathway (e.g. women, minorities). To create a diverse group of candidates for field-site vacancies, EM should consider prioritizing mentoring opportunities for these youths.

3. **Conduct a community outreach program and branding campaign.** EM's work is of critical national importance. It is essential that more Americans know about the efforts EM staff undertake on our behalf to care for the environmental legacy of nuclear weapons development. Our findings detail how none of the EM employees we interviewed knew much about EM's mission before joining the agency. It was particularly striking when individuals who grew up near EM sites knew little of the organization's work until the point of their hire. Since the opportunity to do meaningful work appeals to job candidates and since EM is competing for highly sought after STEM graduates, EM's leadership should consider how to increase community awareness of its mission. Given that this was a significant point of pride for many interviewees, emphasizing the organization's mission and the work that they do may contribute to attracting a younger, diverse workforce.

4. **Spread the word on EM's mission and the importance of its work.** While a national campaign to educate on EM's importance is likely unfeasible, EM could begin this important work by hosting lectures on its efforts in community organizations, libraries and universities with strong nuclear site programs. EM's mission was repeatedly cited by employees as a reason to work for the organization. However, concurrently, employees also noted that few people know about EM or its mission. Marketing and branding EM's work, particularly in the communities where field sites are located, could be significantly beneficial in recruiting STEM talent.

5. **Track pipeline participants and identify metrics for hiring that leadership review cyclically.** First, it is difficult for EM to argue for additional pipeline funding without a case for why it is needed. Tracking pipeline participant experiences will allow EM employees to better understand how current pipeline program meet the organization's needs and what returns EM gains on its pipeline investments. A quarterly or semi-annual meeting to review these data will allow EM leadership to identify trends and react accordingly.

6. **Articulate a value proposition for new hires. Create hiring materials centrally for use by field site staff.** As recruiting staff made clear, articulating why candidates should choose to work for EM will go far in the recruiting process. Central staff should create documents that highlight the opportunities for growth and development in EM roles. These

materials should be shared with staff at field sites for use in their communities.

7. **Identify strong mentors for new employees and train them to fill this important role.** Young employees are looking for opportunities to grow and be mentored by skilled technicians and leaders. Such opportunities can go a long way in recruiting new staff to EM positions. Moreover, it was evident in our interviews that existing young staff would value a formal mentoring program. Mentoring is not something that comes naturally to all people. For this reason, any mentoring experience should include training opportunities for senior staff who will serve in mentor roles.

8. **Conduct interviews with candidates who do not take jobs with EM and use this data to make improvements to the hiring process.** It is clear that many of the hiring hurdles EM staff face are not in EM's locus of control. It is not enough to say that EM should expedite its hiring processes when there are so many approval processes required by other federal agencies. Nonetheless, EM could begin to collect data on the candidate experience during hiring. Such a data set may illuminate ways in which EM is hampering its ability to recruit young staff. Additionally, this information could be leveraged by leadership in conversations with other federal agencies to push for revisions to the current process.

9. **Provide support for succession planning.** Supervisors and staff alike reported EM needed stronger supports for succession planning. EM staff should consider ways to make workforce and succession planning an easier task for supervisors. This could include templates, office hours with EM HR staff, or trainings on how to best create workforce plans to allow for more thoughtful job descriptions and more nimble hiring.

10. **Define key diversity goals.** Continue to work towards defining a clear vision for diversity and inclusion. One first step is defining workforce diversity and continuing to develop measures of effectiveness for diversity initiatives implemented across the agency.

11. **Train field site staff on pipeline programs.** Interviewees indicated they did not know about existing pipeline programs. If they did, it was frequently in the context of the Federal Pathways Program. Few interviewees knew about the ancillary programs in which EM participates. EM HR staff would ensure greater participation in pipeline programs (and perhaps encourage more succession planning on the part of supervisors) if they provided an overview of available pipeline opportunities. Ideally, supervisors would receive counseling on how to make use of succession plans and pipeline opportunities in their specific context as a complement to this training.

12. **Consider reinstating the field rotation program.** As part of a broader argument for ongoing development opportunities, interviewees mentioned how much they valued field rotations, not only in terms of their honing their career but also being able to understand the EM mission more deeply across sites. Field rotations provide an opportunity for staff to better understand the organization's story. This would be an appealing feature of a pipeline or ongoing development program for young employees.

Broader policy recommendations for organizations attempting to recruiting STEM graduates from our study include:

1. Invest in STEM partnerships between practitioners and educators that link STEM employees to elementary and middle school students for mentorship opportunities and rich exposure to science and math; including STEM professional development opportunities for local educators, summer programs, internships, and scholarships for students.

2. Create partnerships between teachers and STEM practitioners to create applied STEM course curriculum.

3. Encourage STEM retirees to serve in mentor capacities for young employees.

4. Invest in local communities with large STEM presence through partnerships with community colleges, universities, and libraries to educate about opportunities in STEM.

CONCLUSION

To address their more immediate hiring needs, EM would also benefit from more robust workforce development and succession planning. Increasing knowledge and utilization of existing pipeline programs, as well as tracking their efficacy in achieving targeted goals would also be beneficial. Implementing a mentoring program in which new employees are partnered with mid-career to senior level employees would ensure the successful transfer of knowledge gained by upper level employees. Recruiting and contracting retiring EM employees to work part-time as mentors could potentially aide in this effort.

In terms of their long-term mission, to accomplish their 70 plus years of nuclear site clean-up, EM will need to be forward thinking and invest heavily in the future by extending their recruitment and outreach into K-12 communities. While the agency must address their immediate need to fill current and near future vacancies due to the retirement of baby boomers, there should also be planning to recruit and hire future employees, many of whom have yet to be born. EM should seek to have a more visible role in the communities in which their sites are located. Given that the remoteness of their site locations presents a challenge to attracting new hires, it would make sense for EM to invest in developing STEM pipelines within the local communities. By partnering with local K-12 schools, districts, community colleges, and universities, EM can aide in creating summer programs, internships, mentoring opportunities, and professional development for K-12 STEM educators which should result in a pool of qualified local candidates. While the current study was specific to the DOE-EM, these policy recommendations also have broader implications for all involved in STEM recruitment.

REFERENCES

Astin, A. W. (1993). What matters in college: Four critical years revisited. San Francisco: Jossey-Bass.

Astin and Astin 1993 Undergraduate science education: the impact of different college environments and the educational pipelines in the college

Austin H. & Sax L., 1996. Developing scientific talent in undergraduate women. In K. Weber (2011). Role models and informal STEM-Related activities positively impact female interest in STEM. Technology and teacher. November.

Bandura, A., Barbaranelli, C., Caprara G.,, & Pastorelli, C. (2001). Self-efficacy beliefs and shapers of children's aspirations and career trajectories. Child Development, Volume 72, Number 1, p. 187-206.

Blackburn, H. (2017). The Status of Women in STEM in Higher Education: A Review of the Literature 2007–2017, Science & Technology Libraries, 36, 3, (235 - 273)

Blickenstaff, J.C (2005). Women and science careers: leaky pipeline or gender filter. Gender and education 17 (4), 369-385.

Booz Allen Hamilton (2011). Keeping the talent: strategies for retaining a federal workforce. Available online at: https://ourpublicservice.org/wp-content/uploads/2011/01/ead68574cec8da75481eeb345869e288-1402949405.pdf

Bozer, G., Sarros, J.C. and Santora, J.C. (2013), "The role of coachee characteristics in executive coaching for effective sustainability", Journal of Management Development, Vol. 32 No. 3, pp. 277-294, doi: 10.1108/02621711311318319.

Campbell, G., Denes, R., and Morrison (2000). Access denied: race, ethnicity, and the scientific enterprise. Oxford University Press, New York. Agricultural and Forest Meteorology. 114. 123–124.

Camp, W. (1990). Participation in student activities and achievement. The Journal of Educational Research (83) 5. 272-278.

Cannady, M. A., Greenwald, E. and Harris, K. N. (2014). Problematizing the STEM Pipeline Metaphor: Is the STEM Pipeline Metaphor Serving Our Students and the STEM Workforce?. Science Education, 98: 443-460.

Chen, X., & Weko, T. (2009). Students who study science, technology, engineering, and mathematics (STEM) in post-secondary education (NCES 2009-161). Retrieved from National Center for Education Statistics website http://nces.ed.gov/pubs2009/2009161.pdf.

Chen, X. (2013). STEM Attrition: College Students' Paths Into and Out of STEM Fields (NCES 2014-001). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Congressional Budget Office (2017). Comparing the Compensation of Federal and Private-Sector Employees, 2011 to 2015. Available online at: https://www.cbo.gov/system/files/115th-congress-2017-2018/reports/52637-federalprivatepay.pdf

Correll, S. (2001). Gender and the career choice process: the role of biased self-assessments, American Journal of Sociology, 106(6): 1691–730.

Dabney, K. P., Tai, R. H., Almarode, J. T., Miller-Friedmann, J. L., Sonnert, G., Sadler, P. M., & Hazari, Z. (2012). Out-of-School Time Science Activities and Their Association with Career Interest in STEM. International Journal of Science Education, Part B,2(1), 63-79. doi:10.1080/21548455.2011.629455

Davidson, J. (2018, September 1). Latest federal diversity report from OPM shows little to progress and some regression. Washington Post. Journal of Business and Psychology, 25(2), 191-199.

Deal, Altman, & Rogelberg. (2010) Millenials at work: what we know and what we need to do (if anything).

Eccles, J.; Wigfield, A (1995). "In the Mind of the Actor: The Structure of Adolescents' Achievement Task Values and Expectancy-Related Beliefs." Personality and Social Psychology Bulletin 21(3): 215-225.

Eccles, J. S., & Barber, B. L. (1999). Student council, volunteering, basketball, or marching band: What kind of extracurricular involvement matters? Journal of Adolescent Research, 14, 10-43.

Family and Work Institute. (2005). Being Overworked New - Families and Work. Retrieved from http://familiesandwork.org/site/research/reports/OverWorkInAmerica.pdf

Georgetown's Center on Education and the Workforce (2016).

Gonzalez, Gabriella C., Christopher Joseph Doss, Julia H. Kaufman, and Robert Bozick, How Educators and Employers Can Align Efforts to Fill Middle-Skills STEM Jobs. Santa Monica, CA: RAND Corporation, 2019. https://www.rand.org/pubs/research_briefs/RB10053.html.

Glassdoor (2015). How Long Should The Interview Process Take? Retrieved from https://www.glassdoor.com/blog/long-interview-process/

Gorman, Susan T.; Durmowicz, Meredith C.; Roskes, Ellen M.; Slattery, Susan P. Forum on Public Policy Online, v2010 n2 2010.

Gottfried, M. A., & Bozick, R. (2016). Supporting the STEM pipeline: Linking applied STEM coursetaking in high school to declaring a STEM major in college. Education Finance and Policy, 11(2), 177–202.

Gottfried, M. A., Bozick, R., & Srinivasan, S. V. (2014). Beyond academic math: The role of applied STEM coursetaking in high school. Teachers College Record, 116(7).

Gottfried, M. A. & Williams, D. (2013). STEM Club Participation and STEM Schooling Outcomes. Education Policy Analysis Archives, 21(79), 1-27.

Griffith, A. (2010). Persistence of women and minorities in STEM majors: Is it the school that matters. Economics of Education Review, 29(6), 911 – 922.

Griffin, K., Pérez, D., Holmes, A., Mayo, C., Harper, S., & Newman, C. (2010). Investing in the future: The importance of faculty mentoring in the development of students of color in STEM. New Directions for Institutional Research, 2010(148), 95–103. https://doi.org/10.1002/ir.365

Hall, C., Dickerson, J., Batts, D., Kauffmann, P., & Bosse, M. (2011). Encouraging STEM in high school and college. Journal of Technology Education, v23 n1, p. 32-46.

Harvard Kennedy School (2015). Key Findings and Insights from our Survey of Young Americans' Attitudes Toward Politics and Public Service. Available online: https://iop.harvard.edu/sites/default/files/content/docs/141119_Harvard%20IOP_Know%20Your%20Customer_JDV.pdf

Hannover, B., and Kresels, U. (2004). Self-to-prototype matching as a strategy for making academic choices. Learning and Instruction, Vol 14, 51-67.

Holland, J. M., Major, D. A. and Orvis, K. A. (2012), Understanding How Peer Mentoring and Capitalization Link STEM Students to Their Majors. The Career Development Quarterly, 60: 343-354. doi:10.1002/j.2161-0045.2012.00026.x

Holzer, H. (2008). Workforce Training: What Works? Who Benefits? (pdf). Retrieved from https://www.purdue.edu/hhs/hdfs/fii/wp-content/uploads/2015/07/s_wifis28c02.pdf

Huang, Taddeuse, Walter, & Samuel (2000) Entry and persistence of women and minorities in college science and engineering education.

Hyde & Gess-Newsome (2000) Factors that increase persistence of female undergraduate science students.

International Coach Federation (2016), "2016 ICF global coaching study: executive summary, available at: http://coachfederation.org/about/landing.cfm?ItemNumber=3936.

Jones, R., Woods, S. Zhou. (2018) "Boundary conditions of workplace coaching outcomes", Journal of Managerial Psychology, Vol. 33 Issue: 7/8, pp.475-496, https:// doi.org/10.1108/JMP-11-2017-0390

Jones, R.J., Woods, S.A. and Guillaume, Y.R.F. (2016), "The effectiveness of workplace coaching: a metaanalysis of learning and performance outcomes from coaching", Journal of Occupational and Organizational Psychology, Vol. 89 No. 2, pp. 249-277, doi: 10.1111/joop.12119.

National Science Board. "Preparing the Next Generation of STEM Innovators: Identifying and Developing Our Nation's Human Capital. 2010, www.nsf.gov/nsb/publications/2010/nsb1033.pdf.

Kendricks, Nedunuri, & Arment (2013) Minority student perceptions of the impact of mentoring to enhance academic performance in STEM disciplines

Kinzie, J., & Stage, F. (2007). Women's paths in science: A critical feminist analysis. New Directions for Institutional Research, 2007(133), 81–93. https://doi.org/10.1002/ir.206

Laboissiere, M., & Mourshed, M. (2017). Closing the skills gap: Creating workforce-development programs that work for everyone. Retrieved from https://www.mckinsey.com/industries/social-sector/our-insights/closing-the-skills-gap-creating-workforce-development-programs-that-work-for-everyone

Laudicina, E. (1995). MANAGING WORKFORCE DIVERSITY IN GOVERNMENT: AN INITIAL ASSESSMENT. Public Administration Quarterly, 19(2), 170–192.

Lee, J. (1998). Which kids can "become" scientists? Effects of gender, self-concepts, and perception of scientists. Social Psychology Quarterly, 61(3), 199–219. https://doi.org/10.2307/2787108

Lee, J. (2002). More than ability: Gender and personal relationships influence science and technology involvement. Sociology of Education, 75(4), 349–373. https://doi.org/10.2307/3090283

Lipscomb, S. (2007). Secondary school extracurricular involvement and academic achievement: a fixed effects approach. Economics of Education Review, 26(4), 463–472. https://doi.org/10.1016/j.econedurev.2006.02.006

Low, K., Yoon, M., Roberts, B., Rounds, J., & Cooper, H. (2005). The Stability of Vocational Interests From Early Adolescence to Middle Adulthood: A Quantitative Review of Longitudinal Studies. Psychological Bulletin, 131(5), 713–737. https://doi.org/10.1037/0033-2909.131.5.713

Mackie, D. (2015), "The effects of coachee readiness and core self-evaluations on leadership coaching outcomes: a controlled trial", Coaching: An International Journal of Theory, Research and Practice, Vol. 8 No. 2, pp. 120-136.

MacPhee, D., Farro, S., & Canetto, S. S. (2013). Academic self-efficacy and performance of underrepresented STEM majors: Gender, ethnic, and social class patterns. Analyses of Social Issues and Public Policy (ASAP), 13(1), 347-369.

Maltese, A., & Tai, R. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. Science Education, 95(5), 877–907. https://doi.org/10.1002/sce.20441

Miller, P.H., Blessing, J.S., & Schwartz, S. (2006). Gender differences in high school students' views about science. International Journal of Science Education, 28(4), 363-381.

Salemi, V. (2016). How Long Does It Really Take To Get A Job? | Monster.com. Retrieved from https://www.monster.com/career-advice/article/how-long-does-it-take-to-get-a-job-0117

Nagy, G., Trautwein, U., Baumert, J., Koller, O., & Garrett, J. (2006). Gender and course selection in upper secondary education: Effects of academic self-concept and intrinsic value. Educational Research & Evaluation, 12, 323–345.

National Science Foundation. (2010). NSB-10-33 - National Science Foundation. Retrieved from https://www.nsf.gov/nsb/publications/2010/nsb1033.pdf

Net Impact. (2012). Talent Report: What Workers Want in 2012 - Net Impact. Retrieved from https://netimpact.org/sites/default/files/documents/what-workers-want-2012-summary.pdf

Office of Personnel Management (2016). The Pathways Programs Their Use and Effectiveness Two Years After Implementation. Available online at: https://www.opm.gov/policy-data-oversight/hiring-information/students-recent-graduates/reference-materials/report-on-special-study-of-the-pathways-programs.pdf

Office of Personnel Management (2017). Full time permanent age distributions. Available online at: https://www.opm.gov/policy-data-oversight/data-analysis-documentation/federal-employment-reports/reports-publications/full-time-permanent-age-distributions/

Osborne, J., Simon, S., Collins, S. (2003). Attitudes towards science: A review of the literature and its implications, International Journal of Science Education, 25:9, 1049-1079.

Patton, M. Q. (2015). Qualitative Evaluation and Research Methods. Thousand Oaks, CA: Sage.

Pryor, J. H., Hurtado, S., DeAngelo, L., Palucki Blake, L., & Tran, S. (2010). The American freshman: National norms Fall 2010. Los Angeles: Higher Education Research Institute, UCLA. Retrieved from http:// www.heri.ucla.edu/pdfs/pubs/tfs/norms/ monographs/theamerican freshman2010.pdf

Raines, J.M. (2012). FirstSTEP: A Preliminary Review of the Effects of a Summer Bridge Program on Pre-College STEM Majors. Journal of STEM Education: Innovations and Research; Auburn Vol. 13, Iss. 1, 22-29.

Rask, K. (2010). Attrition in STEM Fields at a Liberal Arts College: The Importance of Grades and Pre-Collegiate Preferences. Economics of Education Review, 29(6): 892–900. fOPM

Riegle-Crumb, Moore, & Ramos-Wada, 2010 Who wants to have a career in science or math? Exploring adolescents future aspirations by gender and race/ethnicity.

Sadler, P.M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. Science Education, 96 (3), 411-427.

Sahin, A., Ayar, M.C., & Adiguzel, T. (2014). STEM Related After-School Program Activities and Associated Outcomes on Student Learning. Educational Sciences: Theory and Practice, v14, 309-322.

Salzman, H. (2013). What Shortages? The Real Evidence About the STEM Workforce. Issues in Science and Technology,29(4), 58-67. Retrieved from http://www.jstor.org/ stable/43315795

Seligman, L., Weinstock, L., & Heflin, E. N. (1991). The career development of 10 year olds. Elementary School Guidance & Counseling, 25(3), 172-181.

Seymour, E., & Hewitt, N. (1997). Talking about leaving: why undergraduates leave the sciences . Boulder, Colo: Westview Press.

Shapiro, C.A., & Sax., L. J. (2011). Major selection and persistence for women in STEM. New Directions for Institutional Research, 2011, 5-18.

Shernoff, J. D., & Vandell, L. D. (2007). Engagement in after-school program activities: Quality of experience from the perspective of participants. Journal of Youth and Adolescence, 36, 891-903. doi:10.1007/s10964-007-9183-5

Simon, R.M., & Farkas, G. (2008). Sex, class, and physical science educational attainment: Portions due to achievement versus recruitment. Journal of Women and Minorities in Science and Engineering, (14)3, 269-300.

Soliz, A. (2016). Preparing America's labor force: Workforce development programs in public community colleges. Retrieved from https://www.brookings.edu/research/ preparing-americas-labor-force-workforce-development-programs-in-public-community-colleges/

Snyder, T. D.; Dillow, S. A.; and Hoffman, C. M. (2009) Digest of Education Statistics 2008. NCES 2009-020. Washington: Institute of Education Sciences, National Center for Education Statistics, U.S. Department of Education. Available at http:// nces.ed.gov.proxy.library.vanderbilt.edu/pubs2009/2009020.pdf.

Stoeger, H., Duan, X., Schimer, S., Greindl, T., & Ziegler, A. (2013). The effectiveness of a one-year online mentoring program for girls in STEM. Computers and Education, 69, 408 - 418.

Stone, J. R., III, & Lewis, M. V. (2012). College and career ready in the 21st century: Making high school matter. New York: Teachers College Press.

Subotnik, Tai, Rickoff & Almarode, 2009 Specialized public high schools of science, mathematics, and technology and the STEM pipeline: what do we know and what will we know in 5 years?

Tai, R. H., Liu, C. Q., Maltese, A. V., & Fan, X. (2006). Planning early for careers in science. Science, Vol 312, 26.

Theeboom, T., Beersma, B. and Van Viansen, A.E.M. (2014), “Does coaching work? A meta-analysis on the effects of coaching on individual level outcomes in an organizational context”, The Journal of Positive Psychology, Vol. 9 No. 1, pp. 1-18, doi: 10.1080/17439760.2013.837499.

Twenge, J. M. (2010). A review of the empirical evidence on generational differences in work attitudes. Journal of Business and Psychology, 25(2), 201-210.

Tyson et al. (2007) Tyson Lee, Borman, and Hanson Science, Technology, engineering, and mathematics (STEM) pathways: high school science and math coursework and postsecondary degree attainment.

Trzesniewski, K., Donnellan, M., & Robins, R. (2008). Is Generation Me Really More Narcissistic Than Previous Generations? Journal of Personality, 76(4), 903–918. https://doi.org/10.1111/j.1467-6494.2008.00508.

U.S. Department of Commerce and Vice President Al Gore's National Partnership for Reinventing Government Benchmarking Study (2000). “Best practices in achieving workforce diversity.”

Qian, Y., Zafar, B., & Xie, H. (2009). Do female faculty influence female students’ choice of college major, and why? Northwestern University Working Paper.

Wang, M. & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy–value perspective to understand individual and gender differences in STEM fields, Developmental Review, 33 (4), 304-340

Whalen, D., & Shelley, M. (2010). Academic Success for STEM and Non-STEM Majors. Journal of STEM Education: Innovations and Research, 11(1-2), 45–60. Retrieved from http://search.proquest.com/docview/851225217/

Wigfield, A., and Eccles, J. (2000). Expectancy-value theory of achievement motivation. Contemporary Educational Psychology 25, 61-81.

Xie, Yu, and Kimberlee Shauman. 2003. Women in Science: Career Processes and Outcomes. Cambridge: Harvard University Press.

Yoder, E. (2018, May 08). Q&A for federal workers: Dearth of younger employees. Retrieved from https://www.washingtonpost.com/news/powerpost/wp/2018/05/08/qa-for-federal-workers-dearth-of-younger-employees/

APPENDIX A

Comparison of Means Between Agencies (ANOVA Results for Dependent Variables)

	Department of Energy	National Aeronautics and Space Administration	Nuclear Regulatory Commission	F value
Sufficient resources (for example, people, materials, budget) to job done.	3.20 (1.24)	3.50 (1.18)	3.63 (1.15)	198.37
I know how my work relates to the agency's goals.	4.16 (.88)	4.39 (.75)	4.33 (.79)	200.21
The work I do is important.	4.36 (.79)	4.44 (.74)	4.38 (.78)	29.21
Work unit is able to recruit people with skills	3.10 (1.20)	3.52 (1.11)	3.33 (1.17)	311.41
Steps are taken to deal with poor performers	3.02 (1.19)	3.31 (1.15)	3.01 (1.20)	156.5
Work unit has job-relevant knowledge and skills	4.15 (.87)	4.34 (.78)	4.21 (.88)	144.5
Policies and programs promote diversity in the workplace (for example, recruiting minorities and women, training in awareness of diversity issues, mentoring).	3.61 (1.08)	4.11 (.91)	3.86 (1.01)	572.06
My agency is successful in its mission	4.01 (.85)	4.28 (.79)	4.24 (.78)	281.43
I recommend the agency as a good place to work.	3.81 (1.07)	4.36 (.86)	4.01 (1.01)	826.84
My supervisor is committed to a workforce representative of all segments of society.	4.07 (.97)	4.34 (.85)	4.19 (.96)	207.00
My supervisor provides me with constructive suggestions to improve my job performance.	3.86 (1.10)	4.11 (1.01)	3.98 (1.10)	139.2
Supervisors work well with employees of different backgrounds	3.83 (1.01)	4.21 (.86)	3.97 (.97)	394.47
Managers communicate the goals of the organization.	3.70 (1.09)	3.98 (.97)	3.91 (.98)	181.66
Considering everything, how satisfied are you with your job?	3.83 (1.02)	4.15 (.92)	3.91 (1.01)	267.51
Considering everything, how satisfied are you with your pay?	3.73 (1.09)	3.86 (1.07)	3.81 (1.08)	37.62
Considering everything, how satisfied are you with your organization?	3.67 (1.07)	4.04 (.97)	3.82 (1.04)	316.01

All are significant at the $p<.05$. F value stems from one-way correlation from each dependent variable.

APPENDIX B

Semi-structured Interview Protocol
Interview Protocol: Department of Energy, Office of Environmental Capstone Project
September 6, 2018
Rev: December 22, 2018

1. Opening introductions
    A. Purpose of study
    B. Recording consent
    C. Signatures or verbal acknowledgement
2. Tell me about your work for the DOE?
    A. What is your role?
    B. Probing questions to understand job functions
    C. How long have you worked for DOE?
    D. For the Office of Environmental Management?
    E. Have you held multiple roles in the organization? If so, which and for how long did you serve in each?
    F. Did you begin your career with a contracted company?
3. Career Choice
    A. Briefly describe your educational experience.
        1. Do you recall when you first became interested in a science or technology related career?
        2. What subjects did you prefer in early grades?
        3. Did you take any AP courses in a STEM related field in high school?
        4. Did you attend community college? Where and what did you study?
            a. How did you choose this field?
        5. Did you attend a four year institution? Where and what did you study?
            a. How did you choose this field?
        6. Did you attend graduate school? Where and what did you study?
        7. What do you believe helped you achieve in science or technology?
        8. Did you have notable mentors along the way?
        9. Was anyone in your family also interested in science and technology?
    B. Tell me how you came to work at the Department of Energy, Office of Environmental Management.
        1. When did you first become aware of the Office?
        2. What made you decide to apply for your current role?
        3. What attracted you to your position?
    C. Was a career in environmental management always important to you?
    D. Did you participate in any STEM career preparation or pipeline program (secondary, undergraduate, or graduate level)?
        1. If yes, can you please describe your program?
4. STEM Recruitment
    A. What led you to a career in the STEM field?
    B. Were you always interested in a STEM career?
    C. Can you recall when your interest in science began?
    D. Did you have a mentor or someone who influenced or encouraged your interest in a STEM career?
5. Workforce Diversity
    A. How would you define workforce diversity?
    B. What initiatives have you seen EM implement to increase workforce diversity?
        1. If the interviewee names one, probe further: how would you describe these initiatives?
    C. Do you perceive the workforce as diverse? How so?
5. General
    1. What do you like best about working for EM?
    2. What is most challenging about working for EM?
    3. Would you recommend a job in EM to a friend or family member? Why or why not?
6. Recruiting and Hiring
    1. Can you describe your role in the recruiting and hiring processes for your department?
    2. What challenges do you face as you hire?
    3. Are there pipeline programs (e.g. name) that you find to be more effective than others? Why? Those that you find less effective?
    4. What barriers do you face as you try to staff your team?
    5. Do you find your hiring pools diverse? Why or why not?
        1. Racial diversity?
        2. Age diversity?
    6. What do you think keeps young people out of the hiring pool? OR
    7. What do you think keeps young people from being hired?
7. Career Advancement
    1. Are there opportunities for staff to grow once hired? Why or why not?
8. Perception
    1. Are there things EM could do to better recruit? What do you think they are?