Mountain and Plains Education and Research Center

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List of Abbreviations

ABET – Accreditation Board for Engineering and Technology
ABHP – American Board of Health Physics
AC – Administrative Core
ACGME – Accreditation Council for Graduate Medical Education
AEHAP – Association of Environmental Health Academic Programs
AIHF – American Industrial Hygiene Foundation
Am J Ind Med – American Journal of Industrial Medicine
AOHP – Association of Occupational Health Professionals in Healthcare
APHA – American Public Health Association
ASI – ATV Safety Institute
ATV – All Terrain Vehicle
CDC – Centers for Disease Control and Prevention
CDPHE – Colorado Department of Public Health and Environment
CE – Continuing Education
CE/O – Continuing Education/Outreach
CHWE – Center for Health, Work, and Environment
CIH – Certified Industrial Hygienist
CME – Continuing Medical Education
CSM – Colorado School of Mines
CSP – Certified Safety Professional
CSPH – Colorado School of Public Health
CSTE – Council of State and Territorial Epidemiologists
CSU – Colorado State University
CU – University of Colorado
CWA – Center-wide Activities
DORA – Department of Regulatory Agencies
EAP – External Advisory Panel
EC – Executive Committee
ERC – Education and Research Center
ERHS – Environmental and Radiological Health Sciences
GRC – Global Refugee Center
HRSA – Health Resources and Services Administration
HICAHS – High Plains Intermountain Center for Agricultural Health and Safety
HP – Health Physics
IFSCE – Integrated Food Safety Centers of Excellence
IH – Industrial Hygiene
IOM – Institutes of Medicine
LMS – Learning Management System
MAP ERC – Mountain and Plains Education and Research Center
MCOHS – Midwest Center for Occupational Health and Safety
NCOHS – Northwest Center for Occupational Health and Safety
NIOSH – National Institute for Occupational Safety and Health
NORA – National Occupational Research Agenda
OE – Occupational Ergonomics
OEM – Occupational and Environmental Medicine
OHI – Occupational Health Indicators
OHN – Occupational Health Nursing
OHP – Occupational Health Psychology
OS&H – Occupational Safety and Health
OSHA – Occupational Safety and Health Administration
r2p – Research to Practice
RAC – Residency Advisory Committee
RCR – Responsible Conduct of Research
RMCOEH – Rocky Mountain Center for Occupational and Environmental Health

SACNAS – Society for the Advancement of Chicanos and Native Americans in Science
TPG – Training Program Grant
TWH – Total Worker Health
US – United States
WestON – Western States Occupational Network
WHO – World Health Organization
WSD – (NIOSH) Western States Division

Abstract

The mountain and plains states of Colorado, New Mexico, Arizona, Wyoming, Montana, North Dakota and South Dakota share a common set of problems that outstrip existing resources: rising population; large groups of underserved and minority workers; region-specific work-related health issues such as mining, energy, and agriculture; and geographic distance from educational centers of excellence in occupational safety and health. The Mountain and Plains Education and Research Center (MAP ERC) was founded in 2007 to incorporate faculty and trainees from two institutions of higher learning into an integrated, multidisciplinary Center, to improve worker health, safety and well-being.

The objectives of the MAP ERC are to promote interdisciplinary graduate and post-graduate (residency) education in occupational safety, health and well-being; to provide needs-based continuing education and outreach in an underserved region; to support pilot research projects that advance the National Occupational Research Agenda (NORA); and to improve minority recruitment and retention in the core and allied fields of occupational safety and health. The MAP ERC incorporates five training programs from the University of Colorado and Colorado State University. Core programs include Industrial Hygiene and Occupational and Environmental Medicine Residency. Three allied programs offer graduate training in Health Physics, Occupational Ergonomics, and Occupational Health Psychology. All five programs provide graduate or post-doctoral/residency level training. All programs are committed to providing a highly interdisciplinary educational experience through shared courses, field experiences, research collaboration, and conferences. A vigorous evaluation program included the development of logic models for all components of the Centerwide Activities, as well as each training program. These logic models are reviewed periodically and used for programmatic decision making.

Over the past five years, the MAP ERC has trained 68 individuals across the five disciplines. Of the 46 graduates the MAP ERC has produced over the past five years, over 90% are employed in occupational safety and health and the majority are in the western United States. MAP ERC alumni report being highly satisfied with the education they received as ERC trainees, with many citing the interdisciplinary nature of their training as an important component of their success. The diversity of our trainees is important, with 56% female trainees over the five years and 15% diversity, as measured by not only racial and ethnic diversity, but also diverse socioeconomic backgrounds, rural residents, and/or disabilities.

The Continuing Education program has consistently exceeded NIOSH requirements of training 600 individuals per year. In the last year of the MAP ERC grant period, the CE program reached 1,814 individuals across 42 trainings, bringing the five year total to 10,359 individuals trained and 142 trainings. The Pilot Projects program has awarded nearly $350,000 over the five year period to 26 individuals to further their research in occupational safety and health. Resulting products have included 32 professional presentations and 19 peer-reviewed publications to date. Outreach is embedded in all parts of the MAP ERC, bringing together many regional professional organizations and creating collaborative opportunities for addressing workplace challenges, including outreach to hundreds of regional enterprises, agencies, non-profits, and professional societies.

Highlights and Significant Results

Training Program Highlights. The MAP ERC incorporates five training programs from the University of Colorado (CU) and Colorado State University (CSU). Core programs include Industrial Hygiene (IH) and Occupational and Environmental Medicine (OEM) Residency. Three allied programs offer graduate training in Health Physics (HP), Occupational Ergonomics (OE), and Occupational Health Psychology (OHP). All five programs provide graduate or post-doctoral/residency level training. All programs are committed to providing a highly interdisciplinary educational experience through shared courses, field experiences, research collaboration, and conferences. The following common goals exist across training programs and significant results from the 2010-2015 grant period are presented.

Increase the supply of trained professionals in each field. Over the past 5 years, the MAP ERC has trained 68 individuals across the five training programs (see Table 1). Many individuals have received support over multiple years. By training program, this equates to 16 Health Physics trainees, 25 Industrial Hygiene trainees, 8 Occupational Ergonomics trainees, 9 Occupational and Environmental Medicine residents, and 10 Occupational Health Psychology trainees. In the last year of the training grant, the MAP ERC supported 30 trainees. Appendix A contains more detailed trainee information, including research topics, and employment updates.

Table 1. MAP ERC Trainees, 2010-2015

Training Program	Years 4-8 (2010/11 – 2014/15)	Year 8 (2014-2015)
Health Physics	16	6
Industrial Hygiene	25	10
Occupational Ergonomics	8	4
Occupational & Environmental Medicine	9	4
Occupational Health Psychology	10	6
All Programs	68	30

Over the past 5 years, the MAP ERC has produced 46 graduates. Over 90% of graduates of MAP ERC training programs are employed in occupational safety and health (OS&H). Eighty-five percent of graduates are employed in the western United States, demonstrating that we are helping to meet regional needs. The largest percentage of graduates are employed in private industry (57%), followed by academia (17%) and the federal government (13%).

Ensure that graduates are prepared to enter the workforce. When surveyed in 2013, 98% of MAP ERC alumni agreed or strongly agreed that they were well educated in their training program; the mean rating was 4.5 out of 5.0. Further, 85% of alumni indicated they were well prepared for the positions they have held since completing their training, with a mean rating of 4.4 out of 5.0. Alumni were asked what would have helped to better prepare them for their current positions and the answers were diverse. All feedback was shared with training program directors and faculty and was used when developing changes in the curriculum.

Ensure that each training program meets the current standards of practice. All five training programs have systems in place for ongoing review and feedback of their programs to ensure the program meets the needs of the profession. For those programs with professional accreditation, all are fully compliant. Both the Health Physics and Industrial Hygiene training programs received reaccreditation from the Accreditation Board for Engineering and Technology (ABET) in 2014 and are fully accredited through 2019-20. The Occupational and Environmental Medicine Residency received Accreditation Council for Graduate Medical Education (ACGME) reaccreditation in 2012 and continues to be annually accredited. All five training programs have advisory boards that regularly review curriculum and advise programs. These advisory boards and their roles are detailed in the technical report.

Ensure that the MAP ERC produces leaders in the fields of OS&H. While enrolled in MAP ERC training programs, trainees are exposed to a variety of practices that prepare them for leadership in their respective fields. The unique educational opportunities that trainees receive help ensure that they are meeting the evolving and broad needs of the OS&H professions. The MAP ERC curriculum also provides many opportunities for trainees to take leadership roles on interdisciplinary teams, thus preparing them to become leaders in their fields. Graduates from the MAP ERC training programs often hold positions of leadership within

their professions, such as Division of Occupational Medicine Chief at Denver Health and Director of Environmental Health and Safety Services at Occupational Services, Inc. Additionally, graduates have been recipients of multiple external awards.

Ensure Continuing Education is up-to-date and reflects what professionals in the field need to know. The overarching goal of the MAP ERC Continuing Education program (CE) is to serve the needs of OS&H professionals in our region through innovative learning opportunities that are accessible, effective, culturally appropriate and that address learner needs. Our objective is to serve as a major resource for training and Continuing Education in the fields of Industrial Hygiene, Occupational and Environmental Medicine, Occupational Health Nursing, Safety, Occupational Ergonomics, Health Physics, Occupational Health Psychology, and other allied disciplines. Our goal is to meet or exceed the NIOSH requirement of training 600 OS&H practitioners each year, providing high quality, relevant content. Over the past five years, we trained 10,359 OS&H professionals through 142 events in the fields of Industrial Hygiene (541), Safety (1,376), Occupational Health Nursing (1,222), Occupational and Environmental Medicine (4,080) and others (3,140). Training programs contribute to CE activities and content in a variety of ways, which are detailed in the technical report.

Ensure graduates of each training program are fully capable of engaging in an inter-professional workforce. Trainees in the MAP ERC training programs have many opportunities to engage with trainees and researchers from other disciplines. This occurs in both formal course settings and in more informal settings. There are two interdisciplinary courses that all MAP ERC trainees must complete. Further, many trainees take courses from other programs. More informal interdisciplinary interactions occur in the form of group outings, site visits, etc. In the 2013 MAP ERC alumni survey, the interdisciplinary nature of their training was the most frequently cited response to the question asking how the MAP ERC enhanced their educational experience.

Ensure trainees are prepared to responsibly conduct research. Over the last five years, all trainees supported by the MAP ERC have completed education related to the responsible conduct of research. It addition, faculty address research ethics as part of the development and execution of research projects in their laboratories and in the process of preparing research publications. Training in ethics and responsible conduct is an essential component of the education of all ERC trainees.

Increase the diversity of graduates with training in Occupational Safety and Health fields. One goal of the MAP ERC is to ensure all center components incorporate efforts to enhance representation and engagement with diverse and vulnerable populations. Part of this goal includes training a workforce of OS&H professionals who come from diverse backgrounds. The MAP ERC defines diversity to include sex, socioeconomic status, and rural residence, in addition to race and ethnicity. Over the past five year, 56% of trainees have been female and 15% of MAP ERC trainees report ethnic/racial diversity, were economically disadvantaged, were from rural communities, and/or had disabilities.

Centerwide Activities and Continuing Education Highlights. Centerwide Activities (CWA) include 5 elements: 1) Administrative Core, 2) Outreach to OS&H community, 3) Diversity recruitment and retention, 4) Interdisciplinary Coordination, and 5) Pilot Projects research training program. The following broad goals were identified and significant results from the Centerwide Activities and Continuing Education program are highlighted below.

Promote interdisciplinary, integrated graduate education in Occupational Safety and Health. Two interdisciplinary courses are required of all MAP ERC trainees, a 1 credit-hour course in the fall semester of the first year of training (PSY 596D: Spectrum of Professions Protecting and Promoting Worker Health) and a 2 credit-hour course (ERHS 679: MAP ERC Interdisciplinary OS&H Symposium) required every spring semester during MAP ERC training. Thus, our trainees take a *minimum* of 5 credit-hours of interdisciplinary courses together plus a minimum of 6 more credit hours in allied disciplines – most take more. PhD students can expect to take at least 15 credit-hours of courses together. Additional experiences are available to trainees, including field experiences, site visits, and research opportunities, as well as informal interactions among trainees. Feedback from trainees and alumni indicate that these courses are having a positive impact on their education and subsequent employment.

Improve Continuing Education and Outreach activities in an underserved region. The MAP ERC's past performance for CE is outstanding, based on multiple metrics including the number of individuals trained, number of events, relevance and types of activities, course evaluations and the multiplatform approach taken to provide high-quality CE offerings. The MAP ERC past performance represents our accomplishments in meeting the needs of the large heterogeneous groups of professionals, topics and platforms that achieve targeted and interdisciplinary training. Table 2 highlights the number of trainees and person-days that have resulted over the last five years. The large number of trainees served was achieved by matching CE offerings to the needs of OS&H professionals. The MAP ERC continued to sponsor, plan, develop and organize CE events and courses regionally, based on assessed need.

Table 2. MAP ERC Continuing Education Activity Summary

Year	OEM	OHN	IH	SAFETY	OTHER	Total Trainees	Total Courses	Total Person-Days
2010-2011	646	223	164	204	221	1,458	24	2,687
2011-2012	762	247	66	138	258	1,471	21	2,071
2012-2013	1,231	291	82	123	720	2,447	24	2,103
2013-2014	780	223	136	386	1,644	3,169	31	2,980
2014-2015	661	238	93	525	297	1,814	42	3,406
Grand Totals	4,080	1,222	541	1,376	3,140	10,359	142	13,247

The MAP ERC Outreach Program collaborates broadly to reach a diverse group of individuals in our underserved region. This happens through collaborative relationships, translation and dissemination of best practices in OS&H research, reaching non-OS&H professionals, and through the effective use of social media and web resources. Details of the efforts over the last five years are outlined in the technical report.

Support Pilot Projects that advance the NORA agenda. Over the past five years, the MAP ERC has funded a robust Pilot Project Program that has furthered the goals of the MAP ERC and that has advanced the NORA agenda. Each year, the MAP ERC announces funding and solicits applications. A review committee with diverse expertise reviews each proposal and in the spring, awards are announced for the following fiscal year. The main goal of the Pilot Project program is to foster innovative new directions in research, prevention/intervention, education and outreach in OS&H.

Over the last five years, the MAP ERC received 77 applications for pilot projects and funded 26 of those projects (34%). These projects resulted in 19 publications, 32 presentations, and 5 grants (with 8 additional grants pending). Based on the time lag between date of project completion and publications and subsequent grants, we anticipate further publications and grants to accrue from the more recent awards. See Table 3 for summary. Appendix B contains more detailed information about the pilot project recipients, including institutional affiliations, project title, and funding amount.

Table 3. MAP ERC Pilot Project Summary

Year	# Applied	# Awarded	# Publications	# Presentations
2010/11	15	7	8	7
2011/12	20	5	3	9
2012/13	11	4	2	4
2013/14	11	4	5	7
2014/15	20	6	1	5
All Years	77	26	19	32

Ensure all center components incorporate efforts to enhance representation and engagement with diverse and vulnerable populations. The MAP ERC strategies for addressing health disparities among workers include 1) training a workforce of OS&H professionals who come from diverse backgrounds, 2) training a workforce of culturally competent professionals, regardless of their own backgrounds, and 3) promoting research to practice (r2p) that addresses safety and health inequities and that engages vulnerable populations.

Over the past five year, 56% of trainees have been female and 15% of our MAP ERC trainees report ethnic/racial diversity, were economically disadvantaged, were from rural communities, and/or had disabilities. A number of training activities are available to OS&H practitioners and MAP ERC trainees to increase their

cultural competence. These are outlined further in the technical report section of this document. Finally, the Pilot Projects program gives priority to projects that address underserved populations (e.g., aging workers, underserved racial and ethnic groups, veterans). Over the last five years, nine pilot projects have been awarded that addressed vulnerable and diverse workers, representing 35% of all projects.

Outcomes, Relevance, and Impact

The MAP ERC fills a regional need to improve worker safety and health in a seven state region by training OS&H professionals, advancing NORA sector and cross-cutting needs, conducting relevant research, promoting career development, and offering needs-based continuing education opportunities. The long-term goal is to improve worker health, safety and well-being, train the next generation of leaders in the field, integrate health promotion and health protection, and develop a more racially and ethnically diverse OS&H workforce to serve their communities. The following examples demonstrate several high impact success stories from the MAP ERC over the past five years.

Leveraging Online Learning for Occupational Safety and Health Professionals. There are an estimated 48,000 OS&H professionals in the US workforce (McAdams et al., National Assessment of the Occupational Safety and Health Workforce, 2011). Dynamic and changing industries require ongoing and continuing education to ensure that this workforce has the necessary knowledge, skills, and abilities to protect workers and prevent injuries, illnesses, and fatalities. The MAP ERC developed a nationally and internationally accessible Learning Management System (LMS) to deliver leading edge OS&H continuing education and has made it available for all 18 ERCs to use for delivering content. An agreement has been signed by all NIOSH funded ERCs to have our site host online learning for all centers, in order to maximize resources, create a centralized hub, and leverage technology to serve the needs of OS&H professionals, capitalizing on the strengths and special areas of knowledge of the faculty at any ERCs.

The MAP ERC presently hosts more than 119 online courses serving OS&H professionals. The new collaborative ERC service agreement benefits all 18 NIOSH funded ERCs and the nine disciplines supported by NIOSH - occupational safety, industrial hygiene, occupational medicine, occupational health nursing, health physics, ergonomics, occupational epidemiology, occupational health psychology, and occupational injury prevention. Professionals now have greater access to high-quality, affordable and culturally appropriate continuing education. To date, the MAP ERC, the Deep South ERC, and Johns Hopkins Education and Research Center (ERC) for Occupational Safety and Health have launched content on the shared site: maperc.mycrowdwisdom.com.

Helping to Identify Radiation Risks from Fukushima, Japan. After the accident at Fukushima Daiichi Nuclear Power Plant in 2011, workers and the public have had grave concerns regarding their radiation exposures. Under the direction of our internationally recognized faculty in Health Physics, graduate students in the MAP ERC Health Physics training program, Brett Rosenberg and Jenelle Parson, spent the summer of 2014 at the University of Tokyo and Fukushima University. Both trainees conducted research to determine the impact of radiation on workers, the public and the environment. This research has contributed to the public's understanding of radiation risks associated with nuclear power plant accidents. Since the United States has 23 reactors that are similar in design, this research has great relevance for emergency response workers as well as cleanup workers at home and abroad.

Additionally, in the summer of 2015, five students from the Health Physics program traveled to Fukushima for 12 days to further their understanding of the impacts of the disaster on the lives of people living in Fukushima. This program was sponsored by Fukushima University. Activities included tours of the disaster-affected areas, field study of local agricultural and tourism, visiting radiation monitoring centers for locally grown foods, among many other volunteer and social activities.

Providing Medical Assistance to Miners in the West. Many current and former miners live in geographically remote regions of the West and remain at high risk for pneumoconiosis. Under the leadership of Dr. Cecile Rose at National Jewish Health, MAP ERC faculty members, Occupational and Environmental Medicine Residents and alumni conduct clinics in these rural communities. Renewed competitive funding for the Miners Clinics at National Jewish Health was obtained in 2014 from the Health Resources and Services Administration (HRSA). The program identifies miners in Colorado, Wyoming and the Navajo Nation who have developed pneumoconiosis and other work-related health conditions, provides clinical recommendations, and helps address access to care and compensation. The highly successful Miners Clinics program will expand its reach to include Texas coal miners, in collaboration with Dr. Craig Glazer, Occupational and Environmental Medicine Residency alumnus and faculty member at University of Texas Southwestern. Residents in our program will continue to gain special expertise and excel in the field of occupational respiratory disorders. http://www.nationaljewish.org/programs/prevention/miners-clinic

Engaging Local Businesses in Total Worker Health™. In 2013, faculty and staff from the MAP ERC and the Colorado School of Public Health (CSPH), led by MAP ERC Director Lee Newman and CE Director Liliana Tenney, launched Health Links™. Health Links™ is an innovative program recognizing and supporting businesses to help promote the health, safety and well-being of their employees. Health Links™ helps instill a culture of health and safety throughout the business community, and encourages integrated approaches to health promotion and health protection in keeping with the principles of Total Worker Health™ applying an evidence-based framework adopted from CDC's Worksite Health ScoreCard and WHO's Healthy Workplace Framework and Model.

Health Links™ recognizes businesses that meet criteria for workplace health and safety systems, policies and programs with the Health Links™ Healthy Business Certification. This program provides businesses benchmarking and customized feedback for creating an organization that can deliver effective and sustainable best-practices for worker health and safety. Health Links™ also provides onsite advising to qualified small businesses for building worksite wellness and safety programs. An interactive website provides algorithm-driven feedback and links users to local resources. Health Links™ trainers also train community public health and business Health Links Advisors who work with the companies in their communities to develop Healthy Business Action Plans and link them to best practices and resources in their communities.

In its first two year, Health Links™ has certified and provided advising sessions for over 226 businesses in 18 Colorado counties, including some of the most rural counties in Colorado. We have trained 185 Health Links™ Advisors and Ambassadors throughout the state. This non-profit initiative of the Center for Health, Work, and Environment (CHWE) and the MAP ERC is now being recognized as the State of Colorado's Healthy Business Certification and has garnered support from the Colorado Department of Public Health and Environment, the state Office of Economic Development and International Trade, the Governor's Office, the state-based worker's compensation insurer, Pinnacol Assurance, among other strategic partners in the region. http://www.healthlinkscolorado.org

Addressing Occupational Safety and Health Research Gaps in the Oil and Natural Gas Extraction Industry. The oil and gas extraction industry is rapidly growing due to horizontal drilling and high volume hydraulic fracturing, providing new jobs and economic stimulus in the West and elsewhere in the country. Although industry occupational fatality rates are 2.5 times higher than in the construction industry and 7 times higher than general industry, there remain significant gaps in knowledge concerning the safety and health risk of workers.

The MAP ERC Occupational and Environmental Medicine Residency Program, in collaboration with the University of Wyoming, NIOSH Western States Division, and other stakeholders conducted a symposium to examine the state of the science and research needs. This led to the publication of the first comprehensive review of the OS&H research gaps in that industry and case studies illustrating challenges and potential solutions (Witter et al., Occupational Exposures in the Oil and Gas Extraction Industry: State of the Science and Research Recommendations. *Am J Ind Med,* 2014). With the continued increase in the number of workers engaged in natural gas and oil extraction, there is a significant need to advance science that targets protection of the workforce. This symposium and peer-reviewed published report provided important guidance for future research.

Preparing MAP ERC Graduates for Interdisciplinary Environments. When surveyed in 2013, 62% of MAP ERC alumni indicated that their job responsibilities usually or always overlapped with other disciplines. Only one respondent (out of 50 who completed the survey) said that their job never overlapped with other disciplines. To prepare graduates to work in increasingly interdisciplinary environments, the MAP ERC requires trainees to complete two interdisciplinary courses, in addition to other voluntary academic and social activities. The first required interdisciplinary course, Spectrum of Professions Protecting and Promoting Worker Health, is required of all incoming MAP ERC trainees. This is a lecture/presentation based course to introduce students to various OS&H professions including industrial hygiene, occupational ergonomics, occupational health psychology, occupational environmental medicine, occupational health nursing, health physics, epidemiology, occupational safety, workplace health promotion, and risk management. Students learn about each field, types of research and assessment methods. Students are asked to reflect upon each topic and how it relates back to their field of study.

The other required course, the MAP ERC Interdisciplinary OS&H Symposium, promotes practice based learning in interdisciplinary teams. Teams are placed with a regional organization to perform a field project**,** providing consultation on occupational safety, health and wellness issues, using the NIOSH Total Worker Health™ framework. In this highly innovative course, trainees receive instruction on how to serve as small business consultants, conduct worksite evaluations, integrate health protection and health promotion, and present findings to a business audience in writing and orally. Over the years, trainees in this course have been placed in a variety of sites, including a steel fabrication plant, a software company, a legal marijuana grow operation, a local arts school, and a US coin manufacturing facility.

Creating Accessible All-Terrain Vehicle (ATV) Safety Training for Montana Ranchers. ATVs have proven to be unsafe and claimed 12,391 lives between 1982 and 2012. Occupational use of ATVs is on the rise with a 193% increase in work related fatalities between 1999 and 2008. While a number of industries are using ATVs, 65% of occupational fatalities have occurred in the agricultural sector and Montana led the nation in 2012. The High Plains Intermountain Center for Agricultural Health and Safety (HICAHS) partnered with the MAP ERC to increase the number of certified ATV safety trainers serving rural agriculture communities throughout MT. Using the HICAHS small community grant program, 11 Ag Extension Agents located across MT have received ATV Safety Institute (ASI) training and certification. They were able to promote safe ATV use and become certified to teach the five-hour ASI hands-on training in their communities. Extension Agents holding ASI certification must provide two training sessions per year to sustain their certification. Each session trains between six and eight Ag producers resulting in 132-176 Ag producers trained each year in safe ATV operation throughout the state. A recent partnership with the MT Workers' Compensation Assistance Bureau will enable tracking of impacts and expected reductions.

Chronic Pain Management and the Epidemic of Opioid Prescription Abuse. Physicians who prescribe opioids to treat chronic pain in non-cancer patients are contributing to a national epidemic of addiction, abuse, overdose, and delayed recovery after work-related injuries. Our Continuing Education group embarked on a program to retrain practitioners who treat work-related injuries and chronic pain. Through an innovative collaboration with the State of Colorado Department of Labor's Division of Workers' Compensation, Pinnacol Assurance, the state-based workers' compensation insurance carrier in Colorado, and other stakeholders, the CE group developed a 2-hour online Continuing Medical Education (CME) course under the leadership of Ms. Liliana Tenney and Dr. Lee Newman, The training provides instruction to practitioners on evidence and guidelines for the appropriate management of non-cancer chronic pain. Importantly, we have engaged some of the nation's leading experts on the subject, creating engaging as well as educational modules that offer both content and tools for communicating and managing these patients responsibly. This initial program was released in October 2012 and since that time has trained and provided CME credits for over 2,100 physicians, in large part due to the expanded, online accessibility to the course and the high demand for the training.

As a result of the course, Dr. Newman and Ms. Tenney were invited to co-chair the Provider and Prescriber Workgroup for the newly formed Colorado Consortium for Prescription Drug Abuse Prevention commissioned by the governor. This workgroup has worked with the state's Department of Regulatory Agencies (DORA) to identify additional training needs identified for nurses, dentists and veterinarians. 2015 saw the release of three additional training modules, one related to Risk Evaluation and Mitigation Strategy (REMS) for extended-release and long acting opioids, as well as modules aimed at educating veterinary and dental professionals regarding their unique needs. The training has been incorporated into the four DORAs' new Policy for all practitioners under their licensure. Notably, our evaluations (post-test and 3 month follow-up) show that more than 80% report that the course has changed their clinical management of chronic, non-cancer pain. It has been endorsed by the state medical society and is required by Pinnacol Assurance and by the State Division of Workers' Compensation, with incentives provided by the state malpractice insurer COPIC, as well.

MAP ERC Annual Research Day. Each year, the MAP ERC holds an annual Research Day. Attendees include faculty, trainees, Pilot Project recipients, alumni, community members, and the entire MAP ERC External Advisory Panel (EAP). This one day meeting allows trainees and Pilot Project recipients to present their research throughout the day and network with each other, faculty, and professionals in the field. The most recent event was held in March 2015 and approximately 90 people attended. Evaluation results from this event confirm that people are highly satisfied, find the presentations informative, and the interactions valuable.

Interactions with Other ERCs, NIOSH, and Organizations. Since its creation, the MAP ERC has placed a high value on coordinating efforts (and avoiding redundancy) with neighboring ERCs, Training Program Grant recipient institutions, and other stakeholders. Below is a summary of a number of our interactions from July 2010 to June 2015, *specifically involving Administrative Core staff and faculty*

Interactions with other NIOSH-funded Centers: ERCs

- Rocky Mountain Center for Occupational and Environmental Health (RMCOEH – Utah). Our Administrative Core evaluation team conducted two joint Continuing Education needs assessments. Dr. Newman provided a keynote address at their annual NORA Young Investigators Symposium in Salt Lake City. Newman and Tenney engaged Dr. Kurt Hegmann (Director, Utah) in helping us develop training modules on chronic, non-cancer pain management.
- Midwest Center for Occupational Health and Safety (MCOHS – Minnesota). Our AC evaluation team conducted one joint Continuing Education needs assessment. The MAP ERC Administrative Core and MCOHS jointly developed Occupational Health Indicator (OHI) Reports for North Dakota and South Dakota – states that our ERC's "share" in terms of our regional coverage. This work was also done in collaboration with the NIOSH Western States Division.
- Northern California ERC (UCSF/UC Berkeley). Although we do not 'share' overlapping states with this ERC, we have a very successful ongoing collaboration since we helped start the regional organization called WestON. Our Administrative Core serves on the planning committee and provides local logistics for the WestON annual conference that is attended by western states occupational epidemiologists and Centers, in collaboration with the Council of State and Territorial Epidemiologists (CSTE), NIOSH Western States Division, and Dr. Robert Harrison (UCSF). MAP ERC Administrative Core hosted the WestON CSTE conference every year of this grant period.
- Northwest Center for Occupational Health and Safety (NCOHS – Washington). Holding Mother Earth Sacred is a photojournalism exhibit by Earl Dotter that was commissioned by the MAP ERC to examine how natural resource extraction and the new energy economy were impacting OS&H of Native Americans. Through partnership with the NCOHS, the Holding Mother Earth Sacred exhibit has reached tribal groups in the Pacific Northwest at the annual University of Washington Spring Pow Wow, the Duwamish Tribe Longhouse, Northwest Indian College, the University of Washington Bothell and the Squaxin Island Tribe Museum Library and Research Center in 2011.

Interactions with Training Program Grants (TPGs)

- University of Arizona. The MAP ERC collaborated with faculty and students at the University of Arizona's TPG in industrial hygiene to develop the first Occupational Health Indicator Report for the state. This work is partially funded by MAP ERC and was conducted in partnership with their State Health Department.

Interactions with the Four Other NIOSH Extramural Centers in the Region

- High Intermountain and Plains Center for Agricultural Health and Safety (HICAHS). Dr. Stephen Reynolds is both Deputy Director of the MAP ERC and Director of this NIOSH Agricultural Research Center. As such, we have been able to interact extensively over the past five years on multiple levels, including creating opportunities for MAP ERC trainees to conduct research and industrial site visits in the agricultural sector, conduct joint outreach activities, and promote a Total Worker Health™ agenda in the dairy industry through collaboration with Administrative Core faculty members and HICAHS.
- Affiliate Total Worker Health™ Center – The Center for Health, Work, and Environment (CHWE)**.** As a consequence of having an established MAP ERC, the University of Colorado approved the creation of a new University Center, which enables us to broaden the worker safety and health mission through public health practice (r2p), outreach, professional development, and research. Dr. Newman is CHWE Director and Ms. Liliana Tenney is Deputy Director. Multiple TWH initiatives have been developed between MAP ERC Administrative Core staff/faculty and CHWE, including educational opportunities for MAP ERC trainees and graduate students in the Colorado School of Public Health, teaching them how to consult to companies that want to integrate health protection and health promotion.
- US Mine Safety and Health Training Program (Colorado School of Mines (CSM)). NIOSH funds the Western Mining Training Center, which is based at CSM and University of Arizona. Drs. Newman and Reynolds conduct joint trainings for MAP ERC trainees and CSM students, including site visits. They

serve in advisory capacities to CSM with the goal of enhancing the quality and availability of safety and health training for mine workers in the Western US.

- Colorado State Department of Health and Environment (CDPHE) State Surveillance Program. NIOSH funds a fundamental occupational injury, illness and fatality surveillance program in Colorado. Our AC prepared and disseminated the state's first two Occupational Health Indicator Reports, positioning Colorado to obtain this funding. The MAP ERC AC continues to advise CDPHE on its occupational surveillance program.

Interacted with NIOSH, CDC, and other Federal Agencies:

- NIOSH Office of Extramural Programs. Our Administrative Core staff and faculty members conducted a two-day meeting of directors and representatives from all ERCs, Agricultural Research Centers, and Total Worker Health Centers, at the request of NIOSH. Dr. Newman facilitated this meeting in October 2013, when the Federal government "sequester" precluded NIOSH personnel from attending. Our report of this landmark NIOSH Extramural Center Directors Meeting was released on November 19, 2013 and will help NIOSH chart a course for greater interdisciplinary interaction across all extramural centers as well as intramural programs.
- NIOSH Western States Division. The MAP ERC Administrative Core has maintained a close working relationship with the NIOSH Western States Division. Examples include: collaboration in analyzing, preparing and disseminating OHI reports (CO, WY, SD, ND); conducting outreach to the Navajo Nation (including Navajo OSHA and Navajo Technical University); and collaboration in communications and dissemination efforts in the region.
- NIOSH Total Worker Health™ Program, Office of the Director. MAP ERC Administrative Core staff and faculty members have provided assistance to the NIOSH TWH Program, including participation on the planning committee for the first annual TWH International Conference; in a NIOSH-funded Institute of Medicine (IOM) workshop; and speaking at TWH Program conferences and webinars on the TWH approach to small businesses and on the integration of TWH into OS&H curriculum.
- CDC Integrated Food Safety Centers of Excellence (IFSCE). Our Administrative Core assisted the CDC in design of its Food Safety Centers of Excellence program. We also assisted the Colorado IFSCE in online course development, serving as designers for their web content, coordinating meetings of their advisory board, and developing a marketing plan, in order to accelerate its launch.

Interacted with State Governments

- Arizona. As discussed above, the Administrative Core advised and supported that state department of health's development of their first OHI report.
- Montana. Our Administrative Core advised the Montana Department of Labor & Industry as it developed its Occupational Health Indicators report.
- Wyoming. The Administrative Core updated and revised the Wyoming Occupational Health Indicators Report, in collaboration with the NIOSH Western States Division and the Office of the Governor of Wyoming. We continued to provide advice to the state occupational epidemiologist.
- Colorado. In addition to our work with the state health department, our Administrative Core provided ongoing support to the Governor's Office. Administrative Core faculty have been appointed by the governor to the Colorado Consortium for Prescription Drug Abuse Prevention, with responsibility for educating prescribers on guidelines for chronic, non-cancer pain management and the opioid prescription epidemic. The Administrative Core also advised the Colorado Office of Economic Development and International Trade in developing its blueprint for economic development for the health and wellness sector.

Interacted with National Professional Organizations

Administrative Core staff and faculty members provided significant contributions to a number of national organizations in the past five years, including, by way of example:

- Association of Environmental Health Academic Programs (AEHAP). Dr. David Gilkey, Administrative Core at CSU, served as Secretary for this organization and coordinated the Annual Student Research Competition.
- American Public Health Association (APHA). Dr. Newman organized a national symposium for interaction of APHA occupational health professionals with the ERCs. The MAP ERC-sponsored

photojournalism exhibit Holding Mother Earth Sacred was displayed at the 2010 National APHA meeting.

- Association of Occupational Health Professionals in Healthcare (AOHP). Administrative Core staff and faculty members served on multiple committees for this organization both nationally and in AOHP's Region II. The MAP ERC staff also provide research and evaluation technical assistance to this organization.

Interacted with Community Stakeholder Organizations

Administrative Core staff and faculty members provided significant contributions to a many community-based organizations in the past five years, including, by way of example:

- El Centro Humanitario Para Los Trabajadores. MAP ERC Administrative Core partnered with this community organization that advocates for day laborers in the Denver Metro area.
- United Food and Commercial Workers Union and Global Refugee Center. The MAP ERC Administrative Core partnered with these two organizations to raise awareness of OS&H hazards and control strategies among Latin American, African and Nepalese immigrants living in Greeley, Colorado, site of major meat production facilities.
- WorkSafe Colorado. The MAP ERC Administrative Core helped found a new, non-profit organization named WorkSafe Colorado to help promote worker safety and health. WorkSafe Colorado includes the MAP ERC, OS&H professional organizations, businesses, worker groups and government agencies.
- Workers' Compensation Insurers: Pinnacol Assurance and Montana State Fund. The MAP ERC Administrative Core and HICAHS continued to advise Pinnacol Assurance, Colorado's primary workers' compensation insurance carrier, regarding the effects of health promotion and wellness activities on workers' compensation insurance. In Montana, the Administrative Core supplied faculty and staff for a multi-day training on worker's compensation guidelines for the Montana State Fund.
- University of Colorado Office of Diversity and Inclusion. In conjunction with this office and the Colorado School of Public Health, the MAP ERC Administrative Core planned and conducted an annual "Public Health Academy", a two-week long program that introduced high school students to public health principles and public health careers. Two days were devoted to occupational and environmental safety and health careers.
- Center for Bioethics and the Humanities. *Commemoration of the Ludlow Massacre and Coalfield Wars, Ludlow, Colorado.* The AC partnered in commemorating the 100th anniversary of the Ludlow Massacre, which led to major growth of the American labor movement.

Training Programs Report. The MAP ERC incorporates five training programs from the University of Colorado (CU) and Colorado State University (CSU). Core programs include Industrial Hygiene (IH) and Occupational and Environmental Medicine (OEM) Residency. Three allied programs offer graduate training in Health Physics (HP), Occupational Ergonomics (OE), and Occupational Health Psychology (OHP). All five programs provide graduate or post-doctoral/residency level training. All programs are committed to providing a highly interdisciplinary educational experience through shared courses, field experiences, research collaboration, and conferences. The following common goals exist across training programs and details from how the MAP ERC met these goals over the five year grant period follows.

Increase the supply of trained professionals in each field. There exists a shortage of trained professionals across the OS&H professions (McAdams et al., National Assessment of the Occupational Safety and Health Workforce, 2011). To address the need in the region and nationally, over the past 5 years, the MAP ERC has trained 68 individuals, across the five training programs. Many individuals have received support over multiple years. By training program, this equates to 16 Health Physics trainees, 25 Industrial Hygiene trainees, 8 Occupational Ergonomics trainees, 9 Occupational and Environmental Medicine residents, and 10 Occupational Health Psychology trainees. In the last year of the training grant, the MAP ERC supported 30 trainees. Appendix A contains more detailed trainee information, including their research topics and employment.

Over the past 5 years, the MAP ERC has produced 46 graduates. Over 90% of the graduates from MAP ERC training programs are employed in OS&H. Eighty-five percent of graduates are employed in the western United States, demonstrating regional need. The largest percentage of graduates are employed in private industry (57%), followed by academia (17%) and federal government (13%). In addition to training in academic programs, each training program contributes to the continuing education of OS&H professionals in the field, further increasing the supply of trained OS&H professionals. These contributions to Continuing Education are explained in greater detail under the Centerwide Activities section of this technical report.

Ensure that graduates are prepared to enter the workforce. It is not enough to increase the supply of trained professionals, we must also ensure that those professionals are well prepared. When surveyed in 2013, 98% of MAP ERC alumni agreed or strongly agreed that they were well educated in their training program; the mean rating was 4.5 out of 5.0. Further, 85% of alumni indicated they were well prepared for the positions they have held since completing their training, with a mean rating of 4.4 out of 5.0. The alumni who completed the survey offered concrete suggestions for what could have improved their training and made them even more prepared. Suggestions varied greatly, but some examples included more technical writing skills, more statistics, and development of interpersonal skills. Most recommendations were job-specific. In all cases, those suggestions were shared with training program directors who factored them into decisions regarding their training programs. Going forward, an attempt to also survey employers of MAP ERC graduates will also be made in order to gain that perspective on preparedness. Employer input currently occurs through each of the program-specific advisory boards.

Ensure that each training program meets the current standards of practice. All five training programs have systems in place for ongoing review and feedback of their programs to ensure the program meets the needs of the profession. For those programs with professional accreditation, all are fully compliant. Both the Health Physics and Industrial Hygiene training programs were reaccredited in 2014 and are fully accredited by the Accreditation Board for Engineering and Technology (ABET) through 2019-20. The Occupational and Environmental Medicine Residency received Accreditation Council for Graduate Medical Education (ACGME) reaccreditation in 2012 and continues to be annually accredited. Each training program utilizes an external advisory board, which provides input to the training program on areas such as curriculum and needs in the field, helping to ensure the program is educating trainees to meet the current standards of practice. A brief summary of each program is below.

The Health Physics program provides academic and practical experiences that prepare trainees to enter the field of applied health physics. After four years of work experience, a graduate of the HP program should be eligible to begin the process of certification that is administered by the American Academy of Health Physics. All program graduates who meet this criteria have passed the initial American Board of Health Physics (ABHP) certification, demonstrating they are well prepared. By comparison, the pass rate for the most

recent administration of the ABHP Exam was 47% for Part I and 31% for Part II, showing the difficulty of achieving certification. The Health Physics program has a four member external advisory board that meets annually to provide advice, which is actively sought and acted upon to improve the training Health Physics trainees receive. This board is comprised of members from industry, research, government, and a national laboratory.

The Industrial Hygiene program utilizes a 10 member external advisory board who serve as the voice of industry and other stakeholder groups to guide development of program curricula. They also provide networking for employment and internship opportunities. Board members are from government, private companies, and academia and include practicing hygienists, safety professionals, risk management specialists, and research scientists. The board members are important partners in reviewing the needs and performance of the IH Program. They recently contributed to revising the student learning objectives following the ABET site visit in 2013. Many grads have received CIH designation which means they have met the requirements for education and experience, and through examination have demonstrated knowledge and skills in Industrial Hygiene.

The Occupational and Environmental Medicine Residency has a 14 member Residency Advisory Committee (RAC) that includes practitioners, academics, and residents. The purpose of the RAC is to provide oversight and additional direction to the program director. This group meets twice a year and reviews and evaluates all aspects of the residency program. The RAC makes recommendation on program goals, academic curriculum, practicum curriculum, and fiscal policy. Input from this group ensures the OEM residency is providing training and education that prepares residents to meet the current standards of practice in the field.

The Occupational Ergonomics program has a five member external advisory board that includes practitioners and consultants in ergonomics and safety that represent a range of industries as well as academia. The panel members provided feedback and recommendations to the core faculty regarding the Occupational Ergonomics program as well as networking opportunities for trainees regarding internships and future employment. Further in Occupational Ergonomics, the core courses are based on the Ergonomist Formation Model as outlined by the International Ergonomics Association and adopted as the fundamental architecture for professional competence in ergonomics by the Board of Certification in Professional Ergonomics (www.BCPE.org). Sixty percent of alumni are either Associate Ergonomics Professionals (AEP) or Certified Professional Ergonomists (CPE). One OHP graduate also received AEP certification and one OE graduate is a CIH, further demonstrating interdisciplinary nature of the OE program.

The Occupational Health Psychology program has a six member external advisory panel that is comprised of experts from industry, research, education, and government agencies. The members regularly review the training program, advise about field and research needs, and serve as guest speakers. Based on feedback from alumni and the Occupational Health Psychology External Advisory Board, the program invited new core and supporting faculty to join the program to further strengthen training across multiple areas of psychology and management. For example, additional faculty in Applied Social and Health Psychology, Counseling Psychology, and Management were added to the training program to offer courses to trainees and importantly, many more collaborative research opportunities.

Ensure that the MAP ERC produces leaders in the fields of Occupational Safety and Health. While enrolled in MAP ERC training programs, trainees are exposed to a variety of practices that prepare them for leadership in their respective fields. The unique educational opportunities that trainees receive help ensure that they are meeting the evolving and broad needs of the OS&H professions. Graduates from the MAP ERC training programs often hold positions of leadership within their professions, such as Division of Occupational Medicine Chief at Denver Health and Director of Environmental Health and Safety Services at Occupational Services, Inc.

Graduates have been recipients of multiple external awards. From the IH program, 11 trainees have received prestigious national awards from the American Industrial Hygiene Foundation (AIHF), 3M, Emma Byrd Scholarship, US Environmental Protection Agency STAR grant, and National Science Foundation Integrative Graduate Education and Research Traineeship. Health Physics graduate Elizabeth Gillenwalters was recently voted a member of the Health Physics Society Board of Directors. Other Health Physics trainees have received prestigious scholarships and awards. Occupational Health Psychology trainees have similarly received multiple honors, including a Global Impact Award at the CSU Graduate School Showcase and the Carol Baird Scholarship. Occupational Ergonomics trainees have received multiple scholarships and awards, including Outstanding Graduate Student Researcher of the Year, DeField-Buchan Memorial Scholarship, and the AIHF Memorial Scholarship for Ergonomics and Industrial Hygiene.

Our Occupational and Environmental Medicine Residency program has a long and successful track record of graduating highly qualified physicians and our alumni fill regional and national occupational medicine leadership positions. Because there is a deficit of residency trained OEM physicians, both regionally and nationally, our graduates continue to be in high demand as leaders in clinical practice, academia, and government agencies. OEM residency graduates have become directors of occupational medicine clinics, leading and guiding those that treat occupational injuries and illnesses without such training; leaders in the integration of workplace health protection and health promotion because of their training in worksite wellness; continue to fill academic positions, training future OEM physicians and conducting OS&H research; continue to fill positions in state and federal agencies that require the expertise and training only found in an OEM Residency such as ours.

Ensure Continuing Education is up-to-date and reflects what professionals in the field need to know. The overarching goal of the MAP ERC Continuing Education program is to serve the needs of OS&H professionals in our region through innovative learning opportunities that are accessible, effective, culturally appropriate and that address learner needs. We seek to serve as a major resource for training and continuing education in the fields of Industrial Hygiene, Occupational and Environmental Medicine, Occupational Health Nursing, Safety, Occupational Ergonomics, Health Physics, Occupational Health Psychology, and other allied disciplines. Our goal is to meet or exceed the NIOSH requirement of training 600 OS&H practitioners each year, providing high quality, relevant content. Over the past five years, the MAP ERC trained 10,359 OS&H professionals through 142 events in the fields of IH (541), Safety (1,376), OHN (1,222), OEM (4,080) and others (3,140).

Individual training programs contribute a great deal in terms of content for MAP ERC CE. Major examples include expertise for the development of online certification exam review courses (CIH Online for Industrial Hygiene and CSP Online for safety professionals). The Health Physics program is responsible for over 50 online courses that are endorsed by the National Health Physics Society and are linked to the Society's website that reaches over 5,000 members. This has resulted in 1,240 website visits and 40 trained Health Physics professionals each year. Dr. Gwen Fisher, from Occupational Health Psychology, has provided expertise to develop and offer in-person courses addressing stress management. The Occupational and Environmental Medicine program continues to provide resources and lecturers for the Rocky Mountain Academy of Occupational and Environmental Medicine, including their annual conference, which in the future will align with the MAP ERC Annual Research Day. These are just a few of the many examples of how our training programs contribute to the continuing education of OS&H practitioners.

Ensure graduates of each training program are fully capable of engaging in an inter-professional workforce. Trainees in the MAP ERC training programs have many opportunities to engage with trainees and researchers from other disciplines. This occurs in both formal course settings and in more informal settings. In the 2013 alumni survey, the interdisciplinary nature of their training was the most frequently cited response to the question asking how the MAP ERC enhanced their educational experience. As this is an area that spans the MAP ERC, more detailed descriptions of the formal and informal interdisciplinary activities available to trainees appears below under the Centerwide Activities section of this technical report.

Ensure trainees are prepared to responsibly conduct research. Over the past five years, all trainees supported by the MAP ERC have completed education related to the responsible conduct of research (RCR). Training in ethics and responsible conduct of research is an essential component of the education of all ERC trainees. For the four training programs housed at CSU, all ERC trainees are required to complete the RCR training program during their first semester. This training consists of an on-line (http://rcr.colostate.edu/training.html) and face-to-face (GRAD 544 The Ethical Conduct of Research) course. Additionally, all ERC trainees must complete on-line (https://www.citiprogram.org) Institutional Review Board (IRB) human subjects training. Additional coursework in each of the training programs addresses this important area. Residents from the occupational and environmental medicine program also complete RCR training, through the University of Colorado School of Medicine (SOM) Graduate Medical Education (GME) office. OEM residents also complete the online human subjects training through the Collaborative Institutional Training Initiative (CITI). All MAP ERC trainees are involved in research and in addition to the formal training outlined, they receive further preparation through their own supervised research activities.

Increase the diversity of graduates with training in Occupational and Environmental Safety and Health fields. A goal of the MAP ERC is to ensure all center components incorporate efforts to enhance representation and engagement with diverse and vulnerable populations. Part of this goal includes training a workforce of OS&H professionals who come from diverse backgrounds. The MAP ERC defines diversity to include sex, socioeconomic status, and rural residence, in addition to race and ethnicity. Over the past five year, 56% of trainees have been female. Over the same time period, 15% of our MAP ERC trainees report ethnic/racial diversity, were economically disadvantaged, were from rural communities, and/or had disabilities.

Under the direction of Dr. Dominic Martinez, the Senior Director of Inclusion and Outreach at UCD, over the past five years, the MAP ERC participated in a number of pipeline programs that recruited diverse students into the health professions. These include the 1) Public Health Academy, a summer program for high school and undergraduate students that introduced students to the principles of public health, as well as careers in the field; 2) Undergraduate Pre Health Program, which selects students from low-income and underrepresented populations to spend eight weeks on campus where they shadow health professionals, conduct research, and participate in workshops; 3) CREATE Health Scholars, a year-long program for Colorado undergraduate students, which includes an intensive one-month summer curriculum with the goal of improving students' basic educational building blocks in math, science, language arts, as well as providing hands-on training and exposure to health careers; 4) Health Professions Opportunity Day, which is available to any middle and high school students participating in pre-collegiate programs offered by any of the CU-system campuses. Activities include hands-on workshops, speakers, and sessions that will introduce students to different health fields and opportunities in higher education, including. Students are presented with the opportunity to explore the many possibilities in the health careers and learn about the educational path one must take to reach his or her ultimate goal of becoming a health professional; 5) Aurora LIGHTS Program, a partnership designed to help minority and disadvantaged students succeed in science, enroll in pre-med and health sciences school programs and become health science professionals.

In addition to the formal pipeline programs, Dr. David Gilkey was actively involved with CSU diversity efforts. Through his relationships with campus and student organizations – specifically, the Native American Cultural Center, the Black/African American Cultural Center, and the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) -- Dr. Gilkey brought the undergraduate program in environmental health from 8% diverse to greater than 50% diverse in 5 years. He promoted the ERC training programs to students and faculty associated with CSU's diversity programs, including CSU's annual Diversity Symposium and a recent event attended by 15 ERC faculty and staff, as well as 20 students and faculty from SACNAS.

Dr. Thomas Johnson (Health Physics) has had further success in recruiting students from Alcorn State, a Historically Black College and University (HBCU). Dr. Johnson has developed a relationship with the director of the Alcorn State Health Physics program, who has encouraged students to explore opportunities and in the past year, two underrepresented students from Alcorn State University applied and were admitted into the CSU program, one of whom will be supported by the MAP ERC. The MAP ERC EC meets monthly, and one regular topic of discussion is diversity recruitment. Successes, such as this one, are shared among the faculty, with discussion about how best practices can be adapted and adopted by other programs.

Centerwide Activities and Continuing Education Report. Centerwide Activities (CWA) include 5 elements: 1) Administrative Core, 2) Outreach to OS&H community, 3) Diversity recruitment and retention, 4) Interdisciplinary Coordination, and 5) Pilot Projects research training program. The Administrative Core (AC), led by the Center Director and Deputy Director, is based principally at the Colorado School of Public Health, CU campus with additional support at CSU. The AC provides organizational and communications support for all CWA and for Continuing Education. An Executive Committee (EC) and External Advisory Panel (EAP) actively contribute to overall direction, management, and evaluation of all component programs. The Outreach Program relies on our Community Partnership Committee and other established and new relationships, to promote an active regional network of OS&H professional organizations eager to collaborate, identify research-to-practice needs in the community, engage with the training program trainees and faculty and Continuing Education program, to advance professional development in the region. The Diversity Program continues to be an integral component, building on relationships, working with representatives of the region's Native American and Latino worker health communities and with minority student groups to introduce educational and career opportunities. Interdisciplinary Coordination continued to create a sense of community through joint educational offerings, including the new Spectrum of Professions Protecting and Promoting Worker Health course, the OS&H Interdisciplinary Symposium, field trips to regional industries, social events, annual retreat, and annual Research Day. Faculty continued to integrate across disciplines through co-teaching/curricular

redesign, interuniversity course enrollment and shared student/faculty social and educational opportunities, promoted by the AC through website and RoadMAP, our electronic newsletter. The Pilot Projects program widely solicited applications from throughout the region, with emphasis on diversity, NORA goals, and r2p, in order to enhance the quality and number of investigators addressing occupational research needs. The CE program serves the needs of OS&H professionals in our region, and nationally, through innovative learning opportunities that are accessible, effective, and that address student needs. The following broad goals were identified and significant results are highlighted below.

Promote interdisciplinary, integrated graduate education in Occupational Safety and Health. There are two required interdisciplinary courses that provide more formal opportunities for MAP ERC trainees to engage in interdisciplinary activities, with faculty mentoring. The MAP ERC Interdisciplinary OS&H Symposium promotes practice based learning in interdisciplinary teams. Teams are placed with a regional organization to perform a field project**,** providing consultation on occupational safety, health and wellness issues, using the NIOSH Total Worker Health™ framework. In this highly innovative course, trainees receive instruction on how to serve as small business consultants, conduct worksite evaluations, integrate health promotion and health protection, and present findings to a business audience in writing and orally. This course began in 2011 and over the years has placed trainees in a variety of sites, including a steel fabrication plant, a software company, a legal marijuana grow operation, a local arts school, and a coin manufacturing facility.

The second required interdisciplinary course was implemented in the fall of 2014. This course, Spectrum of Professions Protecting and Promoting Worker Health, is required of all incoming MAP ERC trainees. This is a lecture/presentation based course to introduce students to various OS&H professions including industrial hygiene, occupational ergonomics, occupational health psychology, occupational environmental medicine, occupational health nursing, health physics, epidemiology, occupational safety, health promotion and wellness, and risk management. Evaluation results indicate the first iteration of the course was highly successful. Pre- and post-course evaluations demonstrated statistically significant gains in self-reported knowledge and familiarity for all disciplines. The mean rating for expectation of working in an OS&H field upon graduation increased from of 4.1 to 4.7 (out of 5.0) and the mean rating for working in an interdisciplinary field increased from 4.2 to 4.7 over the course of the semester. Qualitative feedback from trainees indicated they were highly satisfied with the course.

Other interdisciplinary experiences available to MAP ERC trainees have included field experiences and interdisciplinary site visits (worksite tours such as Children's Hospital Colorado, Denver Zoo, Edgar Mine, Buckley Air Force Base, and Los Alamos National Laboratory). Additionally, trainees have the opportunity to participate in interdisciplinary research with faculty and trainees in the other MAP ERC training programs. Every year the MAP ERC conducts our Annual Research Day. This event has provided a venue to connect trainees, faculty, community members, alumni, External Advisory Panel members and Pilot Project grant recipients, cutting across many disciplines. This event also adds a dimension of social interaction among our trainees and faculty, as do other events such as the fall welcome picnic for all incoming and continuing trainees, staff and faculty.

There is also a focus on interdisciplinary coordination among faculty. The MAP ERC aimed to foster an environment in which faculty members are increasingly collaborative and interdisciplinary in their own right. For example, six core faculty members from all five training programs contribute to teaching the Interdisciplinary Occupational Safety and Health Symposium course. In addition, Dr. Fisher (Occupational Health Psychology) and Ms. Tenney (Occupational and Environmental Medicine) co-directed the Spectrum of Professions Protecting and Promoting Worker Health course. Cross-mentoring of projects is a common practice.

Collaborative research grant funding continued to grow. For example, Dr. Volckens (IH) is the lead investigator on a R01 grant studying commuters' exposures and a separate R01 developing new air sampling technologies, on which Dr. Newman (OEM) is a co-PI. Dr. Reynolds is regularly involved in research activities with OE faculty members and alumni (Dr. John Rosecrance, Dr. David Gilkey, Dr. David Douphrate). Faculty from OHP and OE merged their respective research interests in industrial/organizational psychology and macro-ergonomics into key areas related to safety climate and safety culture. This collaboration was transformed into funded RO1 research grants in the construction and agriculture fields. Dr. William Brazile (IH) has held several Susan B. Harwood Grants from OSHA in partnership with our OEM faculty at National Jewish Health (Drs. Annyce Mayer, Dr. Cecile Rose, Dr. Michael Van Dyke). Drs. Newman (OEM) and Reynolds (IH) collaborate on Total Worker Health™ initiatives between CHWE and HICAHS. In the past five years, 9% of peer-reviewed papers published by the MAP ERC core faculty included co-authors from two or more of our disciplines, indicative of this progression.

Improve Continuing Education and Outreach activities in an underserved region.

Continuing Education Program. The MAP ERC's past performance for CE is outstanding, based on multiple metrics including the number of individuals trained, the number of events, relevance and types of activities, course evaluations and the multiplatform approach taken to provide high-quality CE offerings. The MAP ERC trained 10,359 students and professionals through 142 events from the various OS&H fields of IH (541), Safety (1,376), OHN (1,222), OEM (4,080) and others (3,140) such as OE, OHP, and HP. These results are significant, demonstrating that we far exceeded the Program Announcement requirement of a minimum 600 trainees per year. The MAP ERC past performance demonstrates our accomplishments in meeting the needs of the large heterogeneous groups of professionals, topics and platforms that achieve targeted and interdisciplinary training. Table 2 in the highlights and significant results section of this report shows more detail for the number of trainees and person-days that have resulted over the last five years. The large number of trainees served was achieved by matching CE offerings to the needs of OS&H professionals. The MAP ERC continued to sponsor, plan, develop and organize CE events and courses regionally, based on assessed need.

Meeting the OS&H CE needs within this geographically vast region is achieved through the support of the MAP ERC Administrative Core; prudent use of available resources; needs-based planning and CE program development; forged partnerships throughout the region including academic institutions, professional organizations, government agencies, philanthropic organizations, and other ERCs; and a strong team. We provided a variety of learning opportunities including regional and local conferences, workshops, seminars, webinars, online learning (lectures and courses), certification exam review courses, and podcasts.

CE needs were assessed through formal surveys (2012, 2013), input from the CE/Outreach (CE/O) Advisory Board/WorkSafe Colorado, and the Center's EAP members, as well as through the use of evidence-based published reports. The input gained from these sources led to the development of new courses, such as CIH Online, a fully online review course for the CIH professional certification exam (44 enrollees), as well as the recent development of a Certified Safety Professional (CSP) examination review course.

Multiplatform learning is the hallmark of the MAP ERC CE program, offering a wide array of options to address preferred learning styles of trainees. We will continue to offer multiplatform trainings that range from seminars featuring distinguished lecturers to fully developed self-paced online courses. We now house 119 individual lectures for asynchronous online learning available around the world. The CE group held and/or sponsored over 70 in-person training events using available resources at both universities, combined with our community and regional partners. The MAP ERC is committed to serving Federal Region VIII plus New Mexico and Arizona (the NIOSH-approved states for our ERC). The online environment is the most efficient medium to achieve this goal and thus was a major focus.

In 2014, the MAP ERC CE group executed a formal agreement to share the Learning Management System (LMS), that we established and that we host, with the other ERCs. This service agreement benefits all 18 NIOSH funded ERCs and the nine disciplines supported by NIOSH. OS&H professionals will have greater access to high-quality, affordable, and culturally appropriate CE. As the only ERC with a Health Physics program, we have assumed responsibility for developing and promoting CE nationally in the field. This includes 54 online courses developed by the Health Physics training program director, Dr. Johnson. These courses are endorsed through the National Health Physics Society and are linked on the society's website that reaches over 5,000 members. This has resulted in 1,240 website visits and 40 trained Health Physics professionals each year.

Outreach Program. The MAP ERC outreach program collaborates broadly to reach individuals in our often underserved seven state region. The MAP ERC has a productive working relationship with other NIOSH grantees, including other ERCs, TPGs, Agricultural Research Centers, and Total Worker Health Centers, as well as with the NIOSH Western States Division and intramural NIOSH researchers. Examples of successful collaborations include partnerships with the NIOSH-funded High Plains Intermountain Center for Agricultural Health and Safety (HICAHS) at CSU. Trainees supported by the ERC often work on agricultural research projects during their graduate education. At least two ERC alumni (Dr. Joshua Schaeffer and Dr. David Douphrate) have proceeded to do post-doctoral research in agricultural health and safety as a result, and both are currently Assistant Professors, continuing their work. Also, through their involvement with HICAHS translational and educational projects, such as Dr. David Gilkey's work on All Terrain Vehicle (ATV) Safety, MAP ERC faculty members do vital outreach across the region and establish relationships with key stakeholders and industry partners.

The MAP ERC outreach program places a high premium on translation and dissemination of best practices into the practitioner community. Over the past five years, this has taken many forms, a few of which are

highlighted here. The MAP ERC developed or helped developed Occupational Health Indicator (OHI) reports for six of the seven states in our region (the 7th, New Mexico, had already developed their OHI report). The MAP ERC has formed an important relationship with the Association of Occupational Health Professionals in Healthcare (AOHP). This organization represents thousands of occupational health nurses. Through collaborative activities, the MAP ERC has provided speakers and direction to their organization. Under the guidance of the MAP ERC outreach director, the Pilot Projects program implemented a track that supports applied, translational research to practice (r2p) projects. This has proven to be an important mechanism for supporting the adaptation, implementation and evaluation of evidence-based practices into the regional community. This also allows for an additional method of involving community organizations with the MAP ERC.

The MAP ERC is privileged to work in a region served by active OS&H professional organizations. By developing partnerships with these professional organizations, the MAP ERC achieved a number of goals. Perhaps most notably, the CE program gained access to its target audience through collaborative relationships focused on educational activities. Partnerships with professional organizations also provided important opportunities for MAP ERC trainees, including potential job opportunities, opportunities to present at conferences as well as research opportunities.

The MAP ERC provides an important mechanism for raising awareness about the field among professionals working or training in disciplines other than OS&H. The impact is felt “closest to home”, among graduate students in the Colorado School of Public Health’s (CSPH) degree programs (MPH, DrPH, MS, PhD), none of which include students supported by the MAP ERC. However, over the years, at least seven trainees from CSPH have continued into MAP ERC training programs. The MAP ERC also believes it is important to raise awareness of OS&H issues in the broader community. Several events over the past five years have been directed to a broader community audience. These include 1) the Commemoration of the Ludlow Massacre, which included four nationally-recognized speakers addressing the historic event from different perspectives; 2) the Holding Mother Earth Sacred photojournalism exhibit which highlights how Native American communities are developing their communities in ways that protect energy workers and the environment; and 3) supporting community-based organizations such as El Centro Humanitario Para Los Trabajadores, a worker center in Denver that advocates for the rights of day laborers.

The outreach team has established a solid social media presence for the MAP ERC, including a Twitter account with 294 followers, a Facebook page with 206 fans, and a LinkedIn group for MAP ERC alumni with 30 members. RoadMAP, an electronic newsletter is sent monthly to over 1400 individuals across the world.

Support pilot research projects that advance the NORA agenda. The goals of the Pilot Projects research training program are to foster innovative new directions in research, prevention/intervention, education and outreach in OS&H. These awards are instrumental in increasing the research and practice capacity of trainees and junior investigators in OS&H within the region. Grant opportunities are open to investigators in other fields who wish to apply their expertise to OS&H issues. Priority is given to projects that address underserved populations (e.g., African Americans, Hispanics/Latinos and Native Americans); proposals that demonstrate novel collaboration with OS&H organizations; projects from junior investigators and those that incorporate trainees or graduate students; projects that include a translational component to take research findings from the laboratory into the workplace; projects relevant to the National Occupational Research Agenda (NORA) and projects that reflect NIOSH's r2p directive. Our Pilot Projects research training program monitors and works to address both existing and emerging NORA goals. Based on our latest review of the NORA council website (May 2014), many of the most recently developed sector agendas are in areas with potential major impacts for our region: agriculture, forestry and fishing (December 2008); construction (October 2008); oil and gas extraction (October 2011); mining (April 2013) and the services sector (August 2013). As is evident from the list of projects that we have funded (Appendix B), our Pilot Projects program is squarely on target with NORA goals.

Over the past five years, the MAP ERC has funded a robust Pilot Project program that has furthered the goals of the MAP ERC and that have advanced the NORA agenda. Each year, the MAP ERC announces funding and solicits applications. A review committee with diverse expertise reviews each proposal and in the spring, awards are announced for the following fiscal year. The main goal of the Pilot Project program is to foster innovative new directions in research, prevention/intervention, education and outreach in OS&H. During this time, the MAP ERC received 77 applications for pilot projects and funded 26 of those projects (34%). These projects resulted in 19 publications, 32 presentations, and 5 grants (with 8 additional pending). Based on the time lag between date of project completion and publication and subsequent grants, we anticipate further publications and grants to accrue from the more recent awards.

Short term and long term outcomes of the Pilot Projects program include the retention and promotion of investigators in research careers. By our estimate, all of the 26 Pilot Projects recipients over the last 5 years of this program have either advanced in their academic positions, resulted in student or trainee publications, or are currently in graduate research training. Two examples are provided below.

While completing her doctoral degree in environmental health sciences at CSU, Natalie Schwatka PhD received funding for her MAP ERC pilot grant in 2011 regarding the impact of aging workforce on workers' compensation claims. This project resulted in two peer-reviewed publications on the aging workforce and injury in the construction industry and contributed to establishing her in the field of construction safety and safety climate. Based on this experience, in 2014, Dr. Natalie Schwatka successfully competed for a faculty position in the Department of Environmental and Occupational Health at the CSPH, where she continues her research on safety climate interventions with leadership in the construction industry and also on the impact of worksite health promotion programs on workers' compensation claims and costs.

While working as a post-doctoral fellow at CSU, Joshua Schaeffer, PhD was awarded a MAP ERC pilot grant in 2013 titled "Modeling and Predicting Microbiomes in Dairies: a Metagenomic Assessment of Bioaerosols." Since he successfully completed this pilot project, Dr. Schaeffer presented this work in multiple outlets and has secured additional funding for this line of research by leveraging the work seeded by the MAP ERC pilot project. Dr. Schaeffer has been awarded a tenure-track position at CSU, where he currently works as an Assistant Professor in the Department of Environmental Health Sciences.

Appendix B contains more detailed information about the pilot project recipients.

Ensure all center components incorporate efforts to enhance representation and engagement with diverse and vulnerable populations. The MAP ERC strategies for addressing health disparities among workers include 1) training a workforce of OS&H professionals who come from diverse backgrounds, 2) training a workforce of culturally competent professionals, regardless of their own backgrounds, and 3) promoting research to practice (r2p) that addresses safety and health inequities and that engages vulnerable populations. The training of the workforce of OS&H professionals who come from diverse backgrounds is addressed above, as a training program goal.

The MAP ERC's Diversity Program recognizes that in addition to recruiting a diverse student body, it is important to elevate the cultural competence of our trainees, faculty and community partners. It is also worthwhile to raise awareness of OS&H among diverse populations throughout the mountain and plains region by partnering with our outreach efforts. These efforts have taken various forms over the past five years; a few examples are presented.

In August 2013, the MAP ERC Outreach Director joined the NIOSH Western States Division's American Indian and Alaska Native Initiative. This included a meeting with representatives from Navajo Nation OSHA and Navajo Nation Workers Compensation Program, as well as various NIOSH representatives, at the Denver Federal Center. This meeting was followed by a trip to the Navajo Nation in February, 2014. The Outreach Director traveled with Max Kiefer and Elizabeth Dalsey (NIOSH) to meet with OS&H professionals who work on the Navajo Nation in New Mexico, Arizona and Utah. The trip included a meeting with safety and health leaders of several Tribal Enterprises owned and operated by the Navajo Nation, including the Navajo Tribal Utility Authority, Navajo Agricultural Products Industry, Navajo Nation Oil & Gas Company, Navajo Engineering & Construction Authority and Navajo Housing Authority. The meeting brought together people working on tribal safety and health issues who had not previously been in contact one another. There was interest among the group in continuing to meet and build capacity in OS&H. The meeting was followed by site visits to various worksites in this geographically dispersed region, including the Twin Arrows Casino, a Navajo Tribal Utility Authority substation, a Raytheon Missile Component manufacturing facility, an agricultural producer on the Navajo Nation, an oil and gas pipeline operation, an oil drilling rig, the correctional facility and Navajo Technical University – a tribal college. The MAP ERC Outreach Director met with the Dean of the University, as well as professors in environmental science to discuss the possibility of collaborations on trainings. The process of building these relationships and identifying ways to engage are ongoing.

The Workshop on Research Translation with Vulnerable Worker Populations was held in June, 2012. It was the first event of its kind to bring together national and international experts in OS&H research translation with experts on vulnerable worker populations. During the two-day workshop, symposia and presentations submitted by researchers and practitioners were shared. MAP ERC and HICAHS faculty (Drs. John Rosecrance, Lorann Stallones and Peter Chen, who is now at Auburn) and CSPH staff (Mr. Kenneth Scott) helped organize and facilitate the workshop. Through their attendance, MAP ERC trainees were able to learn

from national experts about the promises and challenges of improving the safety and health of vulnerable workers.

The Global Refugee Center (GRC) is a non-profit organization based in Greeley, Colorado that provides resources for political refugees. Approximately one-third of meatpacking workers in Greeley, Colorado are refugees from countries that have been facing violent political and civil conflict over the past 10 or more years, including Ethiopia, Somalia, Eritrea, Burma, Guatemala and more than 20 other countries. The Global Refugee Center was founded by an Ethiopian refugee named Asad Abdi to serve refugees' basic needs, ranging from English language education to help grocery shopping. The MAP ERC partnered with the GRC, as well as HICAHS, the United Food and Commercial Workers Union, a local attorney, and OSHA to conduct a series of seminars on labor and employment rights related to workplace safety. Two seminars focused on (1) employees fundamental rights under the OSH Act and (2) employees' rights under workers compensation laws. Each seminar was taught in four languages (Ethiopian, Eritrean, Somalian and Karen – a language spoken in Burma). During the seminars, the MAP ERC Outreach Director and MAP ERC faculty members learned valuable lessons about cultural differences in the workplace that they subsequently shared with faculty and trainees. A presentation on the seminars was presented at the annual WestON meeting in September 2014.

The MAP ERC pilot project program places a high value on projects that address diverse and vulnerable populations. Projects that address worker diversity issues receive additional consideration by our review panel. As such, over the last five years, 35% of projects funded have address vulnerable and diverse workers or have been awarded to researchers from underrepresented backgrounds. A sample of these projects include cultural competency and communication for construction workers, impact of an aging workforce on workers' compensation claims, characterizing inhalable size distributions in the workplace, 3D visualization for safety training of Hispanics in construction, utility of lung clearance index score as a noninvasive marker of deployment lung, among others.

Conclusions. The MAP ERC has demonstrated significant success in the five year grant period, 2010-2015, across all areas of the Center, including the five Training Programs, the Administrative Core, Diversity, Continuing Education, Outreach, Interdisciplinary Coordination, and the Pilot Project grant program. A rigorous evaluation plan has enabled us to document successes and identify areas where programmatic changes could enhance the Center. We are well positioned for further success in the next five years.

Appendix A. 2010 – 2015 MAP ERC Supported Trainees

Name	Program	Start NIOSH Funding	End NIOSH Funding	Research Topic	Employment Title	Employer
Foos, R.	OE	1/20/2015	5/15/2015	Milking parlor efficiency and perception of worker rest	N/A	N/A
Hansen, V.C.	OE	8/16/2010	5/15/2011	Organizational safety	Director EHS Services	Occupational Services, Inc.
Lagerstrom, E.	OE	8/26/2013	5/15/2015	Human factors issues in ATV safety	N/A	N/A
Mixco, A.	OE	8/16/2010	5/15/2015	Use of electromyography in the assessment of muscle usage	Ergonomics Engineer	Boeing Corp.
Paulson, R.	OE	8/22/2011	5/16/2014	3-D kinematic assessment of posture during work	Ergonomics Engineer	Tesla Motors
Schwatka, N.	OE	8/17/2009	6/30/2013	Safety climate in the construction industry	Instructor	Colorado School of Public Health
Smallwood, L.	OE	8/25/2014	5/15/2015	ATV safety in agriculture among women	N/A	N/A
Tucker, D.	OE	1/17/2012	5/11/2012	Human factors in product design	N/A	Self-Employed
Brogan, J.	HP	1/1/2014	5/15/2015	Construction of an EVA dosimeter	N/A	N/A
Gillenwalters, E.	HP	8/1/2009	5/15/2011	Empirical comparison of neutron activation sample analysis methods	Corporate Radiation Safety Officer	Americphysics, LLC
Hall, C.	HP	8/1/2009	6/30/2011	Characterizing canine dose from external beam irradiation	Health Physicist	Los Alamos National Laboratory
Healy, H.	HP	1/1/2014	5/15/2015	Remote sensing of radioactive materials	Health Physicist	Los Alamos National Laboratory
Hetrick, L.	HP	8/20/2012	8/25/2013	Occupational dose assessment of Cu-64-ASTM in a veterinary setting	Health Physicist	Los Alamos National Laboratory
Klumpp, J.	HP	1/22/2013	6/30/2013	Use of Bayes statistical methods in counting	Health Physicist	Los Alamos National Laboratory
Labrake, M.	HP	1/20/2015	5/15/2015	Detection of low level radiation sources using Bayesian statistics	N/A	N/A
Magenis, M.	HP	8/22/2011	5/11/2012	Verification of background rejection in a liquid scintillation counter	Health Physicist	Palo Verde Nuclear Power Plant

Name	Program	Start NIOSH Funding	End NIOSH Funding	Research Topic	Employment Title	Employer
Martinez, N.	HP	1/19/2010	5/16/2014	Occupational radiation dose to persons involved in veterinary positron emission tomography	Assistant Professor	Clemson University
McBeth, R.	HP	1/18/2011	5/11/2012	Doses to solid volumes	Asst. Radiation Officer	University of Colorado Hospital
Mueller, B.	HP	1/22/2013	5/16/2014	Electronic dosimeter and thermoluminescent dosimeter correlation study at Catawba nuclear station	Health Physicist	Idaho National Laboratory
Parson, J.	HP	8/20/2012	5/15/2015	Dose rate profile surrounding a waste repository	N/A	N/A
Pedersen, C.	HP	1/19/2010	6/30/2011	Partial body irradiation of mice	Health Physicist	Uranertz
Roche, N.	HP	1/19/2010	6/30/2011	Analysis of the variation of concentration levels in groundwater at an in-situ recovery uranium mine post-restoration	Health Physicist	Cameco Resources USA
Rosenberg, B.	HP	8/26/2013	5/15/2015	Concentration of Cs-137 in Fukushima soils	N/A	N/A
Shatila, O.	HP	8/25/2014	5/15/2015	Occupational medical radiation dose	Health Physicist	Duke Energy
Adams, K.	IH	8/26/2013	5/15/2015	Indoor Hockey Officials' Noise Exposure and Hearing Threshold Shifts	N/A	N/A
Autenrieth, D.	IH	7/1/2013	5/16/2014	Occupational exposures to noise resulting from the work place use of personal media players	Assistant Professor	Montana Tech
Bainter, J.	IH	8/25/2014	5/15/2015	Nail Tissue as Biomarker for Occupational Welding Fume Metal Exposures	N/A	N/A
Cranston, C.	IH	8/16/2010	12/31/2011	Noise characterization and exposure of indoor sporting events	OHS Specialist	Boeing Corp.
Dean, L.	IH	8/22/2011	12/30/2011	N/A	Unknown	Unknown
Diaz-Rivera, K.	IH	1/1/2011	5/17/2013	Comparison of hexavalent chromium and welding fumes inside and outside of the welding helmet	Industrial Hygienist	Boeing Corp.

Name	Program	Start NIOSH Funding	End NIOSH Funding	Research Topic	Employment Title	Employer
Escobar, M.	IH	8/25/2014	5/15/2015	Methods Assessment for Aerosol Exposure to Antibiotic Resistant Bacteria on a Colorado Dairy	N/A	N/A
Golden, R.	IH	8/26/2013	5/15/2015	Brewing industry hazards	Health and Environmental Safety Specialist	University Corporation for Atmospheric Research
Gorum, D.	IH	1/17/2012	5/17/2013	Occupational noise exposure in the brewing industry	Safety Engineer	Murphy Corporation
Hibiske, S.	IH	1/22/2013	12/19/2014	Safety culture and back pain among construction workers	Safety Coordinator	Bell's Brewery
Johnesee, K.	IH	8/26/2013	6/30/2015	Time motion studies in the assessment of work	Environmental and Safety Health Specialist	Woodward
Kayne, A.	IH	5/15/2012	1/31/2014	Quantifying commuter exposures to volatile organic compounds	Safety Compliance Specialist	Crop Production Services
Koesterich, M.	IH	8/1/2009	5/15/2011	Occupational health and safety management system in a veterinary teaching hospital using the ANSI/AIHA Z10 standard	Industrial Hygienist	Colden Corporation
Krause, L.	IH	8/25/2014	5/15/2015	A Comparison of Endotoxin Assays in Order to Determine the most Effective way to Measure Endotoxin Exposure in Dairy Workers	N/A	N/A
Lake, K.	IH	5/16/2012	12/20/2013	Hazard mapping with direct-reading instruments from facilities with high and low temporal variability	Compliance Officer	OSHA
Langley, A.	IH	2/1/2014	5/15/2015	Noise exposure in hockey officials	Industrial Hygienist	Operation Services, Inc.
Ndonga, M.	IH	8/16/2010	5/30/2012	Design of a portable spectrometer for inhalable aerosols	Industrial Hygienist	Encana Corporation
Quinn, C.	IH	8/15/2013	5/15/2015	Water chemometer: a low-cost device for quantifying metals in water	N/A	N/A

Name	Program	Start NIOSH Funding	End NIOSH Funding	Research Topic	Employment Title	Employer
Radman, A.	IH	9/12/2011	5/11/2012	Noise characterization and exposure at a ski resort	OSHA Consultant	OSH
Radtke, C.	IH	1/20/2015	5/15/2015	Community noise exposure and noise characterization of oil and gas operations	N/A	N/A
Robinson, D.	IH	8/16/2010	5/11/2012	Bacterial Tag-Encoded Flexible (FLX) Amplicon Pyrosequencing (bTEFAP) Technique	2nd LT US Army Medical Core	US Army
Root, K.	IH	1/11/2011	6/30/2013	Noise exposures of firefighters during training activities	Industrial Hygienist	Century Environmental Hygiene
Schaeffer, J.	IH	7/1/2009	6/30/2011	Comparison of isocyanate sampling methods	Assistant Professor	Colorado State University
Shapiro, J.	IH	8/16/2010	5/30/2012	Laboratory evaluation of a microfluidic electrochemical sensor for aerosol oxidative load	EHS Consultant	CH2M Hill
Van Dyke, A.	IH	8/22/2011	5/11/2012	Use of pyrosequencing, riboprinting, culture techniques and microscopic analysis in dairy parlors	N/A	N/A
Bird, K.	OEM	9/1/2009	8/31/2010	Pulmonary disease in returning Iraq war veterans	Clinic Director	Concentra
Cook-Shimanek, M.	OEM	7/1/2013	6/30/2015	Occupational injury in the oil and gas extraction industry	Occupational Medicine Physician	St. Alphonsus Occupational Medicine Clinic
Krefft-Dhoma, S.	OEM	7/1/2014	6/30/2015	Utility of lung clearance index score as a noninvasive marker of deployment lung	N/A	N/A
Lugliani, M.	OEM	7/1/2010	6/30/2011	Foundry worker's silicosis	Staff Physician	Health One
Moses, E.	OEM	7/1/2012	7/1/2013	Indoor air quality investigation	Chief, Division of Occupational Medicine	Denver Health
Robinson, K.	OEM	3/12/2012	3/7/2013	N/A	Unknown	Unknown
Siegel, K.	OEM	7/1/2013	6/30/2015	Occupational illness due to workplace exposures in a pet food manufacturing facility	Physician	Miramont Family Medicine

Name	Program	Start NIOSH Funding	End NIOSH Funding	Research Topic	Employment Title	Employer
Styles, C.	OEM	7/1/20110	6/30/2011	Use of Ketamine to treat CRPS	Emergency Physician	Appalachian Emergency Physicians
Williams, B.	OEM	8/1/2012	7/31/2014	Employer education for managing chronic disease in the workplace	Float Physician	Exempla Physician network
Chafee, D.	OHP	7/1/2014	6/30/2015	Older worker issues, health and safety interventions, work stress	N/A	N/A
Gardner, P.	OHP	8/15/2007	6/30/2011	Dispositional and contextual resources as predictors of need recovery	Human Capital Consultant	PDRI Washington
Hanscom, M.	OHP	1/20/2015	5/15/2015	Older workers, work ability, perceptions of age, social media use at work	N/A	N/A
Hoffmeister, K.	OHP	7/1/2011	6/30/2013	Impact of agreement and disagreement between organizational climates for safety, productivity and quality	HR Analytics Project Manager	JBS
Menger, L.	OHP	8/16/2010	6/30/2015	Suicide prevention networks	N/A	N/A
Naude, L.	OHP	7/1/2014	6/30/2015	Work related underload and organizational outcomes	N/A	N/A
Nowacki, E.	OHP	5/1/2010	9/30/2010	Fostering work engagement through supervisory mentoring	Staff Consultant	FMI, Center for Strategic Leadership
Shtivelband, A.	OHP	8/16/2008	6/30/2011	Strategies to maintain the impact of suicide prevention	Research Associate	RMC Research Corp.
Valley, M.	OHP	8/20/2012	6/30/2015	Mindfulness-based stress reduction in healthcare workers	N/A	N/A
Walters, K.	OHP	8/15/2013	6/30/2015	Occupational health and wellness in the marijuana industry	N/A	N/A

Appendix B. 2010 – 2015 MAP ERC Pilot Project Recipients

Principal Investigator	PI Title	Institution	Title	Award Period	Amount
Year 4 (2010-2011)					
Autenreith, Daniel	Graduate Research Assistant	Colorado State University	Occupational Noise Exposure from Personal Stereos	10/1/10-6/30/11	$10,000
Cooper, Christa	Graduate Student	University of Wyoming	Wyoming Transportation Event Occupational Fatalities and EMS Accessibility	10/1/10-6/30/11	$10,000
Henry, Charles	Associate Professor	Colorado State University	Portable Monitor for Aerosol-Based Heavy Metal Exposure	10/1/10-6/30/12	$20,000
Hoffmeister, Krista	Research Associate	Colorado State University	Ergonomic climate in organizations: Development of an assessment tool	10/1/10-6/30/12	$20,000
Lopez del Puerto, Carla	Assistant Professor	Colorado State University	Cultural competency and communication for construction workers	10/1/10-6/30/12	$15,000
Schwatka, Natalie	Fellowship Grant Trainee	Colorado State University	Impact of an Aging Workforce on Workers' Compensation Claims*	10/1/10-6/30/11	$10,000
Year 5 (2011-2012)					
Burden, Marisha	Chief, Hospital Med. Div.	Denver Health & Hosp. Auth.	Bacterial Contamination of Healthcare Worker Uniforms	7/1/11-6/30/12	$10,000
Hallowell, Matthew	Assistant Professor	University of Colorado Boulder	R2P:PtD and Construction Safety Management Tool for Sustainable Building Projects*	7/1/11-6/30/12	$10,000
Hawley, Brie	Predoctoral Student	Colorado State University	Is Green Diesel Healthy Diesel?	7/1/11-6/30/12	$10,000
Ndonga, Mwangi	Master Student	Colorado State University	Characterizing Inhalable Size Distributions in the Workplace	7/1/11-6/30/12	$9,774
Schwatka, Natalie	Fellowship Grant Trainee	Colorado State University	Impact of Aging Workforce on Workers Compensation Claims (Part 2)*	7/1/11-6/30/12	$5,000
Year 6 (2012-2013)					
Carter, Ethan	Associate Professor	University of Colorado Denver	Hazardous Material Handling and Occupational Exposures in Veterinary Workers	7/1/12-6/30/13	$7,500
Clevenger, Caroline	Assistant Professor	Colorado State University	3D Visualization for Safety Training of Hispanics in Construction*	7/1/12-6/30/13	$10,000
Hallowell, Matthew	Assistant Professor	University of Colorado Boulder	A Lifecycle Safety Risk Analysis of Green Roofing Systems*	7/1/12-6/30/13	$15,000

Principal Investigator	PI Title	Institution	Title	Award Period	Amount
Kayne, Ashleigh	Masters Student	Colorado State University	Cost Effective Monitoring of Commuter's Exposure to Volatile Organic Compounds	7/1/12-6/30/13	$15,000
Thiese, Matthew	Assistant Professor	University of Utah	Weight Loss Intervention in Long-Haul Drivers: A Pilot Study	7/1/12-6/30/13	$10,000
Year 7 (2013-2014)					
Schaeffer, Joshua	Research Associate II	Colorado State University	Modeling and Predicting Microbiomes in Dairies: a Metagenomic Assessment of Bioaerosols	7/1/13-6/30/14	$17,500
Scott, Kenneth	Senior PRA	University of Colorado Denver	Feasibility Study of a Walking Intervention for Aging Healthcare Workers*	7/1/13-6/30/14	$17,500
Serdar, Berrin	Assistant Professor	University of Colorado Denver	Roof core as a modifier of dermal exposures among hot asphalt roofers in Denver	7/1/13-6/30/13	$17,500
Steinhauser, Georg	Assistant Professor	Colorado State University	Rapid Determination of Low-Level Neptunium-239	7/1/13-6/30/14	$17,500
Year 8 (2014-2015)					
Davidson, Rebecca	Instructor	National Jewish Health	Microbial sampling and metagenomics approaches for workplace exposure studies	7/1/14-6/30/15	$15,000
Krefft, Silpa	Postdoctoral Fellow	National Jewish Health	Utility of lung clearance index score as a noninvasive marker of deployment lung	7/1/14-6/30/15	$17,496
Good, Nicholas	Postdoctoral Fellow	Colorado State University	A ventilator model to predict air pollution intake	7/1/14-6/30/15	$17,498
Scallan, Elaine	Assistant Professor	University of Colorado	Preventing occupational zoonoses through improved public health surveillance	7/1/14-6/30/15	$17,239
Walters, Kevin	Graduate Student	Colorado State University	Is the grass greener? Occupational health and wellness in the marijuana industry*	7/1/14-6/30/15	$13,803
Valley, Morgan	Fellowship Grant Trainee Predoctoral	Colorado State University	A randomized control trial: Feasibility of a MBSR intervention on worker safety	7/1/14-6/30/15	$12,798

Appendix C. 2010-2015 MAP ERC Publications

The following articles were written by MAP ERC faculty and trainees (indicated by underlining name) who were supported by the MAP ERC during the grant period. Interdisciplinary articles are marked with an *. Over the five year grant period, the core faculty produced 348 articles, 9% included faculty/trainees from more than one MAP ERC discipline and 22% included trainees as authors or co-authors.

Abraham, J. P., **Brandl, A**. *Disposal Process for High Activity Sources by a University Through the U.S. Department of Energy's Off-site Source Recovery Project*. Proceedings to the Waste Management Symposia 2012, Phoenix (2012).

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Alhajj T, Wang L, Wheeler K, Zhao W, Sun Y, **Stallones L**, and Xiang H. (2010). Prevalence of disability among adolescents and adults in rural China. *Disability and Health, 3,* 282-288.

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Anderson, K.R., Leith, D., **Ndonga, M.**, **Volckens, J.** (2015) "Portable Inhalable Particle Separator: Theory and Design." Aerosol Science and Technology. Accepted, in press.

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Anton D, Gerr F, Merlino L, **Rosecrance J.** (2013) Normative median and ulnar nerve conduction values among a rural aged population. Work: A Journal of Prevention, Assessment and Rehabilitation.

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Asti L, Canan BD, Heaney C, Ashida S, Renick K, Xiang H, **Stallones L**, Bean T, Jepsen SD, and Wilkins III JR. (2011). Compliance with the North American guidelines for children's agricultural tasks among youth working with large animals. *Journal of Agromedicine, 16(3),* 174-193.

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