AIR FORCE CIVIL ENGINEER CENTER (AFCEC) BROAD AGENCY ANNOUNCEMENT (BAA)

Since 2008, the Environmental Directorate (CZ) has provided funds for the Air Force Civil Engineer Center (AFCEC) Broad Agency Announcement (BAA). BAA requirements identified by remedial program managers and environmental restoration programs (e.g., emerging contaminant/issues, complex site initiatives, and critical process analyses) are for innovative technologies and methodologies. Restoration and compliance technologies/methodologies have led to successful coordination with the regulatory community and have decreased Air Force (AF) liabilities.

Table 1, displays awarded BAAs. BAAs that are active and/or need additional review of deliverables, have Accomplishment(s)/Conclusion(s) as To Be Determined (TBD).

BAA statements of need to fulfill AFCEC identified 2016 requirements were for:

(1) Analytical methods for detection and quantification of perfluoroalkyl compounds (PFCs) in water, sediment, or biota;
(2) Treatment train technologies for PFCs;
(3) Integrated characterization and remediation of dense non-aqueous phase liquid at Air Force Plant 4;
(4) Cost-efficient characterization of the arrival front of a large plume at Edwards Air Force Base;
(5) Remediation of metals and pesticides at Avon Park Air Force Range;
(6) Noninvasive identification of bat roost sites and identification of ideal acoustic sampling equipment placement locations; and
(7) Identification of technologies for improving air emissions quantification and assessment, reducing air pollutants, and/or more efficiently leveraging current air quality resources.

The 2016 AFCEC CZ BAA solicitation AFCECBAA-16-001, received 74 Phase I pre-proposals. After in-depth technical review of all pre-proposals, 8 have been selected for Phase II full-proposals. It is expected that ~50% will be awarded.

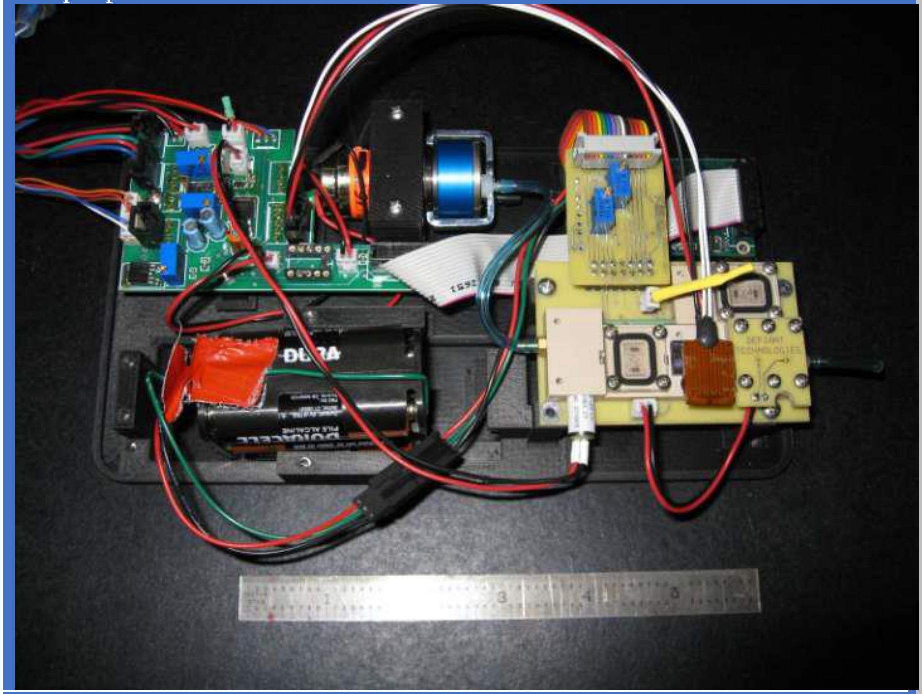
In subsequent years, the plan is to gather BAA requirements for innovative technologies and methodologies from remedial program managers and environmental restoration programs (e.g., emerging contaminant/issues, complex site initiatives, and critical process analyses) and address requirements through solicitations for innovative technologies/methodologies.

Table 1. Awarded BAAs 2008 – 2015

Year	*Title*	*Accomplishment(s)/Conclusion(s)*
2008	*Phytostabilization*	Evaluated the effectiveness of Phytostabilization. Concluded that there are limitations to Phytostabilization; however, it can be a component of an overall remedial approach due to its low impact, low maintenance, and highly sustainable features. 
2008	*RPO Sustainability Tool extension of EDITT*	Sustainable Remediation Tool, or SRT, designed to support decision processes for technology selection and optimization.
2008	*Changes in Chlordane Volatility Produced During Construction Activity Around Air Force Housing Areas*	Laboratory tests indicated that the specific mass transfer rates of chlordane from aged soil are low and are positively correlated with relative humidity levels and the temperature of the soil. Field demonstration suggested that construction activities may release measurable levels of chlordane below regulatory limits. Chlordane vapor intrusion risks resultant of new housing construction is unlikely. 

Year	Title	Accomplishment(s)/Conclusion(s)
2008	*Sustainable Bioreactors to Achieve Remedy In Place*	In situ bioreactors are a simple and cost-effective application of enhanced reductive dechlorination technology. 
2008	*Accelerating Soil and Groundwater Restoration at Chlorinated Solvent DNAPL Sites Using Bioreactors*	Lessons learned provided methods to advance the state-of-science and state-of-practice for design and implementation of bioreactors. 
2008	*P&T System – Expedited Contaminant Mass Removal Assessments and System Enhancements*	At 20 sites, evaluated the performance of pump and treat systems in removing contaminant mass from groundwater plumes, the degree in which natural attenuation is contributing to plume mass reduction, and cost efficiency. Determined that site complexity affected the efficiency of contaminant removal by extraction and natural attenuation.

Year	Title	Accomplishment(s)/Conclusion(s)
2008	*A Decision-Making Tool for LTMO*	Developed a comprehensive, freely distributable open-source, user-friendly Long-Term Monitoring Optimization (LTMO) decision support tool and associated training materials that augments and automates the Parsons 3-Tiered approach. • Nobel, C.; Anthony, J.A. Three-Tiered Approach to Long-Term Monitoring Program Optimization. Bioremediation Journal, 2004, 8, 147-165.
2008	*Enhanced Biogeochemical Degradation of Chlorinated Organics*	Evaluated the effectiveness of enhanced biogeochemical degradation of chlorinated organics in areas with high sulfate concentrations. Field tests confirmed that sulfide could be effectively precipitated from the groundwater by addition of ferrous chloride. Upon removal of the sulfide, complete degradation of the chlorinated ethenes to non-toxic ethene was achieved. 

Year	***Title***	***Accomplishment(s)/Conclusion(s)***
2008	*Field Demonstration of an Innovative Sampler and MicroGC System for Groundwater LTM Program Optimization*	Equipment performance capabilities were not sufficient to develop the proposed sensor. 
2008	*Dem/Val of Innovative Treatment Technologies to achieve RIP*	Demonstration results varied, but overall bioreactors can be installed in a broad range of climates and are effective for shallow aquifers. 

Year	***Title***	***Accomplishment(s)/Conclusion(s)***
2008	*Feasibility Studies of Sustainable Remediation Technologies and Biogeochemical Transformation*	Technology reduces concentrations of trichloroethylene (TCE) and daughter products in soil and groundwater. Compared commercial remediation product costs to the use of readily available, low-cost bulk iron and sulfate amendments to stimulate biogeochemical transformation of TCE. Developed low-cost alternatives to stimulate in situ biogeochemical transformation processes. 
2009	*Optimization of In Situ Biogeochemical Transformation Processes and Development of Engineering Guidance*	Identified and evaluated geochemical parameters that will encourage biogeochemical transformation of chlorinated solvents in biowalls/bioreactors. 

Year	Title	Accomplishment(s)/Conclusion(s)
2009	*Implementation of & Enhancements to RPO Sustainability Remediation Tool*	Developed tool to evaluate remediation technologies based on sustainability metrics such as greenhouse gas emissions, energy consumption, and resource service. Tool facilitates sustainability planning and evaluation.
2009	*Validation of New Tools to Better Manage Vapor Intrusion Liability*	Vapor phase compound-specific stable isotope analysis, molecular biological tools, and additional analytics were employed to evaluate vapor intrusion (VI) and determine better ways to manage VI liabilities.
2009	*Effects of Substrate Injections on Secondary Water Quality*	Investigated secondary water quality impacts (SWQIs) respective of: in situ biological reduction; in situ chemical reduction; in situ biological oxidation; and in situ chemical oxidation. Overall, results indicate that in situ remediation technologies are causing some SWQIs; however, the impacts on the environment are generally not severe.
2009	*Innovative Monitoring for In Situ Bioremediation of DNAPL*	Assessed the efficacy of the innovative in situ bioremediation-monitoring tool Bio-Trap® in selecting, evaluating, monitoring, and optimizing site remediation systems. Demonstrated how current and previous remediation systems (i.e., thermal, biowalls, soil-vapor extraction, and dual-phase extraction), may affect in situ bioremediation of chlorinated solvents and their degradation by-products.
2009	*LTMO MAROS Software Upgrade*	Updated the existing LTMO Monitoring and Remediation Optimization System (MAROS) software. Project assists in reducing AF costs through optimization of long-term monitoring programs.
2009	*Demo of "Green" and Stabilized Nanoparticles for In Situ Destruction of Chlorinated Solvents in Soils & Groundwater*	Used stabilized nanoparticles for the in situ destruction of chlorinated solvents in soils and groundwater. Demonstrated feasibility (mobility, reactivity, and reactive longevity) of using the stabilized nanoparticles for degrading chlorinated solvents. Determined optimal operating conditions. 

Year	Title	Accomplishment(s)/Conclusion(s)
2009	*In Situ Treatment of NDMA at Edwards AFB*	Employed cost-effective in situ biological remediation approach for the treatment of N-nitrosodimethylamine (NDMA) in groundwater. Determined which gases are most effective for stimulating NDMA biodegradation. • Fournier, D.; Hawari, J.; Halasz, A.; Streger, S.H.; McClay, K.R.; Masuda, H.; Hatzinger, P.B. Aerobic Biodegradation of N-Nitrosodimethylamine by the Propanotroph Rhodococcus ruber ENV425. Applied and Environmental Microbiology, 2009, 75, 5088–5093. • Hatzinger, P.B.; Condee, C.; McClay, K.R.; Togna, A.P. Aerobic treatment of N-nitrosodimethylamine in a propane-fed membrane bioreactor. Water Research, 2011, 45, 254–262. 
2009	*In Situ Biogeochemical Transformation*	Evaluated in situ biogeochemical transformation technologies that reduce chlorinated solvent concentrations in soil and groundwater.
2010	*Monitoring Toolbox for In Situ Biogeochemical Transformation*	Factors for promoting biogeochemical transformation are: A) sulfate concentration, B) hydraulic residence time, C) electron donor availability, and D) presence of iron oxides such as magnetite and hematite. The optimal combination of these factors promotes a high volumetric sulfate consumption rate and a high rate of reactive iron sulfide generation. Biowalls should be regularly monitored for: total molar volatile organic compound removal; dissolved sulfide concentration; oxidation-reduction potential; volumetric sulfate consumption rate measured using passive flux meters; and pH. Less frequent monitoring for site characterization and should include: total biowall iron concentrations; total volatile fatty acids; and electron microprobe analysis.

Year	Title	Accomplishment(s)/Conclusion(s)
2010	*Demonstration of Low Intensity, Sustainable Passive Soil Vapor Extraction Technologies at Air Force Sites*	Successfully demonstrated two passive soil vapor extraction technologies using MicroBlower™ and Baroball™ systems. Both technologies were highly effective at removing chlorinated solvents from vadose zone soils. 
2010	*Guidance Manual to Accelerate Closure of Low-Risk Sites*	Guide to assist site managers in determining if they have a low-risk site by providing key concepts, information, and experience in one dynamic decision support tool. This information can be used to assist site managers in developing effective exit strategies for closing low-risk sites and/or reducing long-term monitoring intensity. The guide provides weight-of-evidence decision logic to build consensus between site stakeholders.
2010	*Development of Cost Effective Air Exchange Rate Techniques: Building on Recent Work*	Developed a protocol for estimating air exchange rates (AERs) using concentration decay of instantaneously released helium tracer gas. The AERs calculated for three test buildings using instantaneous helium release and least-squares (LS) methods compared well with the AERs calculated using the modified American Society for Testing and Materials (ASTM) method (ASTM E741-00) with sulfur hexafluoride tracer gas. Results of this study demonstrate that the helium release methodology provides a cost effective, easy to implement method of measuring building specific AERs. The three LS methods help to determine the uncertainty in AER predictions.
2010	*LNAPL Detection for Lowering LTM Costs: Application of Leak Detection Cabling Sensor*	Demonstrated and validated that commercially available leak detection cabling sensors (TraceTek-TT5000 cabling sensor) could be innovatively adapted for the detection and monitoring of Light Non-Aqueous Phase Liquid (LNAPL).

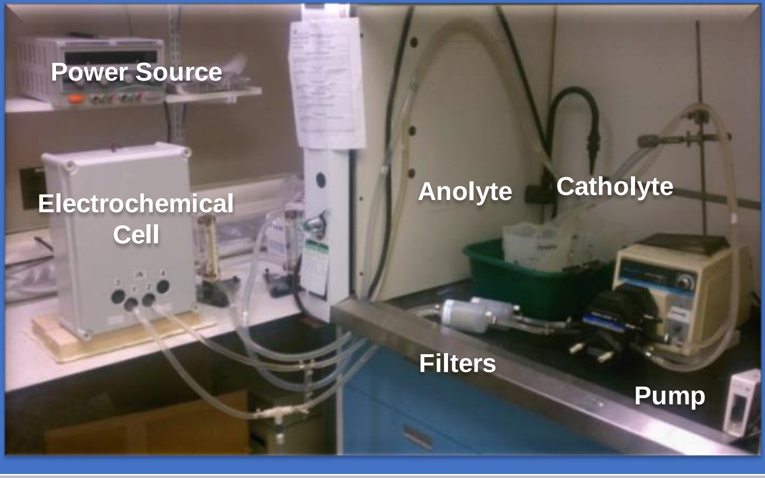
Year	Title	Accomplishment(s)/Conclusion(s)
2010	*Optimizing Key Aspects of Remediation Strategy & Operations to Accelerate Remedy In Place and Control Costs*	Engaged key personnel and appropriate information/materials to identify/clarify best-practice methods and optimize technology transfer for the environmental restoration program.
2010	*Collaborative Process for Whole-System Sustainability*	Examined the environmental management system framework and how it can be used to systematically improve the performance of AF environmental restoration program projects, and incorporate green and sustainable remediation initiatives.
2010	*Anaerobic Bioremediation of DNAPLs*	Biologically treated high concentrations of chlorinated solvents in low-pH aquifers. Reductive dechlorination appears to have been inhibited by high TCE concentrations. pH adjustment with colloidal Mg(OH)2 was effective in increasing the pH of coarse sand layer to a level appropriate for reductive dechlorination. Settling of solid alkaline material in the bottom of the injection wells reduced the effectiveness of base addition in raising aquifer pH. Bioaugmentation was beneficial in enhancing both conversion of TCE to cis-1,2-dichloroethene (cDCE), and cDCE to vinyl chloride and ethene. Emulsified vegetable oil was effectively distributed in the coarse sand layer, accelerating reductive dechlorination, and reducing downgradient migration of contaminants. 

Year	***Title***	***Accomplishment(s)/Conclusion(s)***
2010	*Demonstration/Validation of Multiple Incremental Sampling and High Purge Volume Sampling Versus Conventional Sub-Slab Sampling for Vapor Intrusion Investigations*	High Volume Sampling (HVS) works best when material below the floor is highly permeable (e.g., construction aggregate, or where a gap exists below the floor from differential settlement or soil shrinkage) and where the leakage is relatively low, because this combination results in the maximum lateral extent of vapor extraction in a practical test duration. Multiple incremental sampling works best in large buildings, where conventional sampling programs are considerably more expensive by comparison, and where the material below the floor is not very permeable (e.g., slab on native soil with high silt or clay content where HVS testing is less effective). 
2011	*Fungal Remediation of Legacy Pesticides in Soil around Air Force Base Housing*	Laboratory results did not meet desired criteria. No field demonstration.

Year	Title	Accomplishment(s)/Conclusion(s)
2011	*Chemical Treatment of Soil and Groundwater Contaminated with Perfluorinated Compounds found in Aqueous Fire Fighting Foams*	Perfluorooctanoic acid (PFOA) is oxidized by heat-activated persulfate within 72 h at 50 ºC. PFOA persulfate oxidation follows an unzipping pathway to PFCAs and fluoride. PFOA transformation rates increases with increasing temperature. Heat-activated persulfate oxidizes 6:2 FTSA simultaneously to perfluoroheptanoic acid (PFHpA) and perfluorohexanoic acid (PFHxA). Perfluorooctane sulfonic acid (PFOS) is not transformed with heat (85-90 ºC)-activated with persulfate (60-84 mM). • Park, S.; Lee, L.S.; Medina, V.F.; Zull, A.; Waisner, S. Heat-activated persulfate oxidation of PFOA, 6:2 fluorotelomer sulfonate, and PFOS under conditions suitable for in-situ groundwater remediation. Chemosphere, 2016, 145, 376-383.
2011	*In Situ Remediation of 1,4-Dioxane Contaminated Aquifers*	Propane biosparging and bioaugmentation promoted in situ biodegradation of 1,4-dioxane. Results indicate that 1,4-dioxane can be treated by the demonstrated in situ bioremediation technology to meet regulatory standards. 
2011	*Enhanced In Situ Bioremediation of 1,2-Dibromoethane [EDB] at Massachusetts Military Reservation Using Alkane Gas Addition*	Addition of ethane or propane gas with inorganic nutrients can be used as a remedial strategy to enhance rates of 1,2-dibromoethane degradation. • Hatzinger, P.B.; Streger, S.H.; Begley, J.F. Enhancing Aerobic Biodegradation of 1,2-Dibromoethane in Groundwater Using Ethane or Propane and Inorganic Nutrients. Journal of Contaminant Hydrology, 2015, 172, 61-70.

Year	Title	Accomplishment(s)/Conclusion(s)
2011	*Chemical Oxidation and Inclusion Technology for Expedited Soil and Groundwater Remediation*	Injection of a peroxone activated buffered persulfate oxidant and cyclodextrin, commercialized as OxyZone®-C, degraded and destroyed perfluorinated organic compounds. • Eberle, D.; Ball, R.; Boving, T.B. Peroxone Activated Persulfate Treatment of 1,4-Dioxane in the Presence of Chlorinated Solvent Co-contaminants. Chemosphere 2016, 144, 728-735. 

2011	*Development of Molecular Biomarkers to Support Natural Attenuation and Bioremediation of 1,4-Dioxane*	A set of genes is now available to serve as a specific biomarker for 1,4-dioxane biodegradation. Expression of biomarker genes is a better predictor of biodegradation activity than just presence of genes. Biomarker expression as well as 1,4-dioxane degradation is influenced by environmental factors. Cometabolic biodegradation can only be verified indirectly using nucleic acid-based biomarkers. • Gedalanga, P.B.; Pornwongthong, P.; Mora, R.; Chiang, S.D.; Baldwin, B.; Ogles, D.; Mahendra, S. Identification of Biomarker Genes To Predict Biodegradation of 1,4-Dioxane. Applied and Environmental Microbiology 2014, 80, 3209–3218. • Mahendra, S.; Grostern, A.; Alvarez-Cohen, L. The impact of chlorinated solvent co-contaminants on the biodegradation kinetics of 1,4-dioxane. Chemosphere 2013, 91, 88-92. • Gedalanga, P.; Kotay, S.M.; Sales, C.M.; Butler, C.S.; Goel, R.; Mahendra, S. Novel Applications of Molecular Biological and Microscopic Tools in Environmental Engineering. Water Environment Research 2013, 85, 917-950. • Mahendra, S.; Gedalanga, P.; Kotay, S.M.; Torres, C.I.; Butler, C.S.; Goel, R. Advancements in Molecular Techniques and Applications in Environmental Engineering. Water Environment Research 2012, 84, 814-844. • Sales, C.M.; Mahendra, S.; Grostern, A.; Parales, R.E.; Goodwin, L.A.; Woyke, T.; Nolan, M.; Lapadus, A.; Chertkov, O.; Ovchinnikova, G.; Sczyrba, A.; Alvarez-Cohen, L. Genome Sequence of the 1,4-Dioxane-Degrading Pseudonocardia dioxanivorans Strain CB1190. Journal of Bacteriology, 2011, 193, 4549-4550. 

Year	*Title*	*Accomplishment(s)/Conclusion(s)*
2011	*Utilizing an Injection/Recirculation Approach to Enhance and Sustain Biogeochemical Transformation of Chlorinated Ethenes Plumes to Achieve Faster Site Closure*	In situ biogeochemical reactions relied primarily on reduced reactive iron minerals to abiotically transform chlorinated ethenes. 
2011	*Use of Boron-Doped Diamond Electrodes for Treatment of Perfluorinated Compounds*	Innovative electrochemical oxidation technology decomposed perfluorinated compounds in the laboratory. Although this technology has not been demonstrated in the field, due to demonstration site complications and expiration of funding, the laboratory results suggest that this technology may be useful in the treatment of PFCs. • Schaefer, C. E.; Andaya, C.; Urtiaga, A.; McKenzie, E. R.; Higgins, C. P. Electrochemical treatment of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) in groundwater impacted byaqueous film forming foams (AFFFs). Journal of Hazardous Materials 2015, 295, 170–175. • McGuire, M. E.; Schaefer, C.; Richards, T.; Backe, W. J.; Field, J. A.; Houtz, E.; Sedlak, D. L.; Guelfo, J. L.; Wunsch, A.; Higgins, C.P. Evidence of Remediation-Induced Alteration of Subsurface Poly- and Perfluoroalkyl Substance Distribution at a Former Firefighter Training Area. Environmental Science and Technology 2014, 48, 6644−6652. 

Year	Title	Accomplishment(s)/Conclusion(s)
2011	*Is Bioremediation a Relevant Attenuation Mechanism for Perfluorinated Compounds?*	Phanerochaete chrysosporium, a wood-rotting fungus, was found to transform 6:2 FTOH towards more biodegradable compounds than bacterial transformation processes. • Tseng, N.; Wang, N.; Szostek, B.; Mahendra, S. Biotransformation of 6:2 Fluorotelomer Alcohol (6:2 FTOH) by a Wood-Rotting Fungus. Environmental Science and Technology 2014, 48, 4012-4020. 
2012	*In-situ Enzymatic Oxidative Treatment for Perfluorinated Compounds*	TBD
2012	*Documenting enhanced biodegradation of NDMA and 1,4-Dioxane under methane-oxidizing conditions*	TBD
2012	*Novel Substrate Application for Bioremediation of Comingled 1,4-Dioxane and Chlorinated Solvent Plumes*	TBD
2012	*Focused Remedial Investigation of Potential Ecological Effects of Perfluorinated Compounds and Associated Human Exposures from Fish Consumption*	TBD

Year	***Title***	***Accomplishment(s)/Conclusion(s)***
2013	*Concurrent In-Situ Cometabolic Biodegradation of 1,4-Dioxane and Chlorinated Ethenes Using Recirculation*	TBD
2013	*Bioaugmentation to Enhance Biodegradation of 1,4-Dioxane*	TBD
2013	*Anaerobic Sequencing Batch Membrane Bioreactor with Electrically Conducting Nanofiltration Membranes for Recalcitrant Organic Contaminant Degradation*	TBD
2013	*Complete Mineralization of Fluorochemicals in Aqueous Fire-Fighting Foams Using a Novel Dual-Frequency Based Sonochemical Process*	TBD
2014	*HAPSITE Service and Repair*	AF vapor intrusion investigations.
2014	*Demonstration/Validation of a Holistic System for Reduction of Safe Drinking Water Act Violations and Improved Water Quality*	TBD

Year	Title	Accomplishment(s)/Conclusion(s)
2014	*Reducing Waste Volume and Cost of OWS Sludge Disposal*	TBD
2015	*Implementation of Dynamic In Silico Technologies for AF-wide Complex Sites*	TBD
2015	*Delineation of Complex Preferential Pathways by Hydraulic and Hydrogeophysical Tomography*	TBD
2015	*Determining Preferential Pathways for Complex Sites*	TBD
2015	*Natural Attenuation and Biostimulation for In Situ Treatment of 1,2-EDB*	TBD
2015	*Streamlining the HAP Input and Analysis for Stationary Sources*	TBD
2015	*Streamlining the NSR/PSD Procedures and Reporting Requirements*	TBD
2015	*Demonstration and Validation of an Online Chemical Oxygen Demand Monitor for Wastewater*	TBD
2015	*Species Population Automated Survey System*	TBD

Year	***Title***	***Accomplishment(s)/Conclusion(s)***
2015	*Simplified Air Quality Field Methods for Development of Source Emission Factors*	TBD