Funding Opportunity: Community-Scale Air Toxics Ambient Monitoring
RFP Number: EPA-OAR-OAQPS-11-05
Category: Community-Scale Monitoring

Characterizing Community Exposure to Polycyclic Aromatic Hydrocarbons (PAHs) in a Tri-State Area

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Summary Information

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a. Project Title:
Characterizing Community Exposure to Polycyclic Aromatic Hydrocarbons (PAHs) in a Tri-State Area

b. Applicant Information:
The Shelby County Health Department (SCHD), Pollution Control Section
814 Jefferson Avenue, Memphis, TN 38105
Contact Person: James (Jim) Holt, Assistant Manager
Phone: (901) 544-7737; Fax: (901) 544-7308; E-mail: jholt@co.shelby.tn.us
The SCHD Pollution Control Section is an air pollution control agency defined in Section 302(b)(3) of the Clean Air Act. The Section is mostly funded through local tax dollars, and 103 & 105 Grant Funds.

c. Funding Requested: $594,407. A cooperative agreement is requested with EPA
d. Total Project Cost: $594,407. The study is totally federally funded. No matching funds are being used.
e. Project Period: April 01, 2015 – March 31, 2018
f. DUNS Number: 041174889

Narrative Proposal Work-Plan

1. Basis and Rationale

This proposed project plans to conduct a community-scale monitoring program for polycyclic aromatic hydrocarbons (PAHs) in the ambient air in the Memphis TN-MS-AR Metropolitan Statistical Area, a tri-state area that comprising West Tennessee, North Mississippi, and the Arkansas Delta (Fig 1). For convenience, we use Memphis Tri-state Area (MTA) in this proposal. PAHs have been classified as priority pollutants by the U.S. EPA [1], because of their adverse effects on human health, persistence in environmental matrices, and reactivity and ability to transform into more active species. PAHs pose particular health concerns to MTA residents, due to their toxicity, numerous local sources, lack of monitoring data, related health issues, and unawareness among the general public.

1.1. Particular situation in the Memphis Tri-state Area (MTA)

Exposure to PAHs has been linked to many adverse health effects. PAHs are a complex mixture of compounds formed during incomplete combustion processes of organic materials [2]. They are released into the environment as gases or associated with particles, and are ubiquitous in the general environment [3]. Light PAHs (≤4 rings) predominantly exist in gas phase, while heavy species (>4 rings) are almost exclusively adsorbed onto particles. The major concerned toxicity of PAHs includes immunotoxicity, carcinogenicity, and endocrine disruption. Some PAH compounds, such as benzo[a]pyrene and benz[a]anthracene, have been identified as probable human carcinogens by the U.S. EPA [2,4], and in particular, are associated with respiratory tract and bladder cancers [5]. PAH exposures are also linked to cardiovascular disease [6,7], birth defects [8,9], early childhood development [10-12], childhood obesity [13-15], and asthma and other respiratory diseases [16-18].

Major PAH sources and numerous fugitive sources are present in MTA. The major combustion sources in MTA include industries, airports, trains, truck corridors, highways, and Mississippi River (Fig 1). Southwest Memphis houses clustered heavy industries, including a refinery and a coal-fired power plant. Known as the "Distribution Center of America", Memphis is a major Mid-American commercial and transportation hub. Memphis has the busiest airport for cargo traffic [19], the third largest rail center, and one of the largest inland ports in the nation. Crittenden County, AR, has the region's largest truck corridor. Historically, excessive dust from operations are notable [20]. The Lamar Avenue corridor in Memphis is home to the newly enlarged BNSF rail yard used primarily for freight off-loading operations, and brings thousands of train cars and trucks daily through the area. Major highways include Interstate 40, 240, 55 and 385, and their inner city segments all have high traffic volumes (>50,000 vehicles/day) [21]. Previous studies have confirmed that industries and transportations are major PAH sources in urban settings [3]. In addition, hundreds of grill-type restaurants and backyard barbecues are releasing combustion-related contaminants, which have been recognized as an important community source of PAHs [22,23]. Hence, exposure to PAHs is a potential health threat to inner-city communities considering their proximity to possible local industrial sources and increased traffic density. In rural areas, agricultural burning releases large amount of particles and PAHs that even transport long distances and have wide environmental and health impacts [24,25].

MTA has many health issues that may be related to exposure to particles and PAHs. Memphis was among the nation's top three "Asthma Capitals" from 2010-2014 [26]. Shelby and Crittenden Counties have infant mortality twice of the national level [27]. Shelby County has many health indicators ranked top in TN, such as infant mortality (#1), hypertension (#1), obesity (#2), and stroke mortality (#3) [28]. Cardiovascular disease and cancer are the top two leading causes of death in Shelby [28]. Many schools are located near freeways, which is associated with childhood asthma [29]. Diseases prevalence also displays strong spatial patterns: mortalities of cardiovascular disease, cancer, and chronic lower respiratory disease are all elevated in the western part of Memphis, an area consisting predominantly of low-income African American residents. As air pollution is linked to these diseases [30], communities have high concerns about air pollution and the environmental justice.

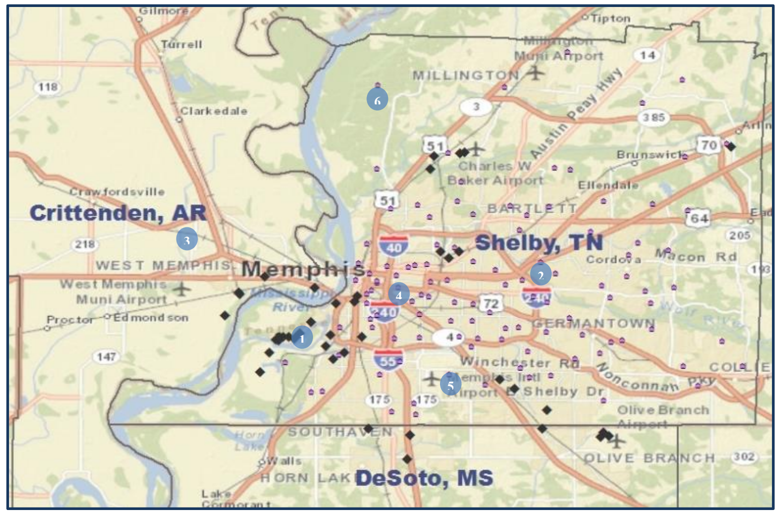

Figure 1. Memphis Tri-state Area.
♦: Major industrial emission facilities; ●: Current monitoring sites; ①-⑥: Proposed stationary sampling sites.

1.2. Rationale and justification for the proposed project

No data are available for ambient PAHs in community settings in MTA. According to 2005 NATA, Shelby County has an overall cancer risk higher than the 95th percentile risk levels both for Tennessee and the U.S. [31]. Small monitoring projects at central sites confirmed several air pollution “hot spots” [32,33]. The current air toxics monitoring program has indicated that the overall cancer risk may be 10 times higher than the national level. Unfortunately, these two local monitoring programs only measured volatile organic compounds (VOCs) not PAHs, as PAH monitoring needs different measurement techniques. To our knowledge, there has been no community-scale PAH study in MTA, nor in EPA’s Region IV states.

PAH speciation information is unavailable for risk assessment. In EPA’s list of 187 air toxics, PAHs are reported as one air toxic, polycyclic organic matter (POM), without speciation information [34]. As a result, EPA’s Toxics Release Inventory (TRI) and NATA only report the emissions and concentrations of composite POM. These estimates are insufficient for risk assessment, as PAH compounds show toxicities that vary over several orders of magnitude [35]. Hence, data gaps and uncertainties must be resolved to evaluate health risks and to set appropriate standards.

Environmental justice (EJ) issues may exist for PAH exposure. Dr. Jia, one investigator of this proposed project, recently published an article that articulates racial disparities in cancer risks from air toxics exposure in Memphis, using 2005 NATA data [31]. The results show that low-income African American neighborhoods tend to reside near mobile sources, and therefore bear higher cancer risks from air toxics. However, NATA has limitations: it provides only modeling data, does not report specific PAH compounds, and does not support hot-spot analysis to identify major sources, which are often located in proximity to disadvantaged communities. As a matter of fact, previous air pollution EJ research is mostly focused on criteria pollutants and VOCs, but has never examined PAHs [36]. A field PAH monitoring will provide valuable data to examine EJ issues related to PAH exposure.

The public has limited knowledge about PAHs. The public’s understanding of air pollution is often limited to odor, open burning, vehicle exhaust, and visible dust [37]. They are unfamiliar with PAHs, despite PAHs’ widespread sources and numerous exposure pathways. The public gets exposure to PAHs not only from mobile and industrial sources, but from many other sources, such as, grilled food and tobacco smoke [38]. While increasing people’s perception and knowledge is a cornerstone for regulations and interventions, the poor comprehension of risk may impede delivery of the optimal level of pollution control measures. A survey among metropolitan residents shows that most people think air pollution information is very useful, and >60% of people are seeking air pollution information in their area [39]. All these facts reflect the great demand of air pollution information, including that for PAHs, among residents in MTA.

2. Technical Approach

2.1. Project objectives

This project targets the communities in MTA that features urbanization gradients, disadvantaged neighborhoods, major and fugitive combustion sources, and potentially serious air pollution related health issues. The overall objective of this study is to delineate the concentrations and distributions of PAHs in ambient air in MTA, identify major sources and characterize near-source PAH profiles, and assess non-carcinogenic and carcinogenic risks. This study will take the community-based participatory research (CBPR) approach, in which community residents and organizations are engaged in all phases of the study [40]. There are five specific aims:

Aim 1: To determine the community-scale concentrations of PAHs and the spatiotemporal variations. This monitoring campaign will yield a rick database of continuous/seasonal PAH measurements at near 70 sites at the census tract level. This database will be used for these sub-aims: (1a) Estimate chronic exposure in the population in MTR, which can then be used for health risk assessment; (1b) Compare PAH levels in MTA with those measured in other regions in the U.S. and worldwide; (1c) Identify PAH exposure "hot-spots", where the local residents are the "high-end" exposure sub-populations; (1d) Describe spatial distributions and temporal trends of ambient PAH levels, and examine the influential factors, such as neighborhood, season, day-of-the-week, meteorology, and industrial and agricultural activities.

Aim 2: To assess public health risks potentially associated with exposures to airborne PAHs. The risk assessment will (2a) estimate inhalation cancer risks; (2b) evaluate the non-cancer effects by comparing results from (1a) with the threshold levels; (2c) prioritize those PAHs that might present the highest health risks; and (2d) estimate the contribution of PHAs to the total risks from all carcinogenic air toxics.

Aim 3: To identify major PAH sources and their locations, and to characterize community PAH source profiles. This task will address the following key questions: What emissions sources contribute to ambient PAHs? How much does each source type contribute? Which sources could be targeted with control measures to effect the highest reduction of PAH concentrations or risks? What are the discrepancies between emission inventories and sources identified by receptor models?

Aim 4: To examine the relation of socioeconomic status (SES) and measured PAH concentrations. A novel aspect of this study is to place PAH exposure in the social context to address potential EJ issues. We will examine how the uneven spatial distribution of PAH sources causes disproportionate environmental exposure among communities in different SES. The hypothesis is that emission sources are often concentrated in these disadvantaged areas and as a result, low SES communities have higher levels of PAH exposures and the associated cancer risks.

Aim 5: To strengthen partnerships among community institutions receptive to learning about and using PAH and air pollution data. We will develop multiple communication venues to engagement communities in the study, ensure widespread dissemination of and access to air pollution data, promote use of these data by community residents to improve daily decisions to reduce harmful effects of air pollutants, and bolster the community's effectiveness in shaping local policies for transportation, development, and construction projects affecting air pollution.

2.2. Project plan and design

Study area. Air samples will be collected in three neighboring counties in MTA: Shelby County, TN, DeSoto County, MS, and Crittenden County, AR (Fig 1). According to the 2010 Census, these counties are MTA's central counties that represent 87% of the total population and 41% of the total area of MTA. The center city Memphis is the largest city in TN, and the 20th largest city in America. It actually is larger than Atlanta, St. Louis, Portland, Nashville, Boston, Miami, Baltimore, and Seattle [41]. Radiant from Memphis, the land-use type displays a clear industrial-urban-suburban-rural gradient: Memphis is an industrial and urban center, Germantown, Bartlett, and Collierville in Shelby, Olive Branch in DeSoto, and West Memphis in Crittenden are suburban areas, and the rest are mostly rural areas. The selected study area should be representative of MTA, and be logistically reachable for field sampling.

Sampling sites and plan. This monitoring campaign will utilize a combination of stationary active and spatial passive sampling sites. This design will allow capturing both spatial and temporal variation, as well as detailed information about major sources. The sampling period will be one year.

- Stationary sites: There will be 6 stationary sites that are located in proximity to ① the industrial park, ② a high-traffic highway, ③ a truck corridor, ④ fugitive restaurant emissions, ⑤ the airport, and ⑥ a background site, as displayed in Fig 1. Active samples will be collected every 12 days for one year.

- Spatial sites: We will deploy passive samplers at census tract level throughout the study area. There are 221, 33, and 20 census tracts in Shelby, DeSoto, and Crittenden, respectively, and we will select 50, 5, and 5 tracts, respectively. We will set up one sampling site at each selected census tract. Thus roughly one site will be selected every five census tracts. As the areas of tracts vary, we will carefully select tracts so that sites are evenly distributed in the study area. According to Dr. Jia's previous study, samples from centrally located monitoring stations within a small area (e.g., several census tracts) could be representative of ambient PAHs [42]. The sites will be chosen to represent a variety of neighborhood settings, e.g., residences, schools, business areas, churches, restaurants, near road areas, farms, and remote areas. Passive samples will be deployed at each site for 90 days every season during the 1-year sampling period.

It should be noted that SCHD has just completed a county-wide VOC monitoring program that recruited 112 sites in 106 census tracts (Fig 1). Thus, site recruitment should be easily achieved.

2.3. Sampling and analytical methods

The field sampling and laboratory analysis of PAHs will generally follow U.S. EPA's Compendium Method TO-13A [43] (TO-13A does not cover passive sampling though).

Active sampling. Active sampling of PAHs will be performed with a high-volume sampler (Model TE-1000PUF+BL, Tisch Environmental Inc., Cleves, OH, USA, Fig 2A). This sampler houses a quartz filter and a polyurethane foam (PUF) plug to capture particulate- and gas-phase PAHs, respectively. The sampler pulls ambient air through the filter/PUF at a flow rate of approximately 225 L/min to obtain a total sample volume of greater than 300 m^3 over a 24-hour period. A total of 180 active samples will be collected.

Passive sampling. Passive sampling will be performed with an outdoor passive air sampler (Model TE-200PAS, Tisch Environmental Inc., Cleves, OH, USA, Fig 2B). A quartz filter is placed on top of the PUF disk to differentiate the particulate and gas components. At each site, passive samples will be collected for 90 days and replaced immediately on a continuous rather than intermittent basis. Previous studies have validated this method [44,45]. A total of 240 passive samples will be collected.

Field blank and duplicate. Field blanks and duplicate samples are required to be deployed at a rate of 10% of total samples, resulting in an additional 84 quality control (QC) samples.

This monitoring campaign will collect a total of 504 active, passive, and QC samples over 1-year sampling period.

Figure 2

Laboratory analysis of PAHs. All field PAH samples will be shipped (cool) to the laboratory at the University of Memphis (UM) for analysis. Samples will be extracted and concentrated using an Accelerated Solvent Extractor (ASE 350, Thermo Scientific Inc., Sunnyvale, CA, USA). This extraction method reduces extraction times and solvent use by up to 90% over traditional methods, and is equivalent to the conventional Soxhlet extraction and concentration methods [46,47]. The filter and PUF of the same sample will be extracted together. Concentrated extracts are finally analyzed on a gas chromatography/mass spectrometry (GC/MS, Model 6890/5973, Agilent Technologies, Santa Clara, CA, USA) system in selective ion monitoring (SIM) mode. The GC/MS analysis targets 44 PAHs, including the EPA 16 priority PAHs (Attachment 3). PAHs are identified and quantified in ChemStation (Ver G1701DA, Rev D.01.02).

The quality assurance is narrated in Attachment 4. A detailed quality assurance project plan (QAPP) will be developed before the monitoring program starts.

3. Data Analysis

We will analyze data following EPA's Air Toxics Data Analysis Workbook [48]. In addition, we will apply advanced statistical and spatial analysis techniques that have been reported in literature.

Analysis 1: Descriptive statistics and distribution fitting (for Aim 1). (1) Clean data: check blank contamination; identify non-detects, outliers, missing data, and suspicious extreme values; and check duplicate precision. (2) Calculate descriptive statistics, including mean, 95% upper confidence limit (UCL) of mean, standard deviation, percentiles, minimum, and maximum. (3) Fit and visualize probability distributions. Fit the full range of PAH concentrations to a number of candidate distributions, e.g., normal, lognormal, Weibull, Pareto, etc., using maximum likelihood method. The best fit distributions will be selected based on several goodness-of-fit tests including chi-square, K-S, and Anderson-Darling tests. These analyses will be conducted using EPA's ProUCL software (Ver 5.0.00), a program specially designed for environmental data analysis [49].

Analysis 2: Comparison with PAHs measured in other studies (for Aim 1). We will search EPA's Air Quality System (AQS) for PAH data obtained elsewhere the same period. We will also compare our data with previous studies in other locations, e.g., Los Angles, Houston and Elizabeth [50]; Paterson [51]; Camden [52]; and Europe [53] and Asia [54].

Analysis 3: Spatial and temporal analysis (for Aims 1 & 3). (1) Visualize spatial distribution of PAHs in ArcGIS (Ver 10, ESRI, Redlands, CA). (2) Visualize temporal variation. Methods for visualization include line graphs, box plots, plots of mean or median values with confidence intervals, and combination of a map and temporal information. (3) Identify key determinants of ambient PAH concentrations. We will examine a number of factors, e.g., temperature, humidity, wind direction and speed, precipitation, land use type, distance to major sources, and SES variables, using multivariate linear regressions. Variables selection will use both forward and backward stepwise methods. (4) Decompose the overall variation of PAH concentrations to between-city (σ^2_C), between-tract (σ^2_T), temporal/seasonal (σ^2_S), and measurement variations (σ^2_M) using variance component analysis. Dr. Jia has developed and applied this method to PAH measurements [42]:

$$\mathrm{Var[PAH]} = \sigma^2_C + \sigma^2_T + \sigma^2_S + \sigma^2_M \quad \text{(Eq.1)}$$

The quantitative variance information helps interpret how PAHs vary in terms of time and space, weigh their influential factors, and identify sources.

Analysis 4: Risk assessment of PAH exposure (for Aim 2). (1) Estimate cancer risks from carcinogenic PAHs (cPAHs). The cancer risk from exposure to a cPAH is estimated as:

$$\text{Risk} = \text{Exposure Concentration} \times \text{Cancer Potency} \quad \text{(Eq.2)}$$

Cancer potency of a cPAH will be determined by EPA's toxic equivalent factor (TEF) and relative potency factor (RPF) approaches [55], in which benzo[a]pyrene (B[a]P) is used as the index PAH, and relative potencies of individual cPAHs are determined relative to the potency of B[a]P. (2) Estimate the cumulative risk. The cumulative risk is calculated by adding risks from individual cPAHs, assuming additivity. (3) For naphthalene, the non-cancer risk is evaluated by comparing the exposure to the reference concentration (RfC), available from EPA's Integrated Risk Information System (IRIS) [56]. A detailed risk assessment plan will be developed before the field sampling starts.

Analysis 5. Source identification and apportionment (for Aim 3). Sources will be characterized using several advanced statistical models, including diagnostic ratios, positive matrix factorization (PMF), and trajectory analysis. (1) The diagnostic ratio of PAH isomers, which is commonly used for source identification [57], is calculated for each season at each site to identify the main emission sources of PAHs. (2) PMF is a multivariate factor analysis tool that is used to identify source types, construct source profiles, and apportion source contributions [58]. We will perform PMF analyses using EPA's PMF 5.0 Model [59]. (3) Use trajectory analysis to trace the most likely areas of influence on high pollutant concentrations. Air parcel movement from the point of interest will be modeled using HYSPLIT, a model developed by NOAA [60]. The use of trajectory analysis after source apportionment helps analysts better understand, interpret, and verify source apportionment results [61].

Analysis 6. Environmental disparity analysis (for Aim 4). As PAH monitoring sites will be established in census tracts, the data can be linked to census-level demographic and SES variables available from U.S. Census. The disparities of PAH exposures and risks will be evaluated using geographically weighted regressions (GWR):

$$\text{Exposure (or Risk)} = \beta_0 + \Sigma\beta\ \text{SES} + \lambda We + \mu \quad \text{(Eq.3)}$$

where SES = SES variables, λ = spatial autoregressive coefficient, W = the spatial weights matrix, e = the random error term in the regression model without the spatial error term, μ = the spatially independent error term. Eq.3 will be run using two regression methods: ordinary least square (OLS) linear regression and quantile regression (QR). These models will provide a full picture of the disproportionately distributed PAH exposures in a quantitative way, as illustrated in Dr. Jia's publications [31,62].

Analysis 7. Data dissemination using interactive maps (for Aim 5). All the PAH exposure data and SES data will be mapped in ArcGIS, and published on a website that displays interactive maps of health equity in Memphis, TN, at www.immemphis.com. SCHD will also create a website for project progress, result dissemination, and risk communication.

4. Environmental Justice (EJ) Impacts

This project will address the needs and concerns for EJ issues in MTA, since health and environmental disparities do exist in this region.

(1) This project will offer a path to identify and prioritize the impacted communities. The first step of EJ research is to identify the impacted populations that bear disproportionate pollution burdens; however, the absence of any comparative risk measures is one of the principal limitations in many EJ studies. This study has a unique design that samples are collected at the census tract level. A census tract is a small geographic entity designed to be relatively homogeneous with respect to population characteristics, economic status, and living conditions. Thus, we are able to link PAH exposure to socioeconomic status (SES), and generate "riskscapes" for PAH mixtures, displaying unequally distributed risks across communities with a gradient of SES.

(2) The study team will work with communities to continuously develop participatory environmental decision-making. EJ analysis often is done *on* communities instead of *with* them. The preferred alternative would be CBPR, which is proved to improve public health decisions, stimulate actions, and contribute to EJ [63]. As detailed in Section 5, the team will involve residents of impacted neighborhoods in all aspects of the study process. Government, academia, and community will collaborate to interpret results, determine priorities, identify alternatives, and propose solutions at the local level, and form a stakeholders group. The stakeholders will foster activities like: request for information release and public records; participate in the development of comprehensive plans and in the integrated resource planning (IRP) processes undertaken by the city and county of the affected community; participate in a new land-use classification; negotiate for an environmentally friendlier and healthier facility with post construction options; advocate for change and request to possibly limit certain emission activities. As a government agency, SCHD will not only generate and disseminate data, but create channels and opportunities for socially vulnerable communities to participate.

SCHD has successful experience in working with impacted communities and interested organizations to address EJ issues. In 2010, SCHD was tasked with developing and implementing a modest grant program in the Riverview Kansas Community in Southwest Memphis. The total grant was $150,000 and the funds were distributed to 501c3 organizations within that community. SCHD staff visited over 500 homes in this community, walking door-to-door, to deliver grant information and air quality information. In addition, several community meetings were held to discuss the events at local churches.

(3) This study will highlight educating low SES residents. A merit of toxics disparity studies is to educate low-income communities about the health risks associated with toxics emissions [64]. Environmental issues often take a backseat in minority communities, as they are more intimately engaged with educational barriers and other social issues, such as crime, drugs, and poverty. We will reach out high-exposure minority communities via educational outreach programs, community wide campaigns, meetings, and workshops. These activities will increase their knowledge concerning the risks of living in close proximity to hazardous waste sites, teach them to use the results of this study to inform public and written testimonies regarding land use planning policy and other regional organizing work for environmental health, and may be instrumental in lessening the migration of such populations into neighborhoods with hazardous sites.

(4) This study will provide evidence for the national EJ movements. We anticipate that this study will provides empirical evidence that spatial distribution of minorities are the driving predictors of environmental disparities, as reported in earlier studies [65]. The findings will enhance our understanding of the extent to which minority concentrated communities bear a disproportionate burden of environmental pollution. MTA shares many similarities with other U.S. metropolitan areas in terms of segregation, black/white differences, and differential exposure to air toxics [66]. Thus, this regional study is expected to be representative of what may be happening in other metropolitan areas in the U.S., and the results could be aggregated to inform national efforts to eliminate environmental disparities [36].

In summary, this study is expected to exert significant EJ impacts at local, regional and even national levels. The project activities, guided by CBPR principles, will inform location and regional actions and programs and provide evidence for the national EJ movements.

5. Community Collaboration / Outreach

SCHD and UM have established wide partnerships in this area. Through our current community-scale air toxics study, we have recruited over 100 partners, including government agencies (e.g., fire stations and police stations), schools, churches, hospitals, and residents. The Board of Shelby County Schools has granted SCHD access to >250 schools for air sampling. SCHD has consistently aired air quality videos through the Comcast network in the Memphis region. This air quality information is estimated to reach 500,000 people every day. SCHD and UM also have institutional relationships with various organizations, initiatives, and community leaders, including Memphis Aerotropolis, Sierra Club, Common Table Health Initiative, Memphis Fast Forward, Urban Child Institute, BRIDGEs, Memphis & Shelby County Office of Sustainability, Westwood Neighborhood Association, and Engineers' Club of Memphis. Connecting and working with these organizations and leaders can help build institutional capacity to conduct effective engagement processes. The project team will seek to assure a bidirectional dialogue with community members and other project stakeholders.

This study will apply the community-based participatory research (CBPR) approach to engage communities throughout the whole project process. (1) The preparatory stage will be focused on partnership building and study design. We will hold a number of stakeholders meetings to bring together researchers, communities, organizations, and individuals of interest to discuss community concerns and needs, plans for monitoring site selection and data analysis, community ideas for analytic work to be done, and feedback regarding data dissemination. We will convene a minimum of educational sessions to deliver air pollution information to schools and community partners. These meetings and sessions will raise the public's interest, facilitate academic and community research partnerships, and help improve quality of the study design. A website will be created to provide project information. (2) The sampling stage will highlight education and interaction. The field workers will demonstrate the science to the participants at each sampling sites. We will deliver presentations and demonstrate samplers for schools' science courses. After the each round of sampling, we will immediately share the results with participants and release them on the project website. The frequent feedback from communities will help researchers to better understand what participants want from the study and to anticipate how participants' local context would likely influence their understanding. This intensive, iterative interaction will allow the team to adjust and align its methods to suit the community's needs. This approach will make the results more applicable to the participants' lived experience. For some participants, the study provides an entree into a discussion of the potential sources of the most common chemicals found in their community. (3) The dissemination stage will enhance risk communication. The research team and communities will work together to translate and disseminate research findings to promote positive changes in air quality and the public's health. Before research findings can be communicated to audiences, it often is necessary to "translate" the message into language and concepts that will be grasped by the target audience. We will structure message development activities around five key questions: what should be transferred; to whom should research knowledge be transferred; by whom should research knowledge be transferred; how should research knowledge be transferred; and, with what effect should research knowledge be transferred? The results will disseminated through public meetings, school classrooms, local and national conferences (e.g., the Annual Sierra Club Environmental Justice Conference), and social media. We will utilize an interactive mapping website (www.immemphis.com) to provide community members with access to environmental health data. The interactive mapping website for the mid-South will enable our partners to use data to visualize patterns, generate maps, identify special populations experiencing health disparities, and identify community assets which potentially can be mobilized to respond to them.

Post-project support and actions. SCHD has the Air Quality Improvement Branch (AQIB), funded by the Tennessee Department of Transportation. This branch is generally responsible for air quality education in the Memphis community. This branch currently has an educational outreach budget of $276,000. The AQIB has visited every public school in Shelby County and provided air quality educational materials to those schools. As long as this branch continues its financial support from TDOT, the AQIB will continue to provide air quality information, such as, information from this study to the community. Dr. Jia' Environmental Health Program at UM has a strong commitment to communities through teaching, research, and services.

6. Environmental Results: Outcomes, Outputs, Performance Measures

The milestones of this project will include: (1) A sampling and analytical system for airborne PAHs that meets QA/QC requirements; (2) QAPP; (3) Community Involvement Plan; (4) Risk Assessment Plan; (5) Recruitment of 70 sites in MTA; (6) Semi-annual or more frequent community outreach activities, including stakeholders' meetings, workshops, lectures, speeches, and courses; (7) Quarterly reports of project progress; and (8) Annual reports and final report. These activities, efforts, and work products and their timeline are summarized in Table 1. SCHD will submit all the collected data to the EPA's Air Quality System (AQS).

Table 1. Proposed schedule and project outputs

Stages and Tasks	2015									2016												2017												2018			
	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	09
Preliminary																																					
Obtain IRB approval	X	X	X																																		
Equipment purchase & optimization		X	X	X	X	X																															
Develop risk assessment plan						X	X	X																													
Develop QAPP						X	X	X	X																												
Field study																																					
Site recruitment							X	X	X	X	X	X																									
Pilot Monitoring				X	X	X	X																														
Formal Monitoring										X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												
Community Outreach																																					
Community Involvement Plan	X																																				
Stakeholders/public meeting	X				X				X																												
Education/risk communication													X				X				X				X	X	X	X	X	X	X	X	X	X	X	X	X
Analysis/reporting																																					
Data analysis and mapping														X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Quarterly reports				X			X			X			X			X			X			X			X			X			X			X			X
Annual reports and the final report													X												X											X	X

The results of this project are expected to fill a critical knowledge gap in assessing and managing community-level PAH exposures. We expect improved environmental and health conditions as well as the public's environmental awareness from carrying out this representative, regional monitoring campaign, as listed in Table 2.

Table 2. Environmental and health outcomes from the proposed project

Time Frame	Outcome
Short Term	- Determine major combustion sources and risk drivers of PAHs; - Determine high exposure communities and sites; - Document agricultural burning events and high PAH exposure days; - Health risk data publicly available on a website; - Enhance community awareness of PAHs via workshops, meetings, and courses;
Mid-term	- Urban planners and developers consider project results when building commercial and residential real estate to minimize PAH exposure; - Local or state legislation on agricultural burning, e.g., burning permit and allowable days for burning; - Induce industries to keep up with their good corporate image by implementing maximum achievable control technologies (MACT); - Push major emission facilities to adopt low-emission technologies or to operate emission control devices;
Long-term	- Reduce PAHs emissions through additional policy or regulatory restrictions; - PAHs induced cancer risks fall below 10^{-6}; - Improved asthma prevalence in this region; - Improved PAH-related health outcomes in this region.

The performance of the project will be evaluated by the following measures:

(1) Geographic coverage: The number of census tracts will meet or exceed the target number.
(2) Data quantity and quality: Meet those required by the QAPP.
(3) Timely submissions of reports and data: All the reports will be submitted as scheduled; validated will be submitted to AQS by the end of the project.
(4) Results dissemination: All the data will be published on an interactive mapping website; results will be presented in national/international conferences, and published in peer-reviewed journals.
(5) Community meetings: All the meetings will be held as scheduled, and participation will be documented.
(6) Community follow-up: SCHD will have designated staff to response project related inquiries from communities.
(7) Health improvement: SCHD will continuously track and investigate community health, and may perform interventions if problems are identified.

7. Programmatic Capability and Past Performance

7.1. Organizational and staff experience

SCHD has staff diverse with a wealth of experience in air monitoring, air pollution modeling, environmental epidemiology, community outreach, and project administration.

Projector manager Mr. James Holt (M.S. and B.S.Ed.) is currently working as Assistant Manager of the Pollution Control Section in SCHD, focusing on budgeting, management, and development of various environmental projects. He has twenty-five years of experience in advanced air monitoring and air pollution permitting. He has been the project manager of several EPA funded air toxics studies. He will be the project manage who oversees and coordinates the project.

Project collaborator Dr. Chunrong Jia is currently an assistant professor in Environmental Health Sciences (EHS) in the School of Public Health at University of Memphis. He is the only EHS professor with expertise in air pollution in Memphis. He has 15 years of experience in field sampling and laboratory analysis of air toxics, and handling of large air toxics databases. He has completed 20+ air toxics studies in the U.S. His lab has an Agilent 6890/5973 GC-MS system with a 7683 auto-sampler, which is capable of analyzing PAHs with high sensitivity. Dr. Jia's biosketch is listed as Attachment 5. He will be responsible for sampling design, field sampling, lab analysis, data organization, analysis and interpretation, and preparation of manuscripts and reports.

7.2. Past performance

SCHD has successfully managed a number of EPA programs. In 2006, EPA audited the permitting program including NSR/PSD and the audit was very favorable. The Air Monitoring Branch monitors for all criteria pollutants, PM2.5, and presently is preparing to operate a NCORE site. In 2006, EPA's auditing found the Branch operated favorably with appropriate monitoring, reporting, and internal controls. SCHD has been awarded two community-scale air toxics grants by EPA:

(1) In 2009, SCHD was awarded a community action grant for approximately $230,000 to study emissions from tank barges. The final report was submitted to EPA in September 2010, and the results have been presented at several national conferences.

(2) In 2012, SCHD was awarded a community-scale air toxics monitoring grant for $574,404. This project (REACT) monitored ambient volatile organic compounds (VOCs) in 106 census tracts in Memphis. The team successfully completed the monitoring portion by December 2014, and will analyze data and disseminate results in 2015. The SCHD and U of M formed a stakeholders group for the REACT study. This group was made up of concerned citizens, Sierra Club representatives, and a representative of industry. Representatives from this core group could be contacted again to form a stakeholders group for the PAH study. The EPA Region 4 project manager had two site visits, and concluded that the progress was successful so far. In particular, EPA values the sampling design that covers over 100 census tracts and the community engagement throughout the project. This work also served the basis for Dr. Jia to be awarded an Environmental Health Fellowship at Harvard University in October 2014.

7.3. History of meeting reporting requirements

The SCHD Pollution Control Section continues to meet all reporting requirements for all EPA grants including: 105 and 103 grants. The specific 103 grants include PM 2.5, Community Scale – Tank Barge Emissions, Community Scale – Reducing Exposure to Air Chemical Toxics (REACT), NCORE Monitoring Site, and the Near-road Nitrogen Oxides Monitoring Site.

8. Budget

The total funding requested is $594,407. The total direct cost for SCHD is $594,407, and there is no indirect cost from SCHD. The tabulated budget numbers are displayed in Attachment 6. Budget justification is narrated as follows.

(1) Personnel: Funds are requested for administration, community collaboration and outreach, and environmental workshops by the SCHD ($12,000/yr for 3 years).
(2) Travel: Funds are requested for the project manager to travel to Washington, DC for annual program progress review ($1,500/yr for 3 years), and to attend national or international scientific conferences to present project findings in the 2nd and 3rd years ($1,500/yr).
(3) Supplies: Funds are requested for general purpose office supplies, e.g., paper, printing, copying, and binding reports ($1,000/yr for 3 years).
(4) A subcontract of $545,407 to UM.

Subcontract to Dr. Chunrong Jia at UM is for sampling design, purchase of samplers and necessary lab equipment, field sample collection, laboratory analysis of PAH samples, data organization and analysis, and preparation of manuscripts and reports. A total of $536,593 is requested. Attachment 7 shows the Letter of Commitment from UM.

(1) Personnel costs include one-month summer salary/yr for Dr. Jia for 3 years (total $22,979), to supervise the pro-

ject; salary for a lab technician for 2 years (total $80,900), to conduct lab analysis; 10% salary for a project coordinator Lisa Krull (total $17,000), to track the project progress and help community outreach; and a graduate student assistant (total $49,500), to conduct field work, community outreach, and data organization.

(2) Fringe benefits are requested for Jia, lab technician, and field coordinator (35.4 % of salary, total $43,033).

(3) Travel costs include travel for field staff to collect samples ($8,000/year for 2 years), and travel for Dr. Jia to present findings in international conferences in the 3rd year ($2,000).

(4) Supplies include consumables for PAH analysis at $50/sample for 504 samples (total $25,200), purchase of 60 sets of passive samplers at $250/set (total $15,000), a laptop for downloading field data (total $1,500), and miscellaneous incentives and consumables (e.g., tools, shelters, locks, shelves, etc.) for field and lab work (total $8,000).

(5) Equipment includes purchase of an ASE Accelerated Solvent Extractor (total $65,000) and six PAH sampler ($6,000 ea, total $36,000). The sum of this extractor, lab supplies ($25,200), a lab technician's salary ($80,900) and benefits (28,800), and indirect cost ($58,681) is $258,582. A contract lab charges $650/sample × 504 samples = $327,600, and there are extra shipping and handling costs and time. Thus, in-town analysis with an investment in an accelerated extractor is a more economic approach (savings of >$70,000) for timely and reliable laboratory PAH analysis. In addition, this purchase will enhance the local environmental analytical capability.

(6) Tuition: Funds are requested to cover the graduate's tuition for 3 years (total $38,140).

(7) The negotiated Facilities and Administration (F&A) rate for UM is 43.5% of the direct cost, effective 01/01/2015. F&A do not apply to equipment over $5,000 or tuition. The total F&A costs requested for UM subcontract are $123,155.

9. Leveraging

The SCHD's current community-scale VOC monitoring project (the REACT study) enters its last stage for results dissemination among communities in Shelby County. If awarded this grant, SCHD and UM will "synchronize" REACT's dissemination stage with the preparatory stage of this project. This synchronization will ensure the continued community outreach activities in the REACT study, and expand outreach to the tri-state region. As mentioned, SCHD's AQIB staff will help with community outreach. Additionally the existing air monitoring stations operated by the SCHD could be utilized as locations for PAH monitoring.

Dr. Chunrong Jia has several ongoing projects than can leverage resources (Attachment 4). He was recently awarded Harvard University JPB Environmental Health Fellowship with a support of $350,000 for 3.5 years, to conduct multidisciplinary research particularly targeting at disadvantaged communities. Master and doctoral students in UM School of Public Health (UMSPH) can participate in this project for their practicum, master's projects, and theses. UMSPH has allocated continuous funds to support the operations of Dr. Jia lab. UM has site licenses of needed software, such as Microsoft Windows, Microsoft Office, SAS, and ArcGIS. UM has a Spatial Analysis and Geographic Education (SAGE) Laboratory that Dr. Jia can utilize to analyze transportation, socioeconomic, demographic, environmental and health databases, and publish maps without charges. All these resources will partially support activities relating to this project, e.g., lab consumables, data analysis, reporting, and dissemination of results.

10. Expenditure of Awarded Grand Funds

The SCHD will provide financial staff to assure budget timelines is followed. Additionally, the SCHD is requesting a collaborative agreement with EPA Region IV to provide guidance. As with the past two Community Scale Grants (Tank Barge and REACT studies), we will request routine conference calls with EPA to ensure project progress and timely expenditure of funds.

The UM has policy, procedures, and controls in place regarding sponsored projects. UM will charge costs to sponsored agreements in compliance with federal regulations, to ensure all costs are reasonable, allocable, consistent and allowable. The Principal Investigator (PI), Business Officer, Research Administration, and Grants and Contracts Accounting work together to ensure that the grant funds will be expended in a timely and efficient manner. The PI, with guidance from the Business Officer, is responsible for directing and managing the fiscal and scientific aspects of the award. The PI is also responsible for reviewing the expenditures on the project on a monthly basis to ensure the appropriateness of the costs budgeted and charged, in accordance with all regulations. Grants and Contracts Accounting reviews the grant expenditures on a monthly basis for reasonableness, allocability, consistency, and allowability to ensure compliance with sponsor regulations. Grants and Contracts Accounting also prepare the financial invoices to the sponsor on a monthly basis and prepares the final financial report at the end of the project period.

Attachments

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A2. Acronyms of Key Terms

AQIB	Air Quality Improvement Branch
CBPR	Community-Based Participatory Research
cPAH	Carcinogenic Polycyclic Aromatic Hydrocarbon
EJ	Environmental Justice
EPA	Environmental Protection Agency
GC/MS	Gas Chromatography/Mass Spectrometry
GIS	Geographic Information System
NATA	National-scale Air Toxics Assessment
MTA	Memphis Tri-state Area
PAH	Polycyclic Aromatic Hydrocarbon
PMF	Positive Matrix Factorization
PUF	Polyurethane Foam
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RfC	Reference Concentration
SCHD	Shelby County Health Department
SES	Socioeconomic Status
TRI	Toxics Release Inventory
UM	University of Memphis
UCL	Upper Confidence Limit
VOC	Volatile Organic Compound

A3. List of Target PAHs

Polycyclic Aromatic Hydrocarbons from selected Environmental and Public Health Agency Lists	**CAS #**	**Molecular Weight**	* - EPA-16	ǂ - EPA-RTK,TRI	cPAH Lists			
					¥ - OEHHA CSF	§ - OEHHA	¶ - EC "15+1"	£ - EPA RPF
Total # PAHs = 43			16	22	7	24	16	26
Acenaphthene	83-32-9	154.21	*					
Acenaphthylene	208-96-8	152.20	*					
Anthanthrene	191-26-4	276.34						£
Anthracene	120-12-7	178.23	*					£
Benz[a]anthracene	56-55-3	228.29	*	ǂ		§	¶	£
11H-Benz[b,c]aceanthrylene	202-94-8	240.30						£
Benz[e]aceanthrylene	199-54-2	252.32						£
Benz[j]aceanthrylene	202-33-5	252.32						£
Benz[l]aceanthrylene	211-91-6	252.32						£
Benzo[a]pyrene	50-32-8	252.31	*	ǂ	¥		¶	
Benzo[b]fluoranthene	205-99-2	252.32	*	ǂ		§	¶	£
Benzo[c]fluorene	205-12-9	216.28					¶	£
Benzo[g,h,i]perylene	191-24-2	276.34	*	ǂ			¶	£
Benzo[j]fluoranthene	205-82-3	252.32		ǂ		§	¶	£
Benzo[k]fluoranthene	207-08-9	252.32	*	ǂ		§	¶	£
Chrysene	218-01-9	228.29	*	ǂ		§	¶	£
Cyclopenta[c,d]pyrene	27208-37-3	226.28					¶	£
4H-Cyclopenta[d,e,f]chrysene	202-98-2	240.30						£
Dibenz[a,h]acridine	226-36-8	279.33		ǂ		§		
Dibenz[a,h]anthracene	53-70-3	278.35	*	ǂ	¥	§	¶	£
Dibenz[a,j]acridine	224-42-0	279.33		ǂ		§		
Dibenzo[a,e]fluoranthene	5385-75-1	302.38		ǂ				£
Dibenzo[a,e]pyrene	192-65-4	302.38		ǂ		§	¶	£
Dibenzo[a,h]pyrene	189-64-0	302.38		ǂ		§	¶	£
Dibenzo[a,i]pyrene	189-55-9	302.38		ǂ		§	¶	£
Dibenzo[a,l]pyrene	191-30-0	302.38		ǂ		§	¶	£
7H-Dibenzo[c,g]carbazole	194-59-2	267.32		ǂ		§		
7,12-Dimethylbenz[a]anthracene	57-97-6	256.34		ǂ	¥	§		
1,6-Dinitropyrene	42397-64-8	292.25				§		
1,8-Dinitropyrene	42397-65-9	292.25				§		
Fluoranthene	206-44-0	202.26	*	ǂ				£
Fluorene	86-73-7	166.22	*					
Indeno[1,2,3-cd]pyrene	193-39-5	276.34	*	ǂ		§	¶	£
3-Methylcholanthrene	56-49-5	268.35		ǂ	¥	§		
5-Methylchrysene	3697-24-3	242.31		ǂ	¥	§	¶	
Naphtho[2,3-e]pyrene	193-09-9	302.38						£
Naphthalene	91-20-3	128.17	*					
5-Nitroacenaphthene	602-87-9	199.21			¥	§		
6-Nitrochrysene	7496-02-8	273.29			¥	§		
2-Nitrofluorene	607-57-8	211.22				§		
1-Nitropyrene	5522-43-0	247.25		ǂ		§		
4-Nitropyrene	57835-92-4	247.25				§		
Phenanthrene	85-01-8	178.23	*					£
Pyrene	129-00-0	202.26	*					£

Notes:

* EPA-16. US EPA - PAHs on the Clean Water Act List of Priority Pollutants, http://water.epa.gov/scitech/methods/cwa/pollutants.cfm

ǂ EPA-RTK,TRI. US EPA (2001) - Right-To-Know Act: Polycyclic Aromatic Compounds Category, http://www.epa.gov/tri/reporting_materials/guidance_docs/pdf/2001/2001pacs.pdf

¥ OEHHA CSF. California Office of Health Hazard Assessment PAH Cancer Slope Factors, http://oehha.ca.gov/tcdb/index.asp

§ OEHHA 2009. California Office of Health Hazard Assessment, http://www.oehha.ca.gov/air/hot_spots/2009/TSDCancerPotency.pdf

¶ EC "15+1". European Commission - Commission Regulation (EC) No 1881/2006, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2006R1881:20100701:EN:PDF

£ EPA Draft RPF - PAHs with Relative Potency Factors from US EPA Draft Document (potency =0 included) - (US EPA, 2010)

A4. Quality Assurance (QA) Narrative

This document presents a summary of overall philosophy, objectives and guiding principles that will provide the structure for a detailed quality assurance project plan (QAPP) for approval by EPA. The QA plan will following EPA's QA/G-4 [67] and QA/G-9 [68].

1. Roles and responsibilities

The EPA Region 4 Office, Shelby County Health Department (SCHD), and University of Memphis (UM) all have important roles in developing and implementing satisfactorily this community-scale PAH monitoring program. As part of the planning effort, the EPA Region 4 Office is responsible for guiding the program goals and providing technical and quality assurance information. SCHD and UM are responsible for taking this information and developing and implementing a quality system that will meet the data quality requirements. Then, it is the responsibility of all the organizations to assess the quality of the data and take corrective action when appropriate. The responsibilities of each organization follow.

2. Data quality objectives and criteria for measurement

The data quality objective (DQO) process described in guidance documents provide a general framework for ensuring that the data collected meets the needs of the intended decision makers and data users. The process establishes the link between the specific end use(s) of the data with the data collection process and the data quality and quantity needed to meet a project's goals. The primary goal of this project is to determine and characterize ambient concentrations of 44 PAHs in near 70 representative census tracts in Memphis Tri-state Area (MTA).

The Memphis PAH Study has the following data quality objectives (DQOs):

- **Data Comparability:** Ambient PAHs will be collected and analyzed by GC/MS following SOPs comparable to TO-13A. The methods and procedures used in this project should be consistent with existing national, state, and local monitoring programs.
- **Data Completeness:** The data completeness should be equal to or greater than 85%. If the completeness is less than 85%, additional field samples and/or laboratory analyses will be used to reach this objective.
- **Data Accuracy and Precision:** Data are collected with precision and accuracy as stated in Table A4.
- **Method Sensitivity:** Methods used to characterize air toxics should have the sensitivity to monitor at concentrations likely to be of health and/or regulatory concern if at all possible.
- **Representativeness:** The monitoring site locations should be reflective of exposure to estimate long-term risk among all the populations in the industrial, urban, suburban and rural areas in MTA.
- **Sampling Size and Frequency:** The sample size and frequency should be sufficient to characterize long-term population exposure. Where and when applicable, sufficient samples will be collected when the predominant wind direction is from nearby stationary and/or mobile source(s).

If the above criteria are met, the data will be considered of sufficient quantity and quality for the decision-making to commence.

Once these DQOs are established, the quality of the data must be evaluated and controlled to ensure that it is maintained within the established acceptance criteria. Measurement quality objectives (MQOs) are designed to evaluate and control various phases (i.e., sampling, preparation, and analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the DQOs. In theory, if these MQOs are met, measurement uncertainty should be controlled to the levels required by the DQO. Table A4 lists the MQOs for this project. More detailed descriptions of these MQOs and how they will be used to control and assess measurement uncertainty will be described in the full QAPP.

The laboratory at UM must demonstrate its ability to be able to meet the MQOs before the laboratory can analyze samples for this project. EPA Region 4 Office and SCHD will review UM laboratory's capabilities, and approve the sample analysis protocols.

Table A4. Measurement quality objectives for ambient PAH monitoring in MTA.

Requirement	Acceptance Criteria
Reporting unit	ng/m^3
Precision from analysis of replicate samples	≤15%
Precision from collection of duplicate samples	≤20%
Recovery	80%-120%
Accuracy	≤ 20% on internal and external performance tests for ≥80% of the target compounds
Representativeness	≥100 Census tracts
Comparability/Method selection	GC-MS/TO-13A
Completeness	≥85%

3. Sample handling and custody

PAH samples will be gathered by trained personnel (in accordance with EPA guidelines). All the samples will be collected into filters and PUFs (supplied by UM), georeferenced, labeled, and logged according to standard chain of custody protocols. Samples will be shipped immediately to Dr. Chunrong Jia's Environmental Monitoring Laboratory at UM for immediate analysis. Samples will not be removed from storage except as labeled samples for immediate study.

4. Laboratory analysis

Sample analyses and acquisition procedures will be carried out as described in the proposal.

4.1 Calibration and performance evaluation of analytical methods

Whenever possible standards, blanks, or controls will be used to calibrate, verify, and confirm results. If standards are not available, surrogates with similar properties to those being analyzed will be utilized. Calibration procedures for a specific laboratory instrument will consist of an initial calibration or initial calibration verification when an initial instrument calibration is not performed on the day of analysis. All standards will be traceable to certified standards and manufacturer lot number. Specific procedures for each analysis and sample preparation will include the calibration procedures, their frequency, acceptance criteria, and the conditions that will require recalibration.

4.2 Laboratory quality control

Quality control samples will be used to determine the validity of data generated in the laboratories. Quality control samples may include, but are not limited to, method blanks, initial and continuing calibration verification standards, laboratory control samples, matrix spike and matrix spike duplicates, or laboratory duplicates. Internally generated samples of reagent grade water or analytical reagents which are treated in the same manner as the corresponding field samples will be used as blank controls. Method blanks will be performed at a frequency of 1 per batch of 20 or fewer samples per matrix type per sample extraction or preparation test method. The results of these samples will be used to determine analytical batch acceptance.

4.3 Laboratory controls review

A quality control program that involves maintenance of instruments in proper working order, adequacy of standards, reagents, media, controlled substances, elimination of adverse environmental factors that could affect analytical results will be implemented. The objective of this procedure is to periodically review the control program to ensure that it is operating satisfactorily.

4.4 Data reduction and reporting

Whenever possible, results will be summarized in tables along with standard deviations and blank values, in graphic form with error bars and standard deviation regions, or in the most appropriate or accepted manner.

These data will be reported to the Systems and Analytics Core Leader. The Systems and Analytics Core Leader will be responsible for the interpretation and dissemination of the data to the investigators in Project 2.

5. Project assessment techniques

An assessment is an evaluation process used to measure the performance or effectiveness of a system and its elements. For this program, assessment is used to denote any of the following activities:

- Siting and review.
- Performance evaluation (PE) or proficiency test (PT).
- Field and laboratory systems audits.
- QA review of data and procedures.
- Peer review, inspection, or surveillance

6. Training requirements

All field personnel and laboratory personnel will have completed all required training. The following are required before working on data generating projects:

- Reading this document and the QA Manual.
- Reading all SOPs specific to their assigned duties.
- Receiving on-the-job training from experienced personnel.

7. Documentation and records

Any record that describes, defines, specifies, reports, certifies, or provides data or results pertaining to the study must be retained in accordance with SCHD records retention schedules. The Project Manager is responsible for securing all project records until project completion. Examples include:

- Network description and site characterization files
- Standard Operating Procedures (SOPs)
- Field and laboratory notebooks
- Sample handling/custody records
- Inspection/maintenance records
- Original data (sample and QA data)
- Electronic data files including email
- System and performance audit reports
- Periodic and Final reports

A5. Biographical Sketch of Dr. Chunrong Jia

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors in the order listed on Form Page 2.
Follow this format for each person.

NAME Jia, Chunrong	POSITION TITLE Assistant Professor of Environmental Health
eRA COMMONS USER NAME (credential, e.g., agency login) CHUNRONGJIA	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	MM/YY	FIELD OF STUDY
Nankai University, Tianjin, China	B.S.	07/98	Environmental Science
Nankai University, Tianjin, China	M.E.	07/01	Environmental Engineering
University of Michigan, Ann Arbor, MI, USA	Ph.D.	05/07	Environmental Health Science

A. Personal Statement

My research interests are in human exposure to air pollutants and the associated health effects. I am especially interested in cumulative health effects from exposure to multiple environmental, social, behavioral, and physical stressors. My research areas include indoor and ambient air pollution, environmental exposure and risk assessment, environmental disparities, environmental epidemiology, environmental modeling, and sampling and analytical methodologies for air pollutants.

My environmental disparity research is focused on examining disproportionate air pollution exposure burden in disadvantaged communities. I have applied innovative spatial quantile regression models to give a complete picture of disparity over the whole range of cancer risks from air toxics. I conducted a local monitoring program to confirm a "hot spot" of air toxics pollution in Southwest Memphis, a low SES and black concentrated area. My recent publication depicts the relationship of racial composition and cancer risks from air toxics exposure in Memphis. I am currently conducting a comprehensive air toxics study, funded by EPA, that examines and compares health risk and air quality across different communities throughout the Greater Memphis Area. I am also a fellow of the Harvard University JPB Environmental Health Fellowship Program that aims to engage young scientists in research on social and physical determinants of environmental health relevant to disadvantaged communities.

I have extensive training and experience with field sampling and laboratory analysis of toxic organic compounds, including volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), carbonyls, polybrominated diphenyl ethers (PBDEs), and polybrominated biphenyls (PBBs). I am currently maintaining an Environmental Monitoring Lab (500 sq. ft.) at the University of Memphis. My environmental survey work consists of a series of air pollution studies. The pollutants I examined included VOCs, semi-VOCs, and emerging environmental contaminants, e.g., PBDEs as flame retardants and siloxanes emitted from semi-conductor manufacturing facilities. All these indicate that I have necessary expertise and experience to successfully conduct field sample collection and laboratory chemical analysis for this project.

Besides laboratory and field work, I have applied many innovative statistical and modeling methods to interpret and extend available environmental exposure measurements. I have used copulas to estimate joint probability distributions of co-exposures, variance component analysis to apportion spatial, temporal, and measurement variability/ uncertainty, factor analysis and positive matrix factorization (PMF) to identify and apportion common sources, and spatial regressions to address socioeconomic and racial disparities in exposures. Other statistical applications include development of models for the relationship between blood and air VOC concentrations, multivariate analysis of indoor and outdoor VOC determinants, and multi-zone models to quantify the sources and migrations of semi-VOCs in homes and workplaces. All these data analysis techniques will extend our understanding of exposures, which is relevant to exposure, risk and epidemiological investigations, to the identification of effective intervention strategies, and to the development of policies and regulations aimed at protecting public health.

B. Positions and Honors

Positions and Employment

2001-2002	Research Associate, College of Environmental Sciences & Engineering; Engineer, Institute of Environmental Planning and Assessment, Nankai University, Tianjin, China
2007-2009	Post-doctoral Research Fellow, Department of Environmental Health Sciences, University of Michigan, Ann Arbor, MI
2009-	Assistant Professor, School of Public Health, University of Memphis, Memphis, TN

Other Experience and Professional Memberships

2012-	Society for Research on Nicotine and Tobacco
2009-	International Society of Indoor Air Quality
2009-	International Society of Exposure Science
2009-	Air & Waste Management Association

Professional Services

On the Editorial Board of *Journal of Environmental and Public Health*
Ad-hot Reviewer for: *Air Quality, Atmosphere and Health, Atmospheric Environment, Biological Trace Element Research, Biomass & Bioenergy, Building and Environment, Bulletin of Environmental Contamination and Toxicology, Cancer Epidemiology, Biomarkers & Prevention, Chemosphere, Environmental Engineering and Management Journal, Environment International, Environmental Pollution, Environmental Science & Technology, Indoor Air, Journal of Air & Waste Management Association, Journal of Exposure Science and Environmental Epidemiology, Journal of Maps, Science of the Total Environment.*

Honors

2014	JPB Environmental Health Fellow, Harvard University.
2012	Increasing Diversity in Nicotine and Tobacco Research Travel Scholarship, Society for Research on Nicotine and Tobacco.
2009	Nominee, Young Professional (YP) Best Paper Award, The Air & Waste Management Association's 2009 Annual Conference & Exhibition, Detroit, Michigan, June 16-19, 2009.
2004	Best Paper of *China Environmental Science* in 2003

C. Selected Peer-reviewed Publications (Selected from 49 peer-reviewed publications, citations >900)

Most relevant to the current application (*: corresponding author)

1. Zhu XL, **Jia CR***. 2012. Apportioning variability of polycyclic aromatic hydrocarbons (PAHs) and chlordanes in indoor and outdoor environments. *Journal of Environmental Monitoring*. 14: 1926-1934.
2. **Jia CR***, Batterman S, Relyea GE. 2012. Variability of indoor and outdoor VOC measurements: An analysis using variance components. *Environmental Pollution*. 169: 152-159.
3. James W, **Jia CR***, Kedia S. 2012. Uneven magnitude of disparities in cancer risks from air toxics. International Journal of Environmental Research and Public Health. 9(12): 4365-4385.
4. **Jia CR***, Foran JA. 2013. Air toxics concentrations, source identification, and health risks: An air pollution hot spot in Southwest Memphis, TN. *Atmospheric Environment*. 81: 112-116.
5. **Jia CR***, James W, Kedia S. 2014. Relationship of racial composition and cancer risks from air toxics exposure in Memphis, Tennessee, U.S.A. *International Journal of Environmental Research and Public Health*. 11(8): 7713-7724.

Additional publications of importance to the field

1. **Jia CR**, Batterman S, Chernyak S. 2006. Development and comparison of methods using MS scan and selective ion monitoring modes for a wide range of airborne VOCs. *Journal of Environmental Monitoring*, 8 (10): 1029-1042.
2. **Jia CR**, Batterman S, Godwin C. 2007. Continuous, intermittent and passive sampling of airborne VOCs. *Journal of Environmental Monitoring,* 9: 1220-1230.

3. Charles SM, **Jia CR**, Batterman S, Godwin C. 2008. VOC and particulate emissions from commercial cigarettes: Analysis of 2,5-DMF as an ETS tracer. *Environmental Science & Technology*, 42: 1324-1331.
4. **Jia CR**, Batterman S, Godwin C. 2008. VOCs in industrial, urban and suburban neighborhoods: Part 1: indoor and outdoor concentrations, variation, and risk drivers. *Atmospheric Environment*. 42(9): 2083-2100.
5. **Jia CR**, Batterman S, Godwin C. 2008. VOCs in industrial, urban and suburban neighborhoods: Part 2: factors affecting indoor and outdoor concentrations. *Atmospheric Environment*. 42(9): 2101-2116.
6. **Jia CR**, D'Souza J, Batterman S. 2008. Distributions of personal VOC exposures: A population-based analysis. *Environment International*.34: 922-931.
7. Batterman S, Chernyak S, **Jia CR**, Godwin C, Charles S. 2009. Concentrations and emissions of polybrominated diphenyl ethers from U.S. houses and garages. *Environmental Science & Technology*, 43 (8): 2693–2700.
8. **Jia CR**, Batterman S, Godwin C, Charles S, Chin J-Y. 2010. Sources and migration of VOCs in mixed-use buildings. *Indoor Air*. 20(5): 357-369.
9. **Jia CR***, Yu XH, Maziak W. 2012. Blood/air distribution of volatile organic compounds (VOCs) in a nationally representative sample. *Science of the Total Environment*. 419: 225-232.
10. **Jia CR***, Ward KD, Mzayek F, Relyea F. 2014. Blood 2,5-dimethyfuran as a sensitive and specific biomarker for cigarette smoking. *Biomarkers*. 19(6): 457–462.

D. Research Support

<u>Ongoing Research Support</u>

JPB Foundation-Harvard University Jia (PI) 10/01/14-06/30/18
Fellow of JPB Environmental Health Fellowship Program
The goal of this program is to support multidisciplinary environmental health research targeting disadvantaged communities in the U.S.
Role: PI

Memphis Research Consortium Jia (PI) 01/01/15-04/30/16
Interaction of Weight Status and Environmental Exposure on Effectiveness of In-Home Asthma Intervention
The overall objective of this proposed project is to explore the roles of weight status, indoor environmental exposure, and in-home asthma intervention in determining asthma status and their interactions.
Role: PI

EPA XA-95490112 Shelby County Health Department (PI) 04/01/12-03/31/16
Reducing Exposure to Airborne Chemical Toxics (REACT) via Community-Scale Air Monitoring in Memphis
The overall objective of this project is to characterize the distribution and concentrations of ambient air toxics in Memphis, identify major sources, and estimate non-carcinogenic and carcinogenic risks.
Role: Subcontract PI

<u>Completed Research Support</u>

Health Effects Institute/EPA Batterman (PI) 09/01/10-12/31/12
Modeling and Analysis of Personal Exposure to Pollutant Mixtures: Further Analysis of the RIOPA Data
This project aims to identify and characterize exposure distributions, exposures to pollutant mixtures, inter-pollutant dependencies, and exposure determinants.
Role: Proposal developer and subcontract PI

FedEx Institute of Technology Jia (PI) 09/01/11-10/31/11
Equipment Acquisition for Memphis Research and Innovation Expo
The goal of this project is to obtain a high-resolution real-time photoionization detector for environmental health teaching and research.
Role: PI.

University of Memphis Faculty Research Grant Jia (PI) 05/01/10-04/30/11
Indoor Environmental Quality in University Buildings and Indoor Air Symptoms
The primary objective of the proposed research is to determine indoor environmental quality in various types of university buildings, and to study indoor air symptoms among university students, faculty, and staff.
Role: PI.

Gemvax &Kael, Inc. Jia (PI) 04/01/12-09/30/12
Monitoring Airborne Siloxanes in Semiconductor Fabrication Plants
The goal of this project is to establish an adsorbent sampling, thermal desorption and gas chromatography/ mass spectrometry method for monitoring trace-level trimethylsilanol in indoor air in semiconductor fabs.
Role: PI.

Benjamin L. Hooks Institute for Social Change Jia (PI) 05/01/11-04/30/12
Socioeconomic and Racial Disparities in Cancer Risk from Air Toxic Exposure in Memphis.
The objective of the proposed study is to characterize the socioeconomic and racial disparities in air toxic exposure and the associated excess lifetime cancer risk in Memphis.
Role: PI.

Center for Health Equity Research and Promotion Jia (PI) 04/01/11-09/30/12
Environmental Inequity and Skewed Riskscapes: Differential Distributions of Ambient Air Toxics in Memphis.
This study is designed to characterize the differential distribution of air toxics by collecting field air toxics samples in 50 sites in Memphis.
Role: PI.

E. Collaborators

Pratik Banerjee	Assistant Professor	Environmental Health, School of Public Health, University of Memphis
Stuart Batterman	Professor	Environmental Health, University of Michigan
Jo-Yu Chin	Research Scientist	New York State Health Department
Ngee-Sing Chong	Professor	Department of Chemistry, Middle Tennessee State University
Gary Emmert	Professor	Department of Chemistry, University of Memphis
Jim Holt	Assistant Manager	Shelby County Health Department
Wesley James	Assistant Professor	Sociology, University of Memphis
Paul Juarez	Professor	Environmental Policy, University of Tennessee Health Science Center
Satish Kedia	Professor	Social & Behavioral Science, School of Public Health, University of Memphis
Jae-Hwan Lee	Director	GemVax&KAEL Inc.
Bian Liu	Assistant Professor	Department of Population Health, Hofstra North Shore-LIJ School of Medicine
Wasim Maziak	Professor	Epidemiology, Florida International University
Fawaz Mzayek	Associate Professor	Epidemiology, School of Public Health, University of Memphis
George Relyea	Research Assistant Professor	Biostatistics, School of Public Health, University of Memphis
David Sweat	Director	Shelby County Health Department
Kenneth Ward	Professor	Social & Behavioral Science, School of Public Health, University of Memphis
Xinhua Yu	Assistant Professor	Epidemiology, School of Public Health, University of Memphis
Tyler Zerwekh	Vice Director	Shelby County Health Department
Xianlei Zhu	Associate Professor	College of Geosciences, China University of Petroleum-Beijing

A6. Budget Table

Items	Year 1	Year 2	Year 3	Total
Personnel	$ 12,000	$ 12,000	$ 12,000	$ 36,000
Travel	$ 1,500	$ 3,000	$ 3,000	$ 7,500
Supplies	$ 2,500	$ 1,500	$ 1,500	$ 5,500
Subcontract to University of Memphis (UM)	$ 260,101	$ 176,608	$ 108,697	$ 545,407
TOTAL PROJECT COST	**$ 276,101**	**$ 193,108**	**$ 125,197**	**$ 594,407**
Detaial of UM Subcontract Budget				
Personnel				
co-PI: Chunrong Jia -Summer 1 month	$ 7,546	$ 7,659	$ 7,774	$ 22,979
Lab technician	$ 20,000	$ 40,600	$ 20,300	$ 80,900
Field coordinator (10% efforts)	$ 5,583	$ 5,666	$ 5,751	$ 17,000
Graduate student ($1,375/month x 12 months)[1]	$ 16,500	$ 16,500	$ 16,500	$ 49,500
TOTAL PERSONNEL	$ 49,629	$ 70,425	$ 50,325	$ 170,379
Fringe				
Fringe Benefits-Salaried employees- 35.6%	$ 11,794	$ 19,197	$ 12,042	$ 43,033
TOTAL FRINGE	$ 11,794	$ 19,197	$ 12,042	$ 43,033
Travel				
Travel for collecting field samples	$ 8,000	$ 8,000	$ 2,000	$ 18,000
Travel to conferences			$ 2,000	$ 2,000
TOTAL TRAVEL	$ 8,000	$ 8,000	$ 4,000	$ 20,000
Supplies				
Consummables for PAH Analysis ($50/sample)	$ 12,600	$ 12,600		$ 25,200
Passive PAH sampler ($250/ea x 60 set)	$ 15,000			$ 15,000
A laptop for field data downloading	$ 1,500			$ 1,500
Misc supplies/consumables for sample collection	$ 4,000	$ 4,000		$ 8,000
TOTAL SUPPLIES	$ 33,100	$ 16,600		$ 49,700
Eqipment				
Accelerated Extrator	$ 65,000			$ 65,000
High-vol PAH sampler ($6000/set x 6 sets)	$ 36,000			$ 36,000
TOTAL SUPPLIES	$ 101,000			$ 101,000
Tuition	$ 11,980	$ 12,699	$ 13,461	$ 38,140
Total Direct Costs	$ 215,503	$ 126,921	$ 79,828	$ 422,252
Total Indirect Costs (F&A)-43.5% of MTDC[2]	$ 44,598	$ 49,687	$ 28,870	$ 123,155
Total for UM Subcontract	**$ 260,101**	**$ 176,608**	**$ 108,697**	**$ 545,407**

Notes: 1. No fringe benefits. 2. F&A does not apply to equipment or tuition.

A7. Consortium Letter from University of Memphis

THE UNIVERSITY OF MEMPHIS.

Research Support Services

315 Administration Bldg
Memphis, Tennessee 38152-3370

Office: 901.678.2533

www.memphis.edu

Title of Application: Characterizing Community Exposure to Polycyclic Aromatic Hydrocarbons (PAHs) in a Tri-State Area

Sponsor: Environmental Protection Agency (EPA)

Applicant/Prime Institution: Shelby County Health Department

Principal Investigator: Jim Holt, Assistant Manager, Pollution Control Section

Cooperating/Sub-recipient Institution: The University of Memphis

Sub-recipient Principal Investigator: Chunrong Jia, PhD

Human Subjects: _X_No __Yes **IRB Approval Date:** N/A

Vertebrate Animals: _X_No __Yes **IACUC Approval Date:** N/A

General Information:
DUNS#: 0556888570000 EIN: 1620648618A1 Congressional District: TN-009

Costs Requested for Initial Budget Period:		**Costs Requested for Entire Budget Period:**	
From: 04/01/2015	To: 3/31/2016	From: 04/01/2015	To: 03/31/2018
Direct Costs:	$215,503	Direct Costs:	$422,252
Total Costs:	$260,101	Total Costs	$545,407
DHHS Agreement Date:	04/14/2014	Indirect Cost Rate (%)	43.5% MTDC

This letter is to verify that the research referenced above has received full administrative review by the University of Memphis. The appropriate programmatic and administrative personnel are familiar with the federal consortium/contractual policies and will comply as they relate to the proposed research referenced above. The University of Memphis will enter into a written inter-organizational agreement with the institution named above that will ensure compliance with all pertinent terms and conditions.

Institution

V. Derell Jones
Signature

Institutional Official: V. Derell Jones, PhD
Title: Senior Sponsored Programs Administrator, University of Memphis

Date: 12/17/14