09-DG-11062765-052 INV
09-NA-IN539-09

U.S Forest Service: Urban and Community Forestry Program
NUCFAC 2009 Challenge Cost Share Grant

Application Cover Sheet

Proposals are due by 11:59 PM Eastern Standard Time February 17, 2009

INNOVATION GRANT CATEGORY: (Total amount available is $500,000)
(Select only one per application)

- ☐ ENERGY AND URBAN FORESTS
- ☐ CLIMATE CHANGE AND URBAN FORESTS
- ☑ PUBLIC HEALTH AND URBAN FORESTS

☐ **BEST PRACTICES GRANTS**. (Maximum amount per application is $50,000 of a total amount available of $500,000)

PROJECT CONTACT: Jacqueline Lu, Director of Research and Analysis

NAME OF ORGANIZATION: City of New York, Department of Parks and Recreation

MAILING ADDRESS 1: Forestry and Horticulture Division

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Is this project being developed to reach a minority or underserved population? ☒ Yes ☐ No

Is this pre-proposal being submitted by a minority or underserved population (owned/operated/directed) business, organization or college/university? ☐ Yes ☒ No

PROJECT TITLE: The Urban Forest, Childhood Asthma and Community Air Quality

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A 50 percent match is required of non Federal, cash, donated materials and/or volunteer time.

REQUESTED: $ 267283 + MATCHING: $ 375581 = TOTAL PROJECT: $ 642864

PARTNERS:

NAME Andrew Rundle, DrPH LETTER OF SUPPORT INCLUDED: YES ☒ NO ☐
NAME OF ORGANIZATION: Columbia University, Mailman School of Public Health

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****

NAME Thomas Matte, MD, MPH LETTER OF SUPPORT INCLUDED: YES ☒ NO ☐
NAME OF ORGANIZATION: New York City Department of Health and Mental Hygiene

MAILING ADDRESS 1: Bureau of Environmental Surveillance and Policy

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NAME Dr. Holger Eisl LETTER OF SUPPORT INCLUDED: YES ☒ NO ☐
NAME OF ORGANIZATION: City University of New York, Queens College

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PROPOSAL OUTLINE: (The Innovation proposal is not to be more than 10 and the Best Practices is not to be more than 5 single spaced pages.) Please make sure each page is numbered and has the project title.

Project Title: The Urban Forest, Childhood Asthma and Community Air Quality

ABSTRACT: Summarize the proposed project in 200 words or less.

We propose an innovative research collaboration to examine and describe the linkages between urban forest structure, community-scale air quality, and respiratory health. The partners will include Columbia University, the New York City Department of Health and Mental Hygiene, the New York City Department of Parks and Recreation, City University of New York's Queens College Center for the Biology of Natural Systems and the University of Vermont Spatial Analysis Lab. We will bring together health data from high-risk children in New York City with detailed urban forest inventories and air quality monitoring in the neighborhoods where they live. Specific attention will be paid to the public health effects that the urban forest may have on childhood asthma which is most likely mediated through changes in community air quality. This study could provide direction for municipal governments and community groups towards mitigating the health effect of air pollution through improved planning and maintenance of urban forests. The national target audiences for this research include cities and municipalities with high air pollution levels.

1. **Scope and Applicability/Justification- Proposal objectives:**
2. **Literature Review: (discussion)**
3. **Organization/Methodology:**
4. **Product:**
5. **Collaboration:**
6. **National Distribution/Technology Transfer of Your Findings:**
7. **Project Evaluation:**
8. **Experience/Personnel/Adequacy of Resources:**
9. **Project Evaluation:**

Attachments:

SF 424 and SF 424 (a). (Make sure DUNS number is on SF424 form)
Copy of indirect cost rate or negotiated rate with cognizant Federal agency
List of Literature reviewed and cited
Letters of Support from Partners

When uploading this form to grants.gov, please upload your narrative as a PDF or Word document. Remember that Best Practices proposals should be no more than 5 pages long, and Innovation proposals should be no more than 10 pages long.

Please write your narrative here. Please remember Best Practices proposals should be no more than five pages long (approximately 68,000 characters), while Innovation proposals should be no more than ten pages long (approximately 136,000 characters).

See attached - Urban Forests and Public Health Innovation Grant Proposal Narrative

Also attached to the Grants.gov application are additional letters of support from partners who were not listed above but are in the proposal (i.e. the University of Vermont) and the references for the proposal as well as a more detailed budget breakdown.

THE URBAN FOREST, CHILDHOOD ASTHMA AND COMMUNITY AIR QUALITY

1. Scope and Applicability/ Justification

We propose an innovative research collaboration to examine and describe the linkages between urban forest structure, community-scale air quality, and respiratory health. The partners will include Columbia University (CU), the New York City Department of Health and Mental Hygiene (DOHMH), the New York City Department of Parks and Recreation (DPR), City University of New York's Queens College Center for the Biology of Natural Systems (CBNS) and the University of Vermont's Spatial Analysis Lab (SAL). We will bring together health data from high-risk children in New York City with detailed urban forest inventories and air quality monitoring in the neighborhoods where they live. Specific attention will be paid to the public health effects that the urban forest may have on childhood asthma which is most likely mediated through changes in community air quality. The national target audiences for this research include cities and municipalities with high air pollution levels.

This proposal will allow us to explicitly examine the role of urban forest structure and function on intra-urban variability in exposures to gaseous air pollutants, and the combined effects of urban forest structure and air pollution on childhood asthma. A prior, cross-sectional ecological study across NYC neighborhoods indicated that a higher neighborhood density of street trees was protective against asthma [1]. Although the analyses controlled for neighborhood socio-demographic characteristics, population density, and proximity to key pollution sources, the findings are not definitive. The proposed project adds stronger methods for individual-level exposure assessment into an on-going study to examine asthma onset with comprehensive measurements of the urban forest and tree canopy. As such, this study could provide direction for municipal governments, health departments, and community groups towards mitigating the health effect of air pollution through targeted tree planting and improved planning and maintenance of urban forests.

The proposed project will leverage unique ongoing research and policy efforts: 1) A longitudinal birth cohort study of high-risk children in New York City (NYC). The cohort was recruited from 1998 to 2004, and has been followed prospectively to examine multiple respiratory symptoms (wheeze, bronchitis, asthma diagnosis and symptom exacerbation) as a function of multiple urban risk parameters, including in-home environmental exposures and socioeconomic factors, and residential history has been recorded. 2) NYC has recently initiated the NYC Community Air Survey (NYCCAS), an intensive year-round air monitoring effort to evaluate intra-urban spatial variability in multiple air pollutants, across all neighborhoods in the five boroughs. The dataset is the most exhaustive of its kind in the U.S., and will provide predictive land use regression (LUR) models and data to support air quality planning in metropolitan areas. 3) U.S. cities are beginning to set aggressive urban tree canopy and tree planting goals, including the ambitious MillionTreesNYC campaign, to provide a multitude of environmental benefits. Such efforts demonstrate a need to understand the connections among urban forest structure, community-scale air quality, and respiratory health. This collaborative project brings together experts in epidemiology, air pollution science, and urban forestry, and leverages the unique combination of related on-going work in NYC, to examine connections among these important facets of urban public health. Ultimately, these findings will be used to inform New York City policy makers and identify planting priorities for MillionTreesNYC.

2. Literature Review

In recent decades, the prevalence of childhood asthma has increased worldwide [2, 3], particularly in developed nations [4-6]. In the U.S., a disproportionate burden of severe childhood asthma affects inner-city communities [7, 8], and this distinct temporal and social distribution in asthma cannot be explained by genetics alone. Recent evidence points to changes in indoor and outdoor environmental exposures (e.g., traffic-related air pollution), lifestyles (e.g., sedentary behavior, diet, obesity) [2, 9-11], and aspects of the social environment [12-17]. In recent years, significant attention has been attributed to intra-urban variability in air pollution and its possible causal role in asthma prevalence and severity. Less attention has been attributed to the role of the urban forest in mitigating air pollution exposures and influencing behavioral patterns. The role of the urban forest in shaping asthma outcomes w arrants investigation, especially as cities including New York and Los Angeles are currently investing significant funding towards large-scale street tree planting efforts.

Urban air pollution has been associated with a range of cardiovascular and respiratory health outcomes [18-26]. Consistent evidence links air pollution to asthma symptoms exacerbation [27-31], though its role in asthma onset remains unclear; some studies support a positive association between air pollution and asthma onset [32-39], others report significant associations only among a subset [14, 40-44], and still others report no association [26, 30, 45-47]. Susceptibility to the health effects of air pollution may also vary by socioeconomic factors [14, 15, 48, 49] and pre-existing health conditions [50-52], which differ in prevalence across urban communities.

The study of intra-urban variability in air pollution has been enabled by the development of geographic information systems (GIS) and related spatial analytic methods [53-55]. Pollution point sources, traffic patterns, land use, and meteorology influence air pollution variation across urban areas [56], and accounting for these factors and complex urban terrain [57], allows the analysis of finer-scale patterns of asthma etiology and exacerbation. More sophisticated spatio-temporal models account for dynamic change in multiple air pollutants over time [51, 58-60], and newer studies combine spatial analysis with source-apportionment techniques to disentangle urban air pollution from various sources [61, 62].

The interplay between street trees and air quality is likely complex; trees may reduce ground-level concentrations of particulate matter [63, 64], but may contribute to downwind ozone formation through emission of VOCs. Conversely, analyses have demonstrated that the potential for urban trees to generate a net increase in VOCs is less of a concern in urban areas with high ambient VOC concentrations and urban trees have a locally positive effect by reducing ozone in urban areas of the Northeast [65]. As ozone formation is driven by a temperature dependent reaction between NOx, CO and VOCs, providing shade trees could also slow the formation of ground level ozone. In addition, by shading buildings, trees can reduce electricity demand for air conditioning especially on hot summer days when the most polluting peak demand generation equipment may come on line. Some trees produce pollen allergens during the spring season, which time-series studies indicate can trigger symptoms among children with atopic (allergic) asthma [66], though tree species differ in ozone-forming potential [67] and pollen production. In urban environments, trees provide attractive natural features and shade, and may encourage outdoor physical activity among children and adults [68, 69].

The geographic association between trees and asthma incidence has been virtually unstudied. A cross-sectional ecological study, performed by our group, reported that a one standard deviation

increase in street tree density (343 trees/km^2) was associated with a 29 percent reduction in asthma prevalence among children aged, assessed through school-based screening, after adjustment for potential confounders (e.g., socio-demographic characteristics, population density, and proximity to pollution sources) [1]. In addition, we observed an inverse association between street tree density and childhood asthma hospitalizations which was non-significant after adjustment. Our study has garnered press attention and critical scientific discussion[70], however, as a cross-sectional study with incomplete urban forest characterization, it is primarily hypothesis generating; alternative explanations for the observed associations include unmeasured indoor exposures [71, 72], and social context[73]. In addition, air pollution exposures[58] could either confound the associations or mediate them if trees can reduce local air pollution exposures.

Despite the relative lack of epidemiological research on the association between trees and asthma, significant effort has been ascribed to the development of methods for characterizing and quantifying tree cover across urban spaces, and the potential impacts of tree cover on urban air quality. At the landscape scale, the Forest Service's Urban Forest Effects (UFORE) model uses standardized field data to quantify urban forest structure and model the ecosystem services it provides. Based on a hybrid of big-leaf and multi-layer canopy deposition models, effects such as the amount of pollution removed hourly by the urban forest and its associated air quality improvement throughout a year using calculated tree canopy resistances for O_3 and NO_2 can be measured[74]. Controlled laboratory studies have quantified the uptake of nitrogen dioxide (NO_2), at concentrations similar to those encountered in urban settings, by various taxa of roadside trees [75]. Other laboratory studies have quantified denitrification processes through the selection of NO_2-philic plants or development of gas-gas converting species [76]. In the UK, dispersion and deposition modeling indicate significant potential reductions in ambient PM_{10} with urban tree planting [77], and cost-effectiveness studies using field assessment and real-time pollution and climate data in dry deposition urban forest effects models have also indicated significant reductions in PM_{10} with improved tree coverage in Santiago, Chile [78].

Given the many pathways potentially linking trees to urban air pollution and asthma, as well as the current scarcity of data on the relationship between trees and asthma, possibly mediated through urban air pollution, refined investigation of the role of the urban forest in shaping respiratory health outcomes is warranted.

3. Organization and Methodology

We propose two intersecting avenues of research: (1) epidemiologic analyses of tree cover and asthma etiology among young children and (2) refined exposure assessment field studies to document and explore the association between urban forest structure and gaseous ambient air pollution across NYC neighborhoods. The exposure work will be incorporated into the epidemiologic analyses, as LUR models predicting the effect of urban forest parameters on pollution concentrations at cohort homes. The Urban Forest Effects (UFORE) model will also be applied to quantify urban forest structure and function, towards quantifying its influence on community-scale air quality.

The epidemiologic analyses will take the form of a birth cohort analysis of asthma development through age five in a cohort of children born in Northern Manhattan and the Bronx. This approach investigates the roles of pertinent exposures and confounders from the pre-natal period through to age 5, the earliest age when a diagnosis of childhood asthma symptoms can be made.

The field studies will investigate the relationship between tree canopy cover and gaseous air pollution levels in the neighborhoods where the children live. These data will also be used to generate an air pollution land use regression model to estimate air pollution levels for all the children in the cohort.

Specific Research Aims:

1) Examine the relationship between pre-natal and early life exposure to the urban forest and asthma etiology by age five in a cohort of 400 children born in Northern Manhattan and the Bronx. At this scale the urban forest will be quantified using an Urban Tree Canopy layer which will be generated by SAL. We hypothesize that children living in neighborhoods with more vegetation and higher tree canopy cover will have a lower risk of developing asthma symptoms.

2) Estimate summertime outdoor street-level air pollution levels across Northern Manhattan and the South Bronx, and examine the relationship between urban forest structure and street level local air pollution. Conduct outdoor air pollution monitoring for NO_2 and O_3 in a selected subset of 60 cohort homes, for exposure extrapolation across the cohort, and to assess the relationship between urban forest structure and pollution levels.

a) Urban forest structure will be quantified using multiple measurement techniques including: (1) "top-down" approaches including Urban Tree Canopy analysis (UTC) and examination of archived orthophotography to estimate tree and other surface cover across jurisdictional boundaries (2) field data collection to quantify critical forest structural attributes (e.g., species composition, leaf area) not obtained from aerial imagery at 60 sample cohort homes. UFORE will be used to estimate the level of pollution removal by the urban forest at each location. Sampled homes will be selected to represent the expected range of traffic and tree densities expected across the cohort, based on available remote sensing and Street Tree Census data. Field work will be performed by teams from the Department of Parks & Recreation, with assistance from the Forest Service.

b) Integrated two-week outdoor NO_2 and O_3 measures will be collected using passive monitors deployed by the same field teams from the Department of Parks & Recreation, with additional training provided by air quality scientists at DOHMH and CBNS.

c) Land use regression (LUR) modeling, which will build upon the on-going city-wide pollution monitoring and modeling work of the NYCCAS study. LUR models will be derived to determine the extent of variability in ambient air pollution across cohort homes, and to examine and predict the influence of urban forest structure and UTC variables on pollution concentrations, controlling for the contribution of traffic density and building topography. This fine-scale LUR model will be compared to the citywide NYCCAS model results. Expected improvements in air quality as a result of urban forest function will be estimated using output of the UFORE model as a predictor in the LUR.

3) The LUR model will be used to estimate residential outdoor pollutant exposures for all cohort children, and statistical analyses will quantify the extent to which variation in air pollution concentrations across urban space may mediate any observed protective effect of tree canopy on asthma etiology and exacerbation.

Our proposal leverages several ongoing research projects in New York City. This collaboration would not be possible without the public health and air quality data from these studies and the expertise of the researchers.

Children's Health Data: The birth cohort data are gathered by the Columbia Center for Children's Environmental Health since before the children were born, and have been described previously [79, 80]. These children's pregnant mothers were recruited by the 20th week of pregnancy from among African American and Dominican women registered at the New York Presbyterian Medical Center and Harlem Hospital. All study procedures were approved by the institutional review board of Columbia University, and informed consent was obtained from all participating women.

A total of 722 children were enrolled, and the retention rate at the 3-year follow up was 90 percent. Those lost to follow-up were not significantly different with respect to maternal age, ethnicity, marital status, education, or income, or gestational age and birth weight of the newborn. To date, 360 children have been followed up through at least 5 years of age and have completed the year 5 respiratory questionnaire, and additional children will be reaching the age of 5 in the next year. Thus, we estimate that 450 children will have a completed 5-year assessment and be and included in our analytic dataset. The data includes several health assessments related to asthma (antibody production and asthma symptoms and measurement of relevant home environment features (tobacco smoke, indicators of disrepair within the home, presence of allergens, etc.) that will be used in the proposed study.

The data that will be used in our project are incidence of wheeze and parental report of diagnosed asthma by age 5. The International Study of Asthma and Allergies in Childhood (ISAAC) [81, 82] has developed a validated questionnaire for asthma symptoms which has now been used in hundreds of publications on asthma prevalence and was used to measure asthma symptoms in the children in our study population. Asthma is also assessed in a study clinic visit between ages 5 and 9, and this clinic-based diagnosis will be available for assessing the validity of parental reports for the older children. Based on preliminary data, we estimate that a quarter (approximately 100) of the children enrolled in the study will have diagnosed asthma at the age of 5 years.

Air Quality Data: With support from PlaNYC, DOHMH has launched the largest survey of neighborhood air quality of its kind in the country. The New York City Community Air Survey (NYCCAS) is designed to systematically monitor and examine variation in street-level air pollution across NYC's diverse neighborhoods. The year-round sampling effort began in December 2008, and focuses on a range of traffic- and health-related air pollutants: fine particles ($PM_{2.5}$), elemental carbon (EC) and other particle constituents, sulfur dioxide (SO_2), nitrous oxides (NOx), and ozone (O_3). Sampling is performed at 150 sites, selected by stratified random sample to reflect the range of traffic and building densities across the five boroughs and supplemented to include at least one site per community district. While most sampling locations are along roadways, 14 sites are in city parks. Tree cover varies considerably across NYCCAS monitoring locations: from 0 to 43 % within 50-meter buffers. Each distributed site will be monitored once every season over two years. NYCCAS is currently collecting and summarizing existing data on NYC's physical environment, including traffic, population, land use, and building features. This data is being used to create spatial covariates using GIS, which will serve as predictors in our city-wide land-use regression (LUR) models.

These ongoing studies provide time-series and citywide data that are central to our proposed project. The following section describes the data that will be gathered for this specific project and how these ongoing research efforts will be utilized as part of the project methodology.

Examining the link between children's asthma and Urban Tree Canopy:

To study the relationship between neighborhood conditions and child health in the cohort, each child's residential address during the prenatal period, six months, 2, 3 and 5 years has been geocoded using geographic information systems (GIS). The socio-demographic and selected built environment characteristics of the child's neighborhood have be characterized in circular buffers with a radius of 250 meters and one kilometer around each address.

An Urban Tree Canopy layer will be developed to quantify urban forest structure in the cohort study area and citywide. Researchers from the SAL will leverage existing GIS data with high-resolution remote sensing data interpreted for trees and other vegetation to quantify existing UTC and other land cover features citywide. The object-oriented classification approach that will be used to quantify land cover is highly accurate (>90%) and is critical for extrapolating urban forest effects on air quality and asthma outcomes from the cohort study area to a citywide scale.

Using the Urban Tree Canopy layer and our extensive geographic database for this cohort, we will estimate canopy cover within each child's surrounding environment, and capture aspects of the social and physical environment that might confound any observed association between trees and childhood asthma.

Generalized estimating equations will be used to assess the associations of Urban Tree Canopy with childhood wheeze, asthma, and other symptoms. Health outcomes models will be adjusted for the child's sex, race/ethnicity, maternal history of asthma, home indoor environment (environmental tobacco smoke, indicators of disrepair, allergens, and endotoxin), proximity to pollution sources, and neighborhood composition measures. For all analyses robust standard errors will be used to correct for spatial autocorrelation within and between community districts. Air pollution (NO_2, O_3) levels estimated from the land use regression model (see below) for each child's residential environ will be analyzed, and incorporated, to estimate how any observed tree canopy-asthma associations may be explained by variation in local air quality.

Detailed Studies of Urban Forest Structure and Exposure to Gaseous Ambient Air Pollution:

To complement the cohort level Urban Tree Canopy analysis described above, we propose to perform an intensive field monitoring effort focused on the environment of a subset of the birth cohort described above. The homes of 60 of the children will be selected using a stratified random sampling process. GIS-based indicators of traffic density and Urban Tree Canopy will be used to assess the expected environmental variability in each across cohort homes, and will select representative sampling home locations across cohort neighborhoods. Due to our interest in the urban forest's effect on traffic-related pollution, we will focus on nitrogen dioxide (NO_2), a primary component of vehicular exhaust, and ozone (O_3), which is rapidly formed from nitrous oxides in the presence of sunlight (photochemical reactivity). Two-week integrated outdoor samples of NO_2 and O_3 will be collected at each of the 60 homes during summer 2010, using NYCCAS sampling protocols.

Since the most precise way to assess urban forest structure is to measure and record information on every tree, beginning summer 2010 UFORE plots will be established by Parks and the Forest Service at each monitor location to collect data on important forest attributes such as species composition, cover types and tree size and condition. UFORE data collection protocols have been used internationally to quantify ecosystem services from the urban forest and their use will

allow us to model expected pollution removal benefits and VOC emissions from trees [74] in the area around each child's home. UFORE pollution removal data will provide further insight on how trees and vegetation affect neighborhood air quality. By conducting a ground-based survey in addition to the Urban Tree Canopy assessment, we will be able to examine how forest attributes such as species composition affect local ambient air pollution levels and therefore have an impact on health outcomes.

A hemispherical digital photo will also be taken at each location to characterize the proportion of sky view that is comprised of trees or buildings. Temporal changes in canopy cover at each child's home will be estimated using photo interpretation techniques on orthophotographs taken in 1995, 2001/2002, 2004 and 2006, a method which yields estimates similar to those obtained via field survey [83]. These complementary datasets coupled with records of the children's lifetime residential history will be used to make estimates of each child's lifetime exposure to greenery and tree canopy for epidemiological analyses.

Comprehensive Data Analysis:

Using the pollution sampling results from the 60 children's homes with detailed urban forest assessments, LUR models will be derived to predict pollutant concentrations as a function of tree canopy and urban forest attributes, traffic density, meteorology, and local source indicators to maximize LUR predictive model fit (R^2). Pollutant concentrations and derived LUR models will be compared to NYCCAS city-wide results, to assess comparability in concentrations and predictors, and to assess the degree to which city-wide models of pollution variability can accurately capture finer-scale variability within specific urban neighborhoods.

The results of the LUR produced for the 60 cohort homes will then be extrapolated to the remainder of the cohort, using Urban Tree Canopy, traffic density, meteorology, and local sources as model covariates. These cohort-wide exposure estimates will be applied in the epidemiological analyses described under Specific Aim 3, to examine: (1) whether the separate and combined effects of tree cover and local-scale air pollution exposures can predict childhood asthma onset and exacerbation, using generalized estimating equations modeling and (2) to quantify the degree to which any tree cover-asthma association is explained by air pollution concentrations, by comparing the coefficient in models for the relationship between tree cover and asthma, with and without correction for air pollution concentrations. All models will be adjusted for individual-level confounders (e.g., age, sex, and socio-demographic characteristics).

4. Product

The deliverable products of this collaborative research project will take various forms:

1. Research Reports: Scientific articles of our findings documenting the results of the research will be submitted for publication in peer-reviewed scientific and policy journals.
2. Fact Sheets: The NYC agencies will also produce a fact sheet for the public which will discuss the connections between the urban forest, childhood asthma and community air quality. The study findings will be summarized using clear graphics and accessible language and targeted towards the public and the non-academic audience. These products will be made available for download on City websites and on the MillionTreesNYC website http://www.milliontreesnyc.org.
3. Presentations: This research will be submitted for inclusion in local, regional and national urban forestry conferences targeting practitioners and policy makers, as well as by webcast

on internet forums such as the Urban Natural Resources Institute. Presentations will also be made by study investigators at academic and research meetings.

4. Policy Integration: Staff from the City of New York from DPR and DOHMH will publicize the results to government agencies and stakeholders, and use the results to guide policy. In particular, DPR will use the findings from this research to inform their citywide tree planting priorities and the execution of the MillionTreesNYC campaign.

5. Collaboration

This innovative research project would not be possible without the capacity and expertise of each the partners. Each partner has a unique contribution to this project and several of the partners in this collaboration have already worked together in various permutations for several years.

Columbia University will provide the health data on the children in the study by the Columbia's Center for Children's Environmental Health. Drs. Andrew Rundle will perform the epidemiologic analyses of the health data in relationship to environmental variables.

DOHMH and its team of environmental health experts led by Dr. Thomas Matte, will provide scientific expertise in the study of the intra-urban variations in air quality and its implications for public health, and apply methods and expertise developed for NYCCAS to the analysis of air pollution data and development and evaluation of land use regression models for this project and to support epidemiological analyses. DOHMH and CBNS will collaborate to design and execute the air pollution sampling around the children's homes.

Parks will provide existing citywide urban forest inventory data to the project team to inform the cohort study design. With the assistance of Forest Service scientists, Parks will also deploy field teams to gather urban forest inventory data and air quality samples around the children's homes. To complement the field data collection, SAL will procure and analyze high-resolution imagery to develop an Urban Tree Canopy layer for inclusion in the analysis so that study results can be extrapolated for the rest of the children in the study and neighborhoods citywide.

6. National Distribution/Technology Transfer of Findings

The project team will use a diverse array of distribution techniques to distribute the outcomes of this study to the public and policy makers.

Research reports and fact sheets will be submitted to local, regional and national outlets and networks to reach a variety of audiences. Research papers and presentations will be submitted for inclusion in peer-reviewed journals and academic conferences. Parks' long-term research partnership with the U.S. Forest Service as embodied by the establishment of the New York City Urban Field Station will ensure that this work will be widely distributed through their network of scientists and forest managers across the country.

Fact sheets and presentations will be suitable for use by a wide audience through mechanisms such as trade magazines and local newsletters. Findings will also be distributed to regional urban ecology networks such as the Urban Ecology Collaborative. Project partners will work with the Urban Natural Resources Institute (http://www.unri.org) to produce an Informational Webcast to discuss the study and its outcomes with a national audience over the internet. We will also make study outcomes and downloadable reports available on the MillionTreesNYC website (http://www.milliontreesNYC.org) which is on track to receive more than 50,000 visits this year.

The MillionTreesNYC program is part of the implementation of PlaNYC, the sustainability plan for New York City announced by Mayor Bloomberg in 2007 which has been widely applauded for its comprehensiveness and long term vision. PlaNYC is overseen by the Mayor's Office of Long Term Sustainability and Planning in consultation with the Sustainability Advisory Board, a group of experts, policy makers and stakeholders from local, regional and national organizations. PlaNYC is currently being studied by ICLEI (Local Governments for Sustainability) to be developed as a model of sustainability planning for U.S. cities. Efforts such as these will ensure that this study's results and potential impact on urban policy is widely disseminated.

7. Project Evaluation

This collaborative research will be evaluated using both quantitative and qualitative methods over the 18 month term of the project. Although many tasks will happen simultaneously, a timeline will be set to insure that the various levels of data collection and analysis and the creation of deliverable products will meet deadlines. Regular project team meetings will be held each month to review the status of the various project elements, to insure that timelines are being met and to discuss data analysis and preliminary findings. Assuming a start date of December 1, 2009 the project will proceed as follows:

December, 2009 through February 2010: Procure high-resolution remote sensing imagery for New York City, and perform object-oriented classification techniques to generate an Urban Tree Canopy layer.

March through May 2010: Analyze Urban Tree Canopy and other data to assess the relationship between children's environment and asthma symptoms for the entire cohort. Select a subset of 60 homes for field data collection. Prepare field data collection protocols and begin temporal analysis of canopy cover change using archived orthophotographs.

June through August 2010: Collect UFORE inventory data at each of the 60 homes. Deploy air quality monitors at each location and collect air quality samples.

September through November 2010: Complete analysis of air quality samples, compile UFORE field data and run UFORE for pollution removal and VOC emission estimates. Integrate field data and UFORE results into the main cohort database.

December 2010 through February 2011: LUR modeling for 60 homes and epidemiological analysis of asthma and environmental variables. Extrapolate results to the remainder of the cohort to assess predictive ability of the model and citywide applicability of the results.

March through May 2011: Drafting of research reports and other products for technology transfer and national dissemination. Conduct meetings with policymakers and stakeholders to present findings. Examine tree planting priorities in light of findings and make changes to location and timing of tree plantings to mitigate poor air quality.

8. Experience/Personnel/Adequacy of Resources

This collaboration brings together a team with complementary expertise and experience well-suited to the proposed project.

Dr. Andrew Rundle from Columbia University is a tenured Associate Professor of Epidemiology at the Mailman School of Public Health. His research program focuses on how neighborhood built and social environments impact health, particularly obesity and asthma and is a nationally recognized researcher in this field. He was the project leader for a recently

published analysis of neighborhood street trees and childhood asthma rates across New York City.

The Department of Health and Mental Hygiene is recognized for data driven, evidence-based program and policy innovations that are being emulated in cities around the world. DOHMH staff contributing to this project includes:

- Thomas Matte, MD, MPH, Director of Environmental Research, who directs DOHMH work assessing public health impacts of extreme weather and air pollution
- Jane Clougherty, MSc, ScD, Senior Research Scientist, the lead DOHMH researcher for NYCCAS.
- Sarah Johnson, MPH, MS, the Senior GIS Analyst for NYCCAS

Dr. Holger Eisl at Queens College Center for Biology and Natural Systems will design field, laboratory and quality assurance protocols for sampling ambient air pollution and will oversee sample analyses.

The Department of Parks & Recreation is responsible for over 28,000 acres of parkland and all trees located in the public right of way, and has initiated large-scale tree planting as part of MillionTreesNYC.

- Jacqueline Lu, Director of Research and Analysis leads the Urban Field Station, a partnership with the Forest Service to support urban environmental research.
- Jessie Braden, GIS Manager, will orchestrate field data collection and generation of urban forest spatial datasets and imagery.

Jarlath O'Neil-Dunne from the University of Vermont is a geospatial analysis at the Spatial Analysis Lab. The results of his Urban Tree Canopy assessments have been used by several major cities to establish tree canopy goals, including New York City.

9. Budget and Funding

Please see the attached spreadsheet showing requested and match funding from all project partners. Please note that because this is a pre-proposal, indirect cost rates have yet to be negotiated with all project partners (although we have attached Columbia University's Indirect Cost Agreement document).

The Urban Forest, Childhood Asthma and Community Air Quality
NUCFAC 2009 Challenge Cost-Share Grant Program

Budget by Quarter (assuming project start of Dec 1, 2009)

REQUESTED FUNDS	Dec 1, 2009 - Feb 28, 2010	Mar 1, 2010 - May 31, 2010	Jun 1, 2010 - Aug 31, 2010	Sept 1, 2010 - Nov 30, 2010	Dec 1, 2010 - Feb 28, 2011	Mar 1, 2011 - May 31, 2011	TOTAL REQUESTED FUNDS
Columbia	$ 19,554	$ 19,554	$ 19,554	$ 19,554	$ 19,554	$ 19,554	**$ 117,326**
NYC Health	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
NYC Parks	$ -	$ 12,720	$ -	$ -	$ -	$ -	**$ 12,720**
Queens College	$ 4,572	$ 22,912	$ 18,853	$ 4,572	$ 4,572	$ 4,572	**$ 60,054**
University of Vermont	$ 77,183	$ -	$ -	$ -	$ -	$ -	**$ 77,183**
TOTAL	**$ 101,310**	**$ 55,187**	**$ 38,407**	**$ 24,127**	**$ 24,126**	**$ 24,126**	**$ 267,283**

MATCH FUNDS	Dec 1, 2009 - Feb 28, 2010	Mar 1, 2010 - May 31, 2010	Jun 1, 2010 - Aug 31, 2010	Sept 1, 2010 - Nov 30, 2010	Dec 1, 2010 - Feb 28, 2011	Mar 1, 2011 - May 31, 2011	TOTAL MATCH FUNDS
Columbia	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
NYC Health	$ 14,327	$ 14,327	$ 14,327	$ 14,327	$ 14,327	$ 14,327	**$ 85,964**
NYC Parks	$ 10,331	$ 10,331	$ 25,191	$ 10,331	$ 10,331	$ 200,331	**$ 266,848**
Queens College	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
University of Vermont	$ 22,769	$ -	$ -	$ -	$ -	$ -	**$ 22,769**
TOTAL	**$ 47,428**	**$ 24,659**	**$ 39,519**	**$ 24,659**	**$ 24,658**	**$ 214,658**	**$ 375,581**

PROJECT TOTAL COST	**$ 148,738**	**$ 79,846**	**$ 77,926**	**$ 48,786**	**$ 48,784**	**$ 238,784**	**$ 642,864**

THE URBAN FOREST, CHILDHOOD ASTHMA AND COMMUNITY AIR QUALITY

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South Asia Secretariat
Delhi, India

International Training Centre
Freiburg, Germany

Project Offices
China
Indonesia
Mexico

February 13, 2009

Nancy Stremple, Executive Staff to NUCFAC
National Urban and Community Forestry Advisory Council
USDA Forest Service
Sidney Yates Building (1- Central)
201 14th Street S.W., MS-1151
Washington, DC 20250-1151

RE: Support for New York City Department of Parks proposal

Dear Ms. Stremple,

I am writing to express ICLEI-Local Governments for Sustainability U.S.A. Inc.'s (ICLEI) support for New York City's proposal to study the linkages between urban forestry and respiratory health. ICLEI is an international non-profit membership association of local governments with over 500 members in the U.S. and 1000 members internationally. ICLEI's mission is to build, serve, and drive a movement of local governments to advance deep reductions in greenhouse gas emissions and achieve tangible improvements in local sustainability. We are committed to sharing best practices with our membership and work closely with the City of New York to share the lessons learned from the City's innovative sustainability and climate protection plan, PlaNYC.

We believe this study will be of tremendous value to our local government members and in particular our members from large metropolitan areas. Air quality issues are of top concern for many of our members, and we believe that the findings from this study will be useful for cities around the country. We would be happy to disseminate the findings from New York City's study and to use the results to help local governments make informed policy decisions around urban forestry and local air quality.

Sincerely,

Michelle Wyman

Michelle Wyman
Executive Director
ICLEI-Local Governments for Sustainability, U.S.A., Inc.
www.icleiusa.org

USDA United States Department of Agriculture | Forest Service | Northern Research Station | Urban Field Station
290 Broadway, 26th Floor
New York, NY 10007

Date: February 16, 2009

Subject: Letter of Support: The Urban Forest, Childhood Asthma and Community Air Quality Project

Nancy Stremple, RLA
U.S. Forest Service
Executive Staff to NUCFAC
Sidney-Yates building (1 Central)
201 14th Street S.W., MS-1151
Washington, DC 20250-1151

Dear Ms. Stremple,

I am writing in support of the proposed joint research initiative on urban forestry, local air quality and children's respiratory health. As I'm sure you are aware, this is an issue of critical importance to policy-makers, researchers, the public - - and perhaps, most importantly, to those individuals suffering in highly urbanized areas from respiratory illness and cardiovascular diseases. This is also an issue around which much speculation has been made. The direct association between urban forest structure and the prevalence of childhood asthma has yet to be fully determined yet it is thought intrinsically by many to be true. The opportunity to explore this relationship has, in large part, been limited to a lack of data and targeted resources to multi-disciplinary project teams.

In New York City, there is an opportunity to assemble a unique project team to examine explicitly the linkages between urban forestry, air quality and children's asthma. This proposal will do so by conducting urban forest inventories and air quality data near the homes of high-risk children and examining the results to see if any patterns emerge. To achieve this goal, this collaborative team will gather detailed urban forest inventory data, while leveraging unique public health and air quality data sets that are being generated in New York City. For several years, the Columbia Center for Children's Environment Health has been collecting longitudinal birth cohort respiratory data of high-risk children, including information on a child's indoor and outdoor environment. At the same time as part of the City's sustainability plan PlaNYC, the NYC Department of Health has initiated the Community Air Survey (NYCCAS), the largest survey of its kind to monitor street-level air quality at the neighborhood scale. This type of 'community –based' data has never existed for New York City, or for most American cities. The NYC Department of Parks and Recreation has the expertise to conduct urban forest inventories, and has assembled an archive of highly detailed and comprehensive data set on its urban forest that will aid in retrospective analyses. Preliminary work with this data suggests there may indeed be a potentially significant relationship between canopy and respiratory health. Parks plans to use the results of this project to inform the large-scale plantings that are part of MillionTreesNYC.

The team assembled on this project is exceptional. As coordinator of the Urban Field Station, a research division of the US Forest Service, Northern Research Station based in New York City, we have worked in successful partnership with nearly all of the partnering organizations on this grant. Team representatives from NYC DOH, NYC Parks, University of Vermont, Spatial Analysis Lab (SAL), Columbia University, CUNY (CBNS) and the US Forest Service scientists participating in this project are all highly professional and well-respected leaders in their fields.

My office has 'watched' as this proposed project has developed over the past few months. I have been personally impressed by the passion of this group, the level of collaboration, and the demand for excellence. As such, we are in full support of this group of collaborators and the research proposed and I urge NUCFAC to consider this proposal for 2009 cost-share grant funding.

If you have any questions or would more details from our office, please do not hesitate to contact me. I would eager to share more about this group of collaborators; the research and this unique moment to better understand the relationship between human health and our urban environments.

Sincerely,

Erika S. Svendsen
Research Social Scientist
NYC Urban Field Station
esvendsen@fs.fed.us

Columbia University
MAILMAN SCHOOL
OF PUBLIC HEALTH

Department of Epidemiology

February 12, 2009

Jacqueline Lu
Director of Research & Analysis
Central Forestry & Horticulture
New York City Parks & Recreation

Dear Ms. Lu,

I am writing to express my enthusiastic support for this grant proposal to the US Forest Service and my support for this collaboration with the Department of Parks & Recreation. Since my research team's 2008 article showing that across New York City neighborhoods, areas with more street trees had lower asthma rates, we have been anxious to conduct more in depth studies of tree canopy cover, air pollution and asthma symptoms. This collaboration with you and the New York City Department of Health and Mental Hygiene is the logical extension of our work and will provide a rigorous analysis of whether exposure to trees protects against asthma. As noted in the budget, another, To Be Named, Columbia University epidemiologist will also contribute to this project. We are currently negotiating to have Dr. Gina Lovasi join our faculty, she was the first author of our original work, and if we are successful in hiring her she will join the research team. If we are unsuccessful, I will recruit another member of my group to work on this project.

The executive committee of the Columbia Center for Children's Environmental Health has approved my proposal to conduct analyses of exposure to trees and greenery and asthma outcomes in the birth cohort. The proposed work to merge aerial photography, detailed tree canopy analyses and air pollution modeling with the Center's data on childhood development will create a tremendously important public health resource. This data set will also be extremely useful for assessing whether urban forestry has other positive health impacts on childhood development, particularly in the areas of lung function and mental development.

In conclusion I am very excited about this project and look forward to working with you on it.

Best regards,

Andrew Rundle

Andrew Rundle, DrPH
Associate Professor of Epidemiology
Director of the Built Environment and Health Research Group

NEW YORK CITY DEPARTMENT OF
HEALTH AND MENTAL HYGIENE
Thomas R. Frieden, MD, MPH
Commissioner

Thomas D. Matte, MD, MPH
Director of Environmental Research
Bureau of Environmental Surveillance and Policy
tmatte@health.nyc.gov

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12th Floor, CN34E
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212-676-2196

Jacqueline Lu
Central Forestry & Horticulture
New York City Department of Parks & Recreation
Olmsted Center, Flushing Meadow Corona Park
Flushing, NY 11368

Dear Ms Lu,

The Department of Health and Mental Hygiene (DOHMH) is pleased to have the opportunity to collaborate with the NYC Department of Parks and Recreation, Columbia University, Queens College, the USDA Forest Service, and the University of Vermont Spatial Analysis Lab in the proposed study: *The Urban Forest, Childhood Asthma and Community Air Quality.*

As you know, this project provides an opportunity to build upon and leverage the recently launched New York City Community Air Survey, a PlaNYC-supported effort by DOHMH and our partners at Queens College to study neighborhood variation in air pollutants that affect public health in New York City. The proposed project will allow us to evaluate air pollution variation the northern Manhattan and South Bronx neighborhoods hardest hit by pediatric asthma using additional air quality measurements beyond those planned for NYCCAS. In addition, by providing more detailed measures of tree canopy cover by multiple methods, this collaboration will advance our understanding of how the urban forest impacts air quality and asthma and inform ongoing efforts to improve New York City's air quality.

In support of this project, Jane Clougherty, Sarah Johnson, and I will provide as an in-kind effort, work needed to: select cohort member addresses for an efficient spatial air sampling plan, in conjunction with design the field protocol and train Department of Parks and Recreation led field teams in deployment and retrieval or air samplers, prepare land use regression variables such as traffic density, analyze the air pollutant data, develop land use regression models, and participate in writing scientific manuscripts and lay audience reports.

We look forward to working with you on this important project.

Sincerely yours,

Thomas D. Matte, MD, MPH

Center for the Biology of Natural Systems
Queens College
City University of New York
Flushing, New York 11367

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February 13, 2009

Jacqueline Lu
Central Forestry & Horticulture
New York City Parks & Recreation
Olmsted Center, Flushing Meadow Corona Park
Flushing, NY 11368

Dear Ms. Lu:

The Center for the Biology of Natural Systems at Queens College is pleased to be a collaborator in the proposed study to examine and describe the linkages between urban forest structure, community-scale air quality, and respiratory health being submitted in response to the National Urban and Community Forestry Advisory Council Challenge Cost Share Grant Program. This collaboration among Columbia University, the New York City Department of Health and Mental Hygiene (DOHMH), the New York City Department of Parks and Recreation (DPR), U.S.D.A. Forest Service (FS), the University of Vermont Spatial Analysis Lab (SAL) and our center will leverage and extend the work of the New York City Community Air Survey (NYCCAS).

Dr. Holger Eisl at our center will work with Department of Health and Mental Hygiene Staff to design field, laboratory, and quality assurance protocols for measuring nitrogen oxides and ozone using methods comparable to those used in NYCCAS. He will also assist in training DPR field teams and manage the processing, shipping and tracking of samples for analysis by our contract lab, RTI. He will perform quality assurance of all results including field blanks, and prepare electronic result files for analysis by the Department of Health and Mental Hygiene.

We look forward to a successful collaboration.

Sincerely,

Steven Markowitz, M.D.
Professor and Director

The UNIVERSITY of VERMONT

Spatial Analysis Laboratory
Rubenstein School of the Environment & Natural Resources

February 15, 2009

Jacqueline Lu
Central Forestry & Horticulture
New York City Parks & Recreation
Olmsted Center, Flushing Meadow Corona Park
Flushing, NY 11368

Dear Ms. Lu:

Thank you for inviting me to participate in your proposal dedicated to examining the public health effects that the urban forest has on childhood asthma. This proposal will build on the strong research partnership that exists between the University of Vermont, the USDA Forest Service and the New York City Department of Parks and Recreation.

Through this letter I am acknowledging the role of the University of Vermont's Spatial Analysis Laboratory in this proposal. Specifically, the development of a high-resolution land cover geospatial dataset for use in the analysis. I believe the cost estimate described below to be accurate for the portion of the project involving the Spatial Analysis Laboratory.

Personnel	$32,000
Fringe	$12,800
Data	$27,583
Facility charges	$4,800
Total	**$77,183**
Match	*$22,769*

Sincerely,

Jarlath O'Neil-Dunne
Geospatial Analyst

81 Carrigan Drive • Aiken Center Room 220 • Burlington, VT • 05405 • 802.656.3324