

PROPOSAL TEMPLATE

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Control Number: _____

COVER SHEET

2014 U.S. Forest Service

National Urban and Community Forestry Challenge Cost-Share Grant Program

Proposals are due by July 15, 2013, 11:59 PM Eastern

INNOVATION GRANT CATEGORY:

Category 1: Making Urban Trees and Forests More Resilient to the Impacts of Natural Disasters and the Long-term Impacts of Climate Change

Category 2: Green Infrastructure Jobs Analysis

Category 3: Utilizing Green Infrastructure to Manage and Mitigate Stormwater to Improve Water Quality

PROJECT CONTACT NAME, ORGANIZATION, ADDRESS, PHONE NUMBER, FAX NUMBER AND EMAIL ADDRESS: Karen Capiella, Director of Research, Center for Watershed Protection, 8390 Main Street, 2nd Floor, Ellicott City, Maryland 21043, 410-461-8323, 410-461-8324, kc@cwpp.org

PROJECT TITLE: Making Urban Trees Count: A Project to Demonstrate the Role of Urban Trees in Achieving Regulatory Compliance for Clean Water

FUNDING REQUEST AND MATCH:

REQUESTED: \$127,727.84 + MATCHING: \$127,727.84 = TOTAL PROJECT: \$255,455.68

OUTREACH

Is this project being developed to reach a minority or underserved population? ___Yes ___x___No

Is this pre-proposal being submitted by a minority or underserved population (owned/operated/directed) business, organization or college/university? ___Yes ___x___No
Applicants should also address how the issue impacts underserved communities and how the proposal can address or minimize these impacts when applicable.

LIST PROJECT PARTNERS:

LETTER OF SUPPORT INCLUDED: **YES** NO

1. Keith Anderson, District of Columbia Department of the Environment, 1200 First Street NE, 6th Floor, Washington, DC, 20002, 202-535-2240, keith.anderson@dc.gov
2. Dr. Sujay Kaushal, University of Maryland Department of Geology & Earth System Science Interdisciplinary Center , 5825 University Research Court, Suite 4001, M Square Building, University of Maryland, College Park, Maryland 20740, 301-405-7048, skaushal@umd.edu

LIST STAKEHOLDER SUPPORT:

LETTER OF SUPPORT INCLUDED: YES NO

1. Julie Mawhorter, U.S. Forest Service Northeastern Area State & Private Forestry, Chesapeake Bay Program, 410 Severn Avenue, Suite 112, Annapolis, Maryland 21403, 410-267-5708, jmawhorter@fs.fed.us
2. Anne Hairston-Strang, Maryland Department of Natural Resources Forest Service, 580 Taylor Avenue, Annapolis, Maryland 21401, 410-260-8509, astrang@dnr.state.md.us
3. Christin Jolicoeur, Arlington County Department of Environmental Services, 2100 Clarendon Boulevard, Suite 705, Arlington, Virginia 22201, 703-228-3588, cjolicoeur@arlingtonva.us
4. Mike Galvin, SavATree Consulting Group, 550 Bedford Road, Bedford Hills, New York, 10507, 914-403-8959, mgalvin@savatree.com

ABSTRACT:

Stormwater managers need cost-effective practices to meet Clean Water Act permit requirements and improve water quality. The use of trees as a BMP is hampered by the uncertainty of how to “credit” trees for runoff and pollutant load reduction in order to compare with other BMPs. Quantified tree benefits are not accessible to the stormwater community, limiting the potential to use them for pollutant removal credits. The Center for Watershed Protection will address this challenge by developing a model design specification for urban tree planting that addresses crediting, verification, cost-effectiveness, and tree health. The expected outcome is incorporation of the specification into stormwater manuals and greater use of tree planting for MS4 compliance.

The Center will conduct a comprehensive literature review, apply a tree planting credit and verification system in Washington, DC, and evaluate the influence of leaf litter on stormwater pollution in partnerships with the District of Columbia Department of the Environment and the University of Maryland. A collaboration of a panel of experts will review these results and make recommendations to inform the model design specification. The Center will transfer the project results through its network of watershed and stormwater professionals in a targeted, national dissemination effort.

Proposal Narrative: The proposed work addresses Category 3 of the Request for Proposals: Utilizing Green Infrastructure to Manage and Mitigate Stormwater to Improve Water Quality. The Center for Watershed Protection (the Center) will develop a model design specification for urban tree planting for stormwater management that is based on science and collaboration with experts in the field of urban forestry, ecology, and stormwater management. With the stormwater community as the primary audience (e.g., municipal separate storm sewer system (MS4) program managers, stormwater engineers and designers, local stormwater plan reviewers and site inspectors, and state and federal stormwater agencies), this work will help to further the forestry goal of increasing the number of healthy trees in urban areas by quantifying how specific urban tree planting applications can achieve compliance with stormwater permits and focusing solely on the stormwater benefits of trees, not other benefits of trees that are already well documented.

In 2004, the Center and the USDA Forest Service spearheaded a cooperative effort to launch urban watershed forestry at a national scale. The research project included convening design workshops on using trees for stormwater treatment in the urban landscape. The goal of the workshops was to identify potential limitations to using trees for stormwater treatment, both from an engineering perspective and for tree survival and health, along with ways to address constraints. The result of this collaboration was a set of best management practices (BMP) designs that were intended to address these limitations through design modifications, species selection or other methods. These designs were widely disseminated in a national manual (Cappiella et al., 2005), website and various trainings and workshops. Nearly a decade later, while researching the effects of long-term maintenance activities on trees planted for bioretention facilities for Arlington County, VA, the Center found only a handful of MS4s across the country are using trees in a major way to achieve stormwater permit compliance – despite the recent emphasis on green infrastructure. The primary reason for this limited application of trees is the lack of data available to quantify the additional runoff or nutrient reduction benefits of planting trees in BMPs compared to BMPs without trees, as well as concerns about tree survival and practice maintenance. There is little motivation for designers to include trees within these practices when no method exists to calculate a credit. A scientific basis for credit development may provide the incentive needed for more broadly and consistently using trees for stormwater management in urban areas if their runoff and pollutant reduction benefits can be quantified in a standardized format.

Some states and MS4s have established stormwater credit systems for tree planting and preservation, but these credits are either 1) based on conservative estimates of the ability of tree canopy to reduce the overall volume of runoff from a development site and do not directly account for other benefits provided, such as filtering of pollutants and their biological transformation or 2) calculated based on undocumented methods. In either case, the credit is not usually sufficient to encourage extensive tree planting for stormwater compliance. A crediting system for urban tree planting that is scientifically defensible, well-defined and provides cost-effectiveness estimates can create incentives to use this practice for stormwater management by putting it on equal footing with other BMPs and providing greater certainty that the practice will continue to perform over the long-term. While there have been some local attempts to quantify and verify the stormwater management benefits of trees, no one has compiled this information on a

national basis, or made it easily accessible to the stormwater community.

The EPA Chesapeake Bay Program (CBP) has begun to address this issue on a regional scale by convening an expert panel to define nutrient and sediment removal efficiencies for “expanded tree canopy” so that urban tree planting can be credited as an acceptable BMP for helping MS4s meet their Chesapeake Bay total maximum daily load (TMDL) requirements. The panel follows a process adopted by USEPA to address the uncertainty associated with BMPs for nonpoint source runoff management (USEPA, 2010) and includes staff from the CBP, the Center for Watershed Protection and state forestry agencies as well as urban forestry experts such as Dr. Susan Day of Virginia Tech and Dr. Dave Nowak of the U.S. Forest Service. The panel has agreed that the credit for expanded tree canopy, defined as planting that does not result in forest-like conditions, should be less than the credit for reforestation, but insufficient information is available to recommend a numeric value.

The primary issues to develop a credit for tree planting as a BMP are the sheer number of variables influencing canopy interception, evapotranspiration, infiltration and pollutant uptake (e.g., tree species size and age, storm event characteristics, distance from impervious cover, soils), and the need to balance the detail provided in crediting recommendations with the level of site data that can be realistically collected in the BMP verification and reporting process. The lack of data on performance limits the development of cost-effectiveness metrics (e.g., cost per pound of nitrogen removed) by which tree planting can be compared relative to other BMPs. The proposed project is designed to address these challenges.

The Center proposes to increase the use of urban tree planting as a stormwater BMP by developing model design specifications that include a method for crediting and verifying their performance and cost-effectiveness metrics. Literature review results will be combined with expert input and field observations to develop these practical tools for MS4 program managers, site designers, plan reviewers and inspectors across the country. In this proposal, the term “urban tree planting” is defined as all tree planting in the urban environment that does not result in a forest-like condition. This includes trees that are planted with no special engineering to accept or treat runoff (e.g., street and yard trees), trees that are designed to accept and treat runoff (e.g., using structural soils and structural cells), and trees that are planted within BMPs such as bioretention or ponds to provide enhanced performance. The research questions addressed by the study include: 1) What is the runoff and pollutant reduction capacity of urban trees and what is their cost-effectiveness in reducing pollution? 2) How is this capacity influenced by factors such as age, species and size of planting, distance from impervious cover? and 3) What planting design, site characteristic or maintenance factors are associated with urban tree health?

2. Originality and Innovation: This project is innovative because it applies the concept of planting trees to reduce runoff volumes and pollutant loads on a national scale. Despite extensive reforestation in agricultural and forestry settings for many years, the practice and detailed specifications have yet to be translated in a cogent fashion to the urban environment specifically for stormwater management. American Forests, among other organizations, has documented the benefits of trees on broad scales. However, trees and reforestation are not “accepted” by most jurisdictions as an official urban stormwater

BMP because the runoff and pollutant reduction benefits have been difficult to quantify in equivalent terms with other stormwater BMPs. The overarching goal of this project is to quantify and credit tree planting in a comparable fashion with other recognized stormwater BMPs and thereby include it in the options available to MS4s as well as private landowners seeking stormwater utility fee discounts for planting trees throughout the United States.

3. Literature Review: A brief review of the relevant literature is provided in an attached Appendix and organized by three major sections 1) stormwater benefits of trees, 2) nutrient outputs from leaf litter, and 3) methods to credit trees for stormwater management. A more extensive review is expected as part of this project.

4. Project planning and timeline: The proposed project tasks are described below, followed by a table that presents the projected timeframe for completing each task and major deliverables.

Task 1. Literature Review and Data Collection. To supplement the initial literature review provided in the Appendix of this proposal, the Center will conduct a much more thorough literature review and synthesis to complete and improve the understanding of the runoff and pollutant removal capabilities of urban trees and the influence of various factors on their performance. Although the literature on hydrologic and water quality processes of trees in general is vast, the goal of this task is to compile and organize this research in such a way that it can be used to better define the range of potential urban tree planting credits that can be given under specific scenarios.

The Center will begin with existing region-specific literature reviews completed by the Chesapeake Bay Program, Piedmont Triad Regional Council, City of Seattle and others to identify specific gaps and add to this body of knowledge through a comprehensive search of recent literature covering a range of study locations and conditions so that correlations to performance can be extracted. The format used by the International BMP Database (www.bmpdatabase.org) will be followed for summarizing these studies.

In addition to the published literature on the hydrologic and water quality benefits of trees, there is a growing body of research to evaluate the performance of urban trees planted in structural soils, within suspended pavement and structural cells, or within permeable pavements, as well as stormwater tree pits. These systems, some proprietary, are designed to accept and treat runoff. Monitoring for these systems is often done to determine compliance with a local permit and is not published in the literature, or is conducted by a non-objective source (e.g., the system manufacturer). Therefore, a comprehensive compilation and review of the data from these studies by an objective, national organization can greatly enhance the knowledge on this subject. The Center will contact researchers to request study data, to include information related to system design and site characteristics, monitoring data such as storm event characteristics and runoff and pollutant reduction performance, and costs to construct and maintain the practice. Some examples of municipal urban tree planting projects and agencies or universities who conduct monitoring on such projects are listed in Table 1.

Monitored Projects	Agencies/Organizations Conducting Monitoring
<ul style="list-style-type: none"> • Marquette Avenue and 2nd Avenue structural cells in Minneapolis, MN • Central Corridor Light Rail Transit in St. Paul, MN integrated tree trench • City of Charlotte, NC suspended pavement • Ithaca, NY structural soils in parking lots • Olympia WA structural soils • Chattanooga, TN permeable pavement with trees at Finley Stadium 	<ul style="list-style-type: none"> • Capital Region Watershed District (Twin Cities, MN) • New York City Department of Environmental Protection Green Infrastructure Monitoring Program • Virginia Tech • Cornell University • University of California at Davis • Bartlett Research Lab (Charlotte, NC) • Villanova Urban Stormwater Partnership • North Carolina State University • University of New Hampshire Stormwater Center • University of Minnesota

The Center will also review existing methods for assessing the stormwater and pollutant reduction values of urban trees, including models (e.g., *CityGREEN*, *i-Tree* Hydro), and field monitoring protocols. Herrera (2008) provides a good starting point for this summary, but a subset of state and local stormwater design manuals will be reviewed to determine which methods are used in existing stormwater credit programs for urban tree planting and the associated performance criteria, credit, and protocols to verify performance including assessments of tree health. The Center will utilize our in-house expertise in stormwater forestry as well as outreach to key external researchers in both the stormwater and urban forestry communities to conduct this review.

Task 2. Pilot Application of Credit System and Verification Procedures for Urban Tree Planting in Washington, DC. The District of Columbia Department of the Environment (DDOE) Stormwater Retention Credit (SRC) program is a unique feature of the recently adopted stormwater rule that requires nearly all development projects to retain the volume of stormwater from 1.2” of rainfall. Rather than meeting all of its retention requirements on site, a development would be allowed to meet up to half of its retention requirements through the purchase of SRCs. The hope is that by creating an SRC trading market, the cost of compliance with the retention requirements will be reduced, and there will be a strong economic incentive to retrofit existing developments in the District. In partnership with DDOE, the Center will develop a protocol for performing site plan reviews and field inspections of stormwater retention sites to calculate an appropriate SRC for trees and other allowable BMPs implemented at each site. The protocol is intended to verify that tree planting occurred, determine if the planting meets the established performance criteria, and evaluate the health of the trees through a visual survey. The crediting and verification procedures will also be applied to calculate stormwater fee discounts for property owners who plant trees. DDOE provides reduced stormwater utility fees to property owners who implement certain stormwater BMPs but a credit has not yet been developed for urban tree planting.

In general, there is a need for empirical data on the relationship between BMP design specifications, maintenance, and BMP performance. A field survey of urban trees to evaluate their performance, maintenance and health will help to identify what works and does not work in terms of design and maintenance practices. The results will help to better understand what factors affect tree health so that design criteria can be modified accordingly. This part of the study is modeled after the *Extreme BMP Makeover* project (Hirschman et al., 2009). The Center will field test the visual survey protocol on up to 300 sites in the District. The visual survey will differ from other tree inventory protocols by looking specifically at factors that indicate hydrologic and water quality performance, in addition to basic indicators of tree health and vigor. The protocol will be developed in coordination with the District's Urban Forestry Administration.

Task 3. Analysis of Leaf Litter Influence on Stormwater Nutrient Loads. One identified concern regarding the use of trees for stormwater management is the influence of leaf litter on stormwater nutrient loads. While the benefits of urban tree canopy are well documented, nutrient processing of leaf litter fall on impervious surfaces is less certain, and may have a negative impact on water quality. The issue of trees' potential contribution to nutrient loads has been identified by Imberger et al. (2014), Hobbie et al. (2013), Law et al. (2013), Newcomber et al. (2012), and Wallace et al. (2008). In urban watersheds, leaf litter collects in curbs and gutters and is flushed through the storm drain system into streams if it is not removed by leaf pick-up programs or street sweeping. This hydrologic pathway differs greatly from natural areas, affecting the rate of decomposition and loss of soluble nutrients and carbon from leaf litter and likely altering stream ecosystem function. In this way, urban trees may contribute nutrients (specifically phosphorus) to urban streams that are generally already impaired for excessive nutrients.

Although regular street sweeping or leaf collection programs can help to prevent street tree leaf litter from entering the storm drain system, a more cost-effective method to reduce nutrient inputs from leaf litter (particularly as more urban trees are planted for stormwater credits) may be to focus on planting tree species that are less likely to contribute high phosphorus loads and limit the use of species that are more problematic. The quality of leaf litter, as measured by carbon and nitrogen ratios, differs by tree species, affecting its decomposition, timing and quantity of bioavailable carbon and nutrients to terrestrial and aquatic ecosystems. However, the relative contribution of nutrients from different tree species to urban watershed pollutant loadings is unknown. Improving our knowledge in this area could allow managers to more cost-effectively address this concern.

The Center will work with the University of Maryland (UMD) to evaluate the influence of leaf litter from various tree species to stormwater nutrient loads. The species selected for analysis will be determined from the review of state stormwater manuals (Task 1) in order to identify the most commonly recommended species in each region of the country. UMD will perform bench-scale measurements of leaf litter from up to 25 tree species. Analysis will include the denitrification rate, production of total nitrogen and phosphorus, nitrate, phosphate and dissolved organic carbon on a per sample basis (including duplicates). The experiments will estimate the retention and loss (e.g., leaching) of nutrients and organic carbon from the leaf species. The results will help to guide species selection for urban tree planting such that trees with lower potential for

contributing nutrients to the system but higher potential for nitrogen retention can be prioritized for urban tree plantings. This task will address concerns about the fate of nutrients from leaf litter in urban catchments and allow the project team to recommend tree species that are most beneficial for stormwater management practices, as they develop the model design specification for urban tree planting.

Task 4. Convene National Panel of Experts to Develop Stormwater Credit Recommendations for Urban Tree Planting. The Center will assemble a panel of experts to review the literature compiled in Task 1 and the results of Task 2 and Task 3 and make recommendations to support urban tree planting as a BMP. The panel will be tasked with making recommendations on assigning runoff and/or pollutant removal credits for urban tree planting. The recommendations will include definitions of all design variations for which a credit can be assigned based on the available science, land uses and geographies where the BMP applies, conditions under which it does/does not work, temporal performance, tracking and reporting procedures, operation and maintenance requirements, and effectiveness estimates. Following a review process established by the EPA (2010) for developing effectiveness estimates for nonpoint source practices, the recommendations will consider the reliability, variability and scientific support for the sources reviewed. Rather than assigning a single value to runoff reduction or nutrient reduction, the panel is expected to define multiple “design variants” of urban tree planting for which credits can be developed, and that credits may vary within each design based on site characteristics such as planting density or distance from impervious cover. Possible design variants include engineered BMPs that use trees, such as tree box filters and open grown urban trees.

The Center will invite experts from across the country to participate in the panel, consisting of four two-hour conference calls held over a 6-month period and review of the draft final product. Invited panel members will include: Dr. Dave Nowak, USDA Forest Service; Dr. Susan Day, Virginia Tech; Dr. Greg McPherson, USDA Forest Service, Randy Neprash, Minnesota Cities Stormwater Coalition; Lisa Hair, US EPA, Peter McDonough, Kestrel Design Group; Dr. Nina Bassuk, Cornell University; Jim Urban, FASLA; Dr. Bill Hunt, NC State; Andy Erickson, University of Minnesota; Graeme Lockaby, Auburn University; Sally Claggett, USFS/CBP, Mike Galvin, SaveATree, and others to be identified at the project start. The panel will also include state and local stormwater program staff so that the recommendations are developed with input from the intended audience, and will achieve a balance between a science-based credit and one that is achievable given on-the-ground capacity for implementing the recommendations. The national representation of the panel is important to ensure that the recommendations address regional design variations.

Task 5. Develop Design Specifications for Urban Tree Planting. The Center will use the expert panel recommendations to guide the development of model design specifications for urban tree planting. Design specifications are the commonly accepted format in which stormwater engineers are provided the essential information about BMPs for implementation. These specifications are included in the state or local design manuals and are intended to ensure that credited BMPs are designed, installed and maintained to meet established performance criteria in order to ensure that they achieve the desired pollutant reductions. Multiple specifications will be developed for significantly different

urban tree planting applications as defined by the panel in Task 4. Since the specifications will be disseminated nationally, they will be developed as a model that can be tailored for state or local use. The specification will reference key sources of information that can be used for tailoring, such as regional species lists. The expert panel will review the draft specification and revisions will be made to address comments. The urban tree planting design specification will include the following sections: 1) Description of the practice; 2) Pollutant removal and/or runoff reduction performance achieved by the practice; 3) Design variants; 4) Typical planting details; 5) Physical feasibility factors and applicability; 6) Design criteria; 7) Regional and special adaptations; 8) Construction sequencing; 9) Maintenance; and 10) Costs and cost-effectiveness.

Table 2 presents the proposed project deliverables and timeline by task. We assumed a project start date of October 2014 and an 18-month timeframe.

Task	Deliverables	Timeline
Task 1. Literature Review	Technical memo	Month 1-4
Task 2. Pilot Testing in DC	Technical memo	Months 2-6
Task 3. Leaf Litter Analysis	Research paper submitted to peer-reviewed journal	Months 3-4
Task 4. Expert Panel	Panel report with urban tree planting credit recommendations	Months 6-12
Task 5. Develop Design Specifications	Draft and final model design specification for urban tree planting	Months 12-14
National Distribution	Dissemination through website and networks; national webcast; addition of studies to International Stormwater BMP Database; 3 presentations at national stormwater conferences; 3 presentations at stormwater meetings; presentation at NUCFAC annual meeting	Months 9-18

5. Product: The major project deliverable will be a national model urban tree planting design specification that can be tailored by MS4 program managers. Details of the specification are described in Task 5. It will also be accompanied by a short guide on how to tailor and incorporate this BMP into the local stormwater program. The final urban tree planting specification will be made available for free download on the Online Watershed Library (OWL), (<http://www.cwp.org/online-watershed-library-owl>). The OWL is a service provided by the Center that allows ready access to publications and other resources (research papers, tools, and stormwater manuals, among others) that support best practices in watershed and stormwater management. OWL is a searchable, online database of basic information, stormwater and watershed manuals and plans,

assessment tools, regulatory information, and other watershed-related resources. The intended users of the specification are stormwater engineers and designers, stormwater plan reviewers and site inspectors, state and federal stormwater agencies, and MS4 program managers. The expected project outcome is incorporation of these recommendations into state and local stormwater design manuals and ultimately greater use of urban tree planting as a BMP in the communities governed by this guidance.

6. Collaboration: The Center will deliver this project in collaboration with DDOE and UMD. As a Phase I MS4, DDOE has worked to demonstrate over the past several years the practicality of using low impact development to meet District stormwater requirements. The Mayor's Sustainable DC plan calls for expanding the urban tree canopy to cover 40% of the District and retrofit 75% of the existing landscape with green infrastructure to filter runoff by 2032. The Center has collaborated with DDOE to develop the District Stormwater Design Manual and deliver related trainings. In 2013, DDOE contracted with the Center to develop a review protocol for stormwater projects that are eligible for Stormwater Retention Credits and stormwater fee discounts, perform site plan reviews and field inspections, and provide training for stakeholders on this process. This District-specific protocol will be developed by the Center using DDOE funds, and its application on up to 300 sites will provide a field testing opportunity whose results will be used in Task 4 and Task 5 of the proposed project to inform development of a more broadly applicable process for MS4 communities to credit and verify urban tree planting. DDOE's role will be to provide input on the work plan for this task, review and comment on draft protocols, attend work sessions, and compile site information and plans for the site visits.

For Task 3, the Center will partner with the UMD Earth System Science Interdisciplinary Center (ESSIC). The ESSIC biogeochemistry laboratory, led by Dr. Sujay Kaushal, will perform the work. Dr. Kaushal is an Assistant Professor in ESSIC and Department of Geology at the University of Maryland, College Park. His area of expertise is Ecosystem Ecology and Biogeochemistry and his current research projects are focused on understanding the interactive effects of land use and climate change on the ecosystem ecology and geochemistry of water resources. UMD will take the lead on the leaf litter analysis to quantify the contribution of up to 25 tree species to stormwater nutrient loads.

The proposed work will build upon and synthesize previous work, such as the expert panel on expanded tree canopy convened by the Chesapeake Bay Program (CBP). The CBP panel has agreed that the credit for expanded tree canopy (which does not result in producing forest-like conditions) should be less than what is given for reforestation, but insufficient information is available to recommend a specific value due to the many influencing variables affecting tree performance. The Center's proposed literature review can help to fill this important gap and build-on recommendations of the CBP. Other collaborative aspects of the work include harnessing the expertise of the proposed expert panel to develop and review the urban tree planting design specifications, working with Wright Water Engineers to incorporate research studies into the International Stormwater BMP Database, and partnering with various organizations to deliver the results on a national scale.

7. National Distribution/Technology Transfer of Your Findings: As a national leader in stormwater management that has influenced the development of more than a quarter of the country's state stormwater design manuals, the Center has a direct connection to the stormwater community. The project results will be used by stormwater engineers and designers, stormwater plan reviewers and site inspectors, state and federal stormwater agencies, and MS4 program managers. The Center will transfer these products on a national basis to the target audience through:

- 1) Direct dissemination of the products to the Center's contact list of more than 12,000 stormwater and watershed professionals and its membership the Center for Watershed Protection Association, OWL, dissemination through partner networks, such as the Chesapeake Stormwater Network, the National Nonpoint Education for Municipal Officials Network, and statewide stormwater manager associations (e.g., CA Stormwater Quality Association, IN Association for Floodplain and Stormwater Management)
- 2) A 2-hour webcast on trees and stormwater as part of the Center's Watershed and Stormwater Webcast Series (<http://www.cwp.org/webcasts>)
- 3) Inclusion of the urban tree performance studies in the International BMP Database. This database is internationally recognized as the source of information on BMP performance and most BMP design manuals reference this source. The database currently focuses primarily on structural BMPs, and the additions proposed through this project would greatly enhance the ability of stormwater managers to credit urban trees as a BMP.
- 4) At least three presentations at national or regional stormwater conferences, such as the Low Impact Development Conference, WEFTEC, or StormCon.
- 5) A presentation at the annual meeting of EPA, Regional and State Stormwater Permit Coordinators and a presentation at the annual NUCFAC meeting in Washington, DC
- 6) At least two presentations to agencies responsible for developing credits for water quality management practices, such as the Chesapeake Bay Program, Piedmont Triad Regional Council, and the Lahonton Regional Water Quality Control Board.
- 7) Integration of the crediting procedure into the Center's watershed planning and stormwater retrofit process.

8. Project Evaluation: The Center's plan for project evaluation includes a structure to identify successes, failures and recommended changes. Project evaluation aligns directly with one of the Center's Strategic Plan goals, to: "institute effective feedback mechanisms on projects to ensure that they meet the needs of our stakeholders, and continuously inform the process of improving our practices."

The goal of this proposed project is to demonstrate the use of trees for stormwater compliance. The specific project objectives, outputs and outcomes are defined below, followed by a plan for how the success in meeting the project objectives will be evaluated, tracked and reported.

Objectives:

- Synthesize urban tree research into a model stormwater specification and credit for tree planting
- Conduct a field assessment of urban trees' performance, maintenance and health

- Evaluate the influence of leaf litter on stormwater pollution
- Disseminate study results to stormwater managers across the country

Outputs

- Technical memo summarizing review of literature on urban trees' pollutant removal capabilities (Month 4)
- Field assessment protocol for evaluating the performance of urban trees for stormwater management (Month 3)
- Technical memo summarizing pilot application of credit system and verification procedures in Washington, DC (Month 6)
- Research paper on leaf litter contribution to stormwater nutrient loads submitted to peer-review journal (Month 4)
- Recommendations for urban tree planting selection (Month 4)
- Four two-hour meetings of national expert panel on urban tree planting (Months 6-12)
- Expert panel report summarizing urban tree planting credit recommendations (Month 12)
- Model design specification for urban tree planting (Month 14)
- One 2-hour national webcast on trees and stormwater (Months 9-18)
- At least 6 presentations at national or regional conferences and meetings (Months 9-18)
- Posting of the model spec on the Online Watershed Library and inclusion in Center and partners' newsletters and emails (Months 9-18)

Outcomes

- Improved understanding of the extent to which urban trees reduce runoff and pollutants
- Dissemination of the model spec to more than 12,000 stormwater practitioners nationwide
- Incorporation of the model spec into state and local regulations
- Increased urban tree planting in Washington DC and other cities as a result of adopting the credit
- Identification of data needs for BMP credit and verification to support nutrient trading
- Improved understanding of leaf litter to urban watershed nutrient mass balance

The primary measure of the project's success in achieving the expected outputs is the timely production of deliverables that have been approved by the Center's Quality Control manager, the client and any external reviewers involved in the project. The Center uses a team structure that consists of a Quality Control Manager, Project Manager and Team Member(s) to manage all projects conducted by the organization. The Project Manager is responsible for the day-to-day administration of the project, including scheduling, budgeting, convening team meetings, communication with the client, coordinating project tasks and preparing progress reports. The project Quality Control

Manager is responsible for overall quality control for the project and reviews all deliverable products prior to their release. The Quality Control Manager will work with the Project Manager to ensure standards are identified and met, corrective actions are identified and performed, and improvements are integrated in the project. The Center takes great care to assign the most qualified staff to each project and to maintain staff consistency across the life of the project. Progress towards completion of deliverables is evaluated on at least a monthly basis through regular team meetings. The Project Manager tracks salary and other expenses on a monthly basis, and begins every team meeting with an update of remaining budget, assigned hours and review of action items from the previous meeting.

Review of products will be incorporated into the project at several stages. For written products, this typically includes establishing interim deliverables (i.e., outline, first draft and second draft) and building in time for review by the project Quality Control Manager, client and external reviewers as appropriate. Progress on deliverables will be reported to the Forest Service grant officer through regular progress reports required under the grant agreement.

To measure the success of the project in terms of achieving the expected outcomes, the Center will track the following metrics:

- The number of people reached through the transfer of results (e.g., number of attendees at conference presentations, webcast attendees, number of downloads of the urban tree planting specification from OWL) will be tracked using website analytical tools, webcast registrations, workshop session sign-in sheets, and number of opens reported from email delivery.
- The number of trees planted for Stormwater Retention Credits or stormwater utility fee discounts in Washington, DC will be tracked annually by DC Department of the Environment through their SRC program.
- The number of state or local design manuals that incorporate the urban tree planting specification will be tracked on an annual basis by the Center as an indicator of the increased awareness of the importance of urban trees to stormwater management. The Center will make a reporting form available as part of the model spec download so that communities incorporating the spec can self-report, but the Center will also periodically (~every 5 years) review state stormwater manuals to determine whether urban tree planting is included as one of the BMP options.

Table 3 maps the outputs and outcomes to the project objectives and will be used to track the status of progress for external reporting purposes. A final report on the project evaluation report will be submitted to the Council's executive staff, Nancy Stremple, at the end of the project.

Table 3. Objectives, Outputs and Outcomes for Project Evaluation

Objective	Output	Outcome	Status
Synthesize urban tree research into a model stormwater specification and credit for tree planting	Technical memo summarizing review of literature on urban trees' pollutant removal capabilities Recommendations for urban tree planting selection Four two-hour meetings of national expert panel on urban tree planting Expert panel report summarizing urban tree planting credit recommendations Model design specification for urban tree planting	Improved understanding of the extent to which urban trees reduce runoff and pollutants Incorporation of the model spec into state and local regulations	
Conduct a field assessment of urban trees' performance, maintenance and health	Field assessment protocol for evaluating the performance of urban trees for stormwater management Technical memo summarizing pilot application of credit system and verification procedures in Washington, DC	Identify data needs for BMP credit and verification to support nutrient trading	
Evaluate the influence of leaf litter on stormwater pollution	Research paper on leaf litter contribution to stormwater nutrient loads submitted to peer-review journal	Improved understanding of leaf litter to urban watershed nutrient mass balance	

Table 3. Objectives, Outputs and Outcomes for Project Evaluation			
Objective	Output	Outcome	Status
Disseminate study results to stormwater managers across the country	<p>Research paper on leaf litter contribution to stormwater nutrient loads submitted to peer-review</p> <p>One 2-hour national webcast on trees and stormwater (Months 9-18)</p> <p>At least 6 presentations at national or regional conferences and meetings (Months 9-18)</p> <p>Posting of the model spec on the Online Watershed Library and inclusion in Center and partners' newsletters and emails</p>	<p>Dissemination of the model spec to more than 12,000 stormwater practitioners nationwide</p> <p>Increased urban tree planting in Washington DC and other cities as a result of adopting the credit</p>	

9. Experience/Personnel/Adequacy of Resources: The Center for Watershed Protection, Inc. is a 501(c)(3) non-profit organization dedicated to fostering responsible land and water management through applied research, direct assistance to communities, award-winning training, and access to a network of experienced professionals. The Center was founded in 1992 and is headquartered in Ellicott City, Maryland. As national experts in stormwater and watersheds, our strength lies in translating science into practice and policy, providing leadership across disciplines and professions. The Center has staff with MS4 program experience, a licensed professional forester (MD) and professional engineers and staff expertise in the field of community forestry and forest resource management. Based on this expertise, the Center has provided technical assistance at the federal, state and local levels to facilitate implementation of urban tree canopy goals and other BMPs. Highlights of the Center's significant contributions to national stormwater management efforts include:

- Development of a three-volume Urban Watershed Forestry Manual (Cappiella et al., 2005, 2006a and 2006b) in partnership with the USDA Forest Service and companion website.
- Authored numerous stormwater management manuals and design criteria at the state level (e.g., Maryland, New York, Vermont, Minnesota, Georgia Coastal Supplement, Virginia, West Virginia, District of Columbia).
- Authored several national manuals and developed numerous tools to assist Phase II MS4 communities with meeting the six minimum control measures (Hirschman and Kosco, 2008; Brown et al, 2004; Schueler, 2004).
- The Center's role as the CBP Sediment and Stream Corridor Restoration Coordinator and have led or had a presence on several BMP expert panels: stormwater retrofits,

stream restoration, buffer enhancements, expanded tree canopy, urban nutrient management, and state stormwater performance standards.

The Center has efficiently managed more than \$1 million of federal assistance agreements in the past six years, and has a solid track record in meeting all of the technical and administrative requirements involved in executing complex federal assistance agreements. The Center has developed internal and external systems to track and report on grants, and meet project objectives. For the proposed project, Karen Cappiella will be the Project Manager and Bill Stack, PE will provide Quality Control. Team Members include Neely Law, PhD, Greg Hoffmann, PE, Bryan Seipp and Laura Gardner. Resumes for these staff are provided in the Appendix.

10. Budget Justification: Table 4 presents the proposed project budget followed by the justification.

Table 4. Budget				
Budget Category	Federal Funds Requested	Non-Federal Match	Total	Source of Matching Funds
Personnel	\$51,094.63	\$127,727.84	\$178,822.47	DDOE
Fringe	\$14,950.29	\$0	\$14,950.29	
Travel	\$2,175.25	\$0	\$2,175.25	
Supplies	\$1,210.00	\$0	\$1,210.00	
Telephone	\$440.00	\$0	\$440.00	
Contractual	\$18,480.00	\$0	\$18,480.00	
Indirect	\$39,377.67	\$0	\$39,377.67	
Total	\$127,727.84	\$127,727.84	\$255,455.68	

Budget Notes:

- Personnel = 1483 hours of staff time
- Fringe = 29.26% of personnel
- Travel: assumes 2 non-local trips to attend conferences and includes airfare (estimated \$300 each), hotel (\$150/night), per diem (\$50/day), and car rental (\$150/trip); also includes mileage (\$0.565/mile) for local trips to Annapolis, Washington, DC and other local meetings and conferences.
- Supplies: includes conference registrations, purchase of articles, and shipping purchase of non-local tree species for leaf litter analysis
- Telephone: for Task 1 interviews and expert panel meetings
- Contractual: for University of Maryland for leaf litter analysis
- Indirect = The Center's approved Final Indirect Cost Rate for 2012 and Provisional Indirect Cost Rate for 2014 is 44.57%.
- Matching funds: the source of matching funds is the District of Columbia Department of the Environment (DDOE), who has contracted with the Center to develop a review protocol for stormwater projects that are eligible for Stormwater Retention Credits and stormwater fee discounts, perform site plan reviews and field inspections, and provide training for stakeholders on this process, which directly relates to Task 2 of the proposed work. The total contract amount of \$297,013.25, of which \$127,727.84 will be used as match in the form of in-kind services.

Appendix:

- Literature Review and Full Reference Citations
- Federal Financial Application Forms
- Partner and Support letters
- Experience/Personnel/Adequacy of Resources support documents

Literature Review and Full Reference Citations

This brief review of the relevant literature is provided below, organized by three major sections: 1) stormwater benefits of trees, 2) nutrient inputs from leaf litter, and 3) methods to credit trees for stormwater management.

Stormwater Benefits of Trees. Trees affect water quality primarily by reducing stormwater runoff through interception (including plant uptake), evapotranspiration and infiltration. Combined, these processes determine how much rainfall becomes stormwater runoff, which is a primary source of water pollution in urban areas. The processes described above are well-accepted in the scientific community; yet, it is difficult to assign a single numeric credit to the services provided by individual trees because these processes are affected by a number of factors. For example, canopy interception depends on leaf area index and tree structure, but is largely dependent on the type of meteorological event (Crockford and Richardson 1990). Transpiration rates are influenced by seasonality, species, and rainfall conditions, while infiltration rates are dependent on land cover, soil type, antecedent soil moisture, seasonality, and rainfall conditions. The table below summarizes the wide range of results from the literature that demonstrates this variability.

Forest Effects on Rainfall Interception, Evapotranspiration, Water Storage and Pollutant Removal	
Function	Research Results
Rainfall interception	A study in California found that a mature deciduous tree intercepted 15% of gross precipitation in winter, while an evergreen intercepted 27% of gross precipitation (Xiao, et al, 2000); Canopy interception in a natural forest ranges from 15 to 40% of annual precipitation in conifer stands, 10 to 20% in hardwood stands and can be greater than 59% for old growth forests (Xiao, et al, 2000); A 32-ft tall tree intercepted rainfall and reduced stormwater runoff by 327 gal (Wolf, 1998); Urban forests have been shown to be most effective at intercepting rainfall from small, short duration storms often responsible for the “first flush” of runoff, during which most annual pollutant runoff occurs (Xiao et al., 1998);_Two studies of canopy interception by deciduous trees report a reduction in rainfall of 13% and 8% respectively (Dunne and Leopold, 1978; Reynolds et al., 1988).

Forest Effects on Rainfall Interception, Evapotranspiration, Water Storage and Pollutant Removal	
Function	Research Results
Evapo-transpiration	Transpiration by deciduous trees reported a 25% reduction in rainfall (Schlesinger, 1997); Poplar trees can transpire between 50 and 300 gal/day (EPA, 1998); An open grown hardwood tree will consume from 1.2 to 1650 gal/day, depending on the size of the tree and the evapotranspiration rate (Perry, 1994); A mature bald cypress can absorb 880 gal/day, depending on the soil type and saturation (Keating, 2002)
Infiltration and runoff reduction	Once wet, forest floors can hold between 1-5 times their own weight (Kittredge, 1948); Soil infiltration rates in forest conditions compared to other land use conditions generally show significant increased infiltration capacity by forest soils (Lal, 1996; Wondzell and King, 2003; Kays, 1980); Before/after clearcutting studies of deciduous forest catchments reported a 23% and 32% increase in runoff after deforestation, one study measuring rainfall and runoff from a deciduous forest catchment reported that 39% of the rainfall was reduced (Martin and Hornbeck, 2000; Hornbeck et al., 1997; Post and Jones, 2001).
Pollutant removal	One sugar maple growing along a roadway removed 60 mg of cadmium, 140 mg of chromium, 820 mg of nickel, and 5,200 mg of lead from the environment during a single growing season (Coder, 1996); Riparian buffers serve as important sinks for the removal and long-term storage of nutrients coming from agricultural drainage (Lowrance, 1992); Buffer widths of 30 m can remove nearly 100% of nitrate (Fennessy and Cronk, 1997).

In the urban environment, increased temperatures and the presence of impervious surfaces can influence the ability of trees to reduce runoff. For example, Barbour et al. (1980) found that, for the City of Chicago, average leaf area index (excluding grass), which is used as an indicator of trees' ability to reduce runoff through water storage, for tree-covered areas was 6.0; a value toward the lower end of the range (5–8) for deciduous forests. Waring and Schlesinger (1985) note that urban trees may have lower CO₂ uptake and transpiration rates than rural trees during summer months.

Nutrients from Leaf Litter. Dorney (1985) and Cowen and Lee (1973) found that street trees can contribute phosphorus to the environment when there is no forest floor or intact riparian ecosystem to process and recycle the nutrients from decomposing leaves. Studies find that leaf litter in urban stormwater has high nutrient concentrations (e.g., 8,050 mg/kg TKN, 557 mg/kg TP (Rushton 2006, Law et al 2013) and the loss of nutrients from decomposing leaves or leaf leachate may have negative water quality impact on impacted urban streams. Leaves in urban impacted streams may be detrimental with their high pollutant loadings and reduced biological processing (i.e., urban stream syndrome, see Walsh et al 2005, Meyer et al. 2005, Wallace et al. 2008). Additional research is needed to better define the pollutant loads associated with leaf litter, target source areas

and identify programs and practices that can lead to their reduced impact on urban waters. Leaf litter removal from urban streets by street sweeping at specific frequencies and times of the year can reduce these nutrient inputs (Kalinovsky et al. 2013).

Existing Methods for Crediting Trees for Stormwater Management. A wide range of study methods and metrics are used to quantify runoff reduction by trees. Monitoring and modeling approaches are both used, however, most modeling studies of runoff reduction by trees are based on simple land use models that use curve numbers and predict runoff based on land use type. A major limitation of the modeling approach is that it may not accurately account for tree interception and canopy storage (Xiao et al., 1998). A few examples of the methods used and results are:

- In Tuscon, AZ, an increase in tree cover from 21% to 35% resulted in a decrease in the mean annual runoff by 50% (Lormand, 1988 in Herrera, 2008).
- New York City estimates that 500,000 street trees can reduce 6.5 billion gallons of stormwater runoff per year (Plumb, 2008).
- Tree cover models in Garland, TX found that a site with 8% tree canopy coverage reduces stormwater runoff equivalent to a 3% runoff reduction. Estimated runoff volume ranged from 2.54 to 3.67 inches based on an average 24-hour, 2 year storm event (American Forests, 2000).
- Wang et al. (2008) used the UFORE-Hydro model to estimate that increasing the tree cover over pervious areas from 12% to 40% in a catchment reduced runoff by 2.6%.

Some municipalities have adopted stormwater credit programs that encourage the addition of more trees into a development or redevelopment site. Unfortunately, most of these programs do not document how the crediting values and framework were determined (Herrera, 2008) and existing summaries of stormwater credit systems focus only on a handful of communities. For example:

- San Jose, CA and Portland, OR provide a credit in a reduction in effective impervious cover on a development site. Each new deciduous tree reduces by 100 square feet the impervious cover that must be controlled by stormwater BMPs, and the credit for each new evergreen tree is 200 square feet (City of San Jose, 2007; Portland BES, 2007).
- Austin, TX provides a credit for new trees with a minimum trunk diameter of 2 inches receive an impervious surface reduction credit of 20 square feet. New trees with a diameter of 4 inches at the time of planting receive an impervious surface reduction credit of an area equal to one quarter the area of the tree canopy (Austin, 2007).
- Pine Lake, GA defines stormwater credits through conserving trees on development sites using the following system: 10 gallons/inch credit for trees < 12" (diameter at breast height or DBH) and 20 gallons/inch credit for trees > 12" DBH.

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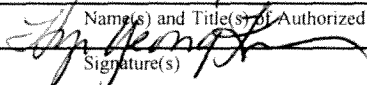
U.S. DEPARTMENT OF AGRICULTURE

Certification Regarding Debarment, Suspension, and Other
Responsibility Matters - Primary Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 7 CFR Part 3017, Section 3017.510, Participants' responsibilities. The regulations were published as Part IV of the January 30, 1989 Federal Register (pages 4722-4733). Copies of the regulations may be obtained by contacting the Department of Agriculture agency offering the proposed covered transaction.

(BEFORE COMPLETING CERTIFICATION, READ INSTRUCTIONS ON REVERSE)

- (1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:
 - (a) are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
 - (b) have not within a three-year period preceding this proposal been convicted of or had a civil judgement rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
 - (c) are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and
 - (d) have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.
- (2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Organization Name	PR/Award Number or Project Name
<u>Center for Watershed Protection, Inc.</u>	<u>Making Urban Trees Count</u>
Name(s) and Title(s) of Authorized Representative(s)	<u>Hye Yeong Kwon Executive Director</u>
<u></u>	Date

Instructions for Certification

1. By signing and submitting this form, the prospective primary participant is providing the certification set out on the reverse side in accordance with these instructions.
2. The inability of a person to provide the certification required below will not necessarily result in denial of participation in this covered transaction. The prospective participant shall submit an explanation of why it cannot provide the certification set out on this form. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective primary participant to furnish a certification or an explanation shall disqualify such person from participation in this transaction.
3. The certification in this clause is a material representation of fact upon which reliance was placed when the department or agency determined to enter into this transaction. If it is later determined that the prospective primary participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.
4. The prospective primary participant shall provide immediate written notice to the department or agency to whom this proposal is submitted if at any time the prospective primary participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.
5. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of the rules implementing Executive Order 12549. You may contact the department or agency to which this proposal is being submitted for assistance in obtaining a copy of those regulations.
6. The prospective primary participant agrees by submitting this form that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.
7. The prospective primary participant further agrees by submitting this form that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.
8. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.
9. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.
10. Except for transactions authorized under paragraph 6 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

U.S. DEPARTMENT OF AGRICULTURE

**Certification Regarding Debarment, Suspension, Ineligibility
and Voluntary Exclusion - Lower Tier Covered Transactions**

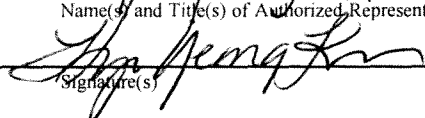
This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 7 CFR part 3017, Section 3017.510, Participants' responsibilities. The regulations were published as Part IV of the January 30, 1989, Federal Register (pages 4722-4733). Copies of the regulations may be obtained by contacting the Department of Agriculture agency with which this transaction originated.

(BEFORE COMPLETING CERTIFICATION, READ INSTRUCTIONS ON REVERSE)

- (1) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.
- (2) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Center for Watershed Protection Inc. Making Urban Trees Count
Organization Name PR/Award Number or Project Name

Hye Yeong Kwon Executive Director
Name(s) and Title(s) of Authorized Representative(s)

 4/9/14
Signature(s) Date

Instructions for Certification

1. By signing and submitting this form, the prospective lower tier participant is providing the certification set out on the reverse side in accordance with these instructions.
2. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.
3. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.
4. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.
5. The prospective lower tier participant agrees by submitting this form that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.
6. The prospective lower tier participant further agrees by submitting this form that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transaction," without modification, in all lower tier covered transaction and in all solicitations for lower tier covered transactions.
7. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.
8. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.
9. Except for transactions authorized under paragraph 5 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

U.S. DEPARTMENT OF AGRICULTURE

**CERTIFICATION REGARDING
DRUG-FREE WORKPLACE REQUIREMENTS (GRANTS)
ALTERNATIVE I - FOR GRANTEEES OTHER THAN INDIVIDUALS**

This certification is required by the regulations implementing Sections 5151-5160, of the Drug-Free Workplace Act of 1988 (Pub. L. 100-690, Title V, Subtitle D; 41 U.S.C. 701 et seq.), 7 CFR Part 3017, Subpart F, Section 3017.600, Purpose. The January 31, 1989, regulations were amended and published as Part II of the MAY 25, 1990, Federal Register (pages 21681-21691). Copies of the regulations may be obtained by contacting the Department of Agriculture agency offering the grant.

(BEFORE COMPLETING CERTIFICATION, READ INSTRUCTIONS ON REVERSE).

Alternative I

- A. The grantee certifies that it will or will continue to provide a drug-free workplace by:
- (a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;
 - (b) Establishing an ongoing drug-free awareness program to inform employees about --
 - (1) The dangers of drug abuse in the workplace;
 - (2) The grantee's policy of maintaining a drug-free workplace;
 - (3) Any available drug counseling, rehabilitation, and employee assistance programs; and
 - (4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;
 - (c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a):
 - (d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will --
 - (1) Abide by the terms of the statement; and
 - (2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;
 - (e) Notify the agency in writing, within 10 calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position, title, to every grant officer on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;
 - (1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or
 - (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;
 - (g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e) and (f).

B. The grantee may insert in the space provided below the site(s) for the performance of work done in connection with the specific grant:

Place of Performance (Street address, city, county, State, zip code)

~~8370~~ 8390 Main St 2nd Floor
Ellicott City MD 21043

Check if there are workplaces on file that are not identified here.

Organization Name Center for Watershed Protection Inc. Award Number or Project Name Making Urban Trees Count

Name and Title of Authorized Representative

Signature 

Date 4/17/14

Instructions for Certification

1. By signing and submitting this form, the grantee is providing the certification set out on pages 1 and 2.
2. The certification set out on pages 1 and 2 is a material representation of fact upon which reliance is placed when the agency awards the grant. If it is later determined that the grantee knowingly rendered a false certification, or otherwise violates the requirements of the Drug-Free Workplace Act, the agency, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.
3. Workplaces under grants, for grantees other than individuals, need not be identified on the certification. If know, they may be identified in the grant application. If the grantee does not identify the workplaces at the time of application, or upon award, if there is no application, the grantee must keep the identity of the workplace(s) on file in its office and make the information available for Federal inspection. Failure to identify all known workplaces constitutes a violation of the grantee's drug-free workplace requirements.
4. Workplace identifications must include the actual address of buildings (or parts of buildings) or other sites where work under the grant takes place. Categorical descriptions may be used (e.g., all vehicles of a mass transit authority or State highway department while in operation, State employees in each local unemployment office, performers in concert halls or radio studios).
5. If the workplace identified to the agency changes during the performance of the grant, the grantee shall inform the agency of the change(s), if it previously identified the workplaces in question (see paragraph three).
6. Definitions of terms in the Nonprocurement Suspension and Debarment common rule and Drug-Free Workplace common rule apply to this certification. Grantees' attention is called, in particular, to the following definitions from these rules:

"Controlled substance" means a controlled substance in Schedules I through V of the Controlled Substances Act (21 U.S.C. 812) and as further defined by regulation (21 CFR 1308.11 through 1308.15);

"Conviction" means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes;

"Criminal drug statute" means a Federal or non-Federal criminal statute involving the manufacture, distribution, dispensing, use, or possession of any controlled substance;

"Employee" means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) all "direct charge" employees; (ii) all "indirect charge" employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if sued to meet a matching requirement; consultants or independent contractors not on the grantee's payroll; or employees of subrecipients or subcontractors in covered workplaces).

Application for Federal Assistance SF-424

* 1. Type of Submission:

- Preapplication
 Application
 Changed/Corrected Application

* 2. Type of Application:

- New
 Continuation
 Revision

* If Revision, select appropriate letter(s):

* Other (Specify)

* 3. Date Received:

4. Applicant Identifier:

5a. Federal Entity Identifier:

* 5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name:

Center for Watershed Protection, Inc.

* b. Employer/Taxpayer Identification Number (EIN/TIN):

54-1644387

* c. Organizational DUNS:

0285765980000

d. Address:

* Street1:

8390 Main Street, Second Floor

Street2:

* City:

Ellicott City

County:

* State:

Maryland

Province:

* Country:

USA: UNITED STATES

* Zip / Postal Code:

21043

e. Organizational Unit:

Department Name:

Division Name:

f. Name and contact information of person to be contacted on matters involving this application:

Prefix:

* First Name:

Hye Yeong

Middle Name:

* Last Name:

Kwon

Suffix:

Title:

Organizational Affiliation:

* Telephone Number:

410-461-8323

Fax Number:

410-461-8324

* Email:

hyk@cwpp.org

Application for Federal Assistance SF-424

9. Type of Applicant 1: Select Applicant Type:

M: Nonprofit with 501C3 IRS Status (Other than Institution of Higher Education)

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

Forest Service

11. Catalog of Federal Domestic Assistance Number:

10.675

CFDA Title:

Urban and Community Forestry Program

*** 12. Funding Opportunity Number:**

USDA-FS-UCF-01-2014

* Title:

2014 National Urban and Community Forestry Grant Program

13. Competition Identification Number:

Title:

14. Areas Affected by Project (Cities, Counties, States, etc.):

*** 15. Descriptive Title of Applicant's Project:**

Making Urban Trees Count: A Project to Demonstrate the Role of Urban Trees in Achieving Regulatory Compliance for Clean Water

Attach supporting documents as specified in agency instructions.

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant MD-007

* b. Program/Project US-all

Attach an additional list of Program/Project Congressional Districts if needed.

17. Proposed Project:

* a. Start Date: 10/01/2014

* b. End Date: 03/31/2016

18. Estimated Funding (\$):

* a. Federal 127,727.84
* b. Applicant 0
* c. State 0
* d. Local 0
* e. Other 127,727.84
* f. Program Income 0
* g. TOTAL 255,455.68

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

a. This application was made available to the State under the Executive Order 12372 Process for review on 07/15/2013.

b. Program is subject to E.O. 12372 but has not been selected by the State for review.

c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes", provide explanation.) Applicant Federal Debt Delinquency Explanation**

Yes No

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix: Middle Name: * First Name: Hye Yeong

* Last Name: Kwon

Suffix:

* Title: Executive Director

* Telephone Number: 410-461-8323 Fax Number: 410-461-8324

* Email: hyk@cwpa.org

* Signature of Authorized Representative: *Hye Yeong Kwon* * Date Signed: 4/9/14

Application for Federal Assistance SF-424

*** Applicant Federal Debt Delinquency Explanation**

The following field should contain an explanation if the Applicant organization is delinquent on any Federal Debt. Maximum number of characters that can be entered is 4,000. Try and avoid extra spaces and carriage returns to maximize the availability of space.

Empty text input area for the Applicant Federal Debt Delinquency Explanation.



United States Department of the Interior

NATIONAL BUSINESS CENTER

Indirect Cost Services

2180 Harvard Street, Suite 430

Sacramento, CA 95815



September 10, 2013

Ms. Hye Yeong Kwon, Executive Director
Center for Watershed Protection, Inc.
8390 Main Street, Second Floor
Ellicott City, MD 21043-4865

Dear Ms. Kwon:

Enclosed is the signed original negotiated indirect cost rate agreement that was processed by our office. If you have any questions concerning this agreement, please refer to the signature page for the name and contact number of the negotiator.


As a recipient of federal funds, you are required to submit Indirect Cost Proposals on an annually basis. Proposals are due within 6 months after the close of your fiscal year end and are processed on a first-in, first-out basis.

Common fiscal year end dates and proposal due dates are listed below:

Fiscal Year End Date	Proposal Due Date
September 30 th	March 31 st
December 31 st	June 30 th
June 30 th	December 31 st

Please visit our Web site at http://www.doi.gov/ibc/services/Indirect_Cost_Services for guidance and updates on submitting future indirect cost proposals. The website includes helpful tools such as a completeness checklist, indirect cost and lobbying certificates, sample proposals, excel worksheet templates, and links to other Web sites.

Sincerely,


Deborah A. Moberly
Assistant Director

Enclosure

cc: Kysha Holliday, Deputy Director, National Policy, Training and Compliance Division, EPA

Ref: J:\Contracts\EPA\Center for Watershed Protection, Inc. (Cwsp130)\FY 12F 14P Issue.ltr.doc



**Nonprofit Organization
Indirect Cost Negotiation Agreement**

EIN: 54-1644387

Organization:

Center for Watershed Protection, Inc.
8390 Main Street, Second Floor
Ellicott City, MD 21043-4865

Date: September 10, 2013

Report No(s): 13-A-1198(12F)
13-A-1199(14P)

Filing Ref.:
Last Negotiation Agreement
dated October 9, 2012

The indirect cost rate(s) contained herein are for use on grants, contracts, and other agreements with the Federal Government to which 2 CFR 230 (OMB Circular A-122) apply, subject to the limitations contained in Section II.A. of this agreement. The rate(s) are negotiated by the U.S. Department of the Interior, Interior Business Center, and the subject organization in accordance with the authority contained in 2 CFR 230.

Section I: Rate(s)

Type	Effective Period		Rate*	Locations	Applicable To
	From	To			
Final	01/01/12	12/31/12	44.57%	All	All Programs
Provisional	01/01/14	12/31/14	44.57%	All	All Programs

***Base:** Total direct costs, less capital expenditures and the portion of subgrants or subcontracts in excess of the first \$25,000.

Treatment of fringe benefits: Fringe benefits applicable to direct salaries and wages are treated as direct costs; fringe benefits applicable to indirect salaries and wages are treated as indirect costs.

Treatment of paid absences: The costs of vacation, holiday, sick leave pay and other paid absences are included in the indirect cost pool in order to be afforded consistent treatment and equitably allocated to all programs. These costs are not included in the direct cost of salaries and wages. Claims for direct salaries and wages must exclude those amounts paid or accrued to employees for periods when they are on vacation, holiday, sick leave or are otherwise absent from work.

Section II: General

Page 1 of 3

A. Limitations: Use of the rate(s) contained in this agreement is subject to any applicable statutory limitations. Acceptance of the rate(s) agreed to herein is predicated upon these conditions: (1) no costs other than those incurred by the subject organization were included in its indirect cost rate proposal, (2) all such costs are the legal obligations of the grantee/contractor, (3) similar types of costs have been accorded consistent treatment, and (4) the same costs that have been treated as indirect costs have not been claimed as direct costs (for example, supplies can be charged directly to a program or activity as long as these costs are not part of the supply costs included in the indirect cost pool for central administration).

B. Audit: All costs (direct and indirect, federal and non-federal) are subject to audit. Adjustments to amounts resulting from audit of the cost allocation plan or indirect cost rate proposal upon which the negotiation of this agreement was based will be compensated for in a subsequent negotiation.

C. Changes: The rate(s) contained in this agreement are based on the organizational structure and the accounting system in effect at the time the proposal was submitted. Changes in organizational structure, or changes in the method of accounting for costs which affect the amount of reimbursement resulting from use of the rate(s) in this agreement, require the prior approval of the responsible negotiation agency. Failure to obtain such approval may result in subsequent audit disallowance.

D. Rate Type:

1. **Fixed Carryforward Rate:** The fixed carryforward rate is based on an estimate of the costs that will be incurred during the period for which the rate applies. When the actual costs for such periods have been determined, an adjustment will be made to the rate for future periods, if necessary, to compensate for the difference between the costs used to establish the fixed rate and the actual costs.

2. **Provisional/Final Rate:** Within 6 months after year end, the final rate must be submitted based on actual costs. Billings and charges to contracts and grants must be adjusted if the final rate varies from the provisional rate. If the final rate is greater than the provisional rate and there are no funds available to cover the additional indirect costs, the organization may not recover all indirect costs. Conversely, if the final rate is less than the provisional rate, the organization will be required to pay back the difference to the funding agency.

3. **Predetermined Rate:** The predetermined rate contained in this agreement is based on estimated costs which will be incurred during the period for which the rate applies and is normally not subject to subsequent carry-forward adjustments. However, if material changes occur in the grantee/contractor's cost structure, adjustments to the rate may be necessary to compensate for the effects of such changes.

E. Agency Notification: Copies of this document may be provided to other federal offices as a means of notifying them of the agreement contained herein.

F. Record Keeping: Organizations must maintain accounting records that demonstrate that each type of cost has been treated consistently either as a direct cost or an indirect cost. Records pertaining to the costs of program administration, such as salaries, travel, and related costs, should be kept on an annual basis.

G. Reimbursement Ceilings: Grantee/contractor program agreements providing for ceilings on indirect cost rate(s) or reimbursement amounts are subject to the ceilings stipulated in the contract or grant agreements. If the ceiling rate is higher than the negotiated rate in Section I of this agreement, the negotiated rate will be used to determine the maximum allowable indirect cost.

H. Use of Other Rate(s): If any federal programs are reimbursing indirect costs to this grantee/contractor by a measure other than the approved rate(s) in this agreement, the grantee/contractor should credit such costs to the affected programs, and the approved rate(s) should be used to identify the maximum amount of indirect cost allocable to these programs.

I. Central Service Costs: Where central service costs are estimated for the calculation of indirect cost rate(s), adjustments will be made to reflect the difference between provisional and final amounts.

J. Other:

1. The purpose of an indirect cost rate is to facilitate the allocation and billing of indirect costs. Approval of the indirect cost rate does not mean that an organization can recover more than the actual costs of a particular program or activity.

2. Programs received or initiated by the organization subsequent to the negotiation of this agreement are subject to the approved indirect cost rate(s) if the programs receive administrative support from the indirect cost pool. It should be noted that this could result in an adjustment to a future rate.

3. This negotiation agreement is entered into under the terms of an Interagency Agreement between the U.S. Department of the Interior and the cognizant agency. No presumption of federal cognizance over audits or indirect cost negotiations arises as a result of this Agreement.

4. New indirect cost proposals are necessary to obtain approved indirect cost rate(s) for future fiscal or calendar years. The proposals are due in our office 6 months prior to the beginning of the year to which the proposed rate(s) will apply.

Section III: Acceptance

Listed below are the signatures of acceptance for this agreement:

By the Nonprofit Organization:

By the Cognizant Federal Government Agency:

Center for Watershed Protection, Inc.
Grantee/Contractor

U.S. Environmental Protection Agency
Cognizant Agency





Hye Yeong Kwon
Name (Type or Print)

Deborah A. Moberly
Name

Executive Director
Title

Assistant Director
Indirect Costs Services Directorate
Title

September 5, 2013
Date

U.S. Department of the Interior
Interior Business Center
Agency

SEP 10 2013

Date
Negotiated by Wayne Guanzon
Telephone (916) 566-7008



July 11, 2013

Nancy Stremple
Executive Staff to NUCFAC
USDA Forest Service
1611 N. Kent Street, RPE 9
Arlington, VA 22209

Dear Nancy,

I am writing this letter in support of the proposal submitted by the Center for Watershed Protection to the 2014 National Urban and Community Forestry Challenge Cost Share Grant Program. This project proposes to increase the use of urban tree planting as a stormwater BMP by developing design specifications, a method for crediting and verifying their performance, and cost-effectiveness metrics. The proposed work directly addresses major barriers to widespread implementation of trees for stormwater treatment by providing a much-needed review and compilation of the literature, vetted by experts, coupled with field-tested guidance that is delivered directly to the stormwater community in a language and format that is meaningful to them.

One research gap that has been identified as a barrier to increasing the use of trees for stormwater management is the uncertainty related to the influence of leaf litter on stormwater nutrient loads. Although regular street sweeping or leaf collection programs can help to prevent nutrient loads from street tree leaf litter from entering the storm drain system, it is unknown whether specific tree species are more likely to serve as sources or sinks for nutrients. Improving our knowledge in this area could allow managers to more cost-effectively address this concern.

The University of Maryland's role in the proposed project is to evaluate the influence of leaf litter from up to 25 tree species to stormwater nutrient loads. The species selected for analysis will be determined from a review of state stormwater manuals in order to identify the most commonly recommended species in each region of the country. We will analyze the denitrification rate, production of total nitrogen and phosphorus, nitrate, phosphate and dissolved organic carbon on a per sample basis. The results will help to guide species selection for urban tree planting such that trees with lower potential for contributing nutrients to the system but higher potential for nitrogen retention can be prioritized for street tree plantings.

Best Regards,

Dr. Sujay Kaushal, Associate Professor
University of Maryland, Department of Geology
& Earth System Science Interdisciplinary Center
skaushal@umd.edu
301-405-7048

GOVERNMENT OF THE DISTRICT OF COLUMBIA
District Department of the Environment



Office of the Director

July 11, 2013

Ms. Nancy Stremple
Executive Staff to the
National Urban and Community Forestry Advisory Council
USDA Forest Service
1611 N. Kent Street, RPE 9
Arlington, VA 22209

Dear Ms. Stremple:

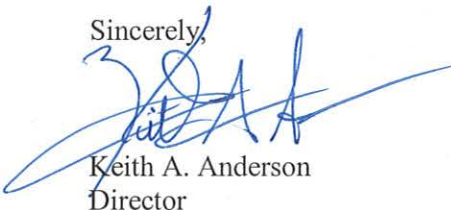
I am writing to describe how the District Department of Environment (DDOE), Stormwater Management Division (SMD) will work with the Center for Watershed Protection (CWP) on a project proposed to the 2014 National Urban and Community Forestry Challenge Cost Share Grant Program. The purpose of the proposal is to increase the use of urban tree planting as a stormwater BMP by developing design specifications, a method for crediting and verifying their performance, and cost-effectiveness metrics. DDOE recognizes the need and benefits of the proposed service and the impact it could have throughout the District of Columbia.

DDOE envisions providing CWP with the following:

- DDOE staff will provide input on the CWP's project work plan and draft protocols.
- DDOE staff will compile site information and engineering plans for site visits.
- DDOE staff will attend grant work sessions with CWP staff.

DDOE has worked to demonstrate over the past several years the practicality of using LID (including tree plantings) to meet District stormwater requirements. Mayor Vincent C. Gray's Sustainable DC Plan calls for enhancing the urban tree canopy to cover 40% of the District, and retrofit 75% of the existing landscape with green infrastructure to filter stormwater runoff, by 2032. The Center's proposal will help the District gain further knowledge about the efficiency of trees at reducing stormwater pollution, and help seize future opportunities for planting trees using existing programs.

Sincerely,



Keith A. Anderson
Director

DISTRICT
DEPARTMENT
OF THE
ENVIRONMENT



green forward





United States
Department of
Agriculture

Forest
Service

Northeastern Area
State & Private
Forestry

180 Canfield Street
Morgantown, WV 26505-3101

File Code: 3000
Date: July 11, 2013

Nancy Stremple
Executive Staff to NUCFAC
USDA Forest Service
1611 N. Kent Street, RPE 9
Arlington, VA 22209

Dear Nancy,

I am writing this letter in support of the proposal submitted by the Center for Watershed Protection to the 2014 National Urban and Community Forestry Challenge Cost Share Grant Program. The Center and its partners propose to increase the use of urban tree planting as a stormwater BMP by developing design specifications, a method for crediting and verifying their performance, and cost-effectiveness metrics. The proposed work directly addresses major barriers to widespread implementation of trees for stormwater treatment by providing a much-needed review and compilation of the literature, vetted by experts, coupled with field-tested guidance that is delivered directly to the stormwater community in a language and format that is meaningful to them.

The Chesapeake Bay Program has adopted a process to address the uncertainty associated with BMPs for nonpoint source runoff management. This process includes assembling a panel of subject matter experts to review the literature and develop recommendations for assigning nutrient and sediment reductions to each BMP. A review panel is in progress to review the credit given to "expanded tree canopy." The panel has agreed that the credit for expanded tree canopy (which does not result in producing forest-like conditions) should be less than what is given for reforestation, but limited information is available to recommend a specific value due to the many influencing variables, such as age and species of trees, distance from impervious cover, and rainfall characteristics, to name a few. The Center's proposed literature review can help to fill this important gap.

While the timing of the proposed work may not align with the conclusion of the expanded tree canopy panel, the results can be incorporated into the next review, or may help to make the case for revisiting this credit sooner than scheduled. We wholeheartedly support the Center's proposal and see it as an important first step that is needed to truly promote urban tree planting on a nationwide scale.

Sincerely,

Julie Mawhorter
US Forest Service, Northeast Area State & Private Forestry, Chesapeake Bay Program
(410) 267-5708, jmawhorter@fs.fed.us



Caring for the Land and Serving People

Printed on Recycled Paper





July 12, 2013

Nancy Stremple
Executive Staff to NUCFAC
USDA Forest Service
1611 N. Kent Street, RPE 9
Arlington, VA 22209

Dear Ms. Stremple,

This letter supports the proposal submitted by the Center for Watershed Protection to the 2014 National Urban and Community Forestry Challenge Cost Share Grant Program. The Center and its partners propose to increase the use of urban tree planting as a stormwater BMP by developing design specifications, a method for crediting and verifying their performance, and cost-effectiveness metrics. The proposed work directly addresses major barriers to widespread implementation of trees for stormwater treatment by providing a much-needed review and compilation of the literature, vetted by experts, coupled with field-tested guidance that is delivered directly to the stormwater community in a language and format that is meaningful to them.

Arlington County would use the results to help foster our tree-planting goals and bolster our efforts to meet the our MS4 regulatory requirements. The County's Urban Forest Master Plan has a primary goal of improving Arlington's urban forest canopy coverage (currently calculated at approximately 40%). In support of the Urban Forest Master Plan and our MS4 program requirements, Arlington County plants approximately 650 trees per year on County property. Arlington County has also established two programs to facilitate tree planting on private property: an annual tree distribution program that provides between 800 and 1,200 small tree "whips" to residents each year for planting in their yards; and, a tree canopy fund grant program administered by the non-profit agency Arlingtonians for a Clean Environment, which provides grants to neighborhood groups for planting trees on private property.

Trees are one of the most cost-effective practices for stormwater, yet their use is hampered by lack of quantifiable data regarding their stormwater benefits. We wholeheartedly support the Center's proposal and see it as an important first step that is needed to truly promote urban tree planting on a nationwide scale.

Sincerely,

A handwritten signature in black ink, appearing to read "Jason Papacosma".

Jason Papacosma
MS4 Program Coordinator

Cc: Jamie Bartalon, Landscape and Forestry Supervisor, Arlington County



Martin O'Malley, Governor
Anthony G. Brown, Lt. Governor
Joseph P. Gill, Secretary
Frank W. Dawson III, Deputy Secretary

July 10, 2013

Nancy Stremple
Executive Staff to NUCFAC
USDA Forest Service
1611 N. Kent Street, RPE 9
Arlington, VA 22209

Dear Nancy,

I am writing in support of the proposal submitted by the Center for Watershed Protection to the 2014 National Urban and Community Forestry Challenge Cost Share Grant Program. The Center and its partners propose to increase the use of urban tree planting as a stormwater BMP by developing design specifications, a method for crediting and verifying their performance, and cost-effectiveness metrics. The proposed work directly addresses major barriers to widespread implementation of trees for stormwater treatment by providing a much-needed review and compilation of the literature, vetted by experts, coupled with field-tested guidance that is delivered directly to the stormwater community in a language and format that is meaningful to them.

As a member of the panel currently reviewing urban tree planting nutrient removal efficiencies for the Chesapeake Bay Program, I am well aware of the great need to develop better data on performance and more detailed design guidance for urban tree planting practices that optimize water quality functions. Urban forest BMPs are an important part of Maryland's Chesapeake Bay Program Watershed Implementation Plan for the TMDL under the Clean Water Act, and this information would help inform and improve the expected increase in urban tree planting.

We urge your support of this project to expand this base of information on urban forest BMPs, and are ready to cooperate as a partner in tracking and implementation.

Sincerely,

Anne Hairston-Strang, Ph.D.
Forest Hydrologist



July 15, 2013

Karen Cappiella
Director of Research
Center for Watershed Protection
8390 Main Street, Second Floor
Ellicott City, MD 21043-4605

Dear Karen –

Thank you for the opportunity to collaborate with on your proposal: Making Urban Trees Count: A Project to Demonstrate the Role of Urban Trees in Achieving Regulatory Compliance for Clean Water, submitted under the 2014 U.S. Forest Service National Urban and Community Forestry Challenge Cost-Share Grant Program Request for Pre-Proposals (RFP).

This letter of intent is provided to document our support for this project and our intent to participate in the project in the event of an award.

I have been involved with the Chesapeake Bay Program's Urban Tree Canopy initiative from the onset. I personally acquired the commitments of Baltimore Mayor Martin O'Malley and Annapolis Mayor Ellen Moyer, among others, to set the first Urban Tree Canopy goals as part of the Bay restoration strategy. Now that we have watched the Urban Tree Canopy goal setting process spread throughout the Bay and the Bay Program move from a voluntary to a regulatory program, it is time to determine a credible scheme to recognize Urban Tree Canopy as a creditable best practice to meet Clean Water Act objectives.

The work described in this proposal will further the work we have done on the Chesapeake Bay Program Urban Tree Canopy BMP Expert Panel, filling a significant information gap and providing important decision support. The findings will also be applicable and transferable to other communities or watersheds trying to assess the value of urban tree canopy as a watershed management tool.

Thank you for your consideration and if you have any questions or require further information, please feel free to contact me.

Best regards,

Michael F. Galvin, Registered Consulting Arborist #432
Director, Consulting Group
SavATree
mgalvin@savatree.com
914-403-8959

Areas of Expertise

Karen joined the Center for Watershed Protection, Inc. in 2000 and directs the Center's Research Program, which conducts applied research to better understand the influence of land use change on water resources and how best to prevent or mitigate these impacts. She has over 14 years of experience providing technical assistance and guidance to communities on responsible land and water management techniques. Karen is co-editor-in-chief of the Center's peer-reviewed journal *Watershed Science Bulletin* and edits the Center's e-newsletter *Runoff Rundown*. Her areas of interest include protecting forests and wetlands through watershed planning, use of GIS to analyze land cover impacts and costs and benefits of water quality management practices for MS4 and TMDL compliance. Karen is trained in various field methods and has extensive project management experience.

Representative Projects

- Cost-Effective Approaches to Achieve Urban Stormwater TMDL Goals in the James River Basin, VA. Project Manager. December 2011- November 2013. To help support localities in the development of cost-effective and feasible plans to meet water quality goals, the Center completed a study to: 1) identify the most cost-effective urban stormwater management strategies that can be used by James River Basin localities to meet pollutant removal goals of the Chesapeake Bay TMDL, and 2) assess the extent to which local TMDL implementation plans can also address pollutant reductions required of localities as part of the Bay TMDL.
- Using Trees to Protect and Restore Urban Watersheds. Project Manager. June 2003- December 2006.
The Center worked with the USDA Forest Service to conduct research on urban forestry, facilitate design workshops on incorporating trees into stormwater treatment practices, produce a 3-part guidance manual that presents new methods in urban watershed forestry, and develop six training modules that provide instruction on these methods. Karen was project manager and lead author on the 3-part *Urban Watershed Forestry Manual* series.
- Urban Forestry Toolkit Website. Project Manager. July 2007-December 2008.
The Center is working with the USDA Forest Service to develop a comprehensive resource website for urban forestry. The website will contain tools, links and additional information on forest planning and assessment, using trees to reduce stormwater runoff, forest-friendly development and planting and maintaining urban trees. Karen is project manager and is developing the content for this website.

Previous Positions

- Adjunct Faculty, University of Maryland University College, 2006
- Program Manager, Center for Watershed Protection, 2006 -2006
- Environmental Analyst, Center for Watershed Protection, 2002-2006
- Watershed Technician, Center for Watershed Protection, 2000-2002
- Geographer, U.S. Census Bureau, 1999-2000
- Earth Science Intern, Environmental Careers Organization, 1998-1999
- Research Assistant, East Carolina University, 1996-1998

Education

- MA East Carolina University. Geography. 1998
- BA Millersville University. Geography. Studio Art minor. 1996

Selected Publications

Cappiella, K., Hirschman, D., and B. Stack. 2013. Using Nutrient Credits and Offsets To Achieve Stormwater Compliance with the Chesapeake Bay TMDL: A Discussion Paper. *Watershed Science Bulletin* December 2013 issue.

Lehman, S., **Cappiella, K.**, Schneider, J., and L. Woodworth. 2012. Tracking the Progress of Watershed Planning: Two Views. *Watershed Science Bulletin* 3(2): 7-20.

Cappiella, Karen, Stack, W.P., Fraley-McNeal, Lisa, Lane, Cecilia, and McMahan, Gerard, 2012, *Strategies for managing the effects of urban development on streams*: U.S. Geological Survey Circular 1378, 69 p.

Drescher, S.R., Law, N. L., Caraco, D.S., **Cappiella, K. M.**, Schneider, J.A., and Hirschman, D.J. 2011. Research and policy implications for watershed management in the Atlantic coastal plain. *Coastal Management* 39: 242-258.

Law, N.L., **Cappiella, K.**, and M. Novotney. 2009. The Need for Improved Pervious Land Cover Characterization in Urban Watersheds. *Journal of Hydrologic Engineering* 14(4): 305-308

Schueler, T., Fraley-McNeal, L., and **K. Cappiella**. 2009. Is Impervious Cover Still Important? A Review of Recent Research. *Journal of Hydrologic Engineering* 14(4): 309-315.

Cappiella, K., Collins, K., Hirschman, D., and M. Novotney. 2008. *New Approaches to "Greening" Stormwater*. WEF Sustainability 2008 Conference Proceedings. Water Environment Federation. Alexandria, VA.

Cappiella, K., Schueler, T., Tomlinson, J., and T. Wright. 2006. *Urban Watershed Forestry Manual. Part 3: Urban Tree Planting Guide*. NA-TP-01-06. USDA Forest Service, Northeastern Area State and Private Forestry. Newtown Square, PA.

Cappiella, K., Schueler, T., and T. Wright. 2006. *Urban Watershed Forestry Manual. Part 2: Conserving and Planting Trees at Development Sites*. NA-TP-01-06. USDA Forest Service, Northeastern Area State and Private Forestry. Newtown Square, PA.

Cappiella, K., Schueler, T., and T. Wright. 2005. *Urban Watershed Forestry Manual. Part 1: Methods for Increasing Forest Cover in a Watershed*. USDA Forest Service Northeastern Area State and Private Forestry. NA-TP-04-05. Newtown Square, PA.

Cappiella, K. and T. Schueler. 2002. Crafting A Lake Protection Ordinance. *LakeLine* 22(2): 15-22.

Cappiella, K. and K. Brown. 2001. Land Use/Impervious Cover Relationships in the Chesapeake Bay. *Watershed Protection Techniques* 3(4): 835-840.

Cappiella, K., Malzone, C., Smith, R. E., and B. Jaffe. 1999. *Sedimentation and Bathymetry Changes in Suisun Bay: 1867-1990*. USGS Open-File Report 99-563.

Phillips, J. D., Golden, H., **Cappiella, K.**, Andrews, B., Middleton, T., Downer, D., Kelli, D., and L. Padrick. 1999. Soil Redistribution and Pedologic Transformations in the Coastal Plain. *Earth Surface Processes and Landforms* 24: pp. 23-39.

Areas of Expertise

Bill has expertise in managing water resource protection and restoration programs related to water supply and source water protection, urban stormwater management, agricultural non-point source control, and flood management. This expertise includes a thorough understanding of environmental laws and the programmatic needs of government agencies to meet these laws including regulatory requirements; ordinances and regulations along with capital, operation and maintenance budgets; funding sources (storm water utilities, revenue bonds); watershed plans; and schedules to meet compliance needs. Bill has a work history spanning over 33 years and is the senior mentor for technical staff.

Representative Projects

- Washington, D.C. Stormwater Guidebook. Quality Control. 2008 – Present
This project entails production of a guidance manual for use by developers and regulators in adhering to and implementing the Washington, D.C. stormwater regulations. As quality control, Bill provides oversight of the guidebook and is working on the redevelopment and fee-in-lieu criteria.
- Swimmable/ Fishable Baltimore Inner Harbor. Project Manager. 2010 – Present
With an ambitious goal to make the Harbor swimmable and fishable by 2020, Bill is helping the Baltimore Waterfront Partnership to navigate and understand regulations and Baltimore City and County's requirements. Tasks include developing summary papers, delivering presentations, and coming up with the plan on how a swimmable/ fishable Harbor can be achieved.
- James River Extreme BMP Makeover. Team Assistant. 2008 –2010
This project is intended to enhance the nutrient removal performance of urban stormwater BMPs by using research and a series of BMP field assessments to develop the next generation of high-performing stormwater BMPs, focusing on the James River watershed in Virginia. Bill was a team assistant.

Previous Positions

- **Chief, Surface Water Management Division, Baltimore City Department of Public Works, 2009-2010**
Principle "architect" and Chief of the newly created Surface Water Management Division. The "new" Division is comprised of 35 engineers, scientist and support staff and includes an annual operating budget of \$4 million and a capital budget of \$7 million and is a consolidation of the City's surface water-related programs within the Bureau of Water and Wastewater.
- **Chief, Water Quality Management Section, Baltimore City Department of Public Works, 1989-2009**
Responsible for the City's Municipal Stormwater Permit Program, Drinking Water Reservoir Watershed Management Program, and Flood Warning Program. Managed a staff of 16 engineers and scientists and oversaw an annual operating and capital budget of \$5-7 million. Also, involved in numerous water monitoring studies involving urban streams,

Baltimore Harbor and drinking water reservoirs and tributaries. Managed over 30 capital projects related to environmental restoration.

- **Pollution Control Analyst Supervisor, Baltimore City Department of Public Works, 1980-1989**

Designed and managed several water quality improvement projects, such as stormwater extended detention systems, hypolimnetic aeration and stormwater wetlands. Also developed a design manual for urban best management practices and established an environmental mitigation offset fee protocol for the City's Critical Area Program.

- **Associate Conservation Engineer, Baltimore County Soil Conservation District, 1977-1980**

Education

- Masters of Science, Biology, Towson State University, 1981
- Bachelor of Science, Biology, St. Mary's College of Maryland, 1975

Accomplishments

- P.E., (MD Professional Engineering License, P.E., #17691), 1990 – Present
- 2011, Recipient of the Carl Weber Award by the Maryland Water Monitoring Council
- 2010, Baltimore Ecosystem Study (BES) Director's Award
- 2007, Recipient of the Innovations in Public Service Local Agency Award, presented by the Maryland, Chapter of the Association of Professional Administrators
- 1999, Recipient of the "Senator Bernie Fowler Award" by the Maryland Chesapeake Bay Tributary Strategy Teams
- 1990, Recipient of Award from Exemplary State and Local Awards Program sponsored by National Center for Public Productivity, Rutgers University

Publications

Reflections on the Baltimore NURP results, 25 years later. 2006 Fisher, G.T., W.P. Stack, K.T. Belt. Conference Proceedings AWRA Annual Conference Baltimore, MD

Urban Hydrology and Water Infrastructure. 2009 Belt, K., S.S. Kaushal, W.P. Stack, C.M. Swan, R. Pouyat, C. Welty, P. Groffman. Conference Proceedings Smart, Clean & Green: 21st Century Sustainable Water Infrastructure Washington, DC

Kaushal, S.S., Peter M. Groffman, Gene E. Likens, Kenneth T. Belt, William P. Stack, Victoria R. Kelly, Lawrence E. Band, and Gary T. Fisher. 2005. Increased salinization of fresh water in the northeastern U.S. Proceedings of the National Academy of Sciences. 102: 13517-13520.

Stack, W.P. and K.T. Belt. 1989. "Modifying Stormwater Management Basins for Phosphorus Control". Lake Line, North American Lake Management Society, Vol. 9, No. 4.

Stack, W.P. and K.T. Belt. 1989. "The Selection of Appropriate Flow Averaging Periods in Evaluating Pollutant Loadings Using the Flow Interval Method". Lake and Reservoir Management 5(2):67-73. North American Lake Mgt. Society.

Urban stream water quality-a product of "urban karst"? 2008 Belt, K.T., W.P. Stack, C. Welty, S.S. Kaushal, P.M. Groffman. Conference Proceedings 2nd Symposium on Urbanization and Stream Ecology Salt Lake City, UT.

Areas of Expertise

Dr. Neely Law has over 15 years of research and work experience in urban watershed and stormwater management. She joined the Center for Watershed Protection in 2004 and brings with her extensive research experience and knowledge in urban watershed management and water quality analysis. Her areas of project management expertise include coordination of interdisciplinary project teams, data management and facilitation. Her areas of technical expertise include modeling, monitoring study designs, survey development and data analysis. Dr. Law is also trained in various field methods to evaluate the condition of stream health and watersheds. As Senior Research Analyst, primary responsibilities include research development and data analysis related to urban watershed management and stormwater techniques. Additional areas of work include watershed monitoring, water quality modeling, and Geographic Information Systems.

Representative Projects

- Deriving reliable pollutant removal rates for municipal street sweeping and storm drain cleanout programs in the Chesapeake Bay Basin. Project Manager. October 2005 – July 2008. Funded through the U.S. EPA Chesapeake Bay Program, Neely was the project manager for the project to develop improved estimates of the potential nutrient and sediment reductions achievable through municipal street sweeping and storm drain cleanouts. The project involved an extensive literature review, survey, field work and paired catchment monitoring for water quality and flow.
- City of Baltimore Monitoring Downspout Disconnections, MD, Project Manager, 2011 – present. The Center was contracted by the Blue Water Baltimore non-profit watershed organization to evaluate the reduction of stormwater runoff through downspout disconnection by a series of field-based monitoring experiments. Neely is leading this effort and developed and implemented a monitoring plan for on-site field monitoring at residential properties in the City of Baltimore, MD. Results will inform regulators on the effectiveness of reducing runoff from simple downspout disconnection to turf grass.
- Tred Avon Watershed Nonpoint Source Control Implementation Projects. Project Manager, Project Manager, 2011 - present: The Center is working with Talbot County Department of Public Works to implement stormwater management practices to reduce urban and rural/agricultural nonpoint sources of pollution. Neely is the project manager for the monitoring project to evaluate the reduction of nutrients from the capture of gross solids at four outfalls in the Town of Easton, MD.

Previous Positions

- Research Assistant, University of North Carolina at Chapel Hill, Department of Geography, 1998-2002
- Instructor, Geography of Environmental Systems, North Carolina at Chapel Hill, Spring 2002
- Planner, City of Windsor, Department of Planning, 1994-1996.
- Research Associate, Wayne State University, Detroit, MI. 1993-1994.

Education

- PhD in Geography; University of North Carolina at Chapel Hill, Chapel Hill, NC, 2004.

Dissertation: *Analysis of Water Quality Trends in Urban-Suburban Watersheds*

- Masters Geography, University of Toronto, Toronto, Ontario, 1996
Thesis: *A preliminary multimedia model to estimate contaminant fate in an urban watershed.*
- Bachelors in Environmental Studies, Urban Planning, University of Waterloo, Waterloo, Ontario, 1992
Thesis: *Urban Watershed Planning*

Publications

- Fralely-McNeal, L., **N. L. Law** and J. Tasillo. 2011. Estimating forest loss with urbanization: an important step towards using trees and forests to protect and restore watersheds. *Watershed Science Bulletin (in press)*.
- Drescher, S.R., **N. L. Law**, D. S. Caraco, K. M. Cappiella, J. A. Schneider and D. J. Hirshman. 2011. Research and policy implications for watershed management in the Atlantic Coastal Plain. *Coastal Management*, 39: 242-258.
- N. Law**, L. E. Band, and J. M. Grove. 2004. Nitrogen input from residential lawn care practices in suburban watersheds in Baltimore, County, MD, *Env.Planning and Mgt*, 47(5): 737-755.
- Shields, C., L.E. Band, N. Law, P. Groffman, S. Kaushal, K. Savvas, G. Fisher, K. Belt, 2008. Streamflow Distribution Of Non-Point Source Nitrogen Export From Urban-Rural Catchments In The Chesapeake Bay Watershed. *Water Resources Research*, 44, W09416, doi:10.1029/2007WR006360
- Pickett, S. T. A., M. L. Cadenasso, J. M. Grove, P. M. Groffman, L. E. Band, C. G. Boone, G. S. Brush, W. R. Burch, Jr., C. S. B. Grimmond, J. Hom, J. C. Jenkins, **N. L. Law**, C. H Nilon, R. V. Pouyat, K. Szlavecz, P. S. Warren, M. A. Wilson. 2007. Beyond Urban Legends: An Emerging Framework of Urban Ecology as Illustrated by the Baltimore Ecosystem Study, *Bioscience*, 58(2): 141-152.
- N. Law**, L. E. Band, and J. M. Grove. 2004. Nitrogen input from residential lawn care practices in suburban watersheds in Baltimore, County, MD, *Journal of Environmental Planning and Management*, 47(5): 737-755.
- Groffman, P., **N. L. Law**, K. Belt, L. E. Band, and G. Fisher. 2004. Nitrogen and phosphorus fluxes in urban watershed ecosystems. Nitrogen fluxes and retention in urban watershed ecosystems. *Ecosystems*, 7:393-403.
- Diamond, M.L., D. L. Priemer, **N. L. Law**. 2001. Developing a multimedia model of chemical dynamics in an urban area. *Chemosphere*, 44(7), 1655-1667.
- N. Law** and M.L. Diamond. 1998. The role of organic films and the effect on hydrophobic organic compounds in urban areas: An hypothesis. *Chemosphere*, 36:2607-2620.
- J.H. Hartig, **N.L. Law**, D. Epstein, K. Fuller, J. Letterhos, and G. Krantzberg. 1995. Capacity-building for restoring degraded areas in the Great Lakes. *Int. J. Sustain. Dev. World Ecol.*, 2:1-10.
- J.H. Hartig, G.H. Weaver, and **N. Law**. 1994. Applying a total quality management framework to remedial action planning. *J. Environmental Engineering and Management*, 4: 23-27.
- J.H. Hartig and **N. Law**. 1994. Institutional frameworks to direct the development and implementation of Great Lakes remedial action plans. *Environmental Management*, 4: 855-864.

Areas of Expertise

Laura joined the Center for Watershed Protection, Inc. in 2012. She is knowledgeable in several areas of watershed and stormwater management. Responsibilities include stormwater retrofitting and creating and updating stormwater management guidebooks.

Representative Projects***Stormwater Management***

- Arlington County Stormwater Retrofitting Projects. Team Assistant. October 2012 – Present
The Center is performing retrofit surveys throughout Arlington, Virginia. Laura's role was to develop preliminary concepts for stormwater retrofits.
- Washington, D.C. Stormwater Guidebook. Team Assistant. December 2012 – Present
This project entails the production of a guidance manual for use by developers and regulators in adhering to and implementing the Washington, D.C. stormwater regulations. Laura's role was to assist in updating the Guidebook based on public comments.
- Stormwater Retrofit Opportunities in Somerset County. Team Assistant. February 2013
The Center identified retrofit opportunities in Somerset County, Maryland to help meet their Phase II Watershed Implementation Plan. Laura's role was to develop preliminary concepts for stormwater retrofits.

Previous Positions**Volunteer****June 2012 to July 2012**

USDA-NRCS Wisconsin State Office, Madison, WI

- Assisted in surveying NRCS projects using Trimble GPS survey equipment
- Attended Comprehensive Nutrient Management Plan (CNMP) workshop

Research and Analytics Senior Specialist**April 2010 to July 2012**

American Family Life Insurance, Madison, WI

- Researched, created, and presented quarterly reports that analyzed business results from multiple sources and provided actionable recommendations for the Life Company leadership team on issues impacting the ability to meet business goals
- Conducted ad hoc analysis of Life Company business problems requested by other Life departments and the agency field force; created reports to customer specifications

Project Manager**January 2005 to March 2010**

Roadview, Inc., Madison, WI

- Supervised field data collection crews, in-house data processing and quality assurance, and delivery of data to customer for long-term projects consisting of several data collection systems
- Created project work flows and quality control procedures to accommodate diverse sets of data in fulfillment of project contracts
- Wrote and edited training manuals for processing data and QA procedures

Graduate Research Assistant**May 2003 – December 2004**

Civil and Environmental Engineering, University of Wisconsin - Madison

Education

Master of Science, Civil and Environmental Engineering

December 2004

University of Wisconsin – Madison

Transportation Management and Policy Certificate

Thesis: Administrative Issues in Highway Freight Transport

Bachelor of Science, Biological Systems Engineering

May 2003

University of Wisconsin – Madison

Emphasis: Natural Resources and Environmental Engineering

Licenses and Certifications

- Engineer in Training, Licensed in Wisconsin. Certificate Number 1510848-500