Full Name	[redacted]	03/07/2018 id. 9840287

Original submission

03/07/2018

Email Address	[redacted]
Professional Title	**Ecological Restoration Specialist**
Organization	[redacted]
Are you applying for:	**CERP**
Do you meet all of the requirements for the Biological Science category?	**Yes**
Enter your courses that fulfill the 9 credits in Ecology	**Ecology and the Environment - 4 credits, Cornell University** **Ecosystem Biology - 4 credits, Cornell University** **Marine Ecology - 3 credits, Cornell University**
Enter your courses that fulfill the remaining 6 credits in Biological Science	**Biological Science Lecture, 101 & 102 - 4 credits, Cornell University** **Biological Science Laboratory, 103 & 104 - 4 credits, Cornell University**
If any of your courses in this category do not have titles that appropriately indicate the course content, please provide additional explanation.	n/a

Do you meet all of the requirements for the Physical Science category?	**Yes**
Enter your courses that fulfill the 6 credits in soils, hydrology, and/or climate science	**Introduction to Soil Science - 4 credits, Cornell University** **Soil Organic Matter - 3 credits, Cornell University**
Enter your courses that fulfill the 9 remaining credits in the Physical Science category	**General Chemistry 207, 208 - 8 credits, Cornell University** **Hydrology and the Environment - 3 credits, Cornell University**
If any of your courses in this category do not have titles that appropriately indicate the course content, please provide additional explanation.	n/a
Do you meet all of the requirements for the Resource Management and Conservation Category?	**Yes**
Enter your courses that fulfill the 3 credits in ecological dimensions	**Wetland Ecology and Management - 3 credits, Cornell University**
Enter your courses that fulfill the 3 credits in human dimensions	**Ethics and the Environment - 4 credits, Cornell University**
Enter the courses that fulfill the remaining 6 credits in the Resource Conservation and Management category.	**Environmental Conservation - 3 credits, Cornell University** **Limnology: Ecology of Lakes, Lecture - 3 credits, Cornell University**

If any of your courses in this category do not have titles that appropriately indicate the course content, please provide additional explanation.	n/a
Do you meet all of the requirements for the Quantitative Science Category?	**Yes**
Enter your courses that fulfill the 6 credits in inventory, monitoring, and/or assessment	**Ecological Methods Lecture & Laboratory - 2 credits, San Diego State University** **Experimental Design - 4 credits, San Diego State University**
Enter your courses that fulfill the remaining 3 credits in the Quantitative Science category	**Univariate Statistics - 3 credits, San Diego State University**
If any of your courses in this category do not have titles that appropriately indicate the course content, please provide additional explanation.	n/a
Do you meet all of the requirements for the Ecological Restoration Category?	**Yes**
Enter your courses that fulfill the 6 credits in Ecological Restoration.	**Restoration Ecology - 3 credits, San Diego State University** **Environmental Conservation Theory - 3 credits, San Diego State University**

f any of your courses in this category do not have titles that appropriately indicate the course content, please provide additional explanation.	n/a

Upload Transcripts

Cornell_University.pdf

San_Diego_State_University.pdf

Provide a brief description of your professional-level experience that satisfies the 5-year full time equivalent.	[redacted]

Upload CV/Resume

[redacted]

Check Project #1 to enter project details.	**Project #1**
Project #1: Name	**Quander Road Stream Restoration**
Project #1: Location	**Mount Vernon District Park, Alexandria, VA**
Project #1: Stage of Project	**Implementation**

Project #1: Objectives	As the first restoration ecologist in my department, my specific goal for all of our restoration projects is to bring them more in line with sound ecological restoration principles. Stormwater Planning in the Fairfax County Department of Public Works (Virginia) is tasked with designing and implementing projects to improve the water quality of the Chesapeake Bay Program. One method to improve water quality is to reduce nutrient and sediment inputs from degraded urban streams. Local projects meet design criteria to qualify for load reduction credits as set by a regional steering committee. By working to set local goals in addition to regulatory criteria, such as ecological lift and minimizing construction impact, I am implementing a higher standard for our watershed improvement projects. I can also move our program towards better restoration by minimizing construction impact, removing undesirable species, and mitigating construction impacts on site. By treating our stream improvement projects as opportunities to restore the whole ecosystem, as opposed to just reduce nutrient and sediment inputs to the Bay, we are using the projects to enhance the ecosystem and improve biodiversity over pre-restoration condition. On the Quander Road Project, my role was to oversee construction, adapt the designed plan for improved riparian restoration and to establish an adaptive monitoring program. Implementing the SER principles already created a better project in at least two areas. Drawing on the great rapport established with the stakeholders during the design phase (Concept 6), continued engagement during construction allowed for the redesign and implementation of a better pedestrian/bicycle crossing. We were also able to take advantage of the expert landscaping subcontractor (Concept 5) by adapting a good re-planting design to a better restoration with careful placement of vegetation. Long-term, as with all of our stream restoration projects, we are looking for a stable stream that will not erode with any future increase in upstream development. The 10-year vegetation and stream function goals are still under-review, see project #3 “Riparian Forest Success,” but include 90% forest cover, a diverse native plant community and a stabilized stream, that seamlessly blend with the existing forested, recreational, district park.
Project #1: Project Description	The Quander Road Stream Restoration project was designed and implemented over a five-year period under the oversight of a Nationwide 27 permit. The project team consisted of land owner (county park system), county oversight (urban forester), community members (both local homeowners and community watershed activists), park recreational users, contracted stream design engineers, contracted stream construction, county engineers, construction managers, and myself. The driving philosophy of our practice is to move the streams into the stable channel that they want to form, bypassing all the erosion that would have to occur to get the stream into that shape (Concept 3).

The project area included a dangerously eroded outfall from a piped stormwater conveyance system, an adjacent tributary, the convergence and ~300 linear feet downstream, for a total length of ~850 lf. Approximately 1.5 acres of riparian buffer and upland vegetative communities were also impacted. At the upstream end of the project, the 16.9 acre watershed has 39% imperviousness. The restored section is contained within a large (95-acre), forested park. The pre-restoration forested ecosystem was generally of good quality, with ongoing threats from both non-native invasive plant species, overgrazing by white-tailed deer, and the 20 foot+, deeply incised channel of the intermittent stream. The underlying geology is highly erodible and has friable soil (marine clay).
A lot of careful thought was given to an appropriate reference system for this project (Concept 1). Given the atypical (and man-made) slope associated with this stormwater conveyence outfall the in-stream portion of the project uses the Rosgen A-Type Channel synthesized reference reach. The riparian and upland portions of the project were referenced with adjacent forested communities. Pre-design surveys determined both vegetation community type and condition, as well as surveyed for endangered and threatened species. The species palette reflects the local community, with minor modifications to allow for more early successional species than were present in the mostly undisturbed system.

The Target System (Concept 2) is enhanced from its pre-restoration condition, however, some ongoing challenges suggest that a 5-star recovery is not feasible. Untreated stormwater will continue to flow into the site. However, the design took this into account, and incorporated several energy dissipating features in the first reach of the restored stream (including any potential future increase in stormwater resulting from infill development.) Enhancing the streams' ability to tolerate high, flashy storms, will protect the downstream reaches from experiencing the same damaging hydroperiod. The lower reach of the stream now has enhanced connectivity to the floodplain and existing seeps on site. The non-native undesirable species have been replaced with desirable native species, maximizing protection and/or transplantation of onsite desirable species. The replanted community contains a high diversity of species with the capacity to build future structure to enhance development of system architecture. In addition to live material, I directed that 16 large logs and 8 root wads were placed to enhance architecture and habitat quality for wildlife during the early stages of recovery. The added benefit of using root wads, was to retain some of the seed bank, although these islands will be closely watched for non-native invasive species as well. By reconnecting the floodplain in the lower reaches, and preventing future scour, this intermittent stream will be able to freely flow over a wider area, improving the water quality downstream.

By working with the large project team, with a variety of expertise, (Concept 5, 6) the Quander Road Stream restoration is likely to lead to a successful restoration of stream water quality. At one year post-construction, anecdotal reports of downstream water clarity have

	improved. Park maintenance personnel report limited to no culvert clean outs of a downstream culvert that regularly clogged pre-restoration. And stream stability has improved, with no movement of installed rock structures. Certainly the initial condition, a 20' gaping chasm that was measurably widening and deepening, is no longer present. Post construction mitigation of access paths could not fully be evaluated at one-year post construction (due to plant dormancy in February), however light monitoring in October did not reveal any dead stems, heavy vegetation growth in the lower elevations and only light infestation with the undesirable non-native invasive plant Lespedeza cuneata. Non-native invasive vegetation will be managed and planted stock will be monitored more thoroughly during the second growing season; more woody stems will be added as needed.
Describe how your project aligns with SER standards and principles of ecological restoration.	**Our restoration program routinely tests the goals and boundaries of ecological restoration, as the scale of our projects include onsite mitigation of the impacts of construction damage, enhancement of intact ecosystems to ecological restoration. Including rehabilitation, repair, intervention, and management, as well as the larger watershed and regional restoration in the scope of work, allows all aspects of the project to adhere to the strictest standards and principles of ecological restoration. I believe in order to achieve our highest and best effort (Concept 4), it is key that the stream restoration occurs throughout the landscape space and without limit to the context of the construction schedule. Effective restoration and ecosystem enhancement occur by enhancing natural recovery processes, through time, and not limiting the project to a defined series of months.** **Efficiency was influenced and prioritized at both the design and construction phases. Both limiting construction access paths, reusing on site material (trees) as structures in the stream and on the floodplain, and working with a highly qualified designer and contractor, minimizes both the impact on the system and the need for corrective actions. Projects are carefully phased so that work can be done in a logical order, limiting duplication of efforts; submittals are scheduled early in the process to allow for lead time for substitutions. Careful attention to detail at the design phase minimized change orders and helped limit time of construction.** **The public, neighbors and stakeholders have been actively engaged since project inception (Concept 6). As the Quander Road project is on public parkland accessed from a residential street, community interest and support was both critical and driving project success. Prior to restoration, the park was treated as an illegal dumping area for yard waste, a problem that has not returned post-restoration, likely due to the improved sight lines and neighborhood familiarity with the value the county places on its park resources. The significant concern right now is the pop-up use of the area as an off-leash dog park (as evidenced by the 10+ abandoned squeaky toys found scattered through the site in February). A liberal scattering of coarse woody debris (one hiker complained it is a "real ankle turner") has not prevented this use developing. Although off-leash dog use is undesirable from a trampling perspective, it is likely having a positive**

effect in driving deer herbivory away from the site, and will likely self-limit as the woody vegetation fills out. The situation will be monitored.

Principled ecological restoration is at the heart of many of our design processes. Clearly defined targets, goals and objectives are defined prior to restoration design. At Quander Road, we had the adjacent and mostly intact 95-acre forest to use as our reference system. It is especially difficult in urban systems to select appropriate reference systems, as the reality of an ecological community in an urban setting is already somewhat degraded. A large database of historical photos can assist in selecting a reference system with a similar land-use history which can improve the fit of the reference system with the project. We have both short-term goals (85% of woody plants survive the first year of restoration with 80% vegetative ground cover) and long-term goals (90-100% canopy cover at 10 years). In order to meet our goals, we have established monitoring and management of non-native invasive species guidelines (0% highly invasive species and <30% medium or low priority invasive species within our disturbance footprint), and are beginning to set objectives for both species diversity (as measured by floristic quality index), woody stem density and benthic macroinvertebrate community quality (where appropriate). Monitoring of several of our projects is beginning prior to restoration (not available at Quander Road), but by including Quander Road into our monitoring program, it can inform on how we can expect nearby restorations to recover, given similar hydrologic, geologic and vegetation community conditions.

Long-term stability will be monitored in perpetuity, with opportunities to provide touches of ongoing maintenance, and given the restoration project is on public parkland, the systems are in place for maintaining institutional knowledge of the asset over the lifespan of the project.

Project #1: Describe your role in the project.

I am the project manager for the Quander Road Stream Restoration project, however, I only became attached to the project once we were in the construction phase. Additionally, I oversee the long-term monitoring of the vegetation and riparian buffer for all restoration projects, and therefore serve both roles for Quander Road.

My role was to oversee the stream restoration implementation, to communicate with the stakeholders, and oversee monitoring. I worked closely with the construction manager to minimize the disturbance footprint, provide better pedestrian/bicycle access within the finished project, design and approve modifications to the landscaping plan, and to enhance structural diversity by introducing a large amount of coarse woody debris into the floodplain.

I will continue to be involved with the project through the initial monitoring program (stream stabilization period) and the longer-term riparian buffer restoration and enhancement cycle.

Upload Project #1 Supporting Information (Optional)

Stakeholder_Tour_13January17.pdf

Check Project #2 to enter project details.	**Project #2**
Project #2: Name	**Reforestation**
Project #2: Location	**Multiple Locations, Fairfax County**
Project #2: Stage of Project	**Implementation**
Project #2: Objectives	**Opportunities to reforest large contiguous parcels are relatively rare in the moderately forested (40% canopy cover) suburban to urban Fairfax County (Virginia). Most unforested land is in use, has easements (such as sewer, sight line) or other conflicting uses. Locating ten acres of low quality old field habitat and/or turf suitable for reforestation, was itself an initial objective. Suitable locations were located in five separate parcels throughout the county.** **Old field habitat was the target initial condition, as the project was to assist natural recovery, with a minimum of disturbance. Conversion of fescue turf fields are able to provide a higher ecological uplift, however, there was less initial information available on restoration trajectory.** **Floristic inventory of adjacent or nearby forests supplemented vegetation community data gathered for different projects (Concept 1).** **In addition to meeting the regulatory requirements for reforestation and land-use conversion, ecological objectives were left to me. My objectives included working with our stakeholders to avoid reforestation failure (either societal or ecological); testing our traditional reforestation scheme vs a modified tree island technique in order to improve all reforestation projects; and testing a second planting method based on larger stock, to potentially lower maintenance costs. Each forest is slightly different, reflecting local vegetative communities, underlying geology, local hydrology and historic human use.** **Each site is unique, but all have the objective of forming a thriving, multi-layered ecosystem on a forested trajectory within 10 years. My goal is to nurture the 10 acres of forest so that they are a self-sustaining forest within 10 years.** **Opportunities for neighborhood stewardship are being pursued, especially at Churchill Road where nearby schools are engaged and a volunteer resource management program was previously established (Concept 6). This reforestation effort is unique in that a reforestation easement was established at each location.**
Project #2: Project Description	**Although the project is 10 Acres in total, it is divided into five different parcels:** **Olney Park (~0.50 acres) was a turf open play area, adjacent to a major highway, it has little connection with surrounding forested**

areas. Existing conditions included fescue dominated turf and a border area containing Hedera spp., Ailanthus altissima and Ampelopsis brevipedunculata. Other land in the park was slowly reforested by a long-term resident who planted trees one at a time over 40 years, mostly native species that he liked, but not according to any community type or natural assemblage. Working with his model, single trees are widely spaced to allow for continued mowing while the human community adapts to the new land use. He continues to informally monitor the restoration. Mowing will cease after year three and as the neighborhood gains acceptance of the planting. The site will be monitored for survival and managed for non-native invasive species and other threats. The system has a chance of achieving its best potential, however, threats from non-native invasive species and lack of connectivity will be difficult to overcome.

Silas Burke (~2 acres) was mostly open turf area, adjacent to an active railroad. A lack of community investment in the selected portion of the park allowed for a much more extensive reforestation. Approximately half of the final reforestation area had been part of a no-mow agreement, with some natural regeneration of Pinus sp., Juniperus virginiana and Andropogon virginicus. Surveying the site with local botanists' revealed a diverse array of native sedges were also present, even in the mowed areas. This area is subject to a high water table. A portion of the site is infested with phragmites. The on-site seep was already forested and the plant pallette for reforestation was chosen to reflect the forest species already present on site. At this site, we are working with the park manager to follow success of tree planting and management with widely spaced specimen trees and numerous understory shrubs. The system has a chance of achieving its best potential, as onsite threats are minimal, once the phragmites is controlled.

Churchill Road (~2.8 acres), Lewinsville Road (~1.2 acres) and Rock Hill (~3.5 acres) parks were all old field parks infested with varying degrees of non-native invasive species (NNI). The gradient of initial condition ranges from Churchill Road < Lewinsville <Rock Hill District Park. Some community investment in Churchill Road and Lewinsville Road may result in long-term care, as these are parks in the center of communities with close ties to schools and community gardeners. Rock Hill Park is remote, however, it has good connectivity with nearby forested habitats and corridors. All three sites have an experimental planting of tree islands as well as substantial 'regular' spacing (typically 8-12 foot on center plantings). We will monitor these for growth and survivorship, as well as deer browse and other signs of wildlife use (e.g. bird nests). These restorations have a chance of achieving their best potential, as long as ongoing non-native invasive species management occurs.

Churchill Road has extensive coverage of NNI species from fescue and Arthraxon hispidus, Rubus phoenicolasius to Pyrus calleryana, Prunus avium, and Ampelopsis brevipedunculata and Celastrus orbiculatus. Repeated mechanical and chemical NNI control were

implemented prior to planting the first part of the project. Additional control, and seeding with a native seed mix will be completed before the second two-thirds of the woody material is installed. Lewinsville (Ampelopsis brevipedunculata, Rubus phoenicolasius and Pennisetum setaceum) and Rock Hill (Pyrus calleryana) have slightly better existing conditions have had two mechanical and chemical NNI control events prior to planting. Lewinsville was completely planted in the fall, RH will be entirely planted in the spring.

Plantings at Churchill, Lewinsville and Rock Hill were divided into two types of planting, a regular density of approximately 9' on center and a tree island method where spacing between individual plants was reduced to ~2.5' and included a dense outer ring of deer resistant shrubs and fast growing, early successional trees. Each park had a slightly different species mix, but typical native early successional species include Robinia pseudoacacia, deer resistant species include Asimina triloba, climax species include Quercus sp. and Nyssa sylvatica and understory species include Rhus spp. and Viburnum spp.

All sites are protected under perpetual reforestation easements. All of the plantings incorporate a diversity of species and structural diversity, based in part on a pre-restoration survey of the sites (Concept 1). Many of the plantings include species from early-mid successional old field communities as well as target desirable climax species such as oak, viburnum and hackberry (Concept 3). Opportunities for stakeholder engagement are sought through informal and formal processes (Concept 6). As much of this work is being undertaken by a contractor who has extensive experience in reforestations, the nature of the experimental plantings has the opportunity to educate them as well as their other clients as we track the progress of the restorations over the next 10 years.

Describe how your project aligns with SER standards and principles of ecological restoration.	**Over the last 15 years, my restoration reforestation model has shifted from habitat specific, locally-sourced natives > limiting the palette to a defined community type > my current goal of an early to mid-successional community, with the foundation of the desired climax community. Over this time I have also improved site selection (not always within my control), protection for remaining intact forests, and protection of reforested lands (reforestation easements). My restoration process recognizes that the restoration benefits begin before day one (stakeholder and community outreach may bring together individuals in a common goal), and may not be dependent on a mature forest (which could be 50 to 100 years away) to meet reforestation functional needs.** **Although each restoration is slightly different, they share similar scores on the Recovery Wheel (Concept 2,4), with similar levels of potential.** **Absence of Threats: Although deer browse and non-native species will be present in these systems, they are on parkland and protected in a reforestation easement. Inclusion of both deer guards on planted**

material and a non-native invasive species management plan suggest a 3- or 4- star recovery potential.
Physical conditions: No known concerns with substrate that cannot be alleviated with deeper rooted trees and shrubs. Rock Hill location is known to have been an abused pasture in the past, but existing vegetation of red cedar, persimmon and broom sedge suggest recovery is possible. Expecting 5 star recovery potential.
Species composition: Each site had between 10 and 15 species restored with careful mowing and non-native invasive species management plans in place, onsite dispersal is likely to occur and increase woody plant diversity. Expecting 4- or 5- star recovery potential.
Structural diversity: Both shrubs and trees were established with the initial and planned follow-up plant installations. Most reference systems are depauperate in the shrub layer, and in species that are not deer resistant. Expecting a 4- star recovery potential.
Ecosystem functionality: Once mowing ceases on all sites, dispersal and recruitment from in situ or planted sources is expected to occur. At Churchill Road, one species already successfully fruited. Expecting a 5-star recovery potential.
External exchanges: The parks are relatively isolated, for the most part, and are not within the larger landscape to improve connectivity between forested tracts. Most sites will be limited to a 2-star recovery potential, however Rock Hill may be able to benefit from better connectivity which may elevate the system to a potential 4-star level.

Species selection was based on site (e.g. surrounding community), abiotic condition, desired climax community, and desired structure. Secondary selection constraints included speed of growth, wildlife benefits, and deer resistance. Our supplier was able to source all of the material, however, we had to go outside of a 250-mile radius for some more wide spread species.
Functional recovery metrics for forest communities are being studied as part of another project (see Project 3, Riparian Forest Success), and are useful references to set goals for this project: in 2017, local forest cover was >90% (measured by spherical densiometer), with a FQI > 12 (floristic quality index), and >5833 woody stems an acre. These three metrics are much higher targets than regulatory requirements for reforestation replanting, which are set at 200 overstory, 400 understory and 400 shrubs per acre. After 10 years, the objective is to be within 75-80% canopy cover, FQI of > 12 and over 1000 woody stems/acre. These objectives should set the restoration trajectory toward an establishing, maturing system, with a mixture of early, mid- and late successional species, specific to each reforestation (Concept 4).

After the initial 10 years of monitoring and management, responsibility returns to the land owner, (the county park system), which has the capacity and knowledge to maintain forests. Maintaining close ties with the Park system has improved restoration design and will improve hand off success (Concept 5, 6).

Project #2: Describe your role in the project.	**I am the project manager and lead on this project. My role started at site selection (I was able to narrow down the 5 locations from 7 possible locations), and I am the primary designer and assessor for these projects. I am responsible for communication with the land owner. I oversee implementation of the invasive species management plan and installation of the plant material. I was also responsible for overseeing the necessary surveys and legal requirements for easements. I personally complete most of this work, but I also manage the team of landscape architect, surveyors, land acquisition officer, landscape contractor and technicians that assist in completing this project. Outreach and education tasks are shared with the land owner. The funding was secured when I took on this role, although I have recommend the budget and allocations between planting, site preparation and maintenance.**

Upload Project #2 Supporting Information (Optional)

Installation_and_one_year_of_growth_Churchill_Road.pdf

Check Project #3 to enter project details	**Project #3**
Project #3: Name	**Monitoring for Restoration Success**
Project #3: Location	**Multiple locations, Fairfax County and Prince William National Forest**
Project #3: Stage of Project	**Implementation**

Project #3: Objectives	**Deliberate interventions, such as natural channel design (NCD) or regenerative stormwater conveyance (RSC) stream restorations, have unclear cost/benefit ratios to both in-stream and riparian buffer ecological communities, but many recognize the possibility of short-term ecological degradation following construction. Regulatory drivers that promote restoration have assumed that the benefits to the larger ecosystem (e.g. sediment reduction) outweigh the cost to the local ecosystem (e.g. canopy tree loss). Success is often defined as stream stabilization, ignoring the ecological principles as defined in the 5-star Recovery Wheel or also known as ecological uplift (often a goal of a restoration). Given recovery acquired by restoration practices may take years to develop and is likely to occur on a shifting scale dependent on initial stream and watershed condition, my objective is to (1) determine ecological metrics that can be used early on in pre-restoration and immediately post-restoration to determine restoration trajectory and (2) incorporate restoration ecology principles in defining successful projects.** **Ecological metrics such as benthic macroinvertebrates (e.g. Index of Biological Integrity) riparian buffer vegetation (e.g. quality, such as Floristic Quality Index), and vegetation structure, such as tree cover, give a picture of pre- and post-restoration ecosystem health. Numerous scientific articles are published on each of these topics individually and are beginning to be evaluated together in developing more robust models of stream health. I am hoping to drive the question to looking beyond these traditional metrics that offer a limited, 2-D model of the ecosystem that is so far inadequate in quantifying ecological costs. I am also working to fund a soil microbial ecologist (bacterial and fungal) to evaluate the soil community at these same locations, before and after restoration in order to develop a multi-dimensional model that includes biological function to determine a picture of potential ecological uplift. Adequate analog and reference sites will also be included in the study design. A more complete understanding of the potential of the ecosystem if it were to remain untouched, as well as early detection of ecological uplift post-construction, can provide further insight in recognizing the trade-offs that may occur when implementing restoration.**
Project Description	**Stormwater Planning, Fairfax County Department of Public Works (Virginia) has undertaken stream restoration projects to support the Chesapeake Bay Restoration for over 15 years, however, as with any program, evaluation and improvements are needed to continue to grow the state of knowledge. The extensive monitoring program has focused on in-stream water quality metrics, such as turbidity, temperature, benthic macroinvertebrates and fish. This robust program has 14+ years of data to inform and assess the program, as well as non-restored streams in Fairfax County. However, this focus provides a limited picture of ecological recovery, and is unable to inform restorations outside of the stream bed itself. Stormwater Planning is ready to move to the next higher level of restoration implementation.**

One absent factor has been the effort to evaluate the riparian buffer community associated with stream restoration projects. (Formal monitoring for contractor compliance with proper implementation of the planting plan has been in place for approximately 4 years). This deficit is in large part due to a lack of regulatory requirement or specificity in defining revegetation or restoration recovery. Existing metrics associated with revegetation are more construction specific: such as, is vegetation sufficient to manage erosion? Or have all the built structures been completed? Another contributing factor contribution to lack of restoration monitoring are strict county regulation on planting density (1089 shrubs, 100 overstory and 200 understory trees per acre of disturbance) but no requirement for evaluating planting success. Over time, the "planting" part of the stream restoration projects have grown to exceed 10% of the construction budget of the restoration program, and has provided a valid opportunity to revamp the entire 'success' monitoring framework.

Restoration success was a difficult term to define for our stream engineers, and my first step was to bring in experts from multiple ecological disciplines to help determine a list of potential success targets, metrics that could be assessed and available county resources by which to complete the necessary monitoring to determine if success was achieved (Concept 5, 6). Using the SER Recovery Wheel has allowed us to define a targeted and informative suite of metrics that will provide a process for our future restoration success evaluation. This working group will check in on this project several times as we progress, and provides a useful sounding board for new ideas and urging each other to expand our efficiency and monitoring scopes.

One outcome of the meetings was an expanded Riparian Forest Vegetation monitoring program which will look at pre- and post-restorations as well as an extensive array of analogs and reference systems (spanning the range of quality), to determine what are good metrics, what are desirable targets within those metrics and how do we best push our restorations to achieving those goals. For instance, popular opinion around the engineer's stream restorations, was that we should and were achieving 100% canopy closure at 10-years post restoration. Our first year of data suggest that even the best reference systems have canopy closure in the 93-97% range, and 100% canopy closure is not a feasible or reasonable goal. The second project that I've included in this application package tests different planting strategies to encourage healthy rates of canopy closure.

The very foundation of this project is meant to drive our stream restorations closer to the SER principles. It has increased our network of expertise, identified the importance of whole-ecosystem thinking in our restoration projects, and has begun to change the way we design, implement and monitor and manage our projects

Describe how your project aligns with SER standards and principles of ecological restoration.

My project is focused on having better restoration outcomes, as defined by higher ecological function. The SER principles provide an easy system to show the need and the method to modify local metrics of success to include ecological uplift. By increasing the monitoring, management and evaluation of our stream restoration program, by expanding on existing resources and building networks to better implement whole-ecosystem restoration, and by evaluating success against a rigorous and objective structure such as the 5-star Recovery Wheel, I will be able to demonstrate the importance of implementing the ecological restoration principles across all of our projects.

Our baseline program has some real strengths, including: identification and consideration of local native reference systems (typical projects have at least two comparable stream reaches, and vegetation pre-monitoring both within the restoration reaches and analog systems has grown within the last two years), a commitment to natural channel design which assists natural recovery processes, and good procedures for engaging and inclusion of experts and stakeholders. Typical projects can be enhanced by focusing on two key principles: targeting improvement of the system's attributes and achieving our highest and best effort. Several of these questions need more research to determine what the metrics and targets within the metric should be, but we have started on the process to identify this missing piece.

I have developed a set of metrics to complete enhanced monitoring at our restoration project sites, both before restoration and after restoration. These sites were already being monitored for a suite of water quality metrics including physical, chemical and biological water quality assessments. Adding riparian buffer metrics allows to capture more of the ecosystem that we are restoring, and to be able to address more metrics on the Recovery Wheel. Additional sites, 'analogs' are also being monitored in the hope of finding both high quality reference systems as well as poor quality sites. We will be able to monitor post-restoration trajectory to watch for traits of those poor quality sites and take interventions as needed.

Additional sets of metrics were identified in expert panel brainstorming sessions on the topic of 'restoration success.' Although not all of these metrics have an identified path to implementation, our local research community has an expert in microbial soil health and quality in both wetlands and forest situations. We expect an understanding of the soil health in Fairfax County will inform aspects of both our vegetation and stream restoration (see conceptual diagram attached). We are working to include her as well as other academic research into our restorations to expand our understanding of how to best restore streams.

This project's goals is to clearly set additional objectives for our stream restoration projects, and ensure that these additional standards are met, meeting both concepts 2 & 4 of the SER Ecological Principles.

Describe your role in the project.	**My role is to lead the county's resources in driving better restoration practices by implementing sound ecological restoration principles like the SER principles. Stormwater Planning, Fairfax County Department of Public Works (Virginia) already had an excellent program of identifying needs, working with stakeholders, and protecting and maintaining the restorations. Within this strong foundation, the finer nuances of ecological restoration, not just engineering a stable stream, can be built. My role is to identify areas where we can improve, manage the expertise and resources to get there, implement the riparian buffer monitoring program, and seek new ways to partner to provide better restorations.**

Upload Project #3 Supporting Information (Optional)

Conceptual_Diagram_for_Ecological_Restoration_Success.pdf

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