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

Center for Watershed Protection

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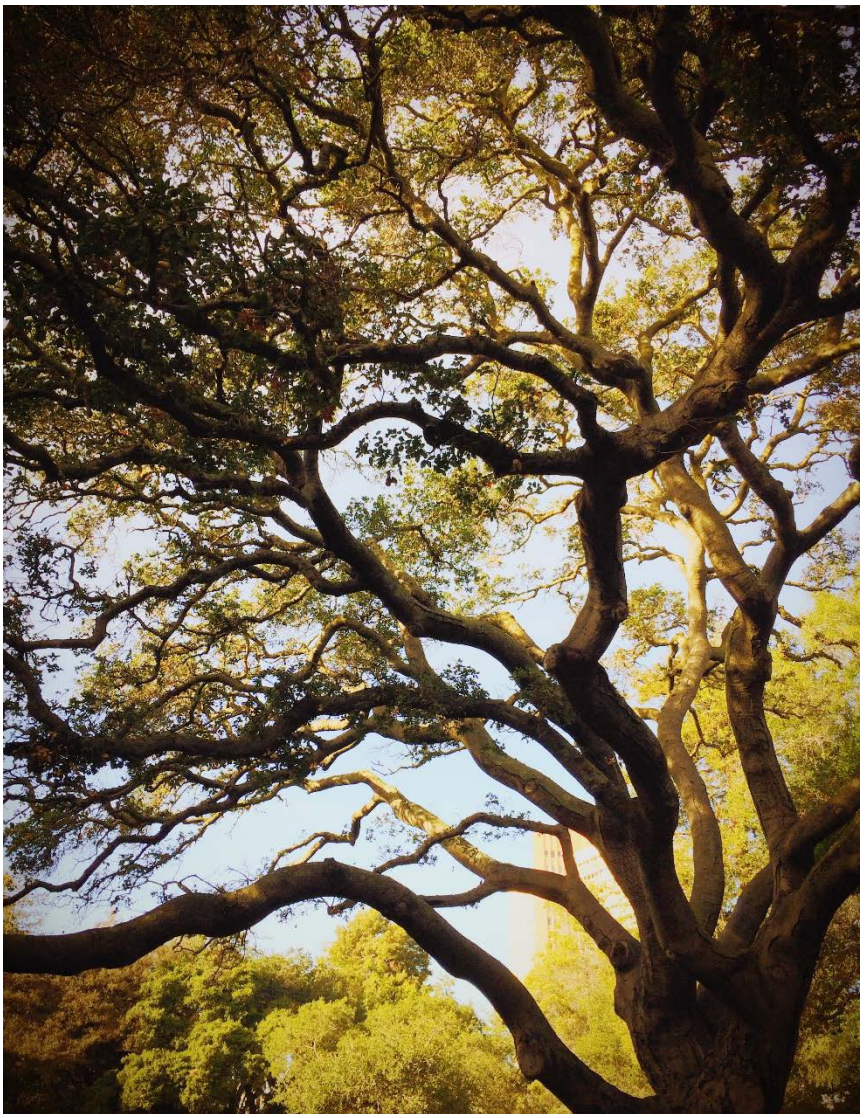

Photo by Victor Zambrano

CREDITING FRAMEWORK PRODUCT #5:

Stormwater Performance-Based Credit

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Stormwater Performance-Based Credit for Urban Tree Planting

Overview

Urban trees and forests improve stream quality and watershed health primarily by decreasing the amount of stormwater runoff and pollutants that reach our local waters. The processes of rainfall interception, evapotranspiration, infiltration, and nutrient uptake are important for providing these benefits and are well-accepted in the scientific community. However, it is difficult to quantify the services provided by individual trees because they vary with tree species and age, storm characteristics, climatic conditions, soils, and other factors. It is this uncertainty on how to "credit" trees for runoff and pollutant load reduction that has limited its use as a stormwater best management practice (BMP) for meeting water quality requirements.

The Center for Watershed Protection developed a national Stormwater Performance-Based Credit for tree planting. This method can be adopted by regulatory entities who would like to offer a scientifically defensible credit that encourages greater use of trees for meeting state (or local) stormwater management requirements. The credit quantifies an event-based reduction in runoff volume and nutrient and sediment loads associated with tree planting. It applies to trees planted in the urban environment, but does not apply to planted riparian buffers, large-scale reforestation projects or trees planted in engineered soils, such as bioretention or structural soils.

How to Use the Credit

The Stormwater Performance-Based Credit can be applied by following the nine steps outlined in the Stormwater Performance-Based Credit Calculator. The Calculator quantifies the runoff reduction benefit of tree planting for a specific storm event (e.g., design storm). It also provides an estimate of the associated nitrogen, phosphorus and sediment load reductions, which are useful where stormwater regulations also tie the design storm to removal of a particular pollutant. The Calculator shows the runoff and pollutant reductions as a percentage at both the site and canopy scales. This can help managers to understand the extent to which tree plantings aid in achieving standards for the design storm, compared to other BMPs. The method outlined in the Calculator can be incorporated by regulatory agencies as part of the stormwater compliance framework.

Needed Inputs

The following inputs required to use the Stormwater Performance-Based Credit Calculator:

- Nearest city (select from a drop-down list of options)
- Tree type (broadleaf deciduous large, medium or small; coniferous evergreen large or small)
- Surface over which the tree will be planted (select from a combination of HSG soil type and pervious versus impervious cover)
- Number of trees planted
- Tree DBH (default is provided based on the tree type and region)
- Tree canopy area (default values are provided based on modeling output from i-Tree Forecast)

- A breakdown of HSG soil type/land cover combinations for the entire site (in square feet)
- The design storm, in inches
- Nitrogen, phosphorus, and sediment concentrations (defaults are provided, but can be overridden with local data)

Calculations

The Stormwater Performance-Based Credit for tree planting was developed using a water balance model to estimate the mean annual runoff for a single tree at maturity planted over turf or impervious cover, compared to runoff from those same sites without trees. The model was run for five different land covers, including grass cover over four hydrologic soil groups (HSGs), and impervious cover. The model represented five tree types at 31 locations in 11 climate zones (Figure 1). Metrics derived from i-Tree Forecast were used to parameterize the water balance model. Documentation of the model is provided in Hynicka and Caraco (2017).

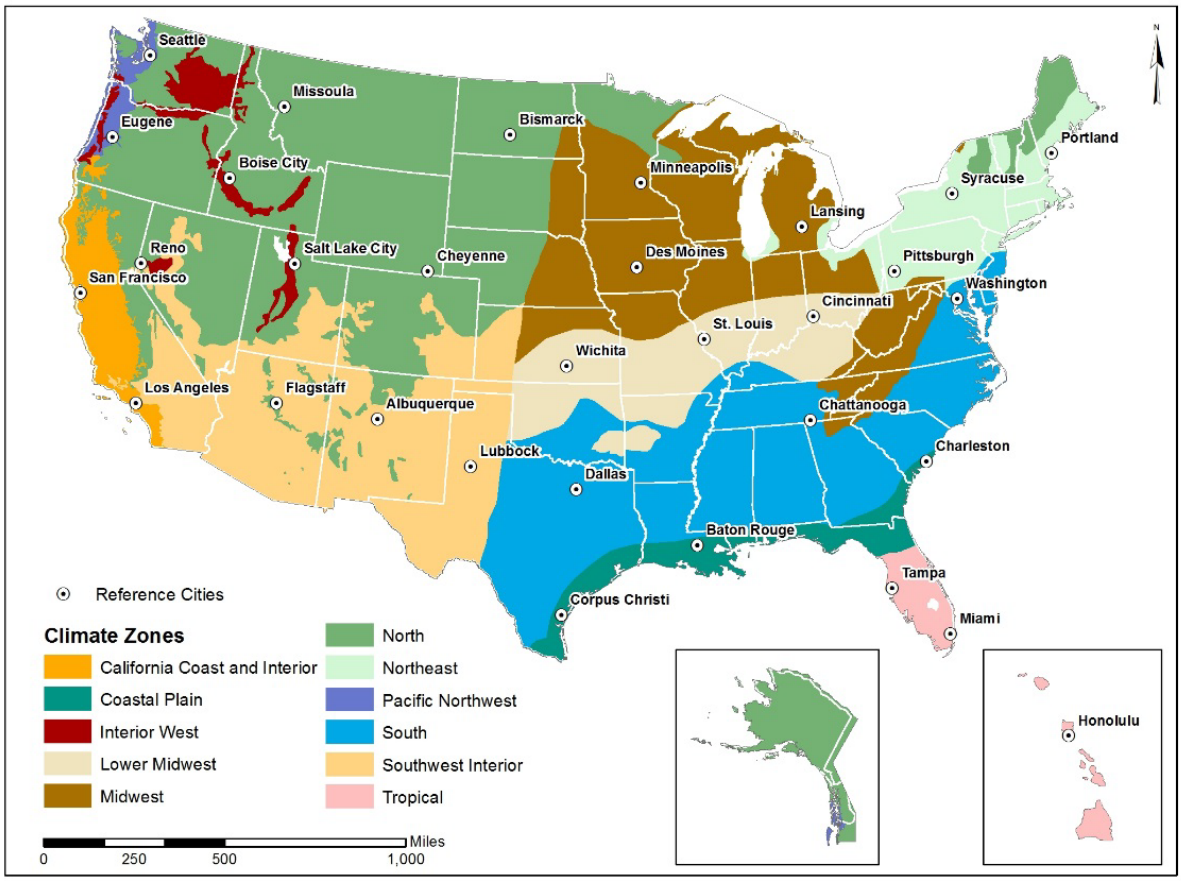

Figure 1. Climate Zones for Crediting Framework (modified from McPherson 2010)

The Stormwater Performance-Based Credit Calculator uses the above inputs to translate the annual runoff reduction from the Water Balance Model to an event-based reduction. The general process by which this is accomplished is to:

1. Scale the annual runoff reduction results to a standardized unit of reduction (cubic feet per inch of tree DBH per inch of annual rainfall)

2. Relate the unit runoff reduction volume to an event-based standard by identifying a representative or anchor storm and determine the curve number using TR-55 methods (USDA 1986) for the representative storm event and surface type
3. Calculate the runoff reduction for the design storm, with and without trees for the specific planting scenario

Documentation for the calculations used are provided in CWP (2017a).

Results

The results provided in the Stormwater Performance-Based Credit Calculator represent the potential benefits provided under optimal conditions (i.e., healthy trees at maturity). Agencies adopting this crediting framework may wish to specify qualifying conditions to obtain the full credit, and offer a reduced credit (70% of the optimal credit, derived from i-Tree Forecast simulations of reduced growth conditions) where these conditions are not met. Another option is to include a credit 'roll out' schedule to account for early growth stages of a tree, relative to the tree at maturity. If the former option is chosen, the following minimum set of qualifying conditions are recommended. These can be modified to account for localized conditions in consultation with a professional arborist or urban forester.

1. Maintenance Agreement and Plan: Periodic maintenance is required to ensure long-term survival and health of urban trees, particularly during the establishment period. To receive full credit, a maintenance agreement and plan should be in place for the planting project. A maintenance agreement should specify the party responsible for maintenance, stipulate the length of time which the agreement is valid, and identify minimum standards for care and any required submittals. A maintenance plan will prescribe the specific maintenance activities and their frequency and will often include a checklist. The key maintenance activities for urban tree planting include regular watering for the first few growing seasons, weeding and mulch replacement, removing staking and tree protection as needed, pruning, and fertilization. Maintenance can also include periodic inspection and tree replacement.
2. Consultation with an Urban Tree Professional: Choosing tree species that are appropriate for the site conditions and determining where to plant them are decisions that determine the ultimate success of an urban planting project. For a project to receive full credit, these decisions should be make in consultation with an urban tree professional (i.e., a licensed arborist or urban forester) so that the project can be designed to work with rather than against the many site constraints found in the urban landscape (e.g., utilities, poor soils, extreme heat). At a minimum, an urban tree professional should be consulted on species selection but these experts can also assist with selecting planting stock, identifying planting locations that provide sufficient soil volume for trees and adequate setbacks from infrastructure, recommending soil amendments, and demonstrating proper planting techniques. The latter is particularly important for projects implemented by volunteer groups.

3. Curbside Leaf Pickup Program (for trees planted over impervious cover only): Emerging studies demonstrate the significance of nutrient leaching from leaf litter, which collects in curbs and gutters in urban areas and is flushed through the storm drain system, ultimately contributing to the nutrient load in local streams. Therefore, for trees planted over impervious cover (i.e., street and parking lot trees), the nutrient reduction credit provided by the trees is likely to be outweighed by the nutrient load contributed by leaf litter, unless the leaves are removed through a curbside leaf pickup program. Therefore, a qualifying condition to receive credit for trees planted over impervious cover is that a leaf pickup program be in place that serves the planting site. In the future, the credit may be able to be modified to better account for the nutrient load from leaf litter as more studies become available to help quantify the average load for a tree planted in the urban environment.

The Design Specifications for Urban Tree Planting provided in CWP (2017b) can also be incorporated as guidance into the crediting framework to ensure that trees planted can reach their full potential benefits.

Assumptions and Limitations

This national credit framework provides a template for a first approximation of benefits provided by urban tree planting for stormwater management credit. Site specific conditions for individual planting scenarios may deviate from these average values where more detailed monitoring or site characteristics are considered (e.g., different tree species). Some key assumptions and limitations include the following:

- The amount of runoff reduction achieved by tree planting is not uniform across all storm events. Rather, it would be expected to see a pattern where the *absolute* runoff reduction is greater as storm size increases, but the *relative* reduction decreases.
- A unit runoff reduction (represented in units of cf/inch/rainfall/inch DBH), is used to translate results from continuous modeling to a runoff reduction for a specific design.
- This unit reduction is used to adjust hydrologic parameters (i.e., the Curve Number) based on an "equivalent storm." These adjusted Curve Number is then used to estimate the runoff for any design storm the user selects.
- The credit only accounts for rain falling on the canopy (e.g., assumes that runoff is not being directed to the tree from an upstream drainage area)
- Credit should not be applied in areas with a high water table, since the underlying model assumed that flow beneath the root zone was not restricted.
- The model results are considered 'optimal' as the growing conditions for the trees does not account for stresses in the urban environment that may affect tree growth or mortality and account for the runoff reduction based on a mature tree.
- The underlying model assumes that trees planted over grass or other pervious surfaces reduce runoff volumes by intercepting runoff as well as altering the soil profile beneath the tree canopy. For impervious surfaces, the only quantified benefit is rainfall interception.
- The tree species used in the model are native species.
- The model assumes that both trees and grass are not irrigated.

References

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