Maryland Stormwater Consortium

Addition to Technical Note 18 for Core Principle No. 1: Increase Onsite Runoff Reduction Volumes.

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- Research indicates that functioning forests act as precipitation sponges that capture 99+% of incoming precipitation and essentially allow zero runoff.
- Forests (and to a lesser extent, single trees) perform 5 essential hydrologic functions: 1) Canopy interception; 2) Stem flow; 3) Leaf Litter storage; 4) Soil absorption/infiltration; and 5) Evapotranspiration.
- The layer of leaf litter on the forest floor plays a small but significant role in stormwater capture and storage (and in protecting the underlying soil from erosion).
- By acknowledging and factoring-in the hydrologic roles of all the forest "layers," Environmental Site Design requirements will help to ensure the full functioning and protection of forest ecosystems as stormwater sponges and stream protectors.

I. Documenting Runoff Capture by Whole Forests

Whole, intact forests provide immense water quality and water quantity (flood protection) benefits. In fact, trees and forests are the most powerful, and cost-effective, "clean water protectors and stormwater managers." It's useful to break the hydrologic functioning of forests into its five component parts; these are described in the table below.
Of the five functions listed, two – canopy interception and evapotranspiration, are dominant in the growing season (roughly April through October in Maryland) and are either non-existent, or significantly reduced, when deciduous leaves are off the trees.

On the other hand, the other three functions – Stem flow, leaf litter absorption, and soil absorption/ infiltration, are fully functional year-round, with soil absorption/ infiltration being the biggest contributor of the three to runoff absorption and therefore the most important single function. To summarize, of the five hydrologic functions of whole forests, soil absorption and infiltration is the single largest year-round contributing function, and also is a determinant of evapotranspiration; thus forest floor preservation and native soil protection/ restoration are paramount in ESD practices and protocols. This is not to say that soil-based practices should be isolated to the detriment of the other forest functions – these 5 forest functions comprise interlocking parts that must function together if they are to be relied upon.

Hydrologic Functions of Forests		
Individual Function	**Water Capture** (percent of incoming precip.)	**Reference(s)**
Canopy Interception (deciduous forest in the growing season) function: *stores precipitation; delays & lessens peak flows*	13%	Dunne and Leopold (1978)[i]
Stem flow: (deciduous, year-round) function: *delays peak flows*	Up to 15%	Portland (OR) Metro[ii]
Soil absorption: Leaf Litter ("Duff") Layer. Function: *stores precipitation; protects the underlying soil from erosion.*	2 – 4%	Dune and Leopold (1978)[iii] p. 86;
Soil absorption: Native Soils. Functions: *stores precipitation; enables groundwater and stream baseflow recharge; enables evapotranspiration; filtration & remediation of stormwater pollutants.*	83 % (summer) to 96% (winter)	Derived from Dunne and Leopold[iv] (1978)
Evapotranspiration. Functions: *Reduces stormwater volume, peak flows and velocities; reduces stormwater pollution loadings; cools the air.*	66% in Howard County subwatersheds (growing season)	Dine et al (1995)[v]

(Note: This is a descriptive table of hydrologic functions of forests, not a "water budget," thus the percentages do not add up to 100.)

II. Clean Water benefits of Whole Forest stands in Montgomery County

As documented by Leopold, Wolman and Miller.

Whole Forests are Nearly-Perfect Stormwater Sponges: Forest quantity and quality both matter for Stormwater Prevention.

Luna Leopold, M. Gordon Wolman and John Miller in 1961, studied the hydrologic functioning of then-fully-forested Sisters Creek subwatershed of second-growth tulip, hickory, and beech trees in the Cabin John Watershed. They reported that:

> "The drainage area is about 2.3 acres and the rill, with a mean gradient of 0.17 foot per foot, has a width of 1.5 feet near the mouth. Both the forest floor and the channel are carpeted with fallen leaves. In 1961, during which there was 37.6 inches of precipitation, there were 11 events during which runoff occurred in the rill, and this runoff totaled about 0.21 inch, or less than 0.6% of the precipitation."[vi]

Thus, a mature forest in Montgomery County has been documented as providing nearly 100% absorption of annual precipitation. Our forests are nearly perfect stormwater "sponges," and we destroy and degrade them at our peril.

Role of Leaf Litter Noted

Note that the authors observed that the "forest floor and channel" were "carpeted with fallen leaves." This points to the importance of the "leaf litter" layer on the forest floor, which plays a water storage and absorption role year-round; our private and public woods need to have this leaf litter or "duff layer" if they are to be fully functional as stormwater sponges; thus the ubiquitous "blow-drying" of our wooded parklands with leaf blowers is a destructive practice that needlessly encourages polluted stormwater runoff.

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[i] Dunne, T. and L. Leopold (1978*). Water in Environmental Planning*. P. 88

[ii] Portland (OR) Metro *Trees for Green Streets: An Illustrated Guide*. First Edition June 2002. Stemflow figure is cited to Tom Liptan, Portland Bureau of Environmental Services, personal communication 2001.

[iii] Dunne and Leopold (1978) op cit, page 86, citing Helvey and Patric (1965) and Helvey (1967).

[iv] Percentage derived from Dunne and Leopold (1978) op cit, page 84 as follows:

Net Rainfall Entering the Soil = Gross Rainfall – Total Interception From Canopy and Litter (Summer)
Net Rainfall Entering the Soil = Gross Rainfall – Total Storage by Leaf Litter (Winter)

[v] Dine, J. et al. (1996) Water Resources of Howard County, MD. Maryland Geological Survey, Bulletin No. 38, 1995. http://www.mgs.md.gov/esic/publications/download/bull38ab.pdf

[vi] Leopold, L.; M. Wolman and J. Miller (1964) *Fluvial Processes in Geomorphology*. (Dover). Page 85.