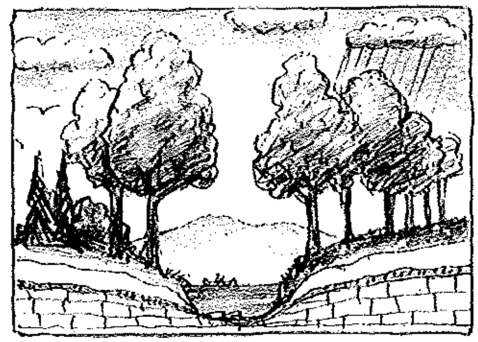
A Stormwater Primer

Part I: Water runs down hill

When it rains, the trees, leaves and soil intercept a lot of rain.

The fate of a rainfall:
90% of all storms are less than one inch. The average rainfall is .3".



.1" never makes it to the ground because it is absorbed by tree leaves. More is absorbed by the forest floor

In Hemlock's early days when there were few houses and roads, rain meandered through the woods in little gullies, through the leaf matter on the forest floor, on its way to the streams. It took days to get to a stream. During that time, much of the water had been absorbed before even reaching the streams, which then flow into the lakes.

But with the grid work of roads and new houses, the gullies were interrupted or totally eliminated and the rain, now known as stormwater runoff, began to run down the hill into the streams in a matter of minutes. (Yes, and rather than being filtered by the leaf litter and soil, it picks up road debris (aka nonpoint source pollution).

As impervious surfaces, the roofs and the roads shed even more water and it flows into the ditches and pipes that are designed to move it quickly. As it runs faster through the ditches, stormwater from more of the community reaches one area during the storm and that causes flooding.

So it's both the impervious surfaces and the reduced flowtime that is causing flooding.

What about the trees:
Trees sequester 1000s of gallons of water in their roots
A mature tree uses 400 gallons of water a day.

The solution:

The solution proposed is to intercept and slow down stormwater in little pockets throughout the community. (There is a demonstration model of a Filtrex Soxx that has been installed in the wooded areas between Widgeon and Curlew). By installing these pockets to retain the rainfall, it gives the trees and the ground time to absorb some of the water and there is less runoff. (This represents an important advance in Green Stormwater Management because trees do not have to be removed to hold back the stormwater runoff.) In addition, the ditches and pipes must be sized to handle the flow that reaches them with a keen regard for the time it take water to get to a location.

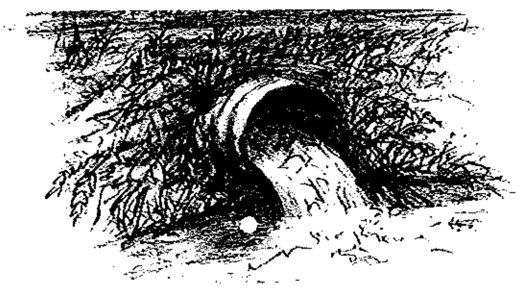
Graphic by Frank Holmes, Text by Mark Bowen, P.E. CFM, Created by Laurie Stuart

Part II
Pipes versus Swales

Stormwater Primer

Previously in Part I:

The cause of flooding is twofold: Impervious surfaces and the reduced flowtime so that stormwater from more of the community reaches one area during the storm and that causes flooding.



(If you can slow water down to 1-2 feet per second, the pollutants will drop out. A major source of pollutants (or total suspended solids) are due to deposits on impervious surfaces. This includes debris from brake drums, tires, and anti-skid material.

A major source of nitrogen in stormwater comes from atmospheric deposition on impervious surfaces.)

Swales provide a great deal of water storage for a short period of time.

Swales can be lined with rock or vegetative material. Rocks are only used when necessary. Vegetative swales are less expensive and more efficient in taking out the total suspended solids than pipes.

PIPES: Pipes cost four times as much as swales. Currently pipes cost $100 per linear foot.

SWALES: Swales cost $25 per linear foot.

There are approximately 50 miles of swales that will need to be installed or repaired.

PIPES: When you put water in a pipe it moves quickly.

SWALES: When you put water in a swale it reduces the velocity of the water to $\frac{1}{2}$ of the speed.

PIPES:
Dirty water in a pipe = dirty water coming out of a pipe.

SWALES: Dirty water in a swale will get filtered and cleaner water will come out the end of the swale.

Swales store water and slow it down and help to prevent flooding situations. Water held in swales has the opportunity to recharge the aquifer.

Swales are designed by taking into account road slope, the volume of water needed to be collected and filtered and the placement and size of driveway culverts. Swales can also be lined with grass or stone.

PIPES & SWALES: The footprint of the excavation for pipes and swales are virtually the same, however, trees cannot grow on top of a pipe.

Swales are a Green Best Management Practice.

A Stormwater Primer

Part III: Two New BMPs invented

Because the Hemlock Farms Board of Directors insisted that a way be found to cut down the least amount of trees and that things be done in the least expensive way, Kleinschmidt engineer Mark Bowen invented two new Green Best Management Practices (BMP) that will not only help Hemlock Farms, but could become cutting-edge stormwater management practices used nationwide. The two BMPs are Retentive Grading (below) and Soft-Bottom Culverts (next month in Part IV!), which utilize sections of pipe with a coupler that will accummulate the sediment behind it and cut costs by 1/3 (rule of thumb).

Retentive grading

This BMP uses a 32-inch SiltSoxx™ that is filled with rotting leaves and ground up trees.* Different lengths of the sock are placed in the woods in strategic places to create barriers that serve as flood storage. The stored water infiltrates into the subsoil and slows down considerably (instead of getting to a lake in an hour by swale, it gets to the lake some 20-30 days later. Along the way, nitrogen, phosphorus and total suspended solids are filtered out, which is important to the continued health of the lakes.

Additionally, the soxx is covered with a layer of dirt and plants and grasses are planted. These plants encourage envapotranspiration, the sum of evaporation (water that moves to the air) and transpiration (the amount of water that is taken up by the plants' roots and leaves).

In order for these plants to grow, the tree canopy needs to be pruned on the uphill side, so that light can reach the forest understory. A small ditch is created so that sand that filters out can be gathered every 5 to 10 years.

*This is considered a LEED innovation because it is utilizing materials that are onsite.

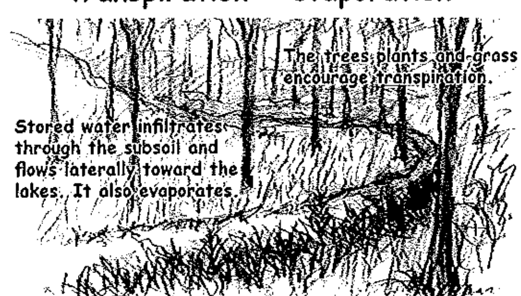
Fun Fact:

Of 53 inches of rain:

- 2/3 is used by evapotranspiration
- 7" soaks into the ground through infiltration (The majority of this water will flow laterally and enhance the flow of streams in its path.)
- 1-2" goes into deep infiltration and reaches the aquifer

A 40' tall oak evapotranspirates 400 gallons of water a day and sequesteres more in its roots.

evapotranspiration = transpiration + evaporation



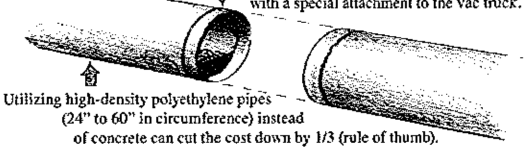
The 32-inch Siltsoxx,™ filled with leaves and ground trees, creates a barrier that stores flood waters.

The acquifer is recharged by some of the water that infiltrates the subsoil.

Graphic by Frank Holmes, Information provided by Mark Bowen, P.E. CFM, Created by Laurie Stuart ©2013 Stuart Communications, Inc.

Stormwater Management Primer

Part IV:
Developing Green Stormwater Infrastructure



In order to cut down costs of the total storm water management system, and to move water from one jurisdictional* wetland or stream to another, Engineer Mark Bowen is developing a "good-bug-friendly" culvert that replaces the traditional concrete one. Utilizing smooth high-density polyethylene pipes (24 to 60 inches in circumference) that come in 5-foot sections, the pipes fit together with a coupler that accumulates sediment behind it. A baffle slows down the speed of the water in the culvert and traps sediment behind it, forming a bridge for good bugs (those that contribute to wetland ecology) to move from one wetlands to another. These culverts will be used under roadways and driveways where jurisdictional waters are involved (32 of the 460 driveway culverts).

*The Army Corps of Engineer guidelines for jurisdictional waters include waters that are navigable in the traditional sense and tributaries and wetlands that have a "significant nexus" to navigable waters.

Previously in the Stormwater Management Primer

Part I: Rainwater becomes stormwater runoff with the increase of impervious surfaces and the reduced time it takes to get to certain parts of the community.
Part II: Swales are less expensive than pipes, slow down the water flow and temporarily store water during storm events.
Part III: Retentive grading creates barriers in strategic places that store water and encourage infiltratation, evapotranspiration and the filtering of stormwater into the subsoil.

The entire series is available at hfca.org

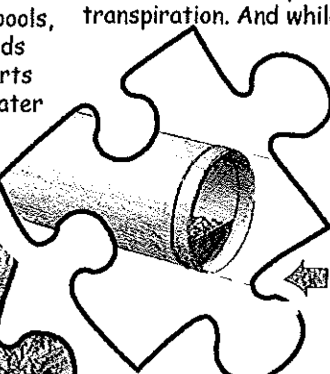
Another BMP that will be utilized is a Regenerative Step Pool Storm Conveyance (SPSC) system. Through a series of surface pools and a subsurface sand seepage filter, Regenerative SPSCs are open-channel structures that help convert surface storm flow to shallow groundwater flow. Adapting technology developed in Maryland to keep sediments and pollutants out of the Chesapeake Bay, Bowen is planning on using the series of cascading pools on hillsides and steep areas right before the lakes.

These three BMPs: **retentive grading** (April edition, graphic right), **bug-friendly culverts** and **step pools** will store storm water, slow down water flow, encourage groundwater absorption and evapotranspiration, and improve water quality through the removal of sediment and pollutants. Stay tuned next month on how all of these pieces fit together to form a community owned stormwater management system.

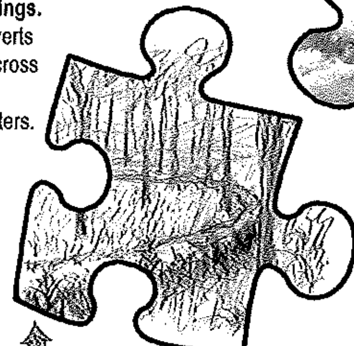
Graphics by Frank Holmes, Information provided by Mark Bowen, P.E. CFM, Created by Laurie Stuart
Step Pool photo courtesy of Mark Bowen, manipulated by Amanda Reed ©2013 Stuart Communications, Inc.

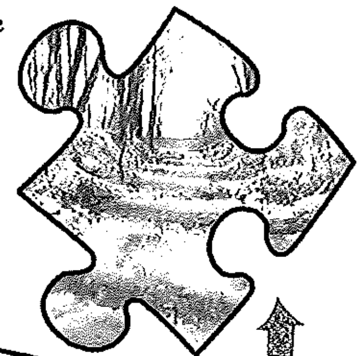
Putting the Stormwater Management Pieces Together

The Community-owned Green Stormwater Management System utilizing swales, step pools, retentive grading, ponds and soft bottom culverts will slow down stormwater runoff and improve water quality by encouraging infiltration and evapo-transpiration. And while many of these BMPs will be on HFCA-owned property, individual homeowners will be required to do their part to keep stormwater runoff from running onto their neighbor's property.

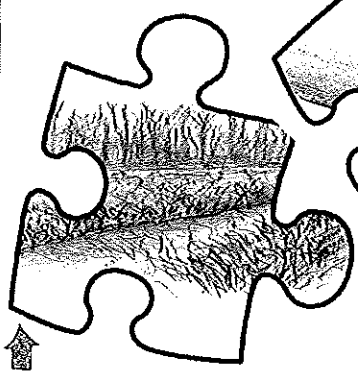


28 Road Crossings. Soft-bottom culverts are required to cross and connect jurisdictional waters.





29 Step Pools. These cascading pools will be constructed on hillsides and steep areas right before the lakes.



45 Miles of Swales. Swales store water, slow it down and help to prevent flooding situations. Water held in swales has the opportunity to recharge the aquifer.

PONDS & WETLANDS

24 Ponds and Manufactured Wetlands. By far the biggest green infrastructure system, artificial wetland basins have the capacity to provide 35-60% of stormwater retention capacity during a storm event.

22 Retentive Grading BMPs. This BMP, installed in strategic places to create barriers for flood storage, is flexible and can bend around trees.

Here's what can be done on YOUR property

RESIDENTIAL RAIN GARDEN

Rain gardens provide temporary storage and encourage evapotranspiration and allows for infiltration of stormwater to recharge the aquifer. Rain gardens can require 2' of soil, which can be a challenge in Hemlock Farms.

RAIN BARRELS

Attaching rain barrels to your roof system can provide drainage for 500' of roof. The stored rainwater needs to be emptied between storms, typically every 3-4 days and can be re-used, such as to water plants or to wash your car.

NATIVE PLANTING

Recreating the under-growth that used to exist significantly reduces stormwater runoff. Additionally, not disturbing natural elements, such as vernal pools, small bog areas, etc., increases stormwater storage during storm events.

POROUS PAVEMENT GREEN ROOFS

Replacing impervious surfaces with porous pavement reduces stormwater runoff by allowing water to infiltrate to the subsoil below. A green roof or living roof is a roof that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane.

MAINTAIN THE CONVEYANCE SYSTEM ON YOUR PROPERTY

In order to move water from one part of the community to the other, a series of swales and other conveyance systems will need to be improved or installed. Certain members will be asked to grant easements to HFCA to protect the existing drainage patterns and establish new ways to safely dispose of stormwater runoff.

For more about how green infrastructure increases property values
http://water.epa.gov/infrastructure/greeninfrastructure/gi_costbenefits.cfm

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