## Stormwater



Image source: http://sevenhillslake.com/stormwater.html

#### West Virginia Water Resources Training Workshops

Presented by the Interstate Commission on the Potomac River Basin

Sponsored by the West Virginia Department of Environmental Protection

With funding from the American Reinvestment & Recovery Act



### What is stormwater?

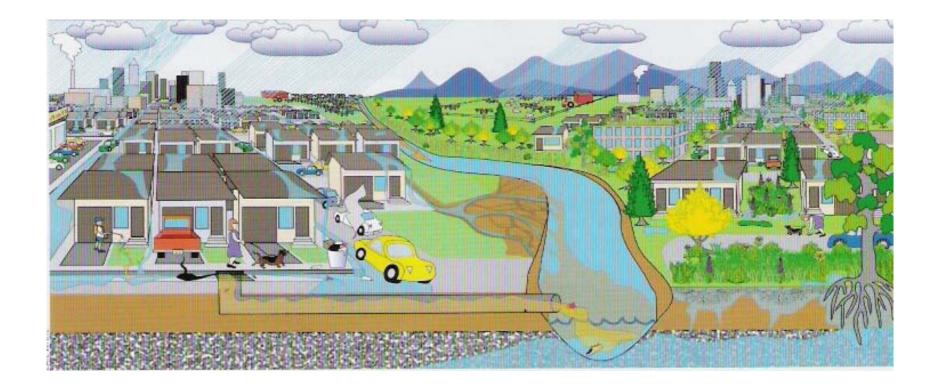


Image source: http://www.blackwarriorriver.net/images/stormwater.jpg

## Change landscape, change flows

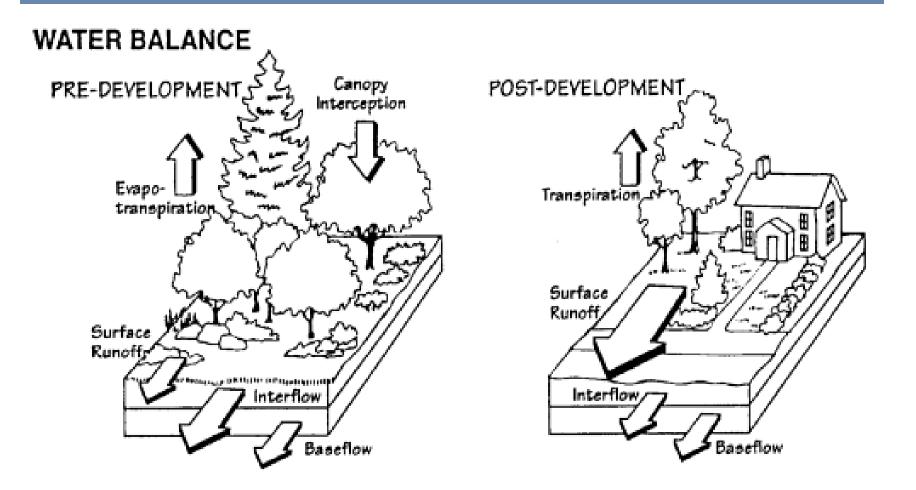


Image source: Maryland Department of the Environment, *Stormwater Manual,* http://www.cwp.org/Resource\_Library/Center\_Docs/PWP/ELC\_PWP63.pdf

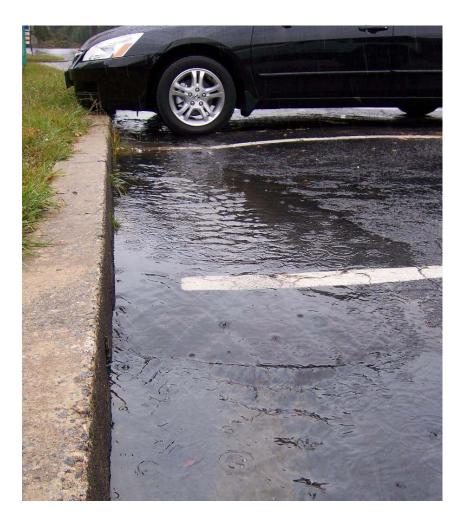
## Altered hydrograph

#### STREAMFLOW Pre-development Large Higher and More Rapid Peak Discharge Storm Post-development Small Storm More Runoff Volume STREAMFLOW RATE Lower and Less Rapid Peak Gradual **Higher Baseflow** Recession TIME

Image source: Maryland Department of the Environment, *Stormwater Manual,* http://www.cwp.org/Resource\_Library/Center\_Docs/PWP/ELC\_PWP63.pdf

## Why do we manage stormwater?

- Flooding
- Reduces infiltration



## **Deteriorates Stream Channels**

- Scours banks
- Deposits and carries sediments



- Habitat degradation
- Undermines roads and infrastructure



Image source: Little Grave Creek Watershed Based Plan, http://www.dep.wv.gov/WWE/Programs/nonptsource/WBP/Documents/LittleGraveCreek\_WBP.pdf

## **Decreases Water Quality**

Stormwater runoff carries anything on the surface to our waterways:

- Pesticides, herbicides, insecticides
- Suspended solids (sediment)
- Nutrients
- Bacteria
- Hydrocarbons
- Chlorides (road salt)
- Trace metals
- Trash



Image source: MPR NewsQ, http://minnesota.publicradio.org/display/web/2010/04/15/storm-water-regulations/

## **General Principles**

- Slow water flow
- Increase time filtering and infiltrating
- Treat the water close to the source
- Reduce impervious cover
- Reduce runoff

#### – Use the water

Image source: Arrinton Engineering, http://www.arringtonengineering.com/stormwater\_management.asp

# Filter Strip





Image source: Wyandotte County Government, http://www.wycokck.org/Dept.aspx?id=22980&menu\_id=1022&banner=15284

#### Swale



Image source: Wyandotte County Government, http://www.wycokck.org/Dept.aspx?id=22980&menu\_id=1022&banner=15284

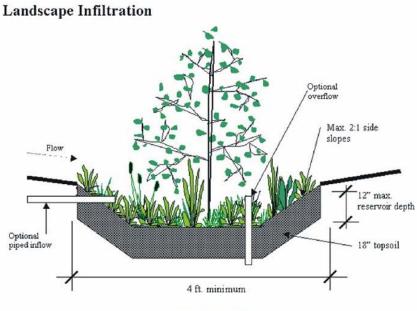
## Rain Garden



Image source: Wyandotte County Government, http://www.wycokck.org/Dept.aspx?id=22980&menu\_id=1022&banner=15284

### **Bioretention**





Section Not to Scale

Image source: http://www.buffalorising.com/2009/02/pushing-green-at-canal-side.html (left) Image source: http://www.epa.gov/oaintrnt/stormwater/cells\_infiltration.htm (right)

#### Green Roof

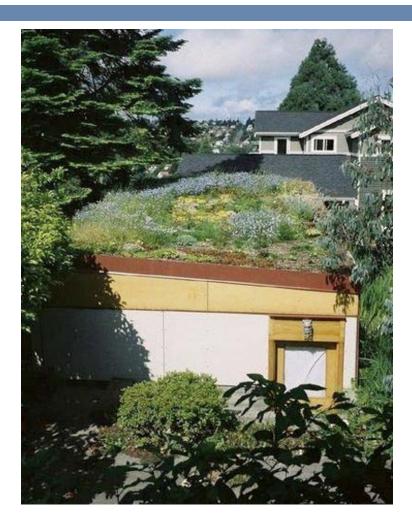




Image source: Green Roofs Australia, greenroofs.wordpress.com/ (left) Image source: http://demakerealestate.blogspot.com/2008\_06\_01\_archive.html (right)

#### Porous Pavement





Image source: Wyandotte County Government, http://www.wycokck.org/Dept.aspx?id=22980&menu\_id=1022&banner=15284 (Left) Image source: Spence Brothers, www.spencebrothers.com/general.asp?ID=24 (right)

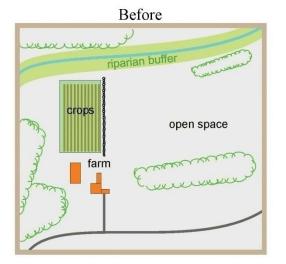
## Selecting Management Techniques

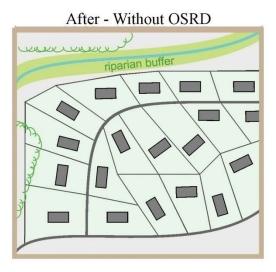
- What problem are you trying to address?
- Area characteristics
- Maintenance requirements
- Funding
- Aesthetics

Practice	Runoff Reduction (%)	Total Phosphorus Removal (%)
Green Roof	45 - 60	0
Rooftop Disconnection	25 – 50	0
Raintanks/cisterns	40	0
Permeable Pavement	45 – 75	25
Grass Channel	10 - 20	15
Bioretention	40 - 80	25 – 50
Dry Swale	40 - 60	20 - 40
Wet Swale	0	20 - 40
Infiltration	50 - 90	25
Sheetflow to Open Space	50 – 75	0
Filtering Practice	0	60 – 65
Constructed Wetland	0	50 – 75
Wet Pond	0	50 – 75

Data source: *Technical Memorandum: The Runoff Reduction Method,* Center for Watershed Protection & Chesapeake Stormwater Network (2008), http://www.cwp.org/Resource\_Library/Controlling\_Runoff\_and\_Discharges/sm.htm

## **Open Space Residential Design**





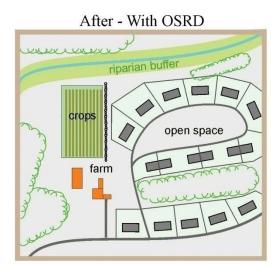


Image source: Massachusetts Smart Growth/Smart Energy Toolkit - http://www.mass.gov/envir/smart\_growth\_toolkit/pages/SG-slides-osrd.html

## Planning opportunities

- Zoning land use type; low density v. high density (WV Code §8A-7 Zoning Ordinance)
- Subdivision codes how parcels are developed
  (WV Code §8A-4 Subdivision and Land Development Ordinance)
- Street standards and road design guidelines
- > Parking requirements set maximum number
- Minimum setback requirements build closer to the street so driveways and walkways are shorter
- Site coverage limits make higher so houses can be closer and therefore less street coverage
- > Height limitations increase so there is less sprawling development
- > Open Space requirements

## Monitoring and Maintenance

- Meeting goals
- Continued functionality
- Save money

- Inspection and enforcement
- Maintenance requirements in permits