Stormwater Management in Your Backyard
for Master Gardeners and Environmental Stewards

Amy Boyajian
Program Associate, Water Resources
Rutgers Cooperative Extension
New Jersey Sea Grant Extension Program

http://water.rutgers.edu/Stormwater_Management/SWMIYB.html
Stormwater Management in Your Backyard
for Master Gardeners and Environmental Stewards

In-class Lecture

Community Outreach

Hands-on Training

Train-the-Trainer

http://water.rutgers.edu/Stormwater_Management/SWMIYB.html
Stormwater Management in Your Backyard
for Master Gardeners and Environmental Stewards

Part 1: Stormwater 101 (55 minutes)
Part 2: Rain Garden Site Selection and Installation (85 minutes)
Part 3: Rain Garden Maintenance (55 minutes)
Part 4: Train-the-Trainer (85 minutes)

Monday, August 31
Friday, September 4
Stormwater Management in Your Backyard
for Master Gardeners and Environmental Stewards

Part 1: Stormwater 101

Amy Boyajian
Program Associate, Water Resources Program
Rutgers Cooperative Extension
New Jersey Sea Grant Extension Program
How much water do we have?

Total volume of water on the planet:
326,000,000 cubic miles
The Earth’s Water Distribution

- 97% of the water on earth is in the oceans
- Only 3% of the water on earth is freshwater
- About 2.4% of the freshwater on earth is permanently frozen in glaciers and at the polar ice caps
- About 1/2 of 1 % of the water on earth is groundwater
- Only about 1/100 of 1% of the water on earth is in the rivers and lakes
Stormwater 101

Four Phases to the Hydrologic Cycle

**Condensation** – the reduction of a gas to a liquid

**Evaporation** – to change a liquid or solid into vapor

**Precipitation** – to condense and cause to fall as rain, snow, sleet, etc.

**Transpiration** – the giving off of moisture through the pores of the skin or through the surface of leaves and other parts of plants
The Hydrologic Cycle

Transpiration
Evaporation
Precipitation
Direct Runoff
Surface Storage
Infiltration
Soil Moisture
Evaporation
Groundwater
Evaporation
Direct Runoff
Surface Waters

Source: J.J. Skupien.
Rain is a Valuable Resource

- Rain is a key element in the Earth’s hydrologic cycle.

- Rain fills our lakes and rivers, recharges the underground aquifers, and provides water to plants and animals.

- 1 inch of rain falling on 1 acre = ~27,154 gallons of water.

- The 48 continental United States, on average, receive enough precipitation in one year to cover the land to a depth of 30 inches!
What is stormwater or “runoff”? 

Stormwater is the water from rain or melting snows that can become “runoff,” flowing over the ground surface and returning to lakes and streams.
Fig. 1.30 – Stream ordering in a drainage network. "1" = first order stream; "2" = second order stream, etc. In Stream Corridor Restoration: Principles, Processes, and Practices (10/98). Interagency Stream Restoration Working Group (15 federal agencies) (FISRWG).
Stream Channel Cross-section

Bankfull Stage

Bankfull Width

(Newbury and Gaboury 1993)
Floodplains Are Dynamic Systems

Rivers and streams are not only conduits of water, but also of sediment.
Surface/Ground Water Interactions

A. Influent Stream Reach

B. Effluent Stream Reach

Fig. 1.16 — Cross sections of (a) influent and (b) effluent stream reaches. Influent or "losing" reaches lose stream water to the aquifer. Effluent or "gaining" reaches receive discharges from the aquifer.

Interagency Stream Restoration Working Group (15 federal agencies)(FISRWG).
Riparian Corridor

Streamside (riparian) plants play a vital role in maintaining river health.

Plants perform a filtering function and prevent sediments and nutrients from entering the stream.

Vegetation and leaf litter slow overland water runoff, thus helping to prevent erosion.

Riparian zones also provide flora and fauna habitat.

Vegetation provides organic matter to the stream.

Trees shade the stream and reduce light and water temperature. This offers protection for instream animals and plants and helps prevent algae formations.

Large Woody Debris (LWD) or snags and living vegetation provide:
- Shelter;
- Feeding and spawning habitat for birds, fish and invertebrates.

Roots act as a binding system for the soil and, by doing so, reduce bank collapse and erosion.

Floodplains are used for agriculture but need to be carefully managed in order to protect the streambank and water quality in the river.
Meteorological Factors Affecting Runoff

- Type of precipitation (e.g., rain, snow, sleet, etc.)
- Rainfall intensity
- Rainfall amount
- Rainfall duration
- Distribution of rainfall over the drainage basin
- Direction of storm movement
- Proceeding precipitation and soil moisture
- Temperature, wind, relative humidity (i.e., factors that affect evapotranspiration)
Physical Characteristics Affecting Runoff

- **Land use**
- Vegetation
- Soil type
- Drainage area
- Basin shape
- Elevation

- Slope
- Topography
- Direction of orientation
- Drainage network patterns
- Presence of ponds, lakes, reservoirs, etc.
Google Earth image of the Variable Source Area hydrology analysis for the Town Brook watershed. (Yellow is <0.2 cm, teal is 0.2 to 0.4 cm, blue is >0.4 cm; average runoff depth)
Hydrologic Implications of Land Use

**Urban** land uses lead to impervious surfaces
- Commercial
- Industrial
- Residential
  - Low Density
  - Medium density
  - High density
- Other
  - Agriculture leads to land alteration that might lead to erosion
Linking Land Use to Waterway Condition

More Imperviousness = More Water
What is impervious cover?

- roads, rooftops, parking lots, and other hard surfaces that do not allow stormwater to soak into the ground

- Even disturbed/constructed open spaces (such as parks) have become impervious due to compaction

- “predominant American vegetation”
Impervious Cover

- provides a surface for accumulation of pollutants
- leads to increased polluted runoff and flooding
- inhibits recharge of groundwater
Impacts from Changing Landscape

Hydrologic Effects

- Disruption of natural water balance
- Increased flood peaks
- Increased stormwater runoff
- More frequent flooding
- Increased bankfull flows
- Lower dry weather flows
The Impact of Development on Stormwater Runoff

natural conditions
The Impact of Development on Stormwater Runoff

low density development
The Impact of Development on Stormwater Runoff

medium density development

35% evapotranspiration

30% runoff

20% shallow infiltration

15% deep infiltration

35%-50% Impervious Surface
The Impact of Development on Stormwater Runoff

urban development

75%-100% Impervious Surface

10% shallow infiltration

5% deep infiltration

55% runoff

30% evapotranspiration
Riverine floods

- **Slow kinds:** Runoff from sustained rainfall or rapid snow melt exceeding the capacity of a river's channel.

- **Fast kinds:** flash flood as a result of e.g. an intense thunderstorm.

- **DOWNSTREAM communities** are always affected by the cumulative effect from **UPSTREAM**.

- **Examples**
  - Trenton, NJ
  - Multiple communities along the Mississippi River Last year.
Impervious Cover & Stream Quality

- At 10% impervious cover, stream degradation (e.g., changes in the aquatic biological community) is detectable.
- At 25-40% impervious cover, streams no longer support biological/human uses.
**Impervious Cover & Stream Quality**

Relationship between Impervious Cover and Stream Quality

- **Non-supporting (>25%)**
- **Impacted (11 to 25%)**
- **Sensitive (0 to 10%)**
Types of Stormwater Management

• Traditional
  - Dams, dikes and levees
  - Hydraulic alterations (straighten, channelize, piped, etc.)
  - Combined sewer systems
  - Curb/gutter or open channel gutters

• Next generation
  - Separate storm sewer systems (MS4s)
  - Detention systems (minimize peak flows and volumes)
    • Concrete flow-flow channel
    • Fill and release slowly over time

• Low Impact Development
Connected Impervious Surfaces (MS4)

- No chance for GW recharge for stream base flow
- No chance for infiltration/plant uptake for improved water quality
- Peak flow rates and volumes can be too high for stream carrying capacity
Newer MS4s are Centralized
Detention Basins and Ponds
Goals of Low Impact Development (LID)

- Mimic natural conditions and water balance
- Decentralization/ disconnection
- Uniform distribution of small-scale controls

Older NJ Municipalities are already at/near build-out
- Unique approach to watershed management
- Requires a retrofits
- Incorporate natural systems as a feature that complements the existing urban design
EPA LID Video

Click here to play video
Stormwater 101

Backyard rain gardens

Education and encouragement of homeowners with help mitigate existing problem of residential impervious cover

Stormwater Management in Your Backyard

• workshops
• incentive programs
• demonstration rain gardens
• website
• landscaper training
Point vs. Nonpoint

Point Source Pollution vs. Nonpoint Source Pollution

What’s the difference?
Point Source Pollution

- comes from a specific source, like a pipe
- factories, industry, municipal treatment plants
- can be monitored and controlled by a permit system
What is nonpoint source pollution?

- Nonpoint Source (NPS) Pollution is pollution associated with stormwater or runoff.

- NPS pollution cannot be traced to a direct discharge point such as a wastewater treatment facility.
Examples of NPS

- oil & grease from cars
- fertilizers
- animal waste
- grass clippings
- septic systems
- sewage leaks
- household cleaning products
- Litter
- Agriculture
“People Pollution”

Nonpoint Source Pollution or people pollution is contamination of our waterways and ocean that results from everyday activities such as fertilizing the lawn, walking pets, changing motor oil, and littering. With each rainfall, pollutants generated by these activities are washed from streets and lawns into stormwater drains that flow into our waterways and ocean.

Each one of us, whether we know it or not, contributes to nonpoint source pollution through our daily activities. As a result, nonpoint source pollution is the BIGGEST threat to many of our ponds, creeks, lakes, streams, rivers, bays, and the ocean.

The collective impact of nonpoint source pollution threatens aquatic and marine life, recreational water activities, the fishing industry, tourism, and most importantly, our precious drinking water resources. Ultimately, the cost becomes the burden of every New Jersey resident.

But there is good news—in our everyday activities we can stop nonpoint source pollution and keep our environment clean. Simple changes in YOUR daily life can make a tremendous difference in the quality of New Jersey’s water resources. Here are just a few ways you can reduce nonpoint source pollution.

Litter: Place litter, including cigarette butts and fast food containers, in trash receptacles. Never throw litter in streets or down storm drains. Recycle as much as possible.

Fertilizers: Fertilizers contain nitrates and phosphates that, in abundance, cause blooms of algae that can lead to fish kills. Avoid overuse of fertilizers, and do not apply them before a rainfall.

Pesticides: Many household products made to exterminate pests are also toxic to humans, animals, aquatic organisms, and plants. Follow the label directions carefully. Do not overuse pesticides, and use natural alternatives whenever possible.

Household Hazardous Products: Many common household products (paint thinners, moth balls, drain and oven cleaners, to name a few) contain toxic ingredients. When improperly used or discarded, these products are a threat to public health and the environment. Do not pour hazardous products down any drain or toilet. Do not discard with regular household trash. Use natural and less toxic alternatives whenever possible. Contact your County Solid Waste Management Office for information regarding hazardous waste collection in your area.
Pollutant Transport Mechanisms

• NPS pollutants build up on land surfaces during dry weather
  ➢ Atmospheric deposition (especially mercury)
  ➢ Fertilizer applications
  ➢ Animal waste
  ➢ Automotive exhaust/fluid leaks

• Pollutants are washed off land surfaces during precipitation events (stormwater runoff)

• Stormwater runoff will flow to lakes and streams

• FIRST FLUSH EFFECT
Impact of Nonpoint Source Pollution

- fish and wildlife
- recreational water activities
- commercial fishing
- tourism
- drinking water quality
Pollutants Found in Runoff

**Sediment**
- Soil particles transported from their source

**Biochemical Oxygen Demand (BOD)**
- Oxygen depleting material
  - Leaves
  - Organic material

**Toxics**
- Pesticides
  - Herbicides
  - Fungicides
  - Insecticides
- Metals (naturally occurring in soil, automotive emissions/tires)
  - Lead
  - Zinc
  - Mercury
- Petroleum Hydrocarbons (automotive exhaust and fuel/oil)

**Nutrients**
- Various types of materials that become dissolved and suspended in water (commonly found in fertilizer and plant material):
  - Nitrogen (N)
  - Phosphorus (P)

**Debris**
- Litter and illegal dumping

**Bacteria/ Pathogens**
- Originating from:
  - Pets
  - Waterfowl
  - Failing septic systems

**Thermal Stress**
- Heated runoff, removal of streamside vegetation
Potential Sources of Pollutants Found in Residential Areas

- Nutrients: Fertilizers and septic systems
- Pathogens: Pet waste and septic systems
- Sediment: Construction, road sand, soil erosion
- Toxic: Pesticides, household products
- Debris: Litter and illegal dumping
- Thermal: heated runoff, removal of streamside vegetation
Why are these pollutants important?

- **Sediment** reduces light penetration in stream, clogs gills of fish and aquatic invertebrates, increases filling of impoundments.

- **Nutrients** act as fertilizer for algae & aquatic plants which can cause highly varying dissolved oxygen levels. At low DO levels, the aquatic life has the potential to be harmed.

- **BOD** measures the amount of organic matter that is decomposed by microorganisms which deplete dissolved oxygen.

- **Toxics** can impact life and contaminate drinking water supplies.

- **Bacteria/Pathogens** are an indicator of possible viruses present in the system.
Why do we care about stormwater?

• **Stormwater Regulations**
  - New Jersey Stormwater Permitting Regulations (NJAC 7:14A)
  - New Jersey Stormwater Management Regulations (NJAC 7:8)

• **Executive Order 109**
  - Issued by Governor Whitman in January 2000
  - Requires nonpoint source analysis for all water quality management plan amendments

• **Protect / Restore Environment**
  - Point sources used to control instream water quality. With advances in wastewater treatment, nonpoint sources often dominate the health of the waterbody.
  - Based upon the New Jersey Department of Environmental Protection’s (NJDEP) latest evaluation, of the 2,308 assessed river miles, 1,913 river miles (i.e., 83%) did not meet the surface water quality standards for at least one parameter.
  - 40 to 70% of existing NJ water quality problems attributed to stormwater (NJDEP, 2003)
Christopher C. Obropta, Ph.D., P.E.
Water Resources Extension Specialist
Rutgers Cooperative Extension
Phone: 732-932-9800 ext. 6209
E-mail: obropta@envsci.rutgers.edu
www.water.rutgers.edu
Amy Boyajian
Program Associate, Water Resources Program
Rutgers Cooperative Extension
New Jersey Sea Grant Extension Program
Phone: 732-932-9800 ext. 6164
E-mail: boyajian@envsci.rutgers.edu
www.water.rutgers.edu
www.njmsc.org