

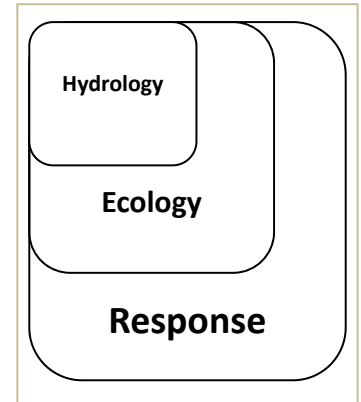
# Urban Watershed Management

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## Watershed Functions

- Collection
- Storage
- Discharge
- Reactions
- Habitat
- Attenuation
- Flushing



## Watershed Characteristics

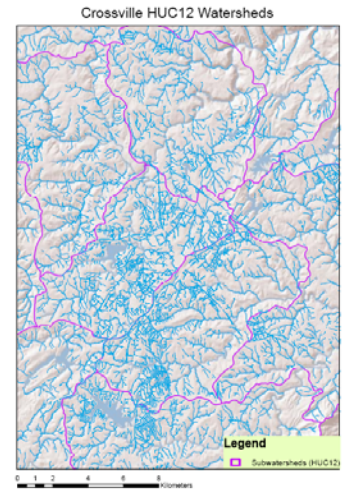
- Physical
- Climate
- Stream order
- Urbanization gradient
  - Roads, mining, agriculture, residential, industry

| DRAINAGE BASIN CHARACTERISTICS |  |
|--------------------------------|--|
| <i>Watershed Morphometry</i>   | Channel Geometry (cross section)<br>Topography (slope, aspect, drainage density) |
| <i>Wetlands/Riparian Areas</i> |  |
| <i>Soils</i>                   | Depth<br>Infiltration  |
| <i>Geology</i> (lithology)     |  |
| <i>Vegetation</i> (upland)     |  |

Cammon, 1998

## Collection

- Surface
- Relief
- Slope
- Conveyance
- Channel



## Urban Collection

- Urban Watershed
- Streams
- Ditches
- Roads
- Pipes
- Trenches

Change of function:  
3-4x the density of natural drainage network

Development process:  
Remove vegetation  
Drain the land



## Storage

Natural Watershed

- Relief
- Soil
- Vegetation
- Channels

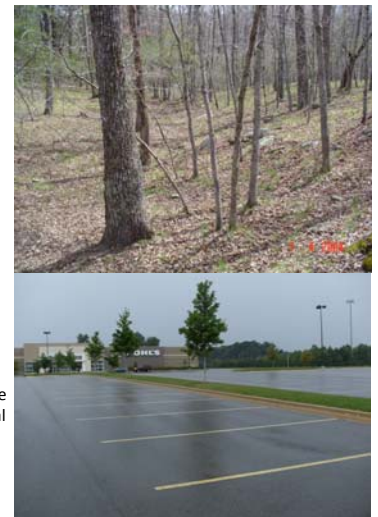
Urban Watershed

- Harvest
- Retention
- Detention
- GIPs

Development process

reduces storage

1. Vegetation and soil removal
2. Relief reduction
3. Soil compaction
4. Surface sealing
5. Biomass reduction

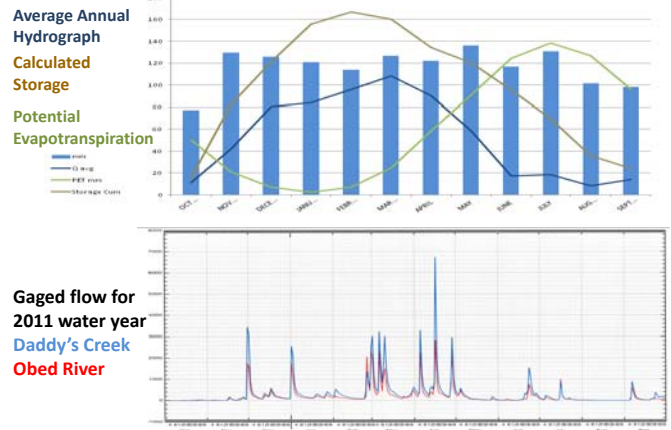


## Urban Storage

- Wetlands, ponds
- Flood plains
- Detention, GIPs



## Watershed Discharge

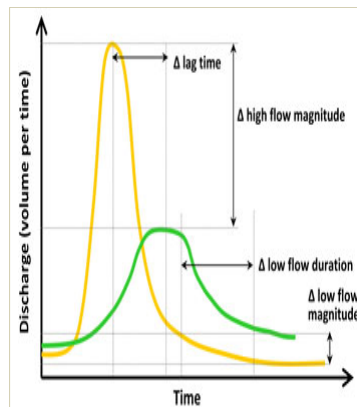


## Urban Discharge

$$Q = P - S - ET$$

Development process shortens travel time reduces storage

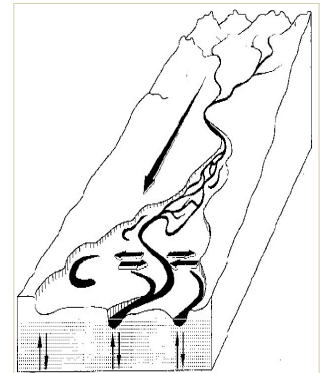
- Length
- Slope
- Roughness



[http://www.epa.gov/caddis/ssr\\_urb\\_hyd1.html](http://www.epa.gov/caddis/ssr_urb_hyd1.html)

## Biogeochemical Reactions

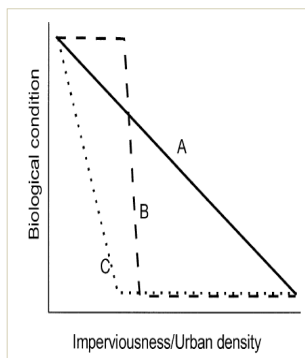
- Dynamic three dimensional interface continuum (Fluvial hydrosystem approach)
- Longitudinal, lateral and vertical transfers of energy, material and biota
- Sediment transport



Petts 1996

## Biogeochemical Reactions Development process effects

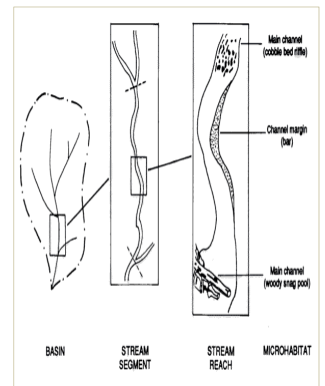
- Increased heat and light input
- Increased pollutant concentrations
- Reduced nutrient uptake
- Reduced quality of biotic indices



Walsh et al. 2005

## Habitat

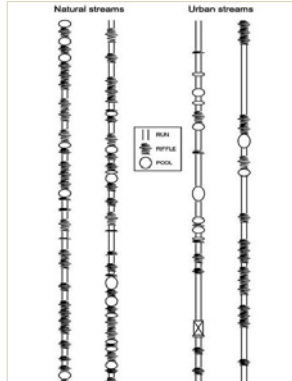
- Life supporting system with a **pulse** of bidirectional interactions over range of spatial and temporal scales
- **Nested hierarchy** of subsystems creates diversity patterns at various levels
- Variability of hydrological and geomorphological processes determine the types of **habitat patches** and the strength, duration and frequency of their **connectivity**



<http://water.usgs.gov/nawqa/protocols/OFR-93-408/habitp5.html>

## Habitat Development process effects

- Hydromodification
- Reduced canopy
- Loss of stream buffer
- Increased bank erosion
- Reduced diversity and connectivity



[http://www.epa.gov/caddis/ssr\\_urb\\_phb1.html](http://www.epa.gov/caddis/ssr_urb_phb1.html)

## Watershed Integrated Response

- Watersheds balance inputs, resources and constraints resulting in integrated response of attenuation and flushing.
- Level of knowledge of hydrologic and ecological functions and leveraging of watershed adaptive capacity is reflected in stormwater management and municipal operations.
- Watershed provides ecosystem services for local economy, recreation, public involvement, education and health of the community.

## Management Framework

- Inventory of assets
- Monitoring as feedback
- Actionable information
- Municipal integrated strategy

| Goals                                 | Strategies  |   |
|---------------------------------------|---|---|
|                                       | Non-site specific   | Site-specific   |
| Water quality improvement             | <ul style="list-style-type: none"> <li>Nonpoint source controls:</li> <li>Septic system upgrade</li> <li>SSO control/leaker repair</li> <li>Maintain minimum flows</li> <li>Low-impact development</li> <li>Litter cleanup</li> <li>Monitoring</li> </ul>   | <ul style="list-style-type: none"> <li>Point source controls:</li> <li>NPDES discharge permits</li> <li>CSO reduction (LTCPs)</li> <li>Green stormwater BMPs</li> <li>Riparian bioengineering</li> <li>Brownfield remediation</li> <li>Reforestation/aquifer recharge</li> </ul>  |
| Flood hazard reduction                | <ul style="list-style-type: none"> <li>Flood modeling and mapping</li> <li>Floodplain regulations</li> <li>Warning/evacuation plans</li> <li>Floodproofing</li> <li>Automated rainfall/streamflow monitoring</li> <li>Public information</li> </ul>   | <ul style="list-style-type: none"> <li>Remove channel obstacles</li> <li>Restore natural flow regime</li> <li>Flood-prone property layout</li> <li>Wetland restoration</li> <li>Green stormwater BMPs (such as rain gardens, green roofs, and porous paving)</li> </ul>   |
| Aquatic habitat/fisheries restoration | <ul style="list-style-type: none"> <li>Maintain minimum flows</li> <li>Increase dissolved oxygen</li> <li>Reduce toxics, organics, metals, etc.</li> <li>Reduce bank erosion and sedimentation</li> <li>Litter clean-up</li> <li>Invasives control (such as the zebra mussel)</li> <li>Fish restocking</li> </ul> | <ul style="list-style-type: none"> <li>Dam removal</li> <li>Stream daylighting</li> <li>Remove shoreline armoring</li> <li>Restore streamflow regime (pool/inflow meanders)</li> <li>Riparian buffer restoration (bioengineering and reforestation)</li> <li>Invasive plant removal/</li> <li>Planting of native species</li> <li>Wetlands restoration</li> <li>Fish passageways on dams</li> </ul> |
| Public use and awareness              | <ul style="list-style-type: none"> <li>Watershed public events</li> <li>Reduce health hazards</li> <li>Improve visibility of stream</li> <li>Public information (such as signage, websites, and newsletters)</li> </ul>   | <ul style="list-style-type: none"> <li>Urban waterfront renewal</li> <li>Greenways/bikeways</li> <li>Public recreation areas</li> <li>Boat launch ramps</li> <li>Environmental education sites</li> </ul>   |

Platt 2006

*“The blind forces of urbanization, flowing along the lines of least resistance, show no aptitude for creating an urban and industrial pattern that will be self-sustaining and self-renewing.”*

Lewis Mumford (1895-1990)

The Natural History of Urbanization  
1956

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## Thank you

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