

# REFERENCE

END NOTES

BIBLIOGRAPHY

ABBREVIATIONS

GLOSSARY

RESOURCES

PHOTO CREDITS



# END NOTES

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# ABBREVIATIONS

BMP	Best Management Practice
CSO	Combined Sewer Overflow
CSS	Combined Sewer System
CWA	Clean Water Act
LID	Low Impact Development
EPA	Environmental Protection Agency
MS4	Municipal Separate Storm Sewer Systems
NPDES	National Pollutant Discharge Elimination System
PlanET	Plan East Tennessee
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority

## **CONTAMINANT ABBREVIATIONS**

HC	Hydrocarbon
HM	Heavy Metal
N	Nitrogen Compounds
P	Phosphorous Compounds
PA	Pathogens
S	Sediment
VOC	Volatile Organic Compounds

# GLOSSARY

## **303(D) LIST**

A list held by the State as required by Section 303(d) of the Federal Clean Water Act of the waterbodies that do not support their designated uses. The Tennessee Department of Environment and Conservation publishes this list every two years: <http://tn.gov/environment/wpc/publications/>.

## **AQUIFER**

An underground layer of permeable rock containing or conducting groundwater. Sub-surface rock types commonly containing aquifers include sandstone, conglomerate, fractured limestone and unconsolidated sand and gravel.

## **ATMOSPHERIC VOLATILIZATION**

Loss of a substance to the atmosphere as a gas (in a gaseous state), such as nitrogen-based fertilizer applied to soil surface that may evaporate as gaseous ammonia.

## **BASIN**

A physical facility that holds stormwater.

## **BEST MANAGEMENT PRACTICES, STORMWATER (BMP)**

A method that is recognized as an efficient, effective, and practical means of reducing stormwater runoff quantity and preventing or reducing the

movement of pollutants into receiving waters. A BMP may be a physical facility or a management practice achieved through action.

## **BIOACCUMULATION**

The process by which contaminants accumulate within the tissues of a living organism.

## **BIOCHEMICAL BREAKDOWN**

Metabolic processes that break down or degrade contaminant compounds into simpler molecules or elements.

## **BIOLOGICAL DIVERSITY (BIODIVERSITY)**

The number and variety of living organisms in a defined geographic area in all forms and at all levels, including ecosystem diversity, species diversity, and genetic diversity.

## **BIORETENTION**

A process enabled by various stormwater best management practice facilities where runoff is captured and pollutants are filtered through physical, chemical, and biological processes. Bioretention facilities are sized to retain a prescribed stormwater runoff volume, designed with specific vegetation and engineered media, and usually incorporate an underdrain to route treated water to a receiving drainage system.

**BLUEWAY**

Water trails that are developed with launch points for canoeists, paddle boarders, kayakers, and others seeking water recreation.

**CHANNELIZATION**

1) Hydrologic modification and straightening of a stream's shape that may cause destabilization of stream banks and stream bed; 2) the formation of steep channel walls that separate the stream from its primary floodplain.

**CLEAN WATER ACT (CWA)**

The primary federal law in the United States governing water pollution. This legislation provides the basic regulatory framework for the protection of water quality through control of discharge of pollutants into surface waters, including the management of stormwater runoff. Public Law 92-500.

**COMBINED SEWER OVERFLOW (CSO)**

Discharge of the combination of stormwater and sanitary wastewater to receiving waters during storms when the capacity of the sewer system to transport, store, or treat the increased flow is exceeded.

**COMBINED SEWER SYSTEM (CSS)**

A sewer system that conveys and treats both stormwater runoff and municipal sewage simultaneously with shared infrastructure.

**CONCENTRATED FLOW**

Runoff that accumulates in defined conveyances, such as swales, gutters, channelized streams, or pipes, resulting in higher velocities.

**CONTAMINANT**

A substance in a concentration that adversely alters the physical, chemical, or biological properties of the natural environment.

**CONVEYANCE**

Constructed and/or natural features that function together as a system to collect, channel, or divert stormwater.

**CULVERT**

A constructed pipe or box structure that conveys surface water or runoff under another structure such as a roadway or embankment.

**DESIGN STORM**

The precipitation depth and intensity used to size stormwater management facilities and select materials for stormwater treatment.

**DETENTION**

The slowing, collecting, or temporary storage of stormwater to decrease peak flow rate into receiving waters.

**DEVELOPED LAND**

Any land that has been modified from its native, vegetated condition to support past or present human activities.

**DISCHARGE**

The release of contaminated water into receiving waters.

**DRAINAGE AREA (CATCHMENT AREA)**

The area of a site that contributes runoff; used to calculate dimensions for structural BMPs.

**ECOSYSTEM**

A clearly defined interconnected and dynamic system of interactions between all living organisms and the abiotic physical environment within a defined area.

**ECOSYSTEM SERVICE**

Resources and processes that are supplied by ecosystems and serve all living organisms. Ecological services provided by healthy watersheds are: atmospheric regulation, climate regulation, disturbance regulation, water supply, erosion control and sediment retention, soil formation, nutrient cycling, waste treatment, pollination, species control, refugia, food production, raw material production, genetic resources, recreation, and cultural enrichment.

**EPHEMERAL STREAM**

A stream that has flowing water only during, and for a short duration after, precipitation events in a typical year. Runoff from rainfall is the primary source of water for stream flow.

**EROSION**

The wearing away of rock and soil due to wind, water, ice, or other physical, chemical, or biological forces. The rate of erosion may be increased by land use activities.

**EUTROPHICATION**

Process by which a waterbody undergoes an increase in dissolved nutrients, often leading to algal blooms, low dissolved oxygen, and changes in community structure. This process occurs naturally over time, but can be accelerated by human activities that increase nutrient inputs into receiving waters' aquatic ecosystems.

**EVAPOTRANSPIRATION**

The sum of evaporation of water from land and water surfaces and the uptake and release of water by vegetation to the atmosphere through transpiration.

**EXTENDED TREATMENT, BIOLOGICAL AND CHEMICAL**

A function of certain Best Management Practices (BMP) that retain water for an extended period of time, thus allowing for improved water quality through passive organic (biological) and/or inorganic (chemical) processes.

**FILTRATION**

Process through which contaminant levels in water are reduced by means of physical removal or chemical decomposition during the movement of water through a medium. Examples of filtering media include soils, root zones, vegetated areas, sand, and gravel.

**FIRST FLUSH**

Stormwater that initially runs off an area, more polluted than the stormwater that runs off later. Generally considered to be the runoff from the first inch of rainfall.

**FLOW RATE**

A measurement indicating a volume of water per unit of time, most often cubic feet per second. Sometimes used interchangeably with velocity. See: Concentrated Flow, Sheet Flow.

**FOREBAY**

A separate chamber through which stormwater is conveyed prior to entering a BMP; used to trap sediment, dissipate runoff energy, and reduce stormwater velocity to best support sedimentation and other treatment processes in the BMP.

**GREEN INFRASTRUCTURE**

Green infrastructure refers to a system of open or green spaces distributed throughout a watershed that provide ecosystem services and environmental benefits, including recreation opportunities, to enhance overall environmental quality and provide utility services. Green infrastructure includes preserved natural spaces and constructed landscapes such as urban parks and waterfronts. As a general principle, Green Infrastructure techniques use soils and vegetation to infiltrate, evapotranspire, and/or recycle stormwater runoff.

**GROUNDWATER**

Water occurring beneath the earth's surface, typically in aquifers, that supplies wells and springs and is a key source of drinking water.

**HEAVY METALS**

Elements, such as zinc, mercury, lead, and copper. These elements can become dissolved in stormwater and are prone to accumulate in urban areas due to human activities—mainly automobile use.

**HOT SPOT**

A term used to describe areas where land use or activities generate highly contaminated runoff with concentrations of pollutants in excess of those typically found in naturally occurring stormwater runoff.

**HYDROCARBONS**

Organic chemical compounds made up of solely carbon and hydrogen. Predominantly used as combustible fuel and, in solid state, asphalt; a pollutant of concern in urban areas due to their contribution to ground level ozone and smog and persistence in soil and water.

**HYDROLOGIC CYCLE (WATER CYCLE)**

The continuous movement of water on, above, or below the earth's surface through processes including precipitation, canopy interception, condensation, evapotranspiration, infiltration/percolation, and storage.

**HYDROLOGY**

The study of the movement and distribution of surface water and groundwater in a system.

**IMPAIRED WATER BODY**

A water body, or segment thereof, that has been identified as failing to support one or more of its designated uses. See: 303(d) List, Threatened Water.

**IMPERVIOUS SURFACE**

A hard surface that either prevents or limits the movement of water into the soil as would naturally occur in a pre-development condition; a surface that causes water to runoff in greater quantities than that occurring under natural or pre-development conditions.

**INFILTRATION**

The movement of water into the ground through air spaces between soil particles.

**INTERCEPTION**

The process of precipitation being caught by trees, plants, or other objects that prevent it from reaching the ground and becoming runoff. Intercepted precipitation may eventually evaporate.

**KARST TOPOGRAPHY**

Geological formations shaped by the dissolution of soluble rock, usually carbonate rock like limestone or dolomite.

**LAND USE**

The way land is used or developed, such as the types of buildings, percentage of impervious surfaces, and activities permitted. Particular land uses are often associated with different types of water quality issues, such as hydrocarbons from refueling stations.





**LOW IMPACT DEVELOPMENT (LID)**

An approach to site planning, design, and development that seeks to avoid, minimize, and manage impacts to water resources by stewarding and reintroducing natural hydrologic processes into developed watersheds.

**MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4)**

A stormwater drainage network (including road drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) that is owned or operated by a local government or designated entity (such as a state, city, town, borough, county, parish, district, association, or other public body).

**NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)**

A regulatory program in the Federal Clean Water Act that prohibits the discharge of pollutants into surface waters of the United States without a permit.

**NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PHASE I**

NPDES Phase I, issued in 1990, requires medium and large cities or certain counties with populations of 100,000 or more to obtain NPDES permit coverage for their stormwater discharges.

**NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PHASE II**

NPDES Phase II, issued in 1999, requires regulated small MS4s in urbanized areas, as well as small MS4s outside the urbanized areas that are designated by the permitting authority, to obtain NPDES permit coverage for their stormwater discharges.

**NON-POINT SOURCE (NPS) POLLUTION**

Pollution originating from diffuse sources without a single point of origin.

**NUTRIENTS**

Substances such as nitrogen and phosphorous that are required by plants and animals for growth. In some circumstances, excessive nutrient additions to surface waters may result in excessive algal or plant growth and, subsequently, the accumulation and decay of increased organic matter. See: Eutrophication.

**OPEN SPACE**

For the purposes of this publication, land set aside for public or private use within a development that is not built upon. Readers should check zoning ordinances for the effective definition in their jurisdiction.

**PATHOGEN**

A microscopic organism, such as certain viruses, bacteria, or fungi, capable of causing disease in another organism.

**PEAK FLOW REDUCTION**

Peak flow refers to the rate of highest stormwater volume that flows during a storm event. Certain Best Management Practices (BMP) reduce peak flow and decrease the risk of floods, reduce pressure on stormwater infrastructure, and protect stream channels.

**PERENNIAL STREAM**

A stream that flows continuously throughout the year. Groundwater is the primary source of water for stream flow.

**PERMEABLE/PERVIOUS SURFACE**

Material or medium that allows the infiltration or passage of water or other liquids.

**PHYTOREMEDIATION**

The mitigation of contaminated soil, water, or air using plants to contain, degrade, or eliminate pollutants. See: Extended Treatment (Biological).

**POINT SOURCE POLLUTION**

Pollution that can be traced to a single point, or output, such as a pipe.

**RECEIVING WATERS**

Any river, stream, reservoir, or other waterbody into which stormwater or other material is discharged.

**RETENTION**

The process of collecting and holding stormwater runoff with no surface outflow. See: Bioretention.

**RIPARIAN AREA**

Terrestrial and aquatic ecosystems along a waterbody. Riparian areas characteristically have a high water table and are subject to periodic flooding.

**RIVER BASIN**

The watershed encompassing all the land drained by a major river. Water that falls within the river basin flows into the major river via lower order watersheds. See: Watershed.

**RUNOFF**

The rainfall that is shed by the landscape to a receiving waterbody when rainfall exceeds the infiltration capacity of the intercepting surfaces and soil.

**SEDIMENT**

Particles of dust, soil, and debris, commonly referred to as suspended solids, that have been moved and subsequently deposited by water, wind, or gravity.



**SEDIMENTATION/SILTATION**

A mechanical process in which suspended solids settle to the bottom of a waterbody under the influence of gravity.

**SHEET FLOW**

Unconfined water that accumulates on the soil surface and moves down gradient as a thin layer of water. See: Concentrated Flow, Flow.

**STORM EVENT**

A discrete period of precipitation with defining characteristics such as depth of precipitation, duration, and the resultant intensity usually measured in inches/hour.

**STORMWATER RUNOFF**

In developed areas, precipitation that does not soak into the surface on which it falls, but rather runs along the surface downslope to receiving waters. Generally, the volume of stormwater runoff is exacerbated by impervious surfaces such as rooftops, parking lots, roadways, and compacted soils on which it may pick up deposited contaminants.

**STRAINING**

Physical filtration that removes large particles and debris, such as sediment, organic debris, and litter. See: Filtration.

**SURFACE WATER**

Water collected on the landscape in any waterbody such as a stream, river, reservoir, lake, or ocean.

**SUSPENDED SOLIDS**

Organic and inorganic particles suspended in the water column and carried by the water. The presence of suspended solids in water is often associated with toxic contaminants that bind to particles.

**THREATENED WATER BODY**

A water body, or segment thereof, that has been identified as likely to not support its designated uses. See: 303(d) List, Impaired Water.

**TREATMENT TRAIN**

A series of structural BMPs sequenced to achieve stormwater quantity management and treatment of contaminated stormwater runoff.

**URBANIZATION**

Changing land use from rural characteristics to urban and sub-urban (city-like) characteristics; typically associated with an increase in impervious surfaces.

**WATER TABLE**

The depth at which soil is saturated by groundwater.

## **WATERSHED**

Topographically defined land area within which surface water drains to a single point of reference. Watersheds are designated with Hydrologic Unit Codes (HUC). See: <http://water.usgs.gov/GIS/huc.html>

## **WETLAND**

Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

## **GLOSSARY SOURCES**

Definitions within this glossary have been informed by, and have occasionally adopted wording from, the following sources:

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Perrin, C., et al. "Low Impact Development: A Guidebook for North Carolina (AG-716)." NC Cooperative Extension Service, NC State University. Published 2009. Accessed April 2013. <http://www.ncsu.edu/WECO/LID>.

United States Army Corps of Engineers. "2012 Nationwide Permit Information." Accessed May 20 2013. [http://www.usace.army.mil/Portals/2/docs/civilworks/nwp/2012/NWP2012\\_corrections\\_21-sep-2012.pdf](http://www.usace.army.mil/Portals/2/docs/civilworks/nwp/2012/NWP2012_corrections_21-sep-2012.pdf).

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USEPA. "National Pollutant Discharge Elimination System (NPDES)." Office of Water. Accessed April 2013. <http://cfpub.epa.gov/npdes/stormwater/munic.cfm>.

University of Arkansas Community Design Center. "Low Impact Development: A Design Manual for Urban Areas." (See End Note 31).

# RESOURCES

## LOCAL ORGANIZATIONS WITH WATER STEWARDSHIP INTERESTS

Beaver Creek Task Force (See Water Quality Forum)

Coal Creek Watershed Foundation  
<http://www.coalcreekaml.com/>

Farragut Stormwater Matters Program  
<http://townoffarragut.org/index.aspx?nid=171>

Fort Loudoun Lake Association  
<http://fllake.org/>

Friends of Williams Creek

Legacy Parks Foundation  
<http://www.legacyarks.org/>

Little River Watershed Association  
<http://www.littleriverwatershed.org/>

Lower Clinch Watershed Council  
<http://www.lowerclinchwatershed.org/>

Stock Creek Task Force (See Water Quality Forum)

Tennessee Izaak Walton League  
<http://www.tnike.com/>

Water Quality Forum (Knox County area)  
<http://waterqualityforum.org/>

## LOCAL WATER QUALITY PROGRAMS

Adopt-A-Stream Program  
[http://waterqualityforum.org/?page\\_id=76](http://waterqualityforum.org/?page_id=76)

Adopt-A-Watershed Program  
[http://waterqualityforum.org/?page\\_id=30](http://waterqualityforum.org/?page_id=30)

Tennessee Yards & Neighborhoods  
<https://ag.tennessee.edu/tnyards/Pages/default.aspx>

## REGIONAL AGENCIES AND ORGANIZATIONS

Clinch-Powell Resource Conservation and Development Council  
<http://www.clinchpowell.net/>

East Tennessee Development District  
[http://www.etdd.org/front\\_page.htm](http://www.etdd.org/front_page.htm)

Foothills Land Conservancy  
<http://www.foothillsland.org/>

Knoxville-Knox County Metropolitan Planning Commission  
[www.knoxmpc.org](http://www.knoxmpc.org)

Plan East Tennessee (PlanET)  
<http://www.planeasttn.org/>

Smoky Mountain Resource Conservation and Development Council  
<http://www.smokymountainrcd.org/>

## STATE AGENCIES

Tennessee Department of Agriculture, Water Resources  
<http://www.tn.gov/agriculture/water/index.shtml>

Tennessee Department of Environment & Conservation (TDEC), Water  
<http://www.tn.gov/environment/water.shtml>

Tennessee Water Resources Research Center  
<http://isse.utk.edu/wrrc/index.html>

Tennessee Wildlife Resources Agency  
<http://www.tn.gov/twra/conservation.html>

US Geological Survey (USGS) Tennessee Water Science Center  
<http://tn.water.usgs.gov/>

University of Tennessee Extension  
<https://utextension.tennessee.edu/Pages/default.aspx>

## STATE ORGANIZATIONS

- Tennessee American Water Resources Association  
<http://tnawra.er.usgs.gov/>
- Tennessee Association of Utility Districts  
<http://www.taud.org/>
- Tennessee Clean Water Network  
<http://www.tcwn.org/>
- Tennessee Stormwater Association  
<http://tnstormwater.org/>
- Tennessee Water and Wastewater Association  
<http://www.twwa.us/>

## STATE AND FEDERAL WATER QUALITY REGULATIONS

- County Soil and Water Conservation Districts  
Erosion Prevention and Sediment Control (EPSC)  
<http://www.tnepsc.org/handbook.asp>
- National Pollutant Discharge Elimination System (NPDES), EPA  
<http://www.epa.gov/oecaerth/monitoring/programs/cwa/npdes.html>
- National Pollutant Discharge Elimination System (NPDES) Permits Program,  
Tennessee Department of Environment and Conservation  
<http://www.tn.gov/environment/permits/npdes.shtml>TN

## FEDERAL AGENCIES AND NATIONAL ORGANIZATIONS

- Natural Resources Conservation Service  
<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/>
- Oak Ridge National Laboratory (ORNL) Environmental Sciences Division  
<http://www.esd.ornl.gov/index.shtml>
- Tennessee Valley Authority (TVA), Water Quality  
<http://www.tva.com/environment/water/index.htm>
- United States Environmental Protection Agency (EPA), Region 4 Water Protection  
<http://www.epa.gov/region4/water/>
- United States Fish and Wildlife Service  
[www.fws.gov](http://www.fws.gov)
- United States Geological Survey (USGS), Water Resources of the United States  
<http://isise.utk.edu/wrrc/expertise/resources.html>

## ECONOMIC STUDIES

- North Carolina Cooperative Extension  
[http://www.ces.ncsu.edu/depts/agecon/WECO/nemo/documents/WECO\\_LID\\_econ\\_factsheet.pdf](http://www.ces.ncsu.edu/depts/agecon/WECO/nemo/documents/WECO_LID_econ_factsheet.pdf)
- ASLA Sustainable Landscapes Toolkit  
<http://www.asla.org/ContentDetail.aspx?id=31837>

## GENERAL INFORMATION

- EPA "Surf Your Watershed"  
<http://cfpub.epa.gov/surf/locate/index.cfm>
- Low Impact Development Center  
<http://www.lowimpactdevelopment.org>

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COVER Edward J. Dumas

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7 Paul Miller Photography

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Norris Dam: flickr user Bryce Giesler  
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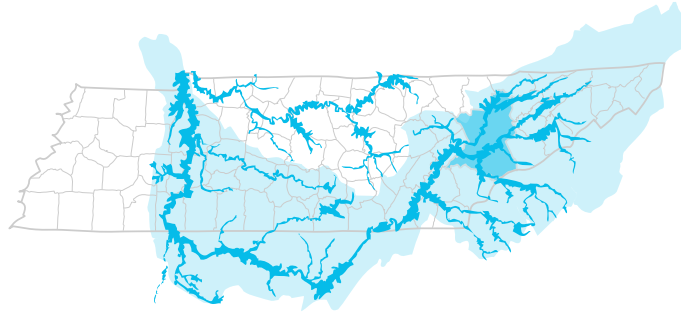
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63 (Base) Ibid  
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## PART III

85 (TL) Ralph Preston Photography  
85 (TR, BL) Tennessee Department of Agriculture  
85 (BR) Oak Ridge National Laboratory, Natural Resources  
89 Hargreaves Associates  
94 Legacy Parks Foundation  
95 (Base) Ibid  
99 Various Government and Non Profit Websites  
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113 (Base) Tennessee Yards and Neighborhoods  
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151 Hawkins Partners, Inc.  
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154 UT College of Architecture and Design, Ken McCown  
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172-173 Hargreaves Associates  
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178-179 Green City, Clean Waters + WRT  
180 Legacy Parks Foundation







East Tennessee's iconic water resources are a sustaining economic, social, and environmental asset. These resources are vulnerable to impacts from prevailing development patterns in the region, human activities, and existing stormwater infrastructure. Each increase the quantity of polluted stormwater runoff draining to the region's streams, rivers, reservoirs, and groundwater resources, compromising their health and the health of the communities they sustain. With the Plan East Tennessee Region's population poised to grow forty-three percent by 2040, reliance upon these water resources will increase while their health is further threatened by expanding development. Low Impact Development methods proposed in this publication offer existing and expanding communities an enhanced approach to watershed planning, community design, and site development that avoids, minimizes, and manages impacts to the region's shared water resources.

This publication is intended for a general audience ranging from homeowners to educators, government and stormwater officials, site designers and engineers, and developers. Everyone lives in a watershed and has a role to play in the stewardship of shared water resources. While its focus is the five-county PlanET Region, the observations and concepts described in this publication are applicable to other parts of the state of Tennessee and the Southeastern United States that face similar water resource stewardship and NPDES compliance challenges.

