Water Resources Element
Greensboro Comprehensive Plan

The Greensboro Comprehensive Plan's "Water Resources Plan Element" (WRE) is a new plan element added to the Comprehensive Plan. This plan element is mandated to assure compliance with the requirements of Maryland House Bill 1141 (HB 1141). The purpose of the WRE is to provide additional layers of planning for water resources in relation to existing use and proposed land use, based on an analysis of growth and development trends to assure demands for water supply can be satisfied as Town growth occurs and to assure measures are taken to minimize impacts to water quality.

The Greensboro WRE is directly linked to a number of other Plan elements including: 1) the Land Use Plan; 2) the Municipal Growth Element; 3) Community Facilities; and 4) Resource Conservation elements. The WRE addresses three major areas including water (both supply and quality), wastewater treatment and discharge, and stormwater management.

Among other things, preparation of the WRE is an exercise intended to test water resource capacity limits, determine the potential implications of water resource issues for future growth, and facilitate development of coordinated management strategies. The Town of Greensboro represents a very small portion of the much larger Choptank River watershed. Since water resource protection issues are of concern watershed wide, much of the effort to protect or enhance water quality will be dependent on County and State actions and programs. Nevertheless, this plan element evaluates Greensboro's role in protection of Water Resources in this larger context.

The purpose of the WRE, as defined in HB 1141, is to establish a clear relationship between existing and proposed future development; it further establishes the relationship between drinking water sources and wastewater facilities that will be necessary to serve that development and measures to limit or control the stormwater and nonpoint source water pollution that will be generated by new development.

Specifically, the statutory requirements are:

- Identify drinking water and other water resources that will be adequate for the needs of existing and future development proposed in the land use element of the plan, considering available data provided by the Maryland Department of the Environment (MDE).

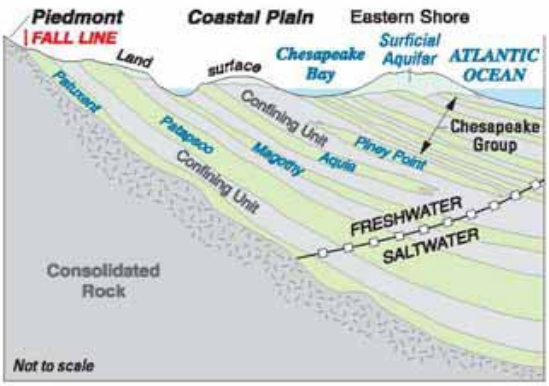
- Identify suitable receiving waters and land areas to meet the stormwater management and wastewater treatment and disposal needs of existing and future development proposed in the land use element of the plan, considering available data provided by MDE.

- Adopt a WRE in the comprehensive plan on or before October 1, 2009, unless extensions are granted by Maryland Department of Planning (MDP) pursuant to law. Zoning classifications of a property may not be changed after October 1, 2009 if a jurisdiction has not adopted a WRE in its comprehensive plan.

This element of the Plan assesses the Town's drinking water sources and wastewater treatment facility and their ability to support existing and future development. It also identifies suitable receiving waters for existing and future wastewater and stormwater discharges. The Town of Greensboro, with substantial assistance and support from the Caroline County Department of Planning and Zoning, has prepared this Water Resources Element to assure the Town will focus its growth to areas best suited to use the existing and planned water and wastewater infrastructure; to nurture efficient patterns of growth; protect and preserve the natural environs; promote economic growth; and support diversity of living environments in the Town.

Water Resources

The Town of Greensboro and Caroline County lie within the Northern Atlantic Coastal Plain (NACP) aquifer system. The NACP system extends from the North/South Carolina border to Long Island, New York. In Maryland, the NACP is bounded in the west by the Fall Line and in the east by the Atlantic Ocean. The Coastal Plain system consists of sand and gravel aquifers interspersed with layers of silt and clay called confining beds. Beneath this system lies a layer of consolidated rock at depths ranging from zero at the Fall Line to about 8,000 feet at Ocean City.



The Northern Atlantic Coastal Plain Aquifer System
Source: *A Science Plan for a Comprehensive Regional Assessment of the Atlantic Coastal Plain Aquifer System*

Greensboro's water system is supplied by the Piney Point aquifer which is one of many located within the Atlantic Coastal Plain. The Piney Point aquifer is a confined aquifer. A confined aquifer has a layer of clay or fine silt above it (a 'confining' layer) that allows very little water to travel vertically into the aquifer. Confined aquifers receive recharge from leakage through confining beds from surficial aquifers and lateral movement of water from adjacent aquifers and thus are less vulnerable to drought conditions.

Water quality in the Piney Point aquifer that serves Greensboro is generally good. In 2003, MDE conducted Source Water Assessments for 19 community water systems and 9 non-community systems located in Caroline County. MDE researched and identified potential sources of contamination for confined aquifers and analyzed each water system for susceptibility to pollutants originating at the land surface. MDE concluded that due to the protected nature of confined aquifers, the water supplies were not susceptible to surface contaminants. Some naturally occurring pollutants, such as arsenic and fluoride, do pose a risk to water systems supplied by the Aquia and Piney Point Aquifers but do not exceed EPA's maximum contaminant level (MCL). Tests conducted as part of MDE's Source Assessments indicated that that arsenic and fluoride levels measured less than 50 percent of the EPA's MCL in Greensboro's water supply.

In 2000, USGS recorded that surface and groundwater withdrawals in Caroline County totaled 21,380,000 gallons per day (Tables 2 and 3 provide details of water withdrawals in the County). Unlike counties on the western shore, the largest water use in Caroline County was irrigation, which averaged 15.48 million gallons per day. The amount of groundwater withdrawn for irrigation purposes in the County is nearly five times higher than the next heaviest use (mining) and more than six times higher than domestic use.

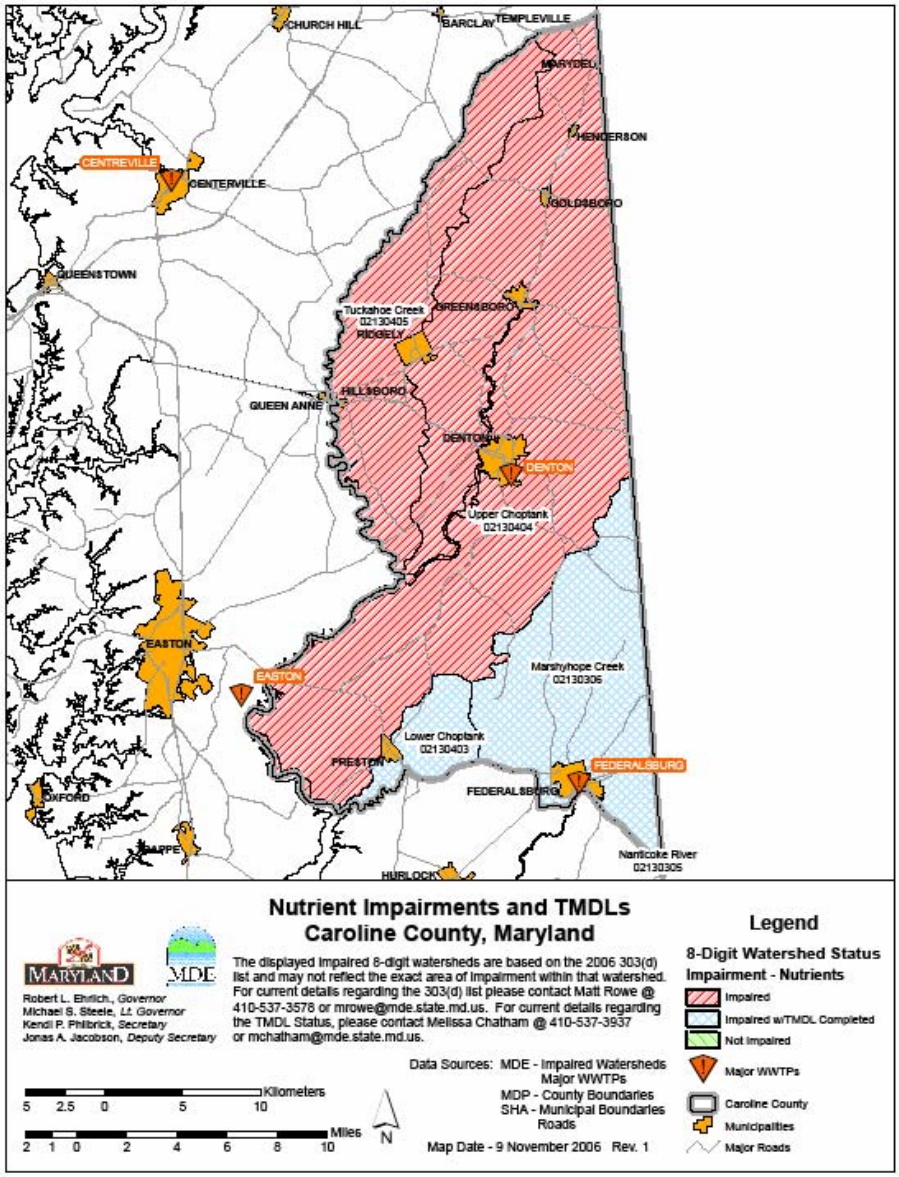
Watershed Characteristics and Conditions

Greensboro drains into the Choptank River Basin which is a State-designated 6-digit watershed. State designated 8 digit watersheds (a subset of the 6-digit basin) within the Choptank Basin include the Tuckahoe River, Upper Choptank, and Lower Choptank Watersheds. Fifty eight percent of Caroline County, including the Town of Greensboro, is located in the Upper Choptank Watershed.

The Upper Choptank River Watershed covers approximately 118,000 acres of land in Caroline County. Land use within the Caroline portion of the watershed is predominantly agriculture (59 percent), followed by forest (29 percent), urban land (8 percent), and wetlands (3 percent). As of 2005, the largest source of nitrogen in the Choptank River Basin was agriculture (70 percent). Agriculture was also the largest contributor of phosphorus (62 percent) and sediment loads (85 percent). In 2007, agricultural land contributed more than two-thirds of the total nutrient loads in the Basin.

A significant portion of the land in the Basin is drained via public ditches that were dug decades ago, primarily to drain land for farming. These ditches cover 368 miles, and including their buffers, occupy 70,137 acres of County land. They are generally kept clear of plants and other vegetative growth, which contributes to increased stream flows and speeds delivery of nutrients to water bodies before they have had a chance to be absorbed into the soil.

The Upper Choptank River is included on the State's 2008 Integrated Report as a Category 5 impaired water body with increases in total nitrogen and phosphorus recorded between 2006 and 2008. Category 5 indicates that a water body is impaired and an assignment of Total Maximum Daily Loads (TMDL) for nitrogen and phosphorus is needed, but not yet established. The watershed has been cited for several impairments including biological, fecal coliform, nutrients and sediments. A watershed plan prepared for the Upper Choptank in 2003 recommended a number of strategies to address water quality issues. A plan update is currently scheduled and will include the establishment and funding of a long-term cover crop program, implementation of improved maintenance and buffer programs for public drainage ditches, better enforcement of local sensitive areas protection measures, flood protection and stormwater management ordinances, and management policies for on-site sewage disposal systems.



Total Maximum Daily Loads (TMDLs)

A TMDL is a calculation of the maximum amount of a pollutant that a body of water can receive and still meet water quality standards. Point sources include urban stormwater systems and wastewater treatment plants with direct discharge permits into waterways (National Pollutant Discharge Elimination System Permits - NPDES). Non-point sources are all discharges other than point source discharges, including stormwater runoff from land and erosion of stream and river banks. A TMDL is used as a regulatory mechanism to identify and implement additional controls on both point and non-point source discharges in water bodies that are impaired from one or more pollutants and are not expected to be restored through normal point source controls.

TMDLs establish limits or "caps" on the amount of pollutants permitted from point and non-point sources through an allocation system. A primary determinant of future growth is the assimilative capacity of local receiving waters for the input of pollutants. Assimilative capacity is expressed in the TMDLs for the receiving waters.

According to a report issued by DNR in 2002, the impairments in the Upper Choptank and Tuckahoe Creek watersheds "will be the subject of TMDL programs within the next few years." To date, no nutrient TMDLs have been set for either watershed, or for any of Caroline County's major tributaries or sub watersheds, however, MDE's Statewide Implementation Plan includes data on basin nutrient loads and "recommended" nutrient caps the Choptank River Basin.

Caroline County's allocations of the load caps for each basin were determined by using the percentage of Caroline County land in each basin, and calculating Caroline County's share using the same percentage of each basin's caps. Caroline County comprises about 40 percent of the land in the Choptank River Basin. Table 1 identifies possible loading caps for the County portion of the basin assuming the County would be allocated 40 percent of the total recommended caps that are yet to be established.

Table 1: Possible Future Nutrient Caps for Caroline County Portion of Choptank River Basin

Source	Nitrogen Cap (lbs/yr)	Phosphorus Cap (lbs/yr)
Point Sources	70,076	6,510
Non Point Sources	705,124	64,890
Total Sources	775,210	71,400

Source: Caroline County Dept. of Planning, Codes and Engineering, 2008.

An estimate of nutrient loads to the watershed from point and non-point sources within the Town of Greensboro are provided later in this Chapter.

Watershed Improvement Initiatives

The Federal Clean Water Act (CWA) provides the framework for managing the nation'swater resources. Water quality standards were developed "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Clean Water Act §101). The standards include designated uses for waterways as well as specific criteria that indicate whether or not the uses are able to be achieved in each waterway. Uses are identified through a public process and are based on the use and value of the water body for: 1) public water supply; 2) protection of fish, shellfish, and wildlife; and/or 3) recreational, agricultural, industrial, and navigational purposes.

A waterway is identified as impaired when it no longer meets the water quality criteria established for it and it is unable to achieve the use for which it is designated. All of Caroline County's major tributaries – Choptank River, Marshyhope Creek and Tuckahoe Creek – are all listed as impaired on the State's 2008 Integrated Report (formerly the 303(d) list).

A report on water quality in Maryland issued by the U.S. Geological Survey in 2004 indicates that the combination of soil and aquifer conditions and the regional predominance of agricultural land use are responsible for the concentrations of nitrogen, phosphorus, and pesticides in streams and rivers on the Eastern Shore. While there are other, lesser contributors to nutrient levels in the region's tributaries (including septic systems, wastewater treatment plants, and urban and suburban chemical applications), the study noted that primary sources of nutrients on the Delmarva Peninsula are inorganic fertilizer, and that the concentrations of nitrogen, phosphorus, and herbicide compounds in streams on the Delmarva Peninsula are similar to those in other predominantly agricultural areas of the United States.

In addition to the Federal Clean Water Act, a number of Federal and State programs exist to provide support for achieving Bay water quality goals and assurance that goals can be reasonably met, including:

Bay Restoration Fund Enhanced Nutrient Reduction (ENR)

The Bay Restoration Fund ENR program uses funding from public sewer taxes to provide up to 100 percent state grant funds to local governments to retrofit or upgrade sewage treatment plants to reduce the nutrient levels in plant discharge to 3 mg/l total nitrogen (TN) and .3 mg/l total phosphorus (TP). Upon completion of an ENR upgrade, the permitting authority (MDE) requires the permittee to make a best effort to meet the load goals, providing reasonable assurance of implementation. At present, funding is targeted only for major wastewater treatment plants treating 500,000 GPD or greater volumes of wastewater. The smaller size of Greensboro's plant precludes access to this funding program at the present time.

The Maryland Water Quality Improvement Act

The Maryland Water Quality Improvement Act "requires that comprehensive and enforceable nutrient management plans be developed, approved and implemented for all agricultural lands throughout Maryland." This Act specifically requires that nutrient management plans for nitrogen be developed and implemented by 2002, and plans for phosphorus to be done by 2005. To date, dozens of Caroline County farmers are enrolled in cost-share programs to implement agricultural best management practices (BMPs). These programs are managed by the Maryland Agricultural Water Quality Cost-Share Program (MACS), Maryland Department of Agriculture's NRCS and FSA, and University of Maryland Cooperative Extension Service. At the end of 2008, over 80 percent of Caroline County farms were implementing nutrient management plans; nearly one-fifth of all farms utilized some form of conservation tillage. Just over 17,000 acres of cover crops were planted in the County in 2008, and over 4,000 tons of manure (mainly from chickens) was transported out of the County. Since 2008, about 4,200 acres of grass buffers and 142 acres of forest buffers have been installed on farms in the County, and 149 acres of agricultural lands were restored to wetlands.

The cumulative result of the buffers, wetlands and cover crops was a total reduction of nutrients (466,155 lbs. of nitrogen and 99,012 lbs. of phosphorus) in the Choptank River Basin, where the farms enrolled in these programs were located. However, the total reduction of nutrients fell far short of the Choptank Basin Tributary Goals.

Tributary Strategies

Tributary Strategies are river-specific cleanup strategies that detail the "on-the-ground" actions needed to reduce the amount of nutrients and sediment flowing into the Chesapeake Bay. When all 36 strategies are added together, cleanup plans will be in place in every part of the Chesapeake Bay's 64,000 square-mile

watershed. The strategies outline how the Bay states and the district will develop and implement a series of "best management practices" to minimize pollution. This includes planting new riparian forest buffers, upgrading sewage treatment plants, implementing nutrient management on farms, wisely managing stormwater runoff, and other innovative programs to accelerate the restoration of the Bay and its rivers.

Each strategy is tailored to that specific part of the Bay watershed - there is no "one-size-fits-all" strategy for the entire Bay watershed. Pollution reduction actions needed in rural watersheds, like the Choptank River Basin, vary greatly from those needed in more urban areas. The strategy prepared for the Upper Choptank in 2003 recommended a number of strategies to address water quality issues. As noted earlier, a plan update is currently scheduled for the coming year.

Water System

Water Supply

Greensboro withdraws its water from the Piney Point Aquifer via three wells located throughout the Town. The Hobbs Street Well, located on the west side of Town, has a design capacity of 300,000 gallons per minute (GPM). The Academy Street well, located near the center of Town, has a capacity of 325,000 GPM. The Town's third well, located in the Eastern portion of Town along MD Route 313, has a capacity of 350 GPM. The Hobbs Street Well and Academy Street Well were rehabilitated in 2007 to ensure efficient production. The Town's MDE Appropriation and Use Permit was increased from 200,000 gpd average annual use to 325,000 gpd in 2007. Maximum daily withdrawal was also increased from 300,000 gpd to 455,000 gpd.

In 2007, the average daily demand on Greensboro's water system was 183,551 gpd, about 57 percent of its permitted average daily capacity. The five-year average daily use was 183,000 gpd, approximately 55 percent of the system's permitted average daily capacity.

Table 2: Greensboro Water System Characteristics - 2008

Source	Permitted Avg. Annual Use (gpd)	Five-Year Avg. Withdrawal 2007 (gpd)	% Avg. Annual Capacity Used	Projected Additional Demand* (gpd)	Water Quality**	Planned Upgrades/ Expansions
Piney Point Aquifer	325,000	185,000	58%	75,600	Good	Permit increase recently approved

* From approved but undeveloped projects and municipal estimates of growth
** 1992 Caroline County Comprehensive Water & Sewerage Plan
Sources: MDE Water Appropriation and Use Permits; Caroline County Departments of Environmental Health and Planning, Codes and Engineering, 2008.

State design recommendations for water systems call for well capacity equal to the peak daily flow rate with the largest well out of service and remaining wells pumping 24 hours per day. Under current maximum daily demand of 455,000 gpd and a capacity of 300 gpm (gallons per minute) with the largest well out of service, the total well-field in Greensboro can produce 864,000 gpd; a surplus of 409,000 gallons per day.

Water Storage Capacity

Two elevated storage tanks located at the east and west ends of Town maintain the system's water pressure. Each tank has a storage capacity of 150,000 gallons. Applying State standards for storage capacity and fire flow rates, the Town has a storage surplus of just under 100,000 gallons in capacity.

Water Distribution System

A number of improvements have been made to the Town's water distribution system over the past 20 years. These include the replacement of nearly all of the water mains on Sunset Avenue and Main Street. Mains to the north and south of MD Route 314 in the eastern section of Town were replaced in 1990 and 2000, respectively. Portions of Cedar Lane were replaced in 1990. More recent subdivisions toward the north end of Town are served by piping installed when they were approved in the early 1990's.

A study of the water distribution system, prepared by Davis, Bowen and Friedel on behalf of the Town in 2005, provided a number of recommendations for upsizing water mains in various locations from 4" to 8" or 6" to 8" lines, to increase fire flows to hydrants.

Projected Water Demand

To calculate future demand on Greensboro's water system, a per-household water usage multiplier of 250 gpd (MDE estimate of single family household daily water usage) was applied to projected dwelling unit increases forecast for the Town. Water demand is based on existing dwellings as well as potential units, which may be built through infill development of vacant and underutilized lots within the current municipal boundary and/or in Town designated municipal growth areas. (see Table 6-2)

Table 3: Greensboro Projected Water Demand Based on Projected Population Growth Within the Corporate Limits (Infill) and in Designated Municipal Growth Areas

Year	2000	2010	2015	2020	2025	2030	Increase 2010-2030
Population*	1,632	2,485	2,995	3,144	3,301	3,458	973***
Household Units**	618	941	1,134	1,191	1,250	1,310	369
Water (GPD)	154,500	235,250	283,500	287,750	312,500	327,500	92,250
% average daily flow capacity****	48%	72%	87%	88%	96%	107%	35%
% maximum daily flow****	34%	52%	62%	63%	69%	72%	----

Projections shown here based on incremental 10 year projections established by methodology defined in Chapter 3 (Municipal Growth Element) and as shown in Table 3-6, for consistency.

Notes:

* Population Projection based on assumption that 386 recorded or to be recorded lots are built on and occupied by 2015. Projections after 2015 assume a growth rate of 1% resulting in additional 463 residents between the years 2015 and 2030.

** Household units projection assuming a sustained average of 2.64 persons per household as evident in 2000.

*** Population totals include growth of existing population plus increased population as a result of infill development.

**** Average daily flow capacity/maximum daily flow: 325,000 gpd/455,000 as per current Groundwater Appropriation Permit.

Projections indicate that demand for water in the Town will increase by 39% from 2010 levels by 2030. Related to Greensboro's Groundwater Appropriation Permit (GAP), MDE determined that annual average withdrawals of 325,000 gpd and 455,000 gpd during the month of maximum use were reasonable and that no significant negative impacts would occur to the aquifer resource or neighboring water users.

Table 3 illustrates that by 2015, projected water usage will be at 87% of the system's average daily flow capacity as limited by the Groundwater Appropriation Permit.

Chapter 3 of this plan clearly indicates that the Town does not plan to "allow any new residential annexations or new major residential projects during the period between this Plan and the next required Plan in 2014. This is the growth strategy adopted by this Plan. Given this policy, the Town's water system should be adequate to support the Town's current overall development policy.

Given current maximum daily demand of 455,000 gpd and a capacity of 300 gpm (gallons per minute) with the largest well out of service, the total well-field in Greensboro can produce 864,000 gpd; a surplus of 409,000 gallons per day. This indicates that water supplies and pumping capacity should be suitable to support projected growth to the year 2030.

However, the actual system capacity that presently exists may be limited by the water distribution and storage facilities necessary to provide adequate fire flows beyond the year 2015. Therefore, replacement of sections of the distribution system will most likely be priority projects to enhance the water system over the next several years.

If other improvements to the water system are determined necessary in the future and need to be made by 2020 to accommodate growth that may occur after that time, then they should be implemented. Any development beyond 2,995 residents or 1,134 households anticipated between 2015 and 2020 will require further modifications to the groundwater appropriation permit and possible improvements to pumping and storage capacity. In addition to system expansion, the Town will need to continue to implement recommendations for improvements to existing water distribution lines identified in the 2005 Town water system evaluation. Many of these recommended line repairs and replacements may serve to conserve water resources or effectively increase fire flows in the current water supply system.

Wastewater Treatment System

The Town of Greensboro currently operates a fixed film, activated sludge type wastewater treatment plant located on the northwest bank of the Choptank River. The facility was originally constructed in 1968 and last modified in 1996. The plant consists of an influent screen, primary clarifier, dual rotating biological contactors, two secondary clarifiers, disinfection, post aeration, and sludge drying beds. Wastewater effluent flows by gravity through the plant to an outfall that discharges into an unnamed tributary of the Choptank River.

The Town's Wastewater Treatment Plant has a permitted design capacity of 280,000 gpd. In 2008, the plant's three-year average daily flow was 142,000 gpd, with gross available capacity of 138,000 gpd. Study of the systems capacity conducted in May, 2005 by Davis, Bowen and Friedel indicated unused wastewater treatment capacity could accommodate up to 483 equivalent dwelling units (EDU's).

The Town calculates that infill development will create demand for treatment of an additional 100,750 gpd, which would leave 37,250 gpd in remaining capacity and place the system at 85 percent of capacity.

Page 31 of this Comprehensive Plan evaluates the capacity of Wastewater Treatment infrastructure to support existing improved parcels with sewer service, together with additional capacity required to support planned development. These estimated treatment demands will be prompted by infill development and development of subdivisions that have been planned and/or approved, and are located within the current corporate limits of the Town. As shown in Table 4, this combination of system demands would leave a remaining available wastewater treatment capacity of only 37,250 gpd or 149 equivalent dwelling units. These projected flows would exceed 80% of the systems permitted treatment capacity, indicating the Town may need to determine actions needed to increase permitted treatment capacity before build-out as shown in Table 4.

As a result, in 2006, the Town limited the sewer allocation to public uses, rehabilitative uses, and non-residential job-creating uses. Policies established in Chapter 3 of this Comprehensive Plan, limit any future

growth to these uses and infill development of recently approved subdivisions. Any annexation of land or additional development would require expanding the plant and upgrading it to ENR treatment level.

Table 4: Current and Projected Wastewater Treatment Capacity Demand

Development Type	Number of EDU's	Demand for Treatment Capacity (GPD)
Currently Improved Parcels	799	142,000 *
Baldwin Subdivision	101	25,250
Greensboro Farms	230	57,500
Town Parcels (currently unimproved)	72	18,000
Total	1,202	242,750
Total Current System Design and Permitted Capacity = 280,000 GPD		
Reserve Capacity = 37,250 GPD		

Note - All new development assumed to generate 250 gpd per unit treatment demand.
* Figure shown denotes most recent three year average daily flow which is less than 250 gpd per EDU.

Chapter 3 of this plan also examined the implications of annexations into surrounding areas designated as the Town's mapped growth areas. A Municipal Development Capacity Analysis for Caroline County was prepared by the Eastern Shore Regional GIS Cooperative in November 2008. This analysis indicated that within the mapped growth area, there is capacity for 2,158 residential units in areas beyond the current corporate limits. Page 30 of the Plan (Table 18) reflects the highest projected growth rate (3% annually) considered among scenarios explored in Chapter 3. This growth rate resulted in 948 additional dwelling units between 2009 and 2030, many of which would have to locate in new growth areas, which would consume 44% of growth area development potential, and require more than double the current permitted wastewater treatment capacity. This consideration serves as the basis for the previously referenced Town policy in the near term to limit development to infill, public uses, rehabilitative uses and non-residential job creating uses.

Point Source Pollution Considerations

Point sources are measurable inputs of pollutants that are discharged into streams, rivers and lakes via pipes or drains, primarily from industrial facilities, and municipal treatment plants. Since Caroline County does not currently operate any wastewater treatment facilities, issues related to managing or reducing point source nutrient loads delivered from the Town's municipal wastewater treatment plant need to be addressed in this Plan.

The Town of Greensboro shares the Choptank River Basin with numerous municipalities that operate public wastewater facilities (Denton, Preston, Cambridge, Easton, St. Michaels, Trappe, East New Market, Secretary, and Hurlock). As shown in Table 5, point source discharges in the Upper Choptank portion of the Choptank River basin represent 8.3% of nitrogen loadings to the watershed and 11.7% of phosphorus loadings.

Table 5: Upper Choptank River Watershed Sources of Impairment			
Watershed	**Nitrogen**	**Phosphorous**	**Sediment**
Point Source	8.3%	11.7%	0.0%
Non-Point Source			
• Agricultural Land	72.7%	66.6%	86.9%
• Mixed Open Land	6.5%	12.2%	4.4%
• Urban Land	5.6%	7.7%	3.4%
• Forest Land	5.4%	0.8%	5.2%
• Atmospheric Deposition	1.6%	1.0%	0.0%

Source: Maryland Tributary Strategy Choptank Basin Summary Report for 1985-2003 and Caroline County Dept. of Planning, Codes and Engineering, 2008.

Table 1 on Page 5 of this plan element, identified possible point source loading caps recommended by Caroline County for the County portion of the Choptank River Watershed assuming that Caroline would be allocated 40 percent of the total recommended caps that are yet to be established (a percentage equivalent to the County's proportionate land area in the basin). Point Source load limits established in these prospective TMDLs were 70,076 lbs. per year for nitrogen (TN) and 6,510 lbs. per year for phosphorus (TP).

Review of available data indicates that the combined flows from wastewater treatment facilities in the Caroline County portions of the Choptank River Watershed are within TMDL limits that may be established in the next few years. Table 6 identifies estimated 2007 point source loads generated from the Greensboro Wastewater Treatment Plant as well as other plants located in Caroline County. Total nitrogen loadings from Town treatment facilities discharging into the Caroline portion of the Choptank River basin are 34,155 lbs/yr. This figure includes all nitrogen loadings shown in Table 6 accepting loadings from the Federalsburg WTP. These totals represent roughly half the total prospective point source TMDL, indicating current loadings are sustainable. This conclusion assumes that the future TMDLs assigned to the Upper Choptank remain consistent with those currently recommended, and that load allocations are based on land area rather than the number of point sources throughout the entire Choptank Watershed.

Table 6: Caroline County Municipal Wastewater Treatment Facilities Effluent Nitrogen and Phosphorus Concentrations and Loadings						
			2007 Concentration		**2007 Avg. Flow Load**	
Wastewater System	**2007 Avg. Daily Flow (mgd)**	**Design Capacity (mgd)**	**TN mg/l**	**TP mg/l**	**TN lbs/yr**	**TP lbs/yr**
Denton	0.349	0.800	8.10	1.18	8,605	1,254
Federalsburg	0.274	0.750	19.85	0.68	16,557	570
Greensboro	0.111	0.280	47.92	3.29	16,192	1,112
Preston	0.058	0.116	11.34	1.00	2,016	177
Ridgely	0.134	0.180	18.00	3.00	7,342	1,224
Totals					50,712	4,336

Source: Chesapeake Bay Program and Caroline County Dept. of Planning, Codes and Engineering, 2008.
Note: Total Nitrogen (TN) is the sum of Organic Nitrogen, Ammonia, TKN or Total Kjeldal Nitrogen, and Nitrate+Nitrite

The same findings apply to phosphorus loadings since Upper Choptank loadings in 2007 totaled 3,766 lbs/year; representing approximately 58% of total prospective loadings to be allocated.

If more restrictive TMDL limits are established, the State will need to give consideration to BNR/ENR technology upgrades to "minor" wastewater treatment facilities, (facilities treating less than 500,000 GPD) including the Greensboro treatment plant.

Review of Table 6 indicates that the 2007 flow from the Greensboro wastewater facility demonstrated a particularly high concentration of over 47 mg/l (milligrams per liter) in its nitrogen loadings.

More recent information indicates that these concentrations are lower than shown in Table 6. Review of monthly reports for the 2008 calendar year indicate average concentrations for this most recent year were 23.67 mg/l. This data also indicates that total nitrogen loads for the year resulted in discharges of 8,522 lbs of nitrogen, well below the 9,876 lbs per year permitted level.

In spite of this reduction in TN concentrations and lower TN loads, this is much higher than other plants in the basin and suggests that the State should consider funding to support BNR/ENR upgrades to the current facility. Phosphorus concentration in current loadings is also higher than other treatment facilities in the County.

The Chesapeake 2000 Agreement outlined a goal for Maryland towns and counties to work cooperatively to achieve a 40 percent reduction from 1985 Bay nutrient levels. This goal was applied to point and non-point sources of pollution. State and Federal funding to reduce point source loads has been concentrated on upgrades to the State's 66 major treatment plants because they are estimated to contribute 95 percent of wastewater flow into the Bay. The required reduction in major WWTP nutrient loads is made with plant upgrades to first BNR, then ENR technology, which reduces total nitrogen load to 3 mg/l and total phosphorus to .3 mg/l.

While upgrades to BNR and ENR treatment levels could result in a significant reduction in nutrient loading from WWTP point sources, the full potential of the advanced technology will go unrealized in plants like Greensboro's whose flow volumes do not qualify for funding assistance.

Current MDE funding policies indicate that ENR upgrades to smaller plants will begin only after all major plant upgrades are completed, and then only if funding is still available. Most minor plants are at secondary treatment levels and concentrations of nitrogen are at 18 milligrams per liter or less. However, Greensboro's particularly high concentrations indicate that the facility may presently be discharging more pounds of nitrogen per year than some major treatment facilities.

EPA and MDE need to consider developing programs in conjunction with local governments to monitor projected growth and increases in flow allocations and resulting impacts from small plants and provide funding access to support restoration efforts for towns like Greensboro. This includes exploring the feasibility of continuing funding for the Bay Restoration Fund program to ensure ENR upgrade funding for all minor plants when cost-effective results can be realized.

Point Source Strategy

- Encourage the Chesapeake Bay Program and MDE to re-evaluate funding policies to include funding for ENR/BNR upgrades to minor treatment facilities when total nitrogen and/or total phosphorus concentrations are particularly high (e.g. TN concentrations over 20 mg/liter).

- Manage wastewater treatment facility operations to reduce flows per household to the extent possible.

- Encourage use of water conservation fixtures and design techniques in new development to reduce water system demands and reduce flows to the wastewater treatment facility.

Non-Point Source Pollution and Stormwater Management Considerations

Non-point source pollution occurs when rainfall, snowmelt, or irrigation runs over land or through the ground and gathers pollutants. Pollutants are then deposited into streams and rivers or introduced into ground water. Stormwater runoff is a significant contributor to non-point source pollutant loading. As of 2005, the largest non-point source of nitrogen in the Choptank River Basin was agriculture (70 percent). Agriculture was also the largest contributor of phosphorus (62 percent) and sediment loads (85 percent).

According to the Maryland Tributary Strategy Choptank Basin Summary Report for 1985-2003, the Town of Greensboro, together with other urban uses in the watershed, contribute approximately 5.6% of non-point source nitrogen loadings, 7.7% of the non-point source phosphorus loadings, and 3.4% of the sediment loadings to watershed tributaries.

Stormwater runoff is part of the natural hydrologic process. Human activities and landscape changes resulting from urbanization can alter natural drainage patterns and add pollutants to rivers. Urban runoff is often a significant source of water pollution, including flows discharged from urban land uses into stormwater conveyance systems and receiving waters.

In the past, efforts to control the discharge of stormwater focused on quantity (e.g. drainage, flood control, etc.) and only to a limited extent on quality. More recently, awareness of the need to improve water quality has increased. With this awareness, Federal, State, and Local programs have been established to reduce pollutants contained in stormwater discharges to our waterways. These programs promote the concept and practice of preventing pollution at the source, before it can cause environmental problems.

In a growing number of communities, a primary determinant of future growth is the assimilative capacity of receiving waters for stormwater runoff associated with land use change. Assimilative capacity is expressed in the TMDLs for the receiving waters.

Greensboro's Projected Non-Point Source Loading

Table 7 illustrates estimated nitrogen and phosphorous loadings from stormwater runoff based on projected growth in the Town through 2030.

To assist Caroline County with preparing a methodology for calculating nutrient loading rates for each of the County's land uses, MDE developed estimates of the County's nutrient loading rates and loads.

Land use acreage totals are applied to a formula developed by MDE that includes soil factors, average annual rainfall and impervious surface percentages (impervious surface percentages vary according to land use – generally, developed land has a higher percentage of impervious surface than undeveloped land). The result is a per-acre rate of loading for each land use. The "Developed Land" per acre rate of loading was applied to the Town of Greensboro since it reflects a mix of residential, commercial and industrial uses.

Table 7: Greensboro Estimated Non-point Source Loading Rates and Loads (2009 and 2030)				
Estimated Acres of Developed Land*	**Nitrogen Loading Rate (lbs/ac)**	**Phosphorus Loading Rate (lbs/ac)****	**Estimated Nitrogen Load (lbs)****	**Estimated Phosphorus Load (lbs)**
Year 2009 428 acres	8.77	1.14	3,754	488
Year 2030† 634 acres	8.77	1.14	5,560	723
Net Increase	---	---	1,806	235

Notes: Loading rates are based on MDE/CBP land use load estimates.
* "Developed" includes residential, commercial, industrial and institutional land uses.
** Represents average load per acre of all acres including estimated 29.5 acres of Town parkland
† Year 2030 estimates assume build-out of Baldwin and Greensboro Farms subdivisions and development on 21 existing vacant parcels within the Town with no new annexations.

Estimates shown in Table 7 indicate that approximately 1,806 additional pounds in nitrogen loading and 235 additional pounds in phosphorus loading can be expected as a result of currently planned development over the period. This estimate does not account for any annexation of land but assumes the build-out of the Baldwin Development and Greensboro Farms subdivision as well as infill development of 21 existing vacant parcels currently located within the corporate limits of the Town.

Table 8 represents results from use of an alternative method used to estimate future levels of pollution from non-point sources in Greensboro. This method utilizes the "Watershed Treatment Model for Urban Watersheds", developed by MDE and the Center for Watershed Protection. The model incorporates estimates made using measurements of annual rainfall and impervious surface area based on land use and Environmental Protection Agency (EPA) estimates of standard concentrations of nitrogen and phosphorous in urban area stormwater runoff. This model, also known as the "simple model" for calculating pollutant loads is as follows:

$$L = 0.226 * R * C * A$$

Where
L = Annual Load (lbs),
R = Annual runoff (inches),
C = Pollutant concentration (mg/l),
A = Acres of impervious surface, and
0.226 is the unit conversion factor for converting milligrams to pounds.

Table 8: Greensboro Stormwater Pollutant Loadings from Projected Infill Development and Growth Within Currently Planned Municipal Areas					
	0.226 Conversion Factor for Converting Milligrams to Pounds	**(R) Runoff (annual inches of water††)**	**(C) Pollutant Concentration (2.0 mg/l)**	**(A) Impervious Surface (acres) †††**	**(L) Total load (lbs/year)**
Estimated Nitrogen loadings †	0.226	42.8 inches	2.0 mg/l Nitrogen concentration	72.1	1,394 lbs/year Nitrogen
Estimated Phosphorus loadings †	0.226	42.8 inches	0.26 mg/l Phosphorus concentration	72.1	181 lbs/year Phosphorus

† Source: Stormwater Manager's Resource Center (SMRC), EPA Offices of Water and Wastewater Management, "Watershed Treatment Model for Urban Watersheds", MDE and the Center for Watershed Protection. Medium density land use impervious surface multiplier (0.28) was used to calculate future impervious surfaces for residential use and (0 .72) for commercial.

†† Source: Worldclimate.com Global Historical Climatology Network (GHCN) for Denton, MD.

††† Impervious surface calculation assumes 352 new residential units at 3.5 units per acre and assumes 266 acres will be converted to single family residential land use between 2009 and 2030 and 20 acres converted to commercial use at Greensboro Farms.

Use of the simple formula results in loadings for nitrogen and phosphorus that are somewhat less as shown in Table 8 when compared with projected increases in Table 7. The two methods establish an estimated range of expected increases in non-point source nitrogen loadings of between 1,394 and 1,806 lbs. per year. Likewise, an estimated range for projected phosphorus loadings falls between 181 and 235 lbs. per year.

These estimates further assume that the loading rates per acre will remain the same through the period to 2030. Greater use of BMPs for management of stormwater quality, which is expected in future Town development, could reduce the projected increases in nitrogen and phosphorus loadings.

Therefore, it would appear that Greensboro's growth will represent a small proportion of total TMDL's likely to be allocated for non-point sources, and can be readily accommodated in watershed-wide context.

This conclusion, of course, does not take into account the demands on the assimilative capacity of the watershed from other growth or activities within the watershed (e.g., County growth and agricultural use) and stresses the importance of coordinated land use and growth management strategies based on sound watershed planning principles. It also underscores the importance of inter-jurisdictional coordination and cooperation between Caroline County, Greensboro, and the County's need to support the agricultural industry's efforts to reduce non-point loadings in the watershed.

For both TMDLs, Maryland has several well established programs that will be drawn upon: the Water Quality Improvement Act of 1998 (WQIA), the Clean Water Action Plan (CWAP) framework, and the State's Chesapeake Bay Agreement's Tributary Strategies for Nutrient Reduction. Also, Maryland has adopted procedures to assure that future evaluations are conducted for all TMDLs that are established. The implementation of point source nutrient controls will be executed through the use of NPDES permits. The NPDES permit for the Greensboro WWTP will have compliance provisions which provide a reasonable assurance of implementation.

Finally, Greensboro's Land Use and Municipal Growth Plans reflect "smart growth" strategies. They are designed to concentrate development adjacent to the existing developed areas within the corporate limits. Growth will be permitted on annexed lands at net densities ranging from 2 to 4 units per acre. The result is development concentrated in cluster form with annexation of additional lands limited over the next 10 years. This approach maximizes opportunities to minimize deterioration in the Upper Choptank River watershed.

Water Resources Goals and Objectives

The Water Resources goal for Greensboro is:

- to maintain a safe and adequate water supply and adequate capacities for wastewater treatment to serve projected growth; to take steps to protect and restore water quality; and to meet water quality regulatory requirements in the Upper Choptank River watershed.

Objectives to support this goal are:

- Assure that existing and planned public water systems meet projected demand.
- Assure that existing and planned public wastewater collection and treatment systems meet projected demand without exceeding their permitted capacity.
- Assure that the Town's stormwater management policies reflect the most recent state requirements, and encourage Low Impact Development (LID) practices in both new development and by existing homeowners.
- Maintain land use patterns that limit adverse impacts on water quality.
- Continue to focus growth to areas best suited to utilize the existing and planned water and wastewater infrastructure efficiently.

Water Resource Strategies and Recommendations

Beyond establishing a land use planning framework that is supportive of water quality protection efforts, the Town can also initiate measures that further support sound management of stormwater flows to improve water quality. These include:

- Use of "Environmental Site Design (ESD) Principles to manage stormwater in new development. The Maryland Stormwater Management Act of 2007 is based upon ESD principles, which attempt to mimic natural hydrology on developed sites. The Stormwater Management Act of 2007 is based upon 13 core principles, which are listed below:

    1. Increase onsite runoff reduction volumes
    2. Require a unified early ESD map
    3. Establish nutrient–based stormwater loading criteria
    4. Apply ESD techniques to redevelopment
    5. Integrate ESD and stormwater management together at construction sites
    6. Provide adequate financing to implement the Act and reward early adopters
    7. Develop an ESD ordinance that changes local codes and culture
    8. Strengthen design standards for ESD and stormwater practices
    9. Ensure all ESD practices can be adequately maintained
    10. Devise an enforceable design process for ESD
    11. Establish turbidity standards for construction sites

12. Craft special criteria for sensitive and impaired waters of the state
13. Implement ESD training, certification and enforcement

The Town should consider amendment to Stormwater Management Regulations to incorporate these principles in standards for future development and site planning:

- Promoting bio-retention as a means of treating stormwater runoff. Bio-retention, such as a rain gardens, provides stormwater treatment that enhances the quality of downstream water bodies by using soil and both woody and herbaceous plants to remove pollutants from stormwater runoff.

- Consider the implementation of a lot coverage limit on all new development.

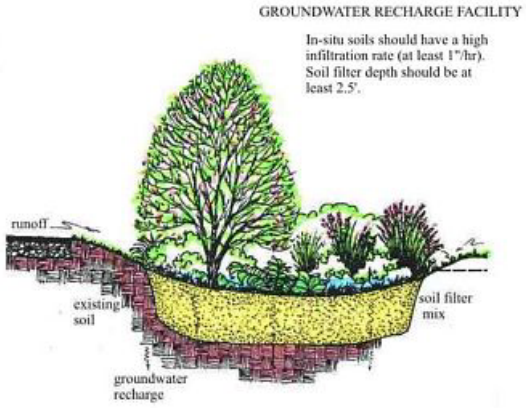
- Encourage water quality improvements for existing development through stormwater management techniques such as rain barrels, rain gardens, and native planting plans.

Rain gardens (see Figure 1) are vegetated surface depressions, often located at low points in landscapes, designed to receive stormwater runoff from roads, roofs, and parking areas. The gardens' sandy soils allow stormwater to infiltrate quickly to the native soils below and eventually contribute to groundwater recharge. Pollutants and nutrients in stormwater runoff are removed by rain garden vegetation and soils through biological and physical processes such as plant uptake and sorption to soil particles. In comparison with stormwater release to receiving waters through conventional storm drain systems, infiltrating stormwater through rain gardens reduces peak flows and stressor loadings.

- Utilize Low Impact Development (LID) stormwater management techniques and devices in new developments to minimize flows and attenuate impacts near their source. These include:

  - Bioretention or vegetated depressions that collect runoff and facilitate its infiltration into the ground. These include rain gardens as discussed above. (See figure 1)

Figure 1. Bioretention Area

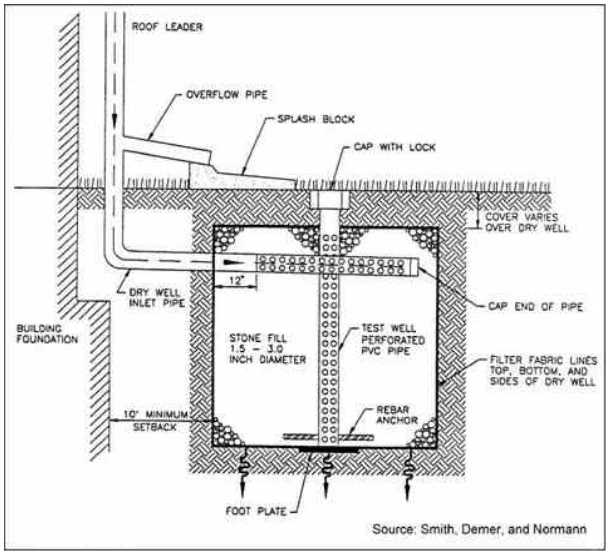


Source: Prince Georges County DER

- Infiltration Trenches: Trenches filled with porous media such as bioretention material, sand, or aggregate that collect runoff and infiltrate it into the ground.

- Dry Wells: Gravel- or stone-filled pits that are located to catch water from roof downspouts or paved areas.

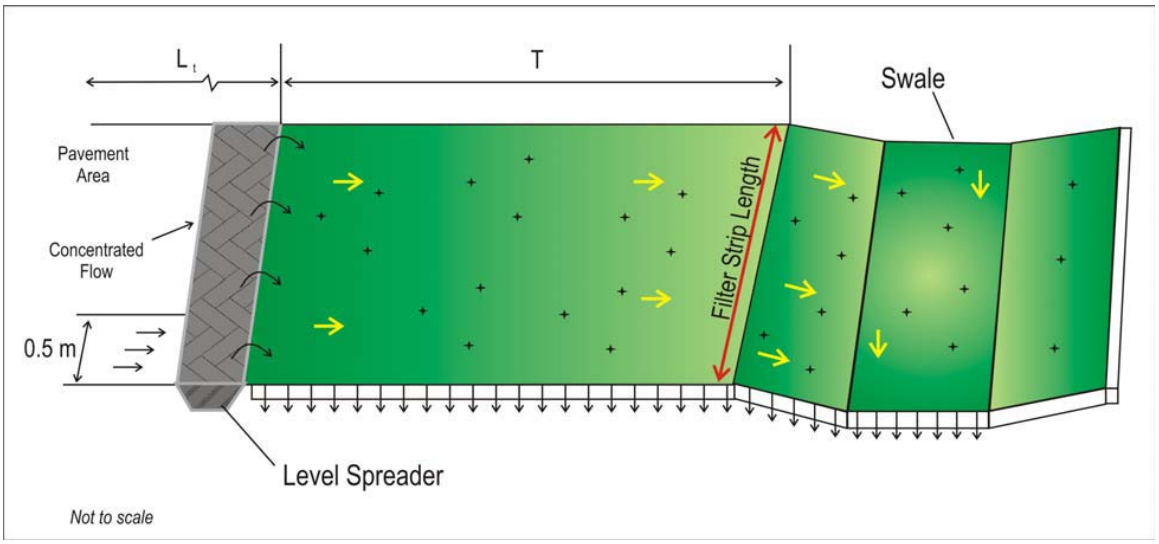
Figure 2. Dry Well Schematic



Source: Stormwater Management for Maine, 1995.

- Filter Strips: Bands of dense vegetation planted immediately downstream of a runoff source designed to filter runoff before entering a receiving structure or water body.

Figure 3. Filter Strip

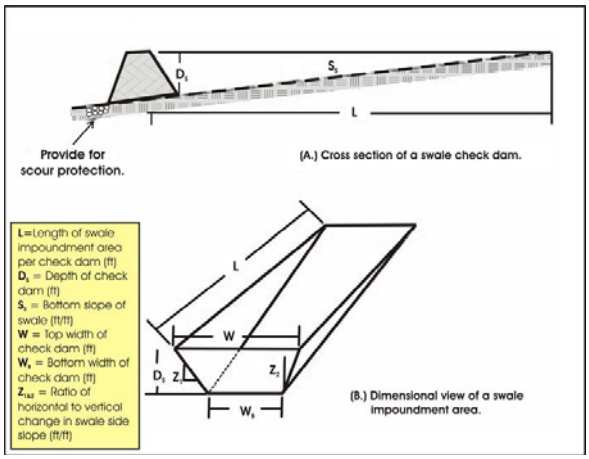


Source: Low Impact Design Manual, US Army Corps of Engineers, 2004

- Inlet Pollution Removal Devices: Small stormwater treatment systems that are installed below grade at the edge of paved areas and trap or filter pollutants in runoff before it enters the storm drain.

- Grassed Swales: Shallow channels lined with grass and used to convey and store runoff.

Figure 4. Grassed Swale Schematic



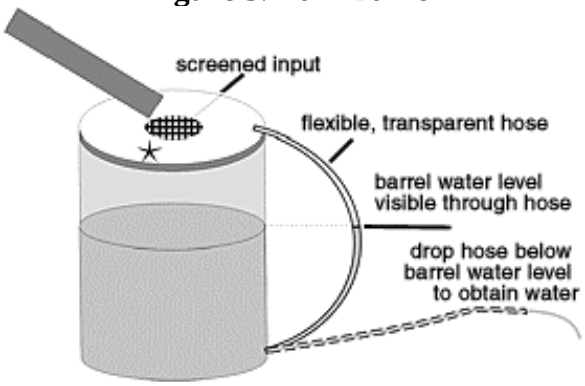
Source: NVPDC, 1991. In EPA, 1999d.

- Permeable Pavement: Asphalt or concrete rendered porous by the aggregate structure.

- Permeable Pavers: Manufactured paving stones containing spaces where water can penetrate into the porous media placed underneath.

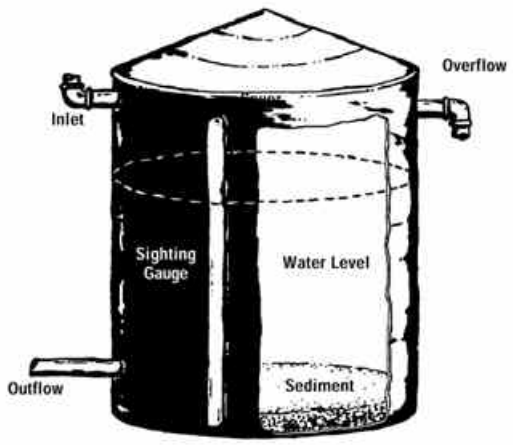
- Rain Barrels and Cisterns: Containers of various sizes that store the runoff delivered through building downspouts. Rain barrels are generally smaller structures, located above ground. Cisterns are larger, are often buried underground, and may be connected to the building's plumbing or irrigation system. Rain barrels and cisterns are low-cost water conservation devices that reduce runoff volume and, for very small storm events, delay and reduce the peak runoff flow rates. Both rain barrels and cisterns can provide a source of chemically untreated 'soft water' for gardens and compost, free of most sediment and dissolved salts.

Figure 5. Rain Barrel



Source: Maryland DNR Green Building Program.

Figure 6. Cistern

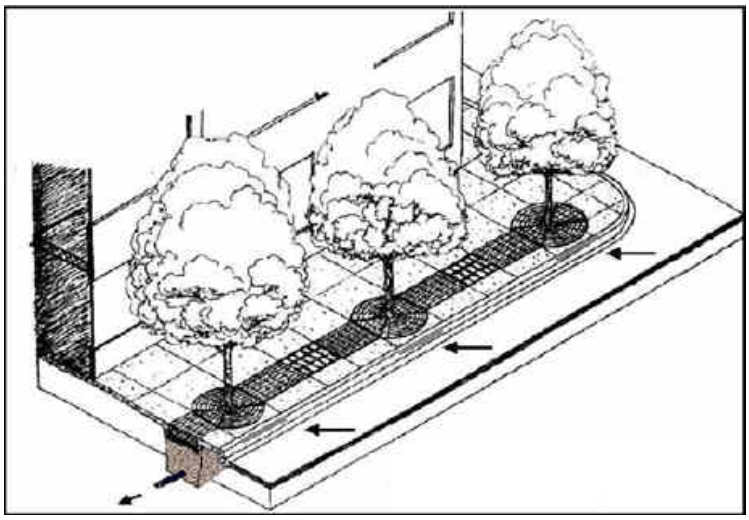


Source: Texas Guide to Rainwater Harvesting.

- Soil amendments: Minerals and organic material added to soil to increase its capacity for absorbing moisture and sustaining vegetation.

- Tree Box Filters: Curbside containers placed below grade, covered with a grate, filled with filter media and planted with a tree in the center.

Figure 7. Manufactured Tree Box Filter



Source: Virginia DCR Stormwater Management Program.

- Vegetated Buffers: Natural or man-made vegetated areas adjacent to a water body, providing erosion control, filtering capability, and habitat.

Sources:

Town of *Greensboro Comprehensive Plan* draft, February 16, 2009

Draft *Caroline County Comprehensive Plan*, Water Resources element, Caroline County Planning Department, April, 2009

The Water Resources Element: Planning for Water Supply and Wastewater and Stormwater Management; publication #26 from the Maryland Department of Planning "Models and Guidelines" series.

Sustainability of the Groundwater Resources in the Atlantic Coastal Plain of Maryland, USGS Fact Sheet FS 2006-2009.

Vokes, Harold E., and Jonathan Edwards, Jr.1974, *Geography and Geology of Maryland.* Maryland Geological Survey, Bulletin 19.

A Science Plan for a Comprehensive Regional Assessment of the Atlantic Coastal Plain Aquifer System in Maryland (Open-File Report 2007–1205), by Robert J. Shedlock, David W. Bolton, Emery T. Cleaves, James M. Gerhart, and Mark R. Nardi, U.S. Department of the Interior and U.S. Geological Survey, prepared in cooperation with the Maryland Geological Survey, the Maryland Department of Natural Resources and the Maryland Department of the Environment.

US Geological Survey *Estimated Use of Water in the United States County-Level Data for 2000*.

Maryland's 2006 TMDL Implementation Guidance for Local Governments, Maryland Department of Environment, May 24, 2006.

Water Quality in the Delmarva Peninsula, Delaware, Maryland, and Virginia, 1999–2001, U.S. Geological Survey Circular 1228, Judith M. Denver, Scott W. Ator, Linda M. Debrewer, Matthew J. Ferrari, Jeffery R. Barbaro, Tracy C. Hancock, Michael J. Brayton, and Mark R. Nardi, 2004.

Maryland Tributary Strategy *Choptank River Basin Summary Report for 1985-2005 Data,* Maryland Department of Natural Resources Tidewater Ecosystem Assessment, August 2007.

Moving Water, Report to the Chesapeake Bay Cabinet by the Public Drainage Task Force, Dr. Wayne H. Bell, Chair, Center for the Environment and Society, Washington College, October 2000.

Moving Water, A Report to the Chesapeake Bay Cabinet by the Public Drainage Task Force, Washington College and the Institute for Governmental Service at University of Maryland College Park, October 2000.

Statewide Tributary Strategy Implementation Plan, Choptank Trib Team/Public Comment Tracking Matrix, 6-23-06