CHAPTER 5 - WATER RESOURCES ELEMENT

INTRODUCTION

This plan serves as the Town of Denton's Water Resource Element mandated through House Bill 1141 by the Maryland State Legislature in 2006. House Bill 1141, Land Use – Local Government Planning, requires that each municipality that exercises planning and zoning authority add a Water Resources Element and Growth Element to its Comprehensive Plan.

The Water Resource Element contains the framework for water resource protection and water quality improvements for the Town. The preparation of the WRE ensures that future comprehensive plans reflect the opportunities and limitations presented by local and regional water resources.

The recommended water resources goals and policies presented in this plan focus on reducing the harmful impacts on water quality from development and extension of facilities to accommodate an increase in population.

The Water Resources goals for Denton are:

- Maintain a safe and adequate water supply and adequate capacities for wastewater treatment to serve projected growth.

- Take steps to protect and restore water quality; and to meet water quality regulatory requirements in the Upper Choptank River Watershed.

- Take steps to reduce nutrient loads from agricultural land uses that contribute to loading in the Choptank River Watershed.

- Promote residential, commercial and industrial water conservation measures in order to reduce inflow to the wastewater treatment facility.

Objectives to support these goals 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 ESD practices in both new and re-development.

- Maintain land use patterns that limit adverse impacts on water quality.

- Continue to focus growth to areas best suited to utilize the existing water and wastewater infrastructure efficiently.

- Conserve open spaces and preserve forested lands to help decrease nutrient runoff.

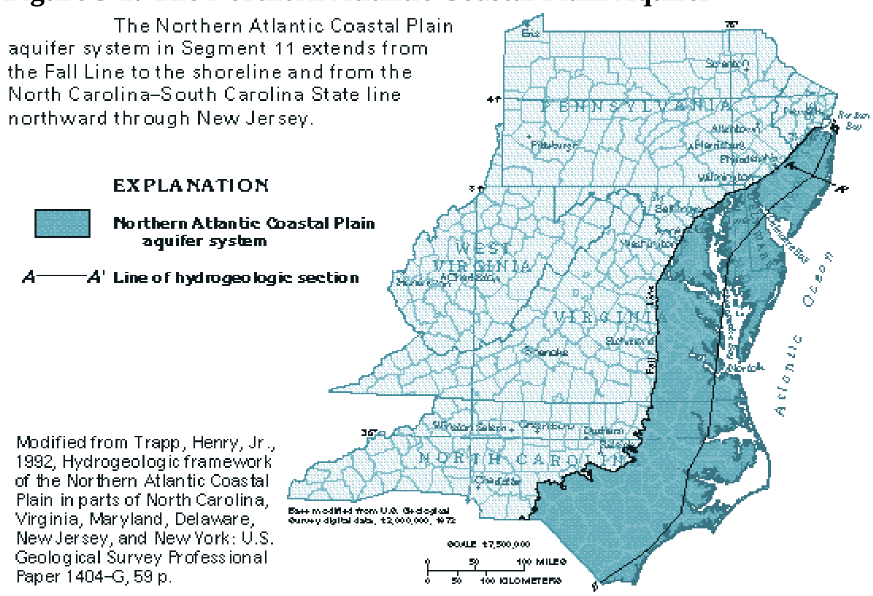
The Town of Denton acknowledges Caroline County Planning and Codes Department for their assistance in the preparation of the following topics discussed in this plan element: point source pollution, aquifers, water quality, and Federal and State programs available to achieve water quality goals. Numerous passages from the County's Water Resources Element are included herein.

WATER RESOURCES

Located in Caroline County and on the Choptank River, Denton's ability to provide a high quality of life to its residents and visitors is inextricably linked to the quality of the water resources.

The phrase "water resources" refers to the supply of groundwater and surface water in a given area. Caroline County lies within the Northern Atlantic Coastal Plain (NACP) aquifer system (Figure 5-1). 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.

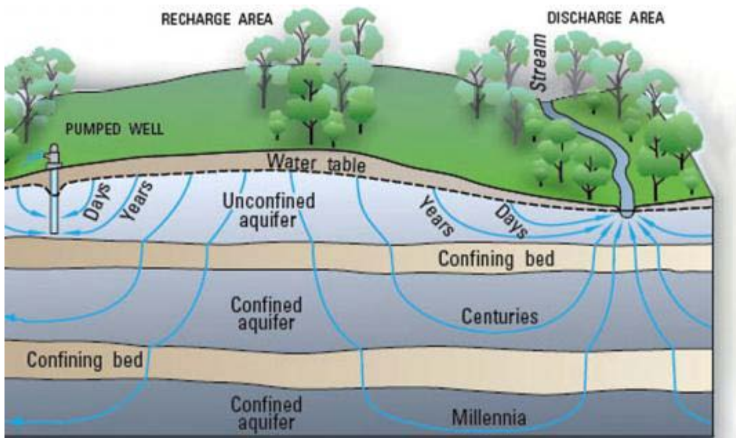
Figure 5-1: The Northern Atlantic Coastal Plain Aquifer



Source: USGS, Ground Water Atlas

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 (an area where an upland region -- continental bedrock -- and coastal plain -- coastal alluvia meet) to about 8,000 feet at Ocean City. Water may become added to aquifers naturally as water infiltrates into the soil. The area over which water infiltrates into an aquifer is known as the "recharge zone." The recharge zone above unconfined aquifers is generally the area above the aquifer because water is able to move directly from the surface into the aquifer. However, for a confined aquifer, the recharge zone may be limited to the range where the impermeable layer reaches the surface. A confined aquifer has an impermeable layer called an aquiclude overlying the aquifer. These aquicludes are particularly important in segregating relatively clean groundwater from brackish or contaminated groundwater. Figure 5-2 illustrates the difference between unconfined and confined aquifers.

Figure 5-2: Confined and Unconfined Aquifer



Source: Google Images, artmax_388.jpg

The major aquifers in the Coastal Plain system in Maryland are the Patuxent, Patapsco, Columbia (a surficial aquifer), Magothy, Aquia, and Piney Point, and the Chesapeake Group. With the exception of the Columbia Aquifer, the Coastal Plain aquifers generally are confined.

Withdrawals from Maryland Coastal Plain aquifers have caused ground-water levels in confined aquifers to decline by tens to hundreds of feet from their original levels. The current rate of decline in many of the confined aquifers is about 2 feet per year. The declines are especially large in southern Maryland and parts of the Eastern Shore, where ground-water pumpage is projected to increase by more than 20 percent between the years 2000 and 2030, with some regions experiencing significantly greater increases. Continued water-level declines at current rates could affect the long-term sustainability of ground-water resources in Maryland's heavily populated Coastal Plain communities and the agricultural areas of the Eastern Shore. Water quality in the Coastal Plain aquifers is a concern for several reasons. Contamination by saltwater intrusion is a significant water quality issue for the confined aquifers, and has been documented in several of Maryland's waterfront communities. However, the potential for saltwater intrusion is not well known in the deeper parts of the aquifer system because few data are available. Some areas have problems with naturally high concentrations of trace-element contaminants (including arsenic and radium), and further evaluation of these public health issues is warranted. Elevated concentrations of nutrients and agricultural chemicals in the surficial aquifer is a significant concern, especially on the Eastern Shore, where shallow ground water is the water-supply source for many homeowners and provides much of the base flow to streams. (*Sustainability of the Groundwater Resources*)

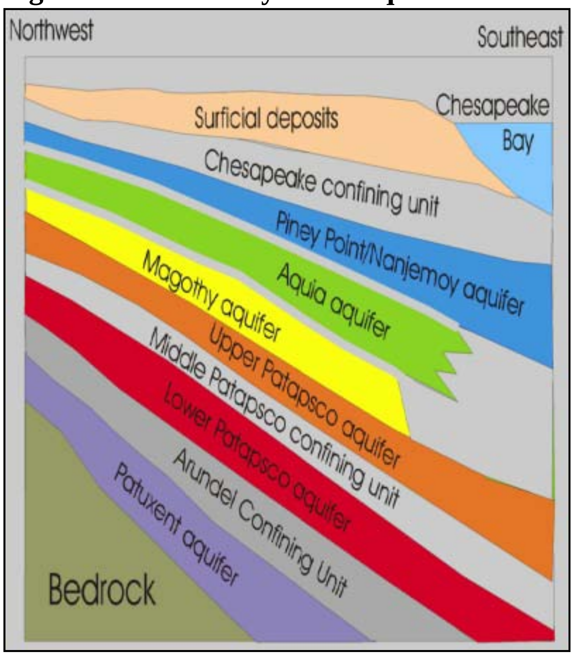
Groundwater sources in Caroline County include the Piney Point, Columbia, and Aquia Aquifers, and the Chesapeake Group, which includes aquifers within the Calvert and Choptank Formations. Aquifers within the Choptank and Calvert Formations yield small amounts of water, primarily to shallow, domestic wells. The Columbia aquifer is the surficial aquifer on most of the Eastern Shore. The Piney Point aquifer is tapped by wells in an area about 40 miles wide between Caroline and St. Mary's Counties and is a major water source for Caroline County. The Aquia is a major water source for parts of the Eastern Shore (including northern Caroline County), southern Maryland, and Anne Arundel County. (*The Status of the Quantity and Quality of Groundwater in Maryland*)

In the western half of Caroline County, which contains gently rolling, well-drained land, the water table lies between 10 and 30 feet below the surface. The eastern half of the County is comparatively flat with poorly drained land, and the water table is generally within 10 feet of the surface.

Potential sources of contamination to confined aquifers include leaking storage tanks, landfills, sewer treatment discharges, and large-scale animal feeding operations. Wells that draw from confined aquifers can only be contaminated via direct injection of a pollutant into the aquifer from poorly constructed or abandoned wells and underground injection wells.

Piney Point Aquifer

Figure 5-3: The Piney Point Aquifer



Source: Maryland Department of Natural Resources. Maryland Geological Survey, David D. Drummond

Denton's water system is supplied by the Piney Point aquifer (Figure 5-3) which is one of many located within the Atlantic Coastal Plain. The Piney Point aquifer is one of the principal aquifers underlying the Delmarva Peninsula. The range of yield for wells in the aquifer is 10 to 1,200 gallons per minute (gpm). *(Water Assessment for Caroline County's Transient Water Systems)*

The first wells tapped from the aquifer were drilled at Cambridge in 1888 (Mack and others, 1971) and at the mouth of the Mahon River near Dover in 1897 *(Sundstrom and Pickett, 1968)*. The use of the Piney Point aquifer has created two regional cones of depression centered about the cities of Dover and Cambridge. *(University of Delaware)*

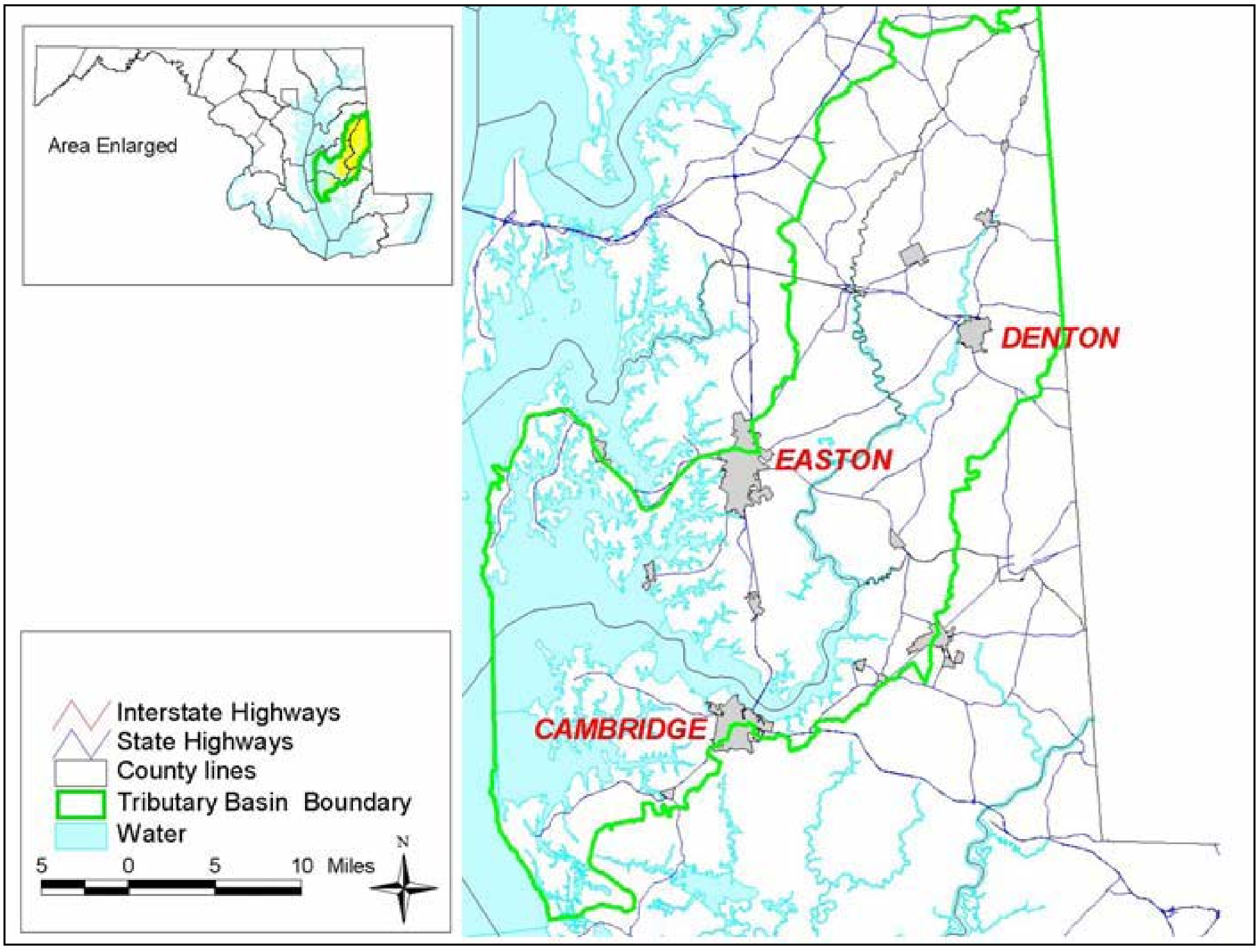
The Piney Point aquifer extends from North Carolina to New Jersey. Within Maryland, it provides 360 million gallons-per-day of potable water in Calvert and St. Mary's counties on the Western Shore; and in Queen Anne's, Talbot, Caroline, and Dorchester counties on the Eastern Shore. Within Caroline County, it is 100 feet down at its most shallow and 500 feet at its deepest.

Groundwater is an abundant, renewable natural resource in Maryland. Yet this "renewable" resource is constrained by human use, which imposes an element of finiteness. Although groundwater can be depleted by harvesting in excess of the replacement rate, if given sufficient time and the right conditions, natural processes will replace the groundwater. These processes take thousands of years, so the key to maintaining the availability of this life sustaining necessity is keeping our rate of use below the rate of natural replacement.

The Delmarva Peninsula relies primarily on groundwater for their freshwater supplies, it is the sole source of drinking water, and it plays a vital role in the industrial and agricultural sectors.

Population growth, development, and changing land use practices have resulted in an increased demand on this essential natural resource.

Map 5-1: The Choptank River Basin

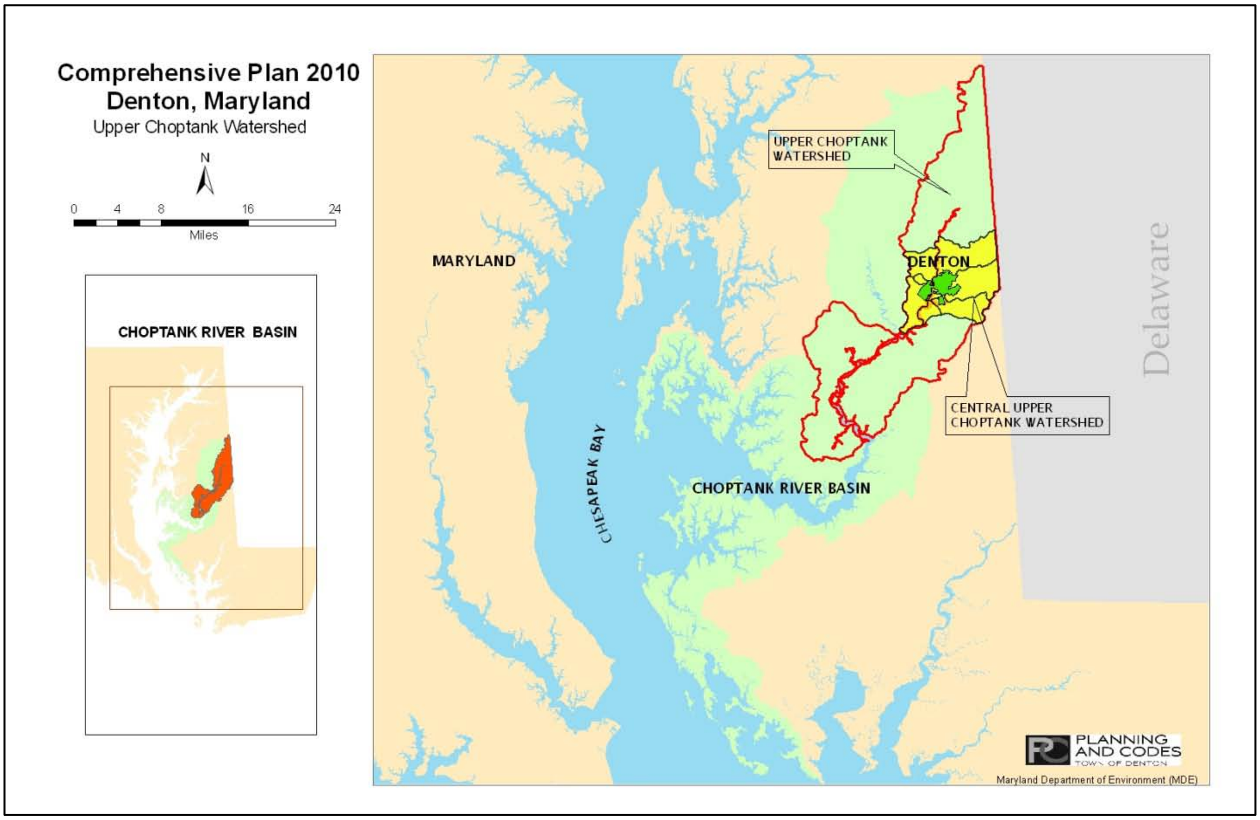


Source: Maryland Tributary Strategy Choptank River Basin Summary Report for 1985-2005 Data

The Choptank River Basin (Maps 5-1 & 5-2) drains approximately 700 square miles of land in Maryland, including portions of Caroline, Dorchester, Queen Anne's, and Talbot Counties in the middle of the Eastern Shore. Larger water bodies include the Choptank, Little Choptank, and Tred Avon Rivers; and Broad, Harris, and Tuckahoe Creeks. The Choptank River basin lies entirely within the Atlantic Coastal Plain. The basin supports over 80 species of fish in its freshwater streams and brackish waters, including striped bass, largemouth bass, and flounder. The lower portion of the watershed is an important concentration area for waterfowl. The Choptank River, along with all tributary basins in the Chesapeake, contributes to and is impacted by nutrient pollution. Nutrient pollution can be divided into two major categories – point sources (pollution that comes from a single, definable location, such as a wastewater treatment plant or industrial discharge) and non-point sources, (pollution that cannot be attributed to a clearly identifiable, specific physical location, such as runoff from land and atmospheric deposition). Runoff from different land uses, point sources, and atmospheric deposition are the major sources of nutrients within the bay watershed. In the Choptank watershed, agriculture is the primary land use and the leading source of nitrogen, phosphorus, and sediment. The remaining contributions come from a combination of non-point and point sources. *(Maryland Department of Natural Resources, Chesapeake Bay Tributary Strategies)*

Choptank Watersheds

Map 5-2: Choptank River Basin and Watershed



Source: Town of Denton Planning & Codes

The Upper Choptank is entirely in the Mid Atlantic coastal of Maryland's Eastern Shore. Maryland is divided into 138 watersheds that are each identified by an 8-digit code, 02130404 UPPER CHOPTANK, hence the term "8-digit" watershed. These watersheds each have an average area of 75 square miles. The 8-digit watersheds can be further divided into 12-digit watersheds (each watershed identified by a 12-digit code). The 8-digit watersheds are an aggregation of the smaller 12-digit watersheds. The Upper Choptank watershed is part of the Choptank River basin. It extends through three Maryland Counties and into Delaware. Denton falls entirely inside the Upper Choptank Watershed. Table 5-1 illustrates counties in Maryland that fall within the Upper Choptank Watershed showing their approximate acreage and land use.

Table 5-1: Acreage and Land Use for the Upper Choptank Watershed

County	Watershed	Land Use (Acres)				
		Total	Agriculture	Forest	Wetland	Developed
Caroline	Upper Choptank	120,501	69,891	36,150	3,615	10,845
Queen Anne's	Upper Choptank	1,912	1,013	860	0	38
Talbot	Upper Choptank	36,284	23,222	8,708	2,177	2,177
	Total	158,697	94,126	45,718	5,792	13,060

Source: Caroline County Department of Planning and Codes

Denton's total acres of approximately 3,284; account for 1.5% of the complete watershed's land cover of approximately 220,000 acres, which includes watershed acreage in Delaware. The Upper Choptank River is listed on the State's 2008 Integrated Report as a Category 5 Priority Watershed. The watershed is cited for four impairments: biological, bacteria-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 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, flood protection, and stormwater management ordinances and development of Geographic Information Systems (GIS) data, approval standards, and management policies for on-site sewage disposal systems.

The Choptank River plays a significant role in the overall health of the Choptank River watershed. Denton has an estimated five and one-half (5.5) miles of shoreline comprised of the mostly developed land, urban land, on the river's eastern shoreline and undeveloped land, currently agriculture, on the river's western shoreline. Caroline County's portion of the watershed and most of the County's wetlands are associated with the River and its tributaries. (*Source: DNR, Upper Choptank River Characterization*)

Photo 5-1: Denton, Maryland Crouse Park Marina Basin

Source: Flickr, AMK1211

The USDA's Farm Service Agency and the Caroline County Natural Resources Conservation Service (NRCS) office work with farmers to take highly erodible land out of production for ten to fifteen years through the USDA's Conservation Reserve Program (CRP).

The soils in this region are poorly drained, the land is predominantly flat, and farmers have employed a network of drainage ditches to drain water off of fields. The practice of clearing these ditches to allow for unimpeded water flow has contributed to the high levels of nutrients leaving farms and entering waterways. The U.S. Department of Agriculture (USDA) Agricultural Research Service (ARS), as part of the Conservation Effects Assessment Project (CEAP) begun in 2003, is conducting a study of the Choptank River Watershed to assess nutrient reduction efforts and determine more accurate nutrient reduction efficiencies for agricultural best management practices (BMPs) including improved management of ditches, and the development of more efficient monitoring technologies for cover crops

Tier II Waterways

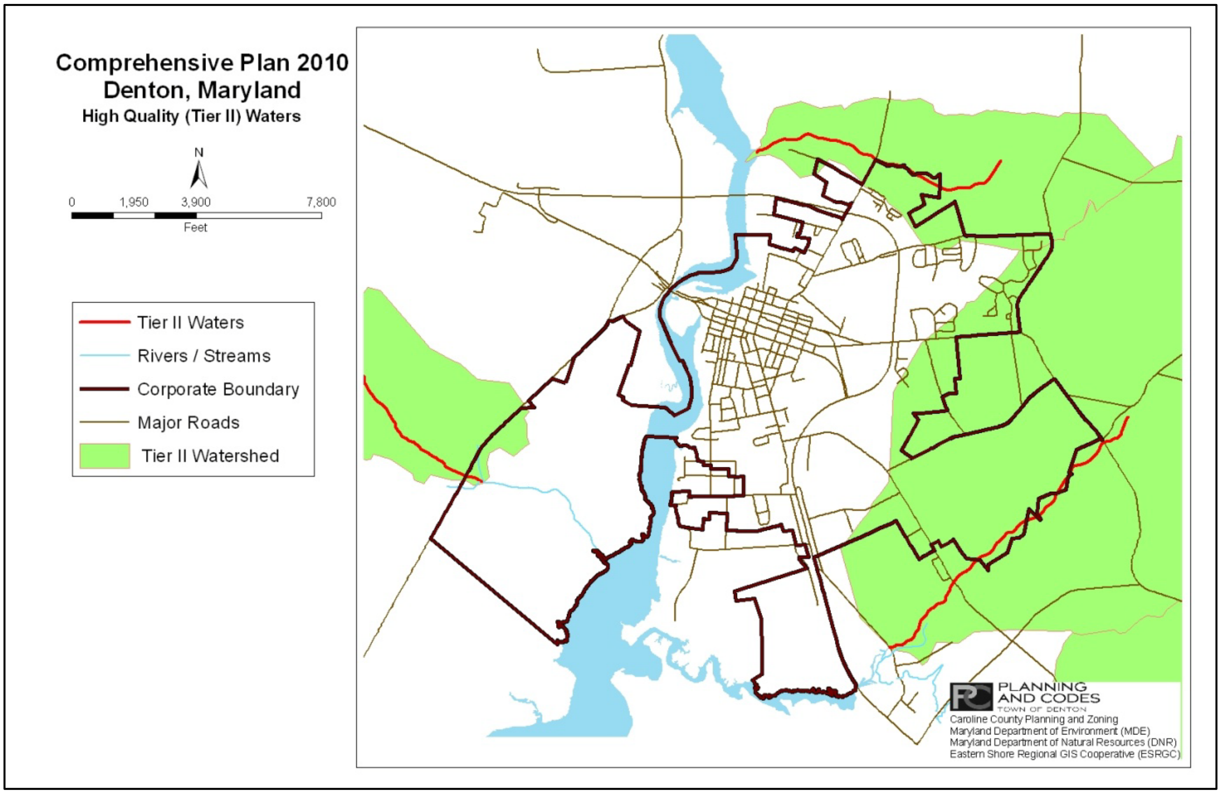
The Federal Clean Water Act requires the State of Maryland to identify water bodies that are high in quality (Tier II water bodies). Maryland currently has 208 designated high quality streams. Map 5-4 illustrates Tier II waters in Caroline County. The Clean Water Act requires three components to water quality standards that set goals for and protect each States' waters. The three components are: (1) designated uses that set goals for each water body (e.g., recreational use), (2) criteria that set the minimum conditions to support the use (e.g., bacterial concentrations below certain concentrations) and (3) an antidegradation policy that maintains high quality waters so they are not allowed to degrade to meet only the minimum standards. The designated uses and criteria set the minimum standards for Tier I. As stated by the Maryland Department of Environment, Maryland's antidegradation policy has been promulgated in three regulations: COMAR 26.08.02.04 sets out the policy itself, COMAR 26.08.02.04-1, which is discussed here, provides for implementation of Tier II (high quality waters) of the antidegradation policy, and COMAR 26.08.02.04-2 that describes Tier III (Outstanding National Resource Waters or ONRW), the highest quality waters. No Tier III waters have been designated at this time. The anti degradation policy states as follows:

<u>1. 26.08.02.04 – 1(B)</u>

"General: An applicant for proposed amendments to county plans or discharge permits for discharge to Tier II waters that will result in a new, or an increased, permitted annual discharge of pollutants and a potential impact to water quality, shall evaluate alternatives to eliminate or reduce discharges or impacts. If impacts are unavoidable, an applicant shall prepare and document a social and economic justification. The Department shall determine, through a public process, whether these discharges can be justified." *(Source: Maryland Department of the Environment, Maryland's High Quality Waters (Tier II))*

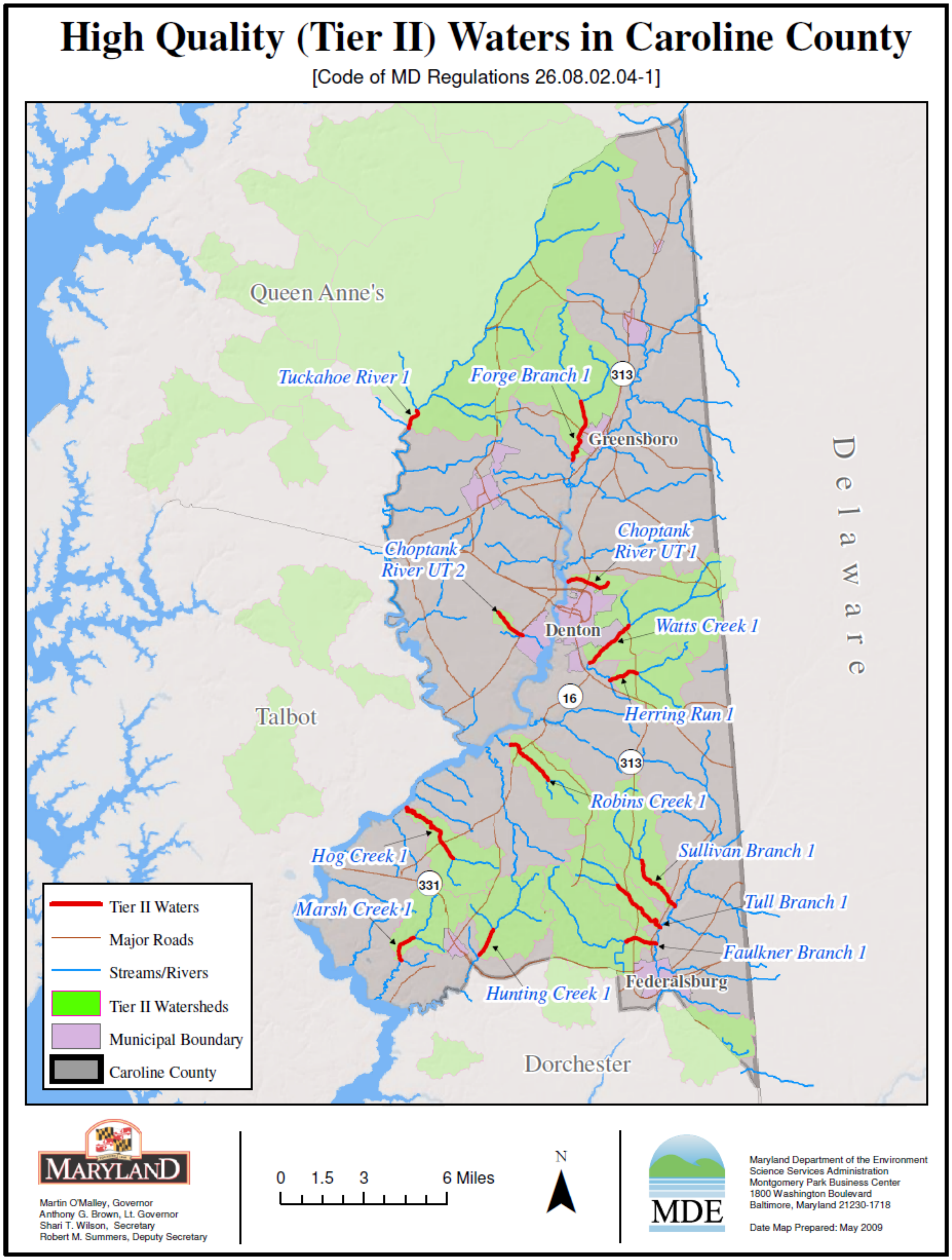
There are three Tier II designated water bodies within Denton's boundary. As shown on Map 5-3, all three streams are located along the Town's current boundary, proposed growth area and proposed "greenbelt." Potential developments for these parcels will have to address the impacts to water quality and as mentioned earlier; if a permit is required, the discharge permit process requirement will follow Maryland's antidegradation policy. The Town should monitor all development within the designations of Tier II waterways affected by urban runoff in Denton and should take measures to protect these high quality natural resources.

Map 5-3: Denton, Tier II Waters



Source: Town of Denton Planning & Codes 2009

Map 5-4: Caroline County Tier II Waters



Source: MDE

Water Quality

Federal Clean Water Act (CWA)

The Federal Clean Water Act (CWA) provides the framework for managing the nation's water 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. These designated uses provide the foundation for determining which of Maryland's waterways are managed under the CWA.

Once a waterway's designated use (or uses) has been established, stringent water quality criteria are developed to ensure the protection of the designated use. Water quality criteria identify quantifiable pollutant thresholds that are not to be exceeded. Once criteria are established they are inviolate, meaning that, "as a society, we have agreed not to violate standards regardless of implications unless we agree to change the underlying designated uses through an open public process, which then allows for the criteria to be changed in response. *(Maryland Department of the Environment, 2006 TMDL Implementation Guidance for Local Governments)*

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. Caroline County's major tributaries – Choptank River, Marshy Hope Creek, and Tuckahoe Creek – are all listed as impaired on the Maryland Department of Environment's (MDE) 2008 Integrated Report (formerly the 303(d) List and 305(b) Report).

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. (*Judith M. Denver*)

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 (BRF) was created by Senate Bill 246 in May 2004. The BRF 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 Enhanced Nutrient Removal (ENR) levels: 3 mg/l total nitrogen (TN) and .3 mg/l total phosphorus (TP). Upon completion of an ENR upgrade, MDE requires the permittee to make a best effort to meet the load goals, providing reasonable assurance of implementation.

Denton will be upgrading its Wastewater Treatment Plant (WWTP) to ENR capabilities (operational beginning 2012). The quality of the total nitrogen and total phosphorus discharged by the facility shall be limited at all times to 9,746 lbs/yr for nitrogen and 731 lbs/yr for phosphorus as stated in the National Pollutant Discharge Elimination System (NPDES) permit.

The BRF also funds the cost of installing denitrification upgrades for septic systems throughout the Chesapeake Bay watershed through funding supplied by septic user fees paid by property owners with septic systems. Denitrification systems remove 50 percent or more of the nitrogen discharged by septic systems. The Chesapeake Bay Nitrogen Reduction Act, passed at the end of the State's last legislative session, requires that septic systems being built or replaced for homes located within the Critical Area must utilize the "best available technology" to reduce the level of nitrogen output of the septic system. The Caroline County office of Maryland Department of Environmental Health oversees implementation of the BRF program and administration of the new law.

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. In 2008, 379 farming operations filed nutrient management plans with MDA; however only 80 percent, about 90,000 acres, reported that their nutrient management plans were actually implemented. EPA, through the Chesapeake Bay Program, continues to emphasize that achieving 100 percent implementation of agricultural nutrient management plans is critical to achieving nutrient reduction. Caroline County supports the 100 percent implementation goal and will identify opportunities to assist Maryland Department of Agriculture (MDA) with increasing implementation of nutrient management plans for Caroline County farms.

Chesapeake Bay Agreement

In the 1987 Chesapeake Bay Agreement, Maryland made a commitment to reduce nutrient loads to the Chesapeake Bay. In 1992, the Bay Agreement was amended to include the development and implementation of plans to achieve these nutrient reduction goals. The Tributary Strategies developed in support of the 1992 Agreement provide a framework to support the implementation of non point source pollution controls in the Choptank River and LES basins.

In 2006, Caroline County Planning staff convened a workgroup composed of representatives from the County, incorporated municipalities, non profits, the County Farm Bureau, and other interested citizens to update a watershed characterization document for the Upper Choptank River Watershed, and to develop a similar document for the Tuckahoe Creek Watershed. The resulting document, released in 2007, is intended to establish the baseline information needed to develop a watershed plan. A Memorandum of Understanding circulated among the affected jurisdictions in which each signatory jurisdiction agrees to take the findings of the watershed characterization into consideration in its planning activities, Denton signed the MOU (Appendix 3). Similar characterizations will be completed for the other major watersheds in the County, followed by the development of watershed plans.

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's six states and the District of Columbia 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 storm water 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. *(Maryland Department of the Environment, Frequently Asked Questions)*

WWTP Discharge Location

The Town of Denton's Wastewater discharge location, off of Sharp Road on the East side of the Choptank River is illustrated on Map 5-5.

Map: 5-5

WATER SUPPLY

The Town of Denton's water source is three potable wells in the Piney Point Aquifer. Two are operational wells. Well #3, drilled in 1970, is located off of Kerr Avenue and Md. Rt. 404 and has a pumping capacity of 439 gallons per minute (gpm). Well #5, drilled in 2000, is located south of Engerman Avenue and West of Park Lane has a pumping capacity of 510 gpm. The third well, Well #1, located off of Fifth and Gay Streets, has recently been abandoned because of silting problems. In 2009, the Town applied for financial assistance through the MDE Water Quality Infrastructure Program Capital Projects Financial Assistance program for the construction of new well. Well #6, Camp Road, will be 12 inches in diameter, 450 feet deep and has the pumping capacity of 700 gpm. The installation of the new well will help ensure adequate water capacity to the Town of Denton, however the new well does not increase systems capacity.

The average daily demand (refer to Table 5-2) in 2009, 2008 and 2007 (3 year average) for Denton's water system was 405,667 gallons per day (gpd), about 53% of the systems permitted daily capacity.

Table 5-2: Denton's Water Supply

3-Year Average daily demand (gpd)	Permitted Daily Capacity (gpd)	Allocated (gpd)	Surplus (gpd)
405,667	770,000	11,905	352,428

Source: Denton Planning and Codes

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 well(s) pumping 24 hours per day. Under current maximum daily demand of 1,000,000 gallons per day and a pumping capacity of 439 gallons per minute (Well 3) with the largest well out of service (Well 5), the total well-field in Denton can produce 632,160 gallons per day. Given the same condition but adding future Well 6, the number increases to 1,640,160 gallons per day.

Water Storage Capacity

Denton has three water storage tanks. One tank has a storage capacity of 100,000 gallons and two tanks have a storage capacity of 300,000 gallons each. Map 5-6 shows the location of Denton's water towers and wells.

Map 5-6: DPW Water Resources

Water Distribution System

The distribution system is a network of water main lines varying in size from 2 to 12 inches, two operational artesian wells and three elevated storage towers. Presently the Town produces its water from two operational artesian wells. For pathogenic disinfection the water is treated with Sodium Hypochlorite that is injected via peristaltic pumps located at the point of entry into the distribution system. The natural water quality warrants no other treatment methods. The water passes through the water meter at the main well, and is then distributed between the Town's three storage tanks. The water is then distributed via gravity-flows through an estimated 20 miles of pipe.

The details below reflect all actual improvement activity that has occurred since the year 2000 as well as planned improvement activity.

Actual Improvement Activity

Water lines in this category represent existing lines that were upgraded to 6-inch or greater. Most of these improvements were recommended in a study created by McCrone, Inc. in 1996. The lines were either undersized, failing or both. Replacing these lines has improved water quality and quantity for fire protection.

- 8th Street from Franklin to Sunnyside
- Market Street from 3rd Street to Gay Street
- Gay Street Extended; from 10th Street to Market Street
- 10th Street
- Crystal Avenue; from 10th Street to approx. ½ of the way to 6th Street
- 3rd Street from Market Street to Franklin Street
- 3rd Street from Gay Street to High Street
- High Street
- Lockerman from High Street to the Middle School

Planned Improvement Activity

Water lines in this category represent future improvements needed and planned. These lines are either undersized, failing or both.

- 5th Avenue from Market Street to Kerr Ave
- Randolph Street from 1st to 2nd
- Randolph Street from 4th to 5th
- Randolph Street from 6th to 7th
- 2nd Street from Randolph Street to Market Street
- Gay Street from 2nd to 3rd

Additions

Water lines in this category represent lines added to the existing system. The additions were necessary for new development needs, line looping or both.

- Sharp Road from 5th to Lupine Lane
- Loop created from 5th Avenue to Maryland Avenue through Parkview Estates
- Legion Road from Engerman Avenue to Walsh Way
- 6th Street from Fleetwood to the Town boundary line north (Goose Creek)
- Camp Road from the old Town line (nursing home) to Savannah Overlook
- Kathryn Court
- Market Street from Pearson to Mila Street

Source: Town of Denton, Department of Public Works

WASTEWATER TREATMENT SYSTEM

Photo 5-2: Denton Wastewater Treatment Plan, 650 Legion Road, Denton, MD

A series of facultative lagoons were constructed in 1964 and provided basic BOD, TSS and Fecal Coliform reduction prior to discharging into the Choptank River. At the time, there were no limitations or goals established for Nitrogen and Phosphorus reduction.

The Denton BNR WWTP was built in 1999 at the same location as the lagoons. The treatment plant operates by the activated sludge process with nitrogen conversion. Phosphorus removal by chemical precipitation is also provided. Included in the process is a head chamber, screening, grit removal, aeration reactor basins, secondary clarifiers, chlorination, dechlorination, and post aeration. Sludge handling consists of a sludge holding basin and sand/reed sludge drying beds.

The Head Chamber is the first structure that raw sewage enters into. The purpose of this structure is to divert raw sewage flow to an emergency overflow basin.

The raw wastewater flow passes through a mechanically cleaned bar screen via the influent channel. The mechanically cleaned bar screen is the primary device for removal of large debris from the wastewater flow stream. A manual bar screen is also provided for bypass of flow, for overflow or for maintenance down time of the mechanical screen. The screens protect the downstream plant equipment from being damaged by large debris in the wastewater stream such as rags, metal objects, sticks and other garbage. The screenings are collected in a dumpster and hauled off site for disposal.

The Grit Chamber is located downstream of the mechanically cleaned bar screen to remove grit from the wastewater stream. The grit is removed from the influent flow in a chamber containing a rotating paddle that includes a vortex settling grit to the bottom of the chamber. The grit is removed from the chamber by a vortex recessed impeller pump and is pumped to a grit concentrator/clarifier and grit washing screen. Dewatered grit is deposited into the screenings dumpster.

The headworks effluent flows by gravity to the reactor basin influent box where the flow is split equally to the two reactor basins. The Biolac reactors provide biological BOD, phosphorus, and nitrogen removal. Aeration to the reactors is accomplished using three positive displacement type blowers located in the operations building. Air enters the basins through a series of pipe headers and is diffused by diffuser tubes attached to the aeration chains.

Mixed liquor from the two reactors flows by gravity to a splitter box where the flow is divided equally to the two secondary clarifiers, and chemicals for precipitation of phosphorus are added. Each clarifier is equipped with a peripheral discharge weir. Reactor effluent flows over the weir and into a sloped effluent launder for conveyance by gravity to the chlorination tank. Secondary sludge is withdrawn from the bottom of the clarifiers and pumped to the reactor basins. The three variable speed RAS pumps are in the sludge pumping station which is located between the secondary clarifiers. Excess sludge is also drawn from the bottom of the secondary clarifiers in the form of waste activated sludge. This sludge is pumped to the sludge holding tank. The two constant speed WAS pumps are located in the sludge pumping station.

Chlorine is added to the secondary clarifier effluent at the secondary clarifier effluent weir. Then, the wastewater flow from the secondary clarifiers enters the dechlorination tank by gravity. A final v-notch weir meter measures the effluent flow in the tank. Sulfur dioxide is added to the stream in the dechlorination tank prior to the v-notch weir to dechlorinate the water.

A v-notch weir near the end of the dechlorination tank is used to add dissolved oxygen to the effluent stream. In the sludge holding tank, the sludge settles and thickens. The sludge is aerated by two blowers and coarse bubble diffusers located at the bottom of the tank. Sludge from the holding tank is deposited on sixteen sand/reed sludge drying beds. By a combination of evaporation, filtrate removal, and water uptake by the reed plants, a very high percentage of water is removed from the sludge. This very dense sludge may be stored on the beds for several years before requiring removal to an off-site location. *(Town of Denton, Department of Public Works, 2010)*

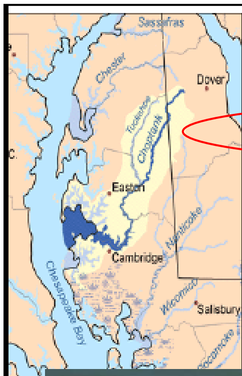
Wastewater Treatment Plant Capacity

The Treatment Plant is designed for an average daily flow of 800,000 gallons and for a peak daily flow of 2.67 million gallons. Currently the plant operates at a three-year rolling average of 394,667 gallons per day, which is 49% of the design capacity.

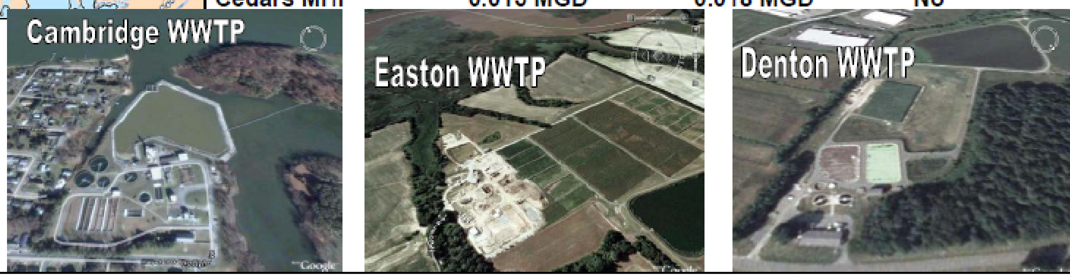
The Town is in the process of upgrading the existing Wastewater Treatment Plant (WWTP) to meet enhanced nutrient removal (ENR) capabilities. The Town's National Pollutant Discharge Elimination System (NPDES) permit for the facility was recently renewed, with ENR criteria in place. The permit stipulates that the facility must be ENR compliant by January 2012. The quality of the total nitrogen and total phosphorus discharged by the facility shall be limited at all times to 9,746 lbs/yr for nitrogen and 731 lbs/yr for phosphorus as stated in the NPDES permit. The capacity of the Denton WWTP will remain at 0.8 MGD with a peak of 2.67 MGD. Based upon performance data received for the years 2006 through 2008, the treatment system is capable of removing total nitrogen and phosphorus to effluent concentrations of less than 8 and 2 mg/l, respectively. *(GMB, George, Miles and Buhr)*

There are only three WWTP's that are scheduled or have been completed for ENR upgrades in the Choptank River Watershed. Easton's upgrade is completed; Denton and Cambridge plant upgrades are scheduled for completion in 2011-2012. Figure 5-4 lists the three plants with ENR upgrades, plus the design flow of surrounding Towns and facilities.

Figure 5-4: Wastewater Treatment Plants in the Choptank River Watershed



WWTP	Design flow	Current flow	ENR
Cambridge	8.1 MGD	3.3 MGD	By 2011
Easton	4.0 MGD	2.3 MGD	Completed
Denton	0.80 MGD	0.36 MGD	By 2011
Twin Cities	0.28 MGD	0.20 MGD	No
Greensboro	0.28 MGD	0.12 MGD	No
Trappe	0.200 MGD	0.10 MGD	No
Ridgley	0.20 MGD (Jan.-March)	0.06 MGD	No
Preston	0.115 MGD	0.10 MGD	No
North Caroline HS	0.024 MGD	0.002 MGD	No
Cedars MHP	0.015 MGD	0.018 MGD	No



Source: Maryland Department of the Environment, Status of the Choptank River

The primary way that the WWTP capacity is set is by the County Comprehensive Water and Sewer Plan. Any County proposed changes must be approved by the Maryland Departments of Planning (MDP) and the Environment (MDE) before they are adopted. The State agencies look at items such as available water and wastewater, priority funding areas, smart growth, etc.

Once a design flow for wastewater is established in the Water and Sewer Plan, MDE will set permit limitations based on the Chesapeake Bay Tributary Strategy and any local Total Daily Minimum Loads, whichever requires the stricter limits. Although flow itself is almost never a permit limit, the cap on pound loading set for nitrogen and phosphorus can establish a de facto maximum design flow based on the lowest concentrations of nitrogen and phosphorus that can be achieved by Enhanced Nutrient Removal (ENR) technology.

For example, a WWTP may have a total nitrogen (TN) allocation either from the Chesapeake Bay Tributary Strategy or from the Choptank River TMDL of 12,200 lbs/yr (based on ENR-level treatment of 4.0 mg/l TN and a design flow of 1.0 MGD). If a WWTP can be designed to achieve 3.0 mg/l TN (the practical limit of technology), then the design flow can be increased by 33% up to 1.33 MGD. Therefore, as long as the flow increase is consistent with the County Water and Sewer Plan, the permit flow can be increased. As stated in Caroline County's Comprehensive Plan 2010, even though 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 whose flows increase to full capacity. Current NPDES permitting standards are based on plant flow capacity, i.e., the maximum number of gallons that can flow through a plant per day. A better permitting strategy would be to base permits on computed loads, i.e., nutrient concentrations times the volume of flow. Maximum limits of loads should be capped at values which sum to a 40 percent reduction from the 1985 load of a specific

plant. Otherwise, if permit limits continue to be based on ENR treatment levels applied to the design capacity of a treatment plant, the long-term result will be that ENR technology will result in a nutrient reduction that is less than the goal of 40 percent reduction from 1985 loads.
(Statewide Tributary Strategy Implementation Plan, Choptank Tributary Team/Public Comment)

A WWTP can have its nutrient allocations increased by receiving nutrient credits through connecting existing septic systems or an existing smaller WWTP, or by purchasing non-point sources nutrient credits. WWTP available flow can be increased by treating part of the wastewater through land application (spray or drip irrigation, for example) if suitable soils are available. (*Maryland Department of the Environment, Status of the Choptank River)*

PROJECTED WATER AND SEWER DEMAND

The Land Use and Municipal Growth Element chapters have indicated that the Town has land available to accommodate substantial growth in the future. The recommended water resource goals and policies presented in this Chapter are directed to account for the projected growth; and to reduce the impacts on water quality from development.

Both the water and wastewater systems have functional and permitted capacities (Table 5-3). The water system capacity is 770,000 gallons per day (gpd). The wastewater treatment plant capacity is 800,000 gpd. Average flows for the last three years are 405,667 gpd and 394,667 gpd respectively for the water and sewer systems. Net available capacities for future growth are calculated from the systems capacities, less three-year averages, less allocations granted to approved development projects. As Table 5-3 illustrates, the limiting capacity for future growth is the water system.

In projecting demand for water and sewer services, each dwelling unit (household) is equal to one Equivalent Dwelling Unit or EDU. In April 1992, the Caroline County Health Department authorized an EDU rate of 225 gallons per day (gpd) for the Town of Denton. One EDU is estimated to consume 225 gpd of drinking water and contribute 225 gpd to wastewater flow (Denton planning assumptions as compared to MDP's 250 gpd). The Denton Utility Commission established a usage table, adopted by the Town Council, which applies EDU's based on the proposed use.

Given the aforementioned water system capacity constraint, the maximum number of dwelling units the system will support can be derived. As shown in Table 5-4, the Water system net capacity divided by the town's average flow per day per dwelling unit (EDU) results in the maximum number of dwelling units the current net capacity could support (equations below). The maximum number of additional dwelling units that the current water/WWTP capacity could support, as derived, is 1,566 dwelling units.

Table 5-3: Water and Sewage Available Capacity

	Water Flow 2009 (gpd)	Sewage Flow 2009 (gpd)
2007	419,000	346,000
2008	401,000	420,000
2009	397,000	418,000
Average Flow	405,667	394,667
Permit	770,000	800,000
Balance Available	364,333	405,333
Allocated	11,905	11,107
Net Available Capacity	**352,428**	394,226

Table 5-4: Population Estimate With Current Water Capacity (Assuming All Allocation To Residential Growth)

A. Flow Balance Available (gpd)	**352,428**
B. Average Equivalent Dwelling Unit Usage (gpd)	225
C. Household Units or DU's (A divided by B)	1,566
D. Population from additional DU's (C times 2.17 PPDU)*	3,398
E. Current Population**	4,022
F. Total Population (D plus E)	7,420

* *Town of Denton of (2.17 persons per household)*
** *2008 U.S. Census data for Town of Denton (4,022 population estimate)*

Projected Population with Water System Capacity Limitation

Calculations for projecting Denton's future population were presented in the Municipal Growth Element of the Comprehensive Plan. Denton's population increase from 1990 – 2000 was 2.98%, and the estimated increase between 2000 and 2008 was 3.9%. Population projections in Table 4-3 of the Municipal Growth Element calculated four different annual compound growth rates of 2%, 3%, 4% and 5%. An analysis of current water and sewer systems' capacities in the above tables, illustrates how the Town's growth is constrained by these capacity limits. Because of the Town's decision at this time not to expand the Water and Wastewater facilities, the maximum population that these systems are able to support is 7,420 (Table 5-4). Further analysis prompted the Town to prioritize allocation first to commercial and industrial uses, and allocate the remainder for residential uses. The decision to prioritize the current capacity allocations resulted in a facility-supported population estimate of 6,125, representing an annual compound growth rate of 2% through 2030. Table 5-5, illustrates the population estimate when 5% of total capacity is reserved for commercial and industrial uses. As the Town reaches capacity, the Maryland Department of the Environment requests that a Wastewater Capacity Management Plan be submitted if the most recent three years average flow is over 80% of its design capacity or if it is anticipated to exceed 80% in the next year. The Town would need to determine courses of actions at this point. Possible actions might have to include a reconsideration to upgrade and expand the current system, impose building moratorium, or allocate remaining capacity incrementally over a period of time.

Table 5-5: Commercial/Industrial allocated first.

	2008	2010	2015	2020	2025	2030
Population with Commercial / Industrial allocated first	4,022	4,179	4,598	5,059	5,567	6,125

Impact of Full Build-Out Analysis

The next analysis shows the impact on water/WWTP with full build-out of the Town as calculated in the capacity analysis for the Municipal Growth Element of the comprehensive plan. The Municipal Growth Element contains details about the process used for calculations of available land area for development.

- The build-out analysis looked at two scenarios:
    - Complete build-out for existing infill and growth area.
    - The maximum and minimum lot area was used to determine the number of potential dwelling units a parcel could support.
- Development Capacities are based on a variable zoning yield in accordance with the Maryland Department of Planning Guidelines (75%). Planned Neighborhood Zoning development capacity is calculated at 55% development capacity to account for commercial and retail. The infill lots consist of those areas that may be eligible for new development and subdivision.

The capacity analysis indicates that the existing wastewater treatment and water facilities are insufficient to meet the demand projected with full build-out (Tables 5-6 & 5-7) for a population between 10,464 – 12,588 residents**.** Total build-out cannot be achieved without capacity increase to the water and wastewater systems.

Table 5-6: Maximum Density

	Dwelling Units	Population
Infill	3,234	7,019
Growth Area	172	373
Current Population in Growth Area	21	48
Current Population		4,022
Approved subdivisions	519	1,126
Total Population		**12,588**

Table 5-7: Minimum Density

	Dwelling Units	Population
Infill	2,256	4,895
Growth Area	172	373
Current Population in Growth Area	21	48
Current Population		4,022
Approved subdivisions	591	1,126
Total Population		**10,464**

Denton is divided by the Choptank River. Until 2004, the Town boundary encompassed only land east of the river. In 2004, approximately 850 acres west of the river were annexed into the Town. The Town does not plan on extending Water/WWTP to the west side of Denton (Town Council supported planning assumption). Consequently, the Denton properties west of the Choptank River cannot be developed unless separate water and wastewater systems are permitted and built to supply infrastructure demand. All available water and wastewater capacity will be utilized for development on the Town's east side only, including both infill and proposed growth areas.

POINT SOURCE POLLUTION

Pollution originating from a single, identifiable source, such as a discharge pipe from a factory or sewage plant, is called point-source pollution. Point sources are measurable inputs of pollutants that are discharged into streams, rivers, and lakes.

Table 5-8, shows point source discharges in the Upper Choptank portion of the Choptank River basin with loadings of 8.3% Nitrogen and 11.7% Phosphorus. Types of point source discharges are: 1) sanitary sewerage system discharge outfall, 2) industrial waste discharge outfall, 3) combined sanitary and storm sewer discharge outfall, 4) separated storm sewer discharge outfalls, and 5) groundwater heat pump discharge.

All of the above must apply for an individual National Pollution Discharge Elimination System (NPDES.) permit with the exception of the separated storm sewer discharge and watersource heat pumps discharging to waters of the State. An NPDES permit (required federally, but administered through the State MDE) specifies allowable discharge limitations, where applicable, of biochemical oxygen demand (BOD), suspended solids, coliform organisms, pH, dissolved oxygen, nitrogen, phosphorous, temperature, flow, heavy metals, and pesticides.

Agricultural activities which may require an NPDES permit include animal waste facilities, aquaculture operations, crop irrigation, and large concentrated animal feeding operations. Wastewater treatment plants (WWTPs) require NPDES permits to discharge treated sewage into surface water or the ground. Permitted facilities must adhere to water quality standards as well as effluent limits. A water quality standard is an "instream" standard and applies to a water body whether or not there is a discharge. An effluent limit is a condition of a discharge permit which limits the amount of a particular pollutant that may be discharged into the water body

Table 5-8: Upper Choptank River Watershed Sources of Impairment

	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

Non-point sources are all discharges other than point source discharges, including stormwater runoff from land and erosion of stream and river banks. Table 5-8 includes a list of non-point sources of impairments for the watershed. Non-point pollution sources are addressed later in the chapter.

Total Maximum Daily Loads (TMDL's)

TMDL's address a single pollutant for each water body. TMDL's are a tool for implementing Maryland's water quality standard. 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. TMDL's also allocates that load (amount) among pollution contributors. Maryland has listed the Choptank as impaired on the 303(d) list for failing to meet the state standard for dissolved oxygen in the water, caused by excessive TN & TP. A TMDL is required by the Clean Water Act for water bodies that fail to meet water quality standards. **To date no nutrient TMDL's targets have been set for the Upper Choptank watershed.** Data on water basin nutrient loads and recommended nutrient caps for the Choptank River Basin is included in Maryland Department of the Environment's Statewide Implementation Plan.

With the completion of Denton's ENR upgrade, the plant will be capable of achieving an effluent with Total Nitrogen of 3 mg/l and a Total Phosphorus of 0.3 mg/l. Chart 5-1 (pg 28) illustrates the total loads from 1984 up to projected 2015 after implementation of ENR upgrade.

Table 5-9 shows Denton's plant concentrations for the last four years, 2006-2009. Total Nitrogen concentrations range from 4.6 mg/l to 16.67 mg/l. Total Phosphorus concentrations range from 0.66 mg/l to 1.17 mg/l. Prior to 2008 the plant was operating at 50% flow and utilizing half the process treatment equipment. In 2008, operations staff made the decision to run both biological process basins instead of one. This was decided due to one basin being overloaded and having difficulty with denitrification during the warmer months. The incoming load was inadequate for complete denitrification utilizing both basins so operators were challenged to find the best operating parameters possible under these conditions. Ultimately optimal operating parameters were achieved.

Town of Denton Municipal Wastewater Treatment Facilities Effluent

Table 5-9: Nitrogen and Phosphorus concentrations and loadings

			CONCENTRATION		AVE ANNUAL FLOW LOAD		ANNUAL TOTALS	
	Average Daily Flow (mgd)	Design Capacity (mgd)	TN (mg/l)	TP (mg/l)	TN (lbs/yr)	TP (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)
2009	394,667	800,000	8.93	0.86	1,056	97	12,677	1,166
2008			16.67	0.96	1,742	102	20,902	1,226
2007			8.89	1.17	705	103	8,456	1,240
2006			4.66	0.66	420	61	5,036	728

Source: Town of Denton, Department of Public Works, Denton WWTP Annual Nutrients.pdf

As shown in Caroline County's Comprehensive Plan 2010, there are five wastewater treatment plants (WWTP's) in Caroline County. Two municipalities in Caroline County have major treatment plants, also known as "significant" point sources: Federalsburg and Denton. The Federalsburg WWTP ENR upgrade is currently underway; and as mentioned earlier Denton is in the later design phase of its upgrade. The towns of Preston, Greensboro, and Ridgely own minor treatment plants (flow less than 0.5 mgd).

Table 5-10, provided by Caroline County, gives information on the five municipal plants located in Caroline County. Chart 5-1 shows pounds per year for total nitrogen and total phosphorus for years from 1984 to a projection load of approximately 5,000 lbs/yr for Total Nitrogen and approximately 500 lbs/yr for Total Phosphorus in the year 2015.

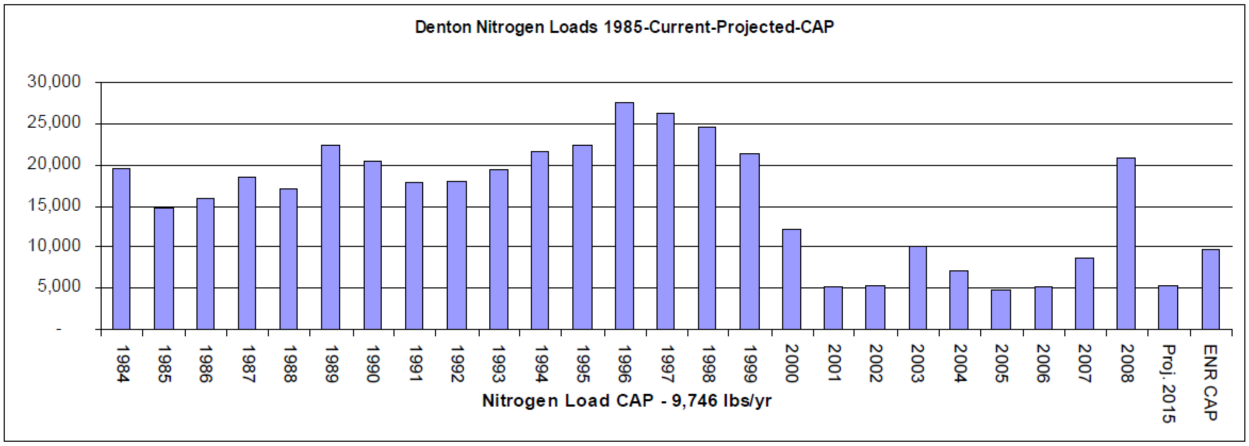
Table 5-10: 2007 Municipal Water Flows and Nutrient Loads

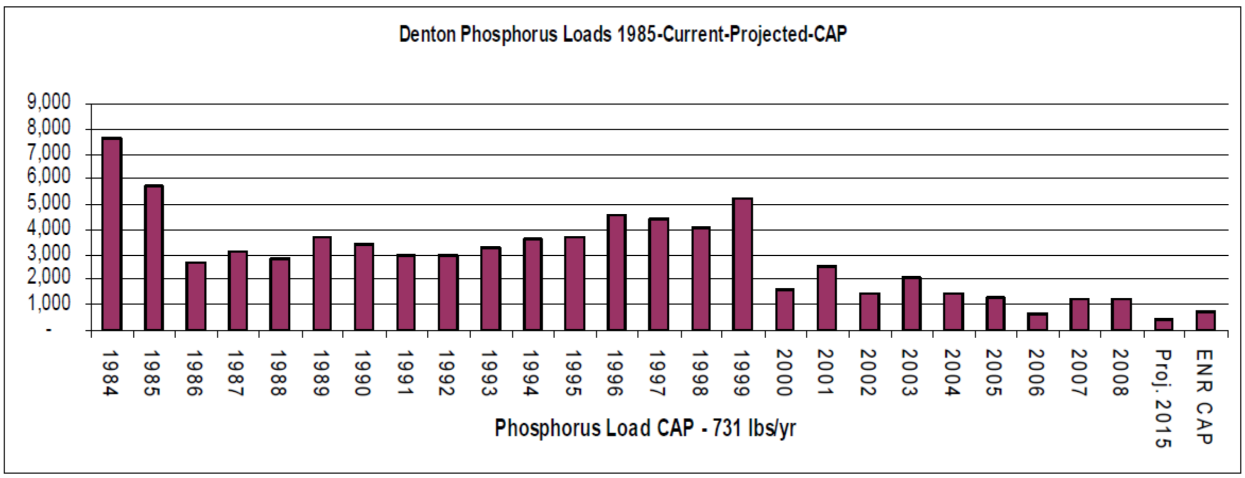
WWTP	2007 Average Daily Flow (mgd)	Connections	Design Capacity (mgd)	2007 Data TN mg/l	TP mg/l	TN lbs/yr	TP lbs/yr
Denton	0.349	1,396	0.8	8.10	1.18	8,605	1,254
Federalsburg	0.274	1,096	0.75	19.85	0.68	16,557	570
TOTAL MAJOR						25,162	1,823
Greensboro**	0.149	444	0.28	21.02	3.48	9,534	1,578
Preston	0.058	232	0.116	11.34	1.00	2,016	177
Ridgely	0.134	536	0.18	18.00	3.00	7,342	1,224
TOTAL MINOR						18,892	2,979
TOTAL POINT SOURCES						44,054	4,802

***2007 TN & TP mg/l concentrations are average of 2002-2006 data*

(EPA Chesapeake Bay Program Point Source Database; Caroline County Dept. of Planning, Codes and Engineering, 2008)

Chart 5.1: ENR CAPS FOR DENTON



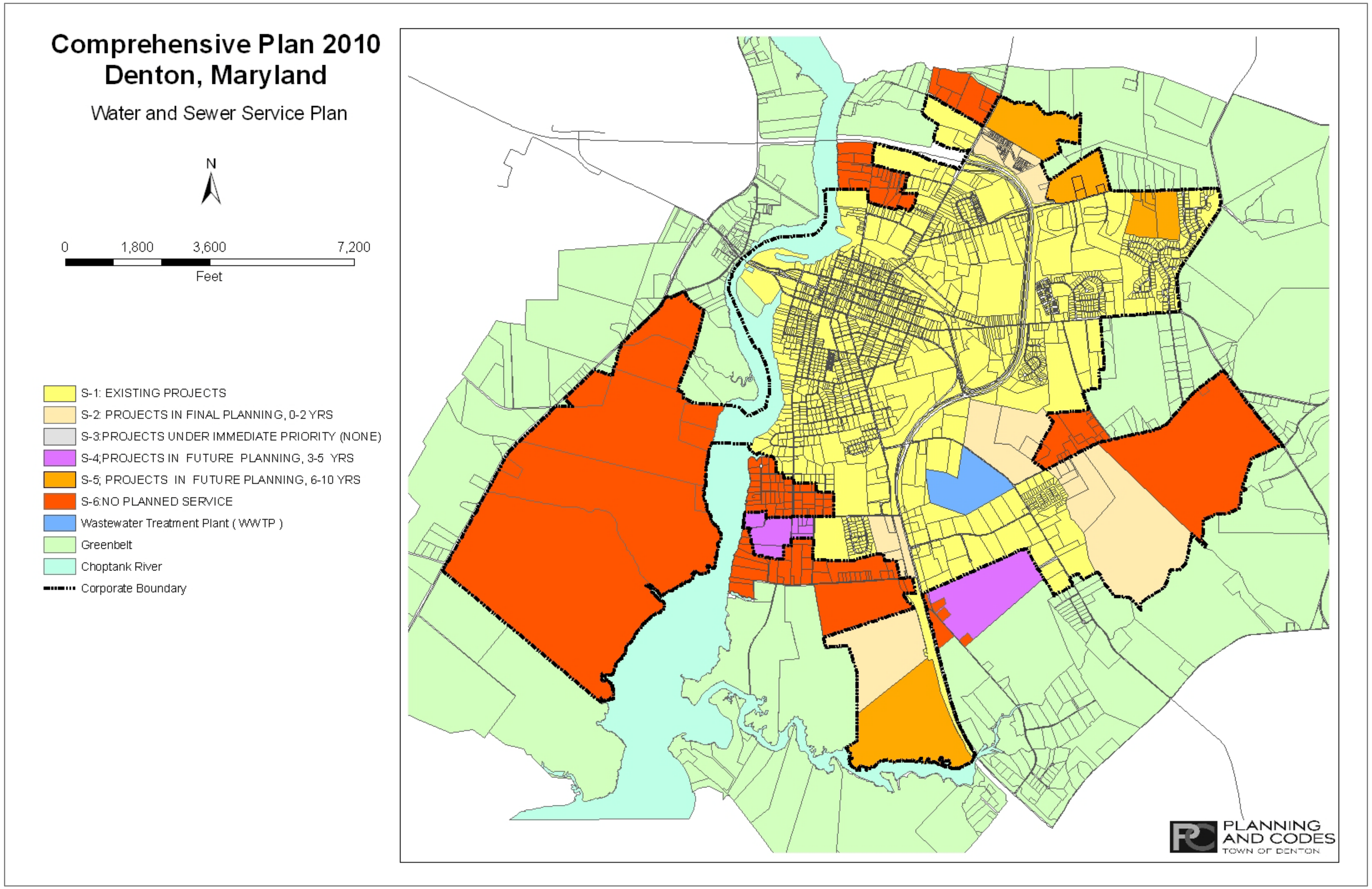


Source: Maryland Department of the Environment (MDE), Facts About...

Water and Sewer Service Plan

Denton's Water and Sewer Service Plan, Map 5-7, illustrates the existing and projected service areas. The properties listed in the S-2 grouping are projects that have gotten final approval and projects that are still in the process of review, while S-3 shows that there are no projects for immediate consideration. The S-6 category represents the areas where no water and sewer service is planned during the planning period. As shown in Map 5-7, the area west of the Choptank River, as discussed in the Municipal Growth Element and previously in the Water Resource Element narrative, is not scheduled for public water or non-septic wastewater provisioning. Water quality protection strategies include routine sanitary surveys on well sites and the Town will investigate the implementation of a wellhead protection program. The Maryland Department of the Environment offers information to help with the strategic planning for such a program.

Map 5-7:


Comprehensive Plan 2010
Denton, Maryland
Water and Sewer Service Plan
N
0
1,800
3,600
7,200
Feet
S-1: EXISTING PROJECTS
S-2: PROJECTS IN FINAL PLANNING, 0-2 YRS
S-3:PROJECTS UNDER IMMEDIATE PRIORITY (NONE)
S-4;PROJECTS IN FUTURE PLANNING, 3-5 YRS
S-5; PROJECTS IN FUTURE PLANNING, 6-10 YRS
S-6:NO PLANNED SERVICE
Wastewater Treatment Plant (WWTP)
Greenbelt
Choptank River
Corporate Boundary
PLANNING
AND CODES
TOWN OF DENTON

Septic Systems

The Maryland Department of the Environment standardizes all sewage disposal systems in Maryland. Their responsibilities include issuing permits, licensing septic system installers, and managing complaints. Aerobic treatment units, mounds, and alternative soil absorption designs are covered in current regulations available from The Maryland Department of the Environment. Alternative treatment technologies are approved on a per-case basis. Use of experimental systems is approved for system failures.

Authorized septic treatment and disposal systems approved for use in Maryland include waterless toilets with grey water, groundwater injection, wetlands treatment, spray irrigation, gravelless chamber systems, evapotranspiration beds, recirculating sand filters, and drip irrigation. Typically, a septic system does not remove nitrogen.

The Maryland Department of the Environment regulates septic systems in Maryland and oversees the Bay Restoration Fund, which was created by law in 2004 to provide improved OSDS technology throughout the state and reduce excess nitrogen and phosphorus in the Bay. As mentioned earlier in this chapter the Bay Restoration Fund offers funding to help with the cost of installing denitrification upgrades for septic systems. Senate Bill 554 requires any septic system for a newly constructed building or replacement system in the Critical Area must include Best Available Nitrogen Removal Technology (BAT). An upgraded septic system cuts a systems nitrogen load in half. The Maryland Department of the Environment will prioritize funding for septic system upgrades toward systems as follows: 1) failing septic systems in the Critical Area, 2) failing septic systems outside the Critical Area, 3) non-failing systems in Critical Area, and 4) all other systems, including new construction.

Caroline County's properties that are not located in corporate areas and some located within municipal boundaries, including Denton, are served by on-site sewage disposal systems – septic systems. Approximately 11,105 existed in the county as of the end of 2008. The nitrogen loading rate of a septic system is:

> 9.5 lbs nitrogen/person/year x average number persons per household x 0.4 (transport factor)
> (***Source: Caroline County, Draft Comprehensive Plan, June, 2009, Caroline County Department of Planning and Codes)***

Denton's Town Code requires connection to the public sewer, provided that the public sewer is within 100 feet of the property line. There are several properties in Town that are serviced by private septic systems due to annexations over the last decade. These 84 properties are serviced by 84 septic systems. Applying the previous nitrogen loading formula to the number of current septic systems located in Denton, a total of 731 pounds of nitrogen could impact groundwater quality.

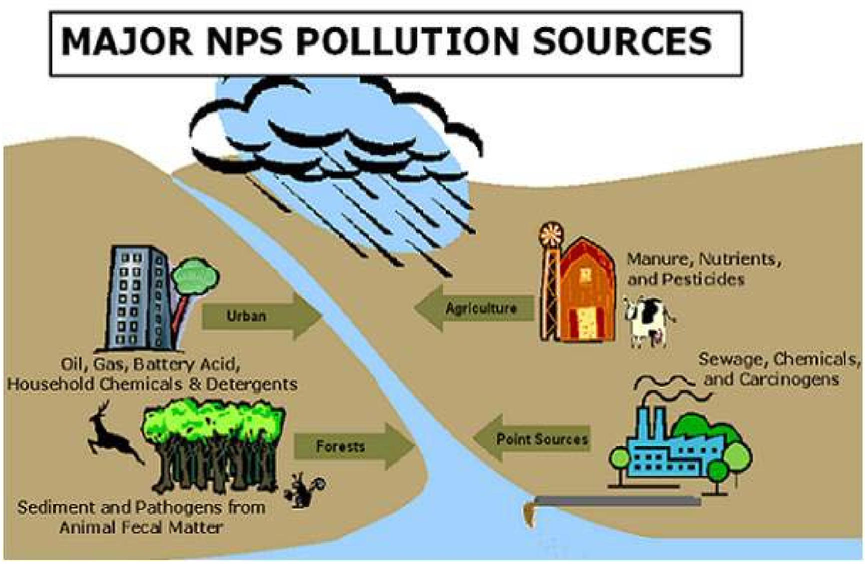
$$[(9.5 \times 2.29) \times 0.4] \times 84 \text{ systems} = 731 \text{ lbs/year}$$

Using another estimate of nitrogen loading, a report from MDE, titled "Environmental Matters Committee Briefing on the Bay Restoration Fund." January 19, 2010, estimated 12 pounds per year from each system reaches surface waters. Denton's 84 septic systems without upgrades could produce 1,008 lbs of nitrogen potentially impacting surface waters. The non-point pollution forecast does not incorporate the pollution reductions expected from connecting these septic systems to the Town's WWTP.

NON-POINT SOURCE POLLUTION & STORMWATER MANAGEMENT CONSIDERATIONS

Non-point source pollution occurs when surface runoff generated by rainfall, snowmelt, or irrigation is conveyed over-land, gathering pollutants along the way. The collected pollutants are then deposited directly into waterways or infiltrate into native soils, where they are introduced into ground water resources. Stormwater runoff is an important contributor to non-point source pollutant loading (Figure 5-5). As of 2005, the largest non-point source of nitrogen and phosphorus in the Choptank River Basin was agriculture, being 70 percent and 62 percent of the total contribution, respectively. Agricultural land use was also responsible for the highest volume of the river basin's sediment loads (85 percent).

Figure 5-5: Major NPS Pollution Sources



Source: roanokecountyva.gov/Departments/Engineering/1Stormwater/2NPSPollution.htm

According to the Maryland Tributary Strategy Choptank Basin Summary Report for 1985-2003, the Town of Denton, 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 but human activities and the urbanization created by both new and in-fill development can alter natural drainage patterns and add pollutants to local waterways. Urban runoff, especially from impervious surfaces, is often a considerable source of water pollution, including flows released from urban land uses into public or private stormwater conveyance systems and, subsequently, receiving waters.

Traditional methods designed to manage stormwater runoff focused more so on the quantity of runoff that was being released (e.g., volume) while, in general, the overall quality of the runoff being released was of a secondary concern. More recently, though, such dominating policies have been altered and a more acute awareness for the need to improve water quality has amplified. With a more concentrated focus, Federal, State, and Local guidelines have been established to effectively reduce the pollutant loads contained in the stormwater discharges that are directed to receiving waterways. These guidelines, along with associated programs, promote the perception and practice of preventing pollution at source locations, before it can create aggravated environmental problems.

Denton's Projected Non-Point Source Loading

Data available allows for the estimation of nitrogen and phosphorous loadings from non-point source runoff based on projected growth in the Town through 2030 (Table 5-10). 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. Denton applied these same rates.

Land use acreage totals are applied to a formula developed by MDE that includes particular soil factors, average annual rainfall totals and impervious surface ratios (impervious surface ratios vary according to general land use – in brief, developed lands have higher ratios of impervious surface than that of undeveloped lands). The end 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 Denton since it reflects a mix of residential, commercial, and industrial uses.

Table 5-11: Denton's estimated non-point source loading rates and loads (2009 and 2030) (full build-out)

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 1,358 acres	9.02	1.31	12,250	1,779
Year 2030† 2,452 acres	9.02	1.31	22,118	3,213
Net Increase	---	---	**9,868**	**1,434**

Notes: Loading rates are based on MDE/CBP land use load estimates.
* "Developed" includes residential, commercial, industrial and institutional land uses, along with those portions of public, semi-public and open spaces that are documented as being developed.
** Represents average load per acre of all acres including Town parkland but excluding agricultural land
† Year 2030 estimates assume full build-out of all undeveloped residential and commercial-zoned properties, while environmentally constrained areas remain undeveloped.

Estimates shown in Table 5-11 indicate that approximately **9,868** additional pounds of nitrogen loading and **1,434** additional pounds of phosphorus loading can be expected as a result of land development over the period. It should be noted that the year 2030 developed land acreage in this table assumes a "maximum" development scenario, where all undeveloped residential and commercial-zoned properties are developed, while any areas restricted by environmental constraints (buffers, preservation lands, etc.) remain undeveloped.

The Town of Denton has instituted a development strategy from year 2009 until year 2030 so as to restrict development by the ability to provide sanitary sewer and potable water service. More specifically, the available capacity of the Town's wastewater treatment facility and the distribution capability of the Town's well systems will be allocated over a twenty-year period to properly manage growth and assure that upgrades to those associated infrastructures would be needless. As such, alternative estimates can be created that more pragmatically illustrate the non-point loading impact that future development would have in the Town of Denton, as exhibited in Table 5-12.

Table 5-12: Denton's estimated non-point source loading rates and loads (2009 and 2030) (WWTP constrained growth)

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 1,358 acres	9.02	1.31	12,250	1,779
Year 2030† 1,689 acres	9.02	1.31	15,235	2,213
Net Increase	---	---	**2,985**	**434**

Notes: Loading rates are based on MDE/CBP land use load estimates.
* "Developed" includes residential, commercial, industrial and institutional land uses, along with those portions of public, semi-public and open spaces that are documented as being developed.
** Represents average load per acre of all acres including Town parkland but excluding agricultural land
† Year 2030 estimates assume build-out of undeveloped residential and commercial-zoned properties, where growth is restricted by available wastewater treatment capacity and well production capabilities.

When comparing the "maximum" development scenario (Table 5-11) estimates with the actual planned growth expected by the Town of Denton (Table 5-12), approximately **2,985** additional pounds of nitrogen loading and **434** additional pounds of phosphorus loading can be projected as a product of land development over the period. This results in net decreases of 6,883 and 1,000 pounds of nitrogen and phosphorous loading, respectively, when comparing potential and planned growth. All estimates assume that the loading rates per acre will remain the same through year 2030, where the uses of Environmental Site Design (ESD) strategies are not taken into consideration.

Table 5-13 represents results from use of an alternative method used to estimate future levels of pollution from non-point sources in Denton. 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 5-13: Denton non-point pollutant loadings from projected infill development and growth within currently planned municipal areas (maximum development)

	Conversion factor for converting milligrams to pounds	(R) Runoff (annual inches of water) ††	(C) Pollutant Concentration	(A) Impervious Surface (acres) †††	(L) Total load (lbs/year)
Estimated Nitrogen loadings †	0.226	42.8 inches	2.0 mg/l Nitrogen concentration	977	18,901 Nitrogen
Estimated Phosphorus loadings †	0.226	42.8 inches	0.26 mg/l Phosphorus concentration	977	2,458 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. A 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 Year 2030 full build-out of all undeveloped residential and commercial-zoned properties, while environmentally constrained areas remain undeveloped. Those portions of public, semi-public and open spaces that are documented as being developed are also included in the calculation.

The use of this method generates results for loading estimates where nitrogen and phosphorus concentrations are lower when compared with similar projected increases in Table 5-11. The two methods institute a range of estimates in non-point source nitrogen loadings between 18,901 and 22,118 lbs per year, while the estimated range for projected phosphorus loadings fall between 2,458 and 3,213 lbs. per year. As with Table 5-11, Table 5-13 reflects the pollutant loading potential when utilizing a “maximum” development scenario, in which case impending growth is only limited to certain environmental constraints.

Since the Town of Denton has a clear strategy for the management of future growth, the same mathematical formula can be used to estimate non-point loading rates associated with development potential when limited to the capacities of existing infrastructure, as was exhibited by Table 5-11. Those estimates are more clearly illustrated in Table 5-14.

Again, the use of this method generates results for loading estimates where nitrogen and phosphorus concentrations are lower when compared with similar projected increases in Table 5-12. For actual projected growth, a range of estimates in non-point source nitrogen loadings between 14,761 and 15,235 lbs per year and between 1,919 and 2,213 lbs. per year for non-point source phosphorous loadings could be surmised. When comparing the results illustrated in Table 5-14 with the results illustrated in Table 5-13, net decreases of 4,140 and 539 pounds of nitrogen and phosphorous loading, respectively, are realized when limiting planned growth by available infrastructure capabilities.

Table 5-14: Denton non-point pollutant loadings from projected infill development and growth within currently planned municipal areas (constrained growth)

	Conversion factor for converting milligrams to pounds.	(R) Runoff (annual inches of water) ††	(C) Pollutant Concentration	(A)Impervious Surface (acres) †††	(L) Total load (lbs/year)
Estimated Nitrogen loadings †	0.226	42.8 inches	2.0 mg/l Nitrogen concentration	763	14,761 Nitrogen
Estimated Phosphorus loadings †	0.226	42.8 inches	0.26 mg/l Phosphorus concentration	763	1,919 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. A 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 Year 2030 build-out of undeveloped residential and commercial-zoned properties, where growth is restricted by available wastewater treatment capacity and well production capabilities. Those portions of public, semi-public and open spaces that are documented as being developed are also included in the calculation.

As previously mentioned, the single largest contributor of non-point source nitrogen and phosphorous loading in the Choptank River Basin is agricultural land use, being 70% of the total impact as of 2005. The nature of the land use makes it so the loading rates for nitrogen and phosphorous are significantly higher than what is experienced on developed properties. It is because of this, the development of agricultural properties helps to reduce the prevalence of non-point source pollutants contained in stormwater runoff, as evidenced in Table 5-15.

Table 5-15: Denton's estimated non-point source loading rates and loads from agricultural sources (2009 and 2030)

Estimated Acres of Agricultural Land*	Nitrogen Loading Rate (lbs/ac)	Phosphorus Loading Rate (lbs/ac)	Estimated Nitrogen Load (lbs)**	Estimated Phosphorus Load (lbs)**
Year 2009 1,633 acres	23.15	2.17	37,804	3,544
Year 2030† 1,070 acres	23.15	2.17	24,771	2,322
Net Decrease	---	---	13,033	1,222

Notes: Loading rates are based on MDE/CBP land use load estimates.

* "Agricultural" includes farmland and any other land use where cultivation of a harvested crop occurs.

** Represents average load per acre of all agricultural acres.

† Year 2030 estimates assume all remaining agricultural lands within the municipal limits that have not been developed.

Analysis indicates that the development of agricultural properties would have a significant effect in reducing the indicated non-point source pollutants. Additional reduction of non-point source pollutants would also be achieved on those developed parcels through the use of both ESD methods and Best Management Practices (BMPs).

Worth mentioning is that stormwater runoff from any land cover condition generates non-point source pollution. Properties that remain undeveloped yet uncultivated still contribute to the pollutant load in a watershed, although their impact is far less since the tendency is to leave such lands in a "natural" state where nutrients are not applied and man-made sources of said pollutants are not present. As such, the pollutant contribution from these lands can still be quantified (Table 5-16).

Table 5-16: Denton's estimated non-point source loading rates and loads from undeveloped sources (2009 and 2030)

Estimated Acres of Undeveloped Land*	Nitrogen Loading Rate (lbs/ac)	Phosphorus Loading Rate (lbs/ac)	Estimated Nitrogen Load (lbs)**	Estimated Phosphorus Load (lbs)**
Year 2009 300 acres	1.48	0.02	444	6
Year 2030† 533 acres	1.48	0.02	789	11
Net Increase	---	---	345	5

Notes: Loading rates are based on MDE/CBP land use load estimates.

* "Undeveloped" includes private open space, environmentally sensitive areas and those portions of public, semi-public and open spaces that are documented as being undeveloped.

** Represents average load per acre of all agricultural acres.

† Year 2030 estimates assume all remaining undeveloped lands within the municipal limits where build-out has taken place and growth is restricted by available wastewater treatment capacity and well production capabilities.

Once the cumulative impact of development within the municipal limits is analyzed, a more definitive estimation can be made that depicts what the Town of Denton's approximate total contribution for the specified non-point source pollutants would be over the planning period (Table 5-17).

Table 5-17: Denton's estimated non-point source loading from all sources (2009 and 2030)

Total Acreage*	Estimated Nitrogen Load (lbs)**	Estimated Phosphorus Load (lbs)**
Year 2009 3,291 acres	50,498	5,329
Year 2030† 3,291 acres	40,321	4,252
Net Decrease	**10,177**	**1,077**

* Total acreage includes all agricultural, residential, commercial, industrial and undeveloped lands.

** Represents total load estimate of nitrogen and phosphorous from agricultural, residential and commercial development.

† Year 2030 estimates assume all agricultural acreage and build-out of undeveloped residential and commercial-zoned properties, where growth is restricted by available wastewater treatment capacity and well production capabilities.

As described, the development of agricultural acreage will have a significant effect on the non-point source loading within the watershed. Based on the data presented in Table 5-17, non-point source nitrogen and phosphorous pollutants could be effectively reduced by **10,177** and **1,077** lbs per year, respectively. Since the Town has implemented a specific growth strategy over the planning period, the total developed acreage included within the year 2030 estimate is based on the build-out of undeveloped residential and commercial properties, constrained by the ability to provide wastewater treatment and potable water service with existing infrastructures.

SUMMARY OF POINT AND NONPOINT SOURCE LOADS

With the information in the above narrative, an estimate of increases in nutrient loadings from both point (wastewater treatment facility) and non-point (stormwater) loads is shown in Table 5-18.

Table 5-18: Projected point-and nonpoint source pollutant loads 2009 - 2030

	Estimated load increase from point source	Estimated load from non-point sources	Estimated load from both sources
Nitrogen	9,746 lbs./yr.	40,321 (lbs/yr.)	50,067 (lbs. /yr.)
Phosphorous	731 lbs./yr.	4,252 (lbs/yr.)	4,983 (lbs. /yr.)

Review of the projected loads, though sizable, indicate that Denton's growth will represent a small proportion of total TMDL's likely to be allocated for non-point sources, and may therefore be able to be accommodated in watershed-wide context. The development strategy of the Town to restrict growth by the capabilities of existing infrastructure, coupled with the development of agricultural lands and the use of associated ESD methods and BMPs, show that the Town is looking to effectively limit pollutant loadings within the watershed. However, until such time as final TMDL's are assigned to non-point sources of pollution in the watershed, no conclusion can be drawn regarding the assimilative capacity of the watershed to indicate it is fit to support the combined additional loads resulting from wastewater and contaminated stormwater runoff attributable to future growth projected in the Town's Land Use Plan.

This evaluation also does not take into account the demands on the assimilative capacity of the watershed from orderly growth (e.g., County growth and Agricultural use) and underscores the importance to implement 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, Denton, and other municipalities' need to sustain the Agricultural industry's efforts to reduce non-point loadings in the watershed.

For Total Maximum Daily Loads (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 Denton WWTP will have compliance provisions, which provide a reasonable assurance of implementation.

Finally, Denton's Land Use and Municipal Growth Plans reflect "smart growth" strategies. They are designed to assure that the capabilities of existing infrastructures can support orderly within the municipality without requiring that substantial upgrades to said infrastructures would be necessary. Limiting growth in such a method assures that impacts to the watershed will be limited over the planning period to year 2030, while focusing on ESD and BMP compliance during development planning. This approach maximizes opportunities to minimize deterioration in the Upper Choptank River watershed.

The Town's land use plan addresses the combined point and non-point source pollution impact at the best possible scenario. The allocation of water resources to commercial/industrial use first, growth will be directed by the market with further allocation on a first come basis, except that the Town's septic systems current and any future annexations will have first priority. Future updates to the Comprehensive Plan will take a detailed look at the proposed plan and make adjustments when needed.

WATER RESOURCE STRATEGIES AND RECOMMENDATIONS

As mentioned earlier, Denton's plan to limit development on the eastside of the Choptank River due to water constraints will keep more agricultural land in production. The lands on the west side of the Choptank River that are zoned "rural" with a Planned Neighborhood overlay can only be developed if adequately served by sewer and water facilities provided by the developer. These requirements may serve as a limiting factor to the future development on the west side of the Choptank River, keeping additional acreage in agricultural use.

The single largest contributor of non-point source nitrogen and phosphorous loading in the Choptank River Basin is agricultural land use. The Town will encourage Best Management Practices (BMP)'s to be implemented, reducing nutrient loads for agricultural uses. Some of the agricultural BMP's utilized are; the installation of forest and grass buffers, implementation of soil conservation, water quality and nutrient management plans, planting of cover crops, and installation of drainage water control systems. These practices will support Caroline County's effort to reduce non-point source loads throughout the entire county. Table 5-19 is from Caroline County's Draft Comprehensive Plan and illustrates how implementation of BMP's can result in lowering nutrient loads from agricultural lands in the Choptank River Basin.

Table 5-19: Nutrient Reduction from 2008 Agricultural BMP's Implemented in Choptank River Basin

TN Reduction	TP Reduction	BMP	2008 Acres Implemented	BMP TN REDUCTION (lbs)	BMP TP REDUCTION (lbs)
3%*	5% *	Conservation Plans/ Conservation Till	55,439	31,187	6,062
8% *	15% *	Conservation Plans/ Conventional Till	5,544	10,267	2,245
24.3% **	7% **	Cover Crops Total	7,125	40,081	1,082
25% *	25% *	Forest Buffers	142	820	230
17% *	75% *	Grass Buffers	4,382	17,243	7,131
3.11 lbs/ac^	0.3 lbs/ac^	Nutrient Management	90,941	282,827	27,282
17% *	0 *	Small Grain Enhancement Total	10,267	40,406	0
25% *	50% *	Wetland Restoration	147	848	159
			TOTAL	423,680	44,193

* *Peer-Reviewed and CBP-Approved Nonpoint Source Best Management Practices for Phase 5.0 of the Chesapeake Bay Program Watershed Model, Revised 1/18/06.*
** *Chesapeake Bay Program Cover Crop TN Effectiveness for Phase 5 Watershed Model.*
^ *Chesapeake Bay Program Nutrient Sub-Committee, 2008 (Beth Horsey, MD Department of Agriculture)*
Sources: MD Department of Agriculture; Natural Resource Conservation Service; USDA Farm Service Agency
Source: Caroline County Comprehensive Plan Draft, 2009, Table 21, pg. 75

Caroline County stated that even though nutrient and phosphorus loads were reduced it was not sufficient enough to bring the County's NPS load within reach of the recommended nutrient cap.

EPA's published review of the accomplishments to date of the Chesapeake 2000 Agreement and progress on the 2010 Goals addresses the major issues impeding significant progress on Bay cleanup, one of which is the limited implementation of agricultural conservation practices. In March 2009, EPA issued a "Bay Barometer" that the agricultural community had achieved 50 percent of the 2000 Agreement goal for reducing nutrient loads from agricultural land. The 2009 Barometer also reported that wastewater plants Bay-wide had achieved 67 percent of the WWTP nitrogen reduction goal and 91 percent of the phosphorus reduction goal. EPA acknowledges that since the 2000 Agreement, "less pollution is coming from the agricultural sector but the reduction is not enough to meet the water quality goal." Of the major issues impeding progress in reducing nutrient loads to the Bay, the issue of limited implementation of agricultural BMPs is the one most relevant to the County's role in the impairment of Bay water quality. The predominance of agricultural land use in the County makes the attainment of agricultural nutrient loading goals central to the success of the County's efforts to improve basin-wide water quality. The gap between the progress anticipated as a result of agricultural BMPs, as stated in the Tributary Strategy goals for the Choptank and LES basins, and the actual performance of those BMPs has not fully been explained. The fact that achievements have been lower than expected has been attributed to actual BMP efficiencies being lower than those projected by the Chesapeake Bay Watershed Model, as well as farmers not fully or incorrectly implementing BMPs. The lack of consistent and sustained funding sources to underwrite the cost of implementing BMPs is also cited as an impediment to progress. The field-tested effectiveness of grass and forest buffers, cover crops and nutrient management plans continues to be significant enough to merit their inclusion in MDA and USDA cost-share programs. Caroline County supports effort to increase funding and implementation of these BMPs in the future. The County recommends the implementation of these BMPs and additional strategies to achieve reductions in agricultural land nutrient loads, including:

- Nutrient Management Plans
- Soil Conservation and Water Quality Plans (SCWQP)
- Traditional Cover Crops
- Riparian Forest and Grass buffers
- Ditch Erosion and Drainage Control Systems
- Retire Highly Erodible and Potentially Highly Erodible Agricultural Land
  Quoted in Caroline County Comprehensive Plan Draft, 2009, pg 76

Denton's goal is to assist in applying these techniques to the agricultural lands within the Town boundaries as a mechanism to reduce nutrient loads in the Town, County, and Choptank River Basin.

The Town will also initiate procedures that more intently support the practical management of stormwater flows to advance water quality. Such procedures would include:

- Use of "Environmental Site Design (ESD) Principles to manage Stormwater in new development. The Maryland Stormwater Management Act of 2007 is based upon Environmental Site Design (ESD) Principles, which attempt to imitate natural hydrology on developed properties. 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 Stormwater Management Ordinance provides an exacting framework of both structural and nonstructural methods that shall be used, either alone or in a combination, to create a site design that promotes water quality perpetuation. Planning techniques and practices associated with specific site planning include, but are not limited to:

- Promoting bio-retention and infiltration techniques as a means of treating stormwater runoff. Design methods, such as a rain gardens, infiltration berms and bio-filtration swales provide for the extended detention of stormwater runoff so as to enhance the quality of local tributaries by using the soil and vegetative networks to remove pollutants from stormwater runoff.

- Minimizing impervious surface coverage on all new development.

- Reducing the impervious area within the limit of disturbance (LOD) by at least 50 percent on all redevelopment projects.

- Encourage water quality improvements for redevelopment through techniques such as rainwater harvesting and the use of native planting plans.

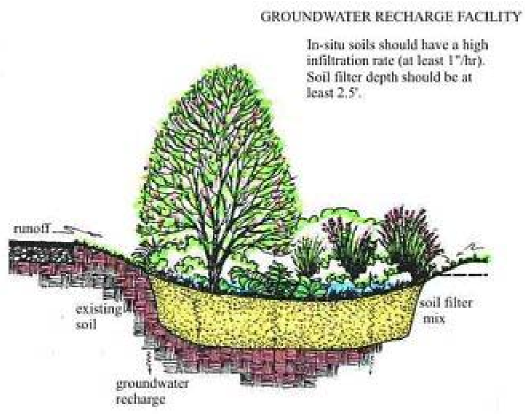
- Using green roofs, permeable pavements, reinforced turf and other alternative surfaces.

Rain gardens and bio-filtration areas are vegetated surface depressions, often located at low points in landscapes, which are designed to receive stormwater runoff from impervious surfaces. The highly permeable soil structure within the features allows stormwater to infiltrate rapidly into the native soil substructure and eventually contribute to groundwater recharge. Pollutants associated with the accepted runoff are detained by vegetation within the feature and soils through biological and physical processes such as plant uptake and sorption to soil particles. When compared to the method that a traditional storm drain system utilizes to release captured runoff into a water body, bio-filtration practices reduce peak flows and stressor loadings.

- Utilize Environmental Site Design (ESD) treatment practices to facilitate a concentration on natural stormwater runoff quality treatment, prior to the design of structural Best Management Practices (BMP’s). These include:

    - Bio-retention Facilities. Landscaped depressions that are filled with a special soil media and are designed to infiltrate and clean stormwater runoff. When incorporated into an urban environment, they can provide substantial filtering and nutrient removal before runoff is discharged into a conveyance system. These include rain gardens as previously discussed. (Figure 5-6)

Figure 5-6: Bioretention Area

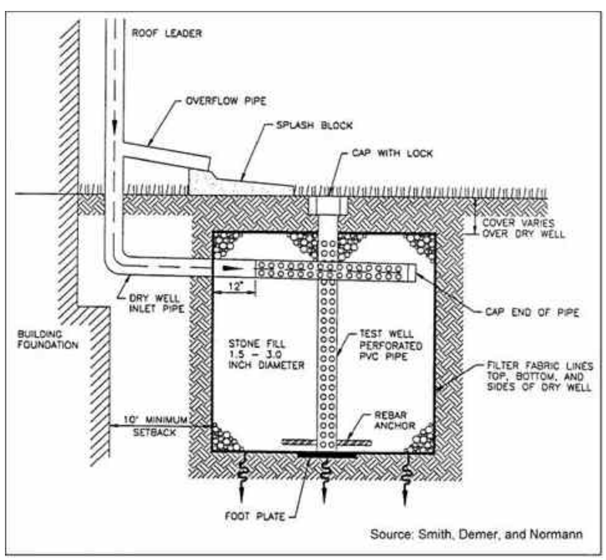


Source: Prince Georges County DER

- Infiltration Trenches: Trenches filled with porous media such as bio-retention material, sand, or aggregate which collect runoff and allow for percolation into the soil substructure. When located in grassed swales, infiltration trenches provide additional wetted surface area and storage volume and often they can be designed to penetrate shallow impermeable soil profiles to recharge deeper horizons.

- Dry Wells: Man-made, aggregate-filled pits, located adjacent to residential or commercial structures which are designed to collect runoff from downspouts or impervious surfaces (Figure 5-7)

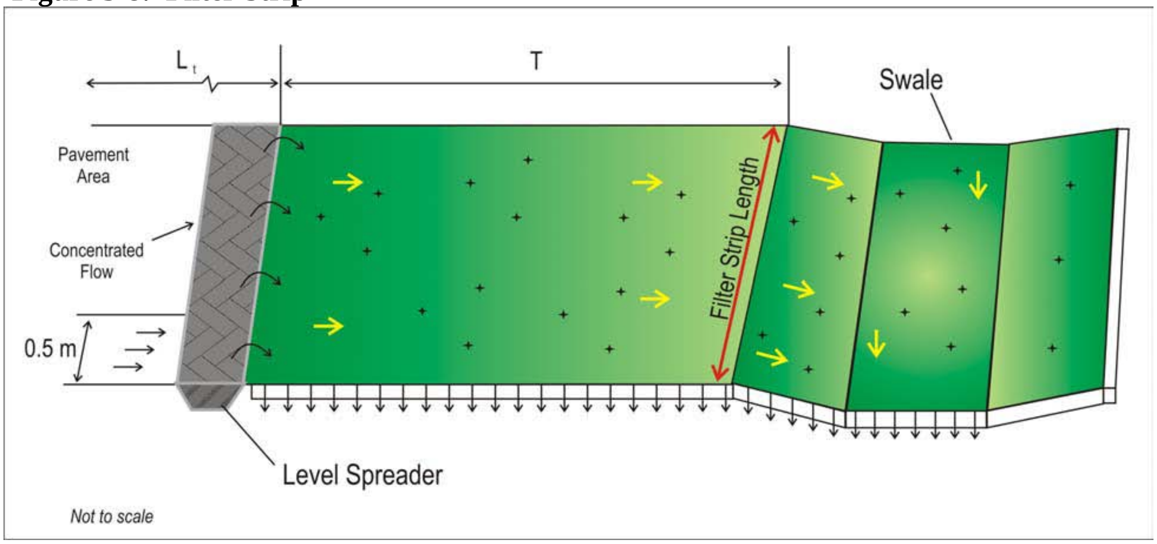
Figure 5-7: Dry Well Schematic



Source: Stormwater Management for Maine, 1995.

- Filter Strips: Vegetated areas located immediately downstream of a runoff source designed to spread runoff uniformly over the filtering surface, providing infiltration and pollutant removal before runoff enters a natural conveyance or structural BMP (Figure 5-8).

Figure 5-8: Filter Strip

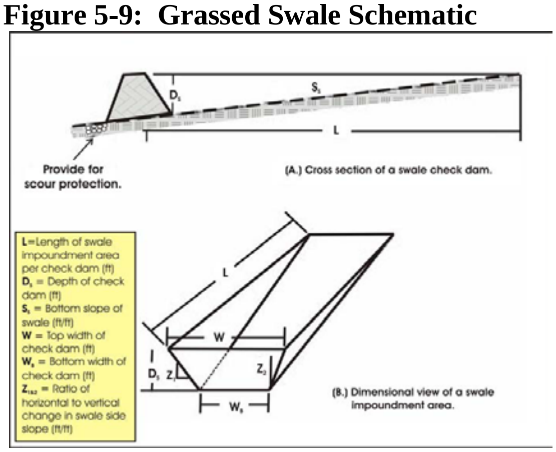


Source: Low Impact Design Manual, US Army Corps of Engineers, 2004

- Inlet Pollution Removal Devices: Small management systems that are fitted to storm drain inlets that entrap or filter pollutants contained in runoff before they enter into a conveyance system.

- Bio-filtration Swales: Vegetated conveyances that transmit runoff at shallow flow depths through wide, flat-bottomed swales. Very effective at removing suspended solids and absorbed metals (Figure 5-9)

Figure 5-9: Grassed Swale Schematic



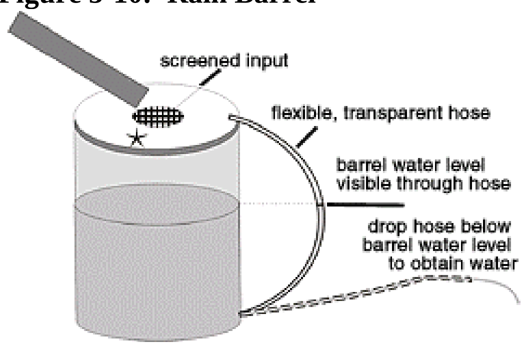
Source: NVPDC, 1991. In EPA, 1999d.

- Permeable Pavement: Alternative paving surfaces rendered porous by their aggregate structure.

- Permeable Pavers: Manufactured paving stones containing voids where stormwater runoff can infiltrate into the permeable, underlying media.

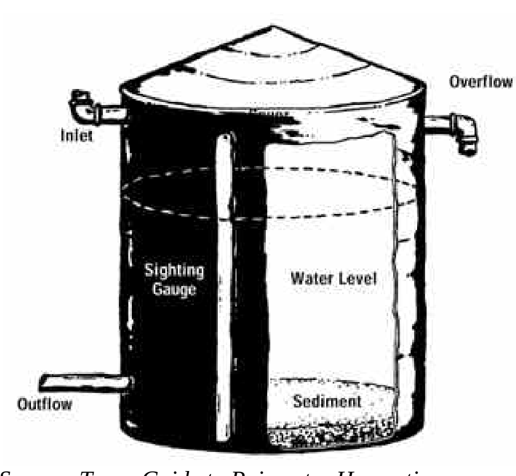
- Rainwater Harvesting Devices: Structures of various sizes that capture the stormwater runoff conveyed through building downspouts. Rain barrels (Figure 5-10) are generally smaller structures that sit on finished grade while cisterns (Figure 5-11) are larger, are often below grade, and may possibly be connected to a building's plumbing or irrigation system. Rain barrels and cisterns are both low-expenditure conservation strategies that reduce runoff volume and, during smaller storm events, postpone and diminish peak runoff flow rates. Rain barrels and cisterns can afford a source of untreated 'soft water' for landscaping and compost, free of most sediments and salts that could be present in runoff from either impervious or pervious ground cover.

Figure 5-10: Rain Barrel



Source: Maryland DNR Green Building Program.

Figure 5-11: Cistern

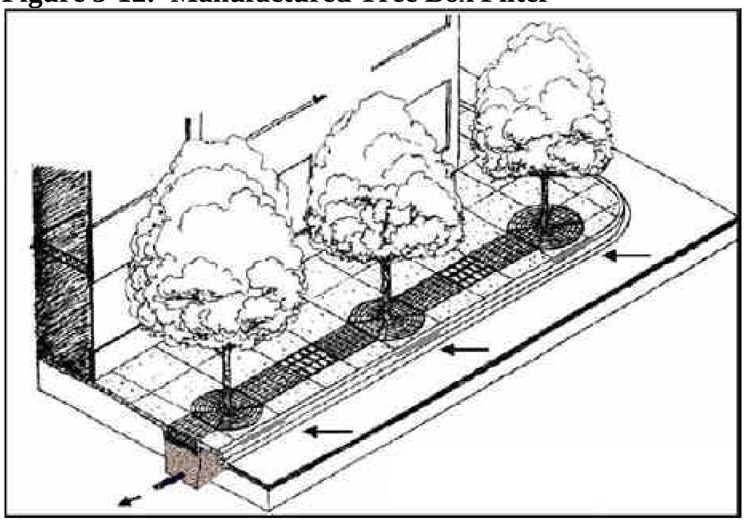


Source: Texas Guide to Rainwater Harvesting.

- Soil amendments: Minerals and organic material supplementary to native soils to augment their capability for absorbing moisture and supporting vegetation.

- Landscape Infiltration: Methods of conservation site design that focus on reducing the extent of impervious surfaces and increasing the extent of natural areas made available for the quality treatment of stormwater runoff. Tree box filters (Figure 5-12), for example, are curbside containers placed below grade, covered with a structural inlet. These areas are traditionally filled with highly permeable soil media and landscaped with trees or other native vegetation.

Figure 5-12: Manufactured Tree Box Filter



Source: Virginia DCR Stormwater Management Program.

Vegetated Buffers: Natural or man-made vegetated areas adjacent to a waterway providing erosion control, filtering of sediment and nutrients contained in runoff, and habitat for fauna.