CHAPTER 7 - WATER RESOURCES ELEMENT

Introduction

The Water Resources Element (WRE) is a fundamental planning requirement mandated by Maryland House Bill 1141 (HB 1141). The WRE aims to assess water resource capacity to meet current and future needs. Specifically, the statutory requirements are to:

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

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

The Water Resources goals for Denton are:

- Maintain a safe and adequate water supply and adequate capacities for wastewater treatment to serve projected growth.
- Protect and restore water quality.
- Reduce nutrient loads that contribute to loading in the Choptank River Watershed.
- Protect the habitat value of the Choptank River and tributary streams.

Objectives to support these goals are:

- Meet water quality regulatory requirements in the Upper Choptank River Watershed.
- Assure that existing and planned public water systems meet projected demand.
- Assure existing and planned public wastewater collection and treatment systems meet projected demand without exceeding the permitted discharge parameters.
- Assure that the Town's stormwater management policies reflect the most current state requirements.
- Promote land use development patterns that limit adverse impacts on water quality.
- Conserve open spaces and preserve forested lands to help decrease nutrient runoff.

Federal, State, regional, and local government agencies, institutions, private companies, and concerned citizen volunteer organizations are focused on identifying and addressing the sources of impairment to improve water quality in the Chesapeake Bay and its tributaries. Denton has a role to play in these efforts. The WRE provides a broad overview of the water resource and related capacity issues, current programs to address these issues, assesses the water resource impacts of Denton's growth, and recommends strategies.

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. "Water resources" refers to the ground and surface water supply.

Groundwater Resources

Several aspects of drinking water are considered: groundwater supply, allowable withdrawals, and the capacity to store, treat, and distribute water to end users. Groundwater supplies are the primary resource, while the Town's water systems are the delivery components necessary to serve current and future uses.

The Delmarva Peninsula relies primarily on groundwater for its freshwater supplies. It is the sole source of drinking water and supplies industrial and agricultural processes. Groundwater is an abundant, renewable natural resource in Maryland. Although groundwater can be depleted by harvesting more than the replacement rate, natural processes will replace the groundwater with sufficient time and the right conditions. These processes take thousands of years, so the key to maintaining this life-sustaining necessity's availability is keeping the use rate below the natural replacement rate.

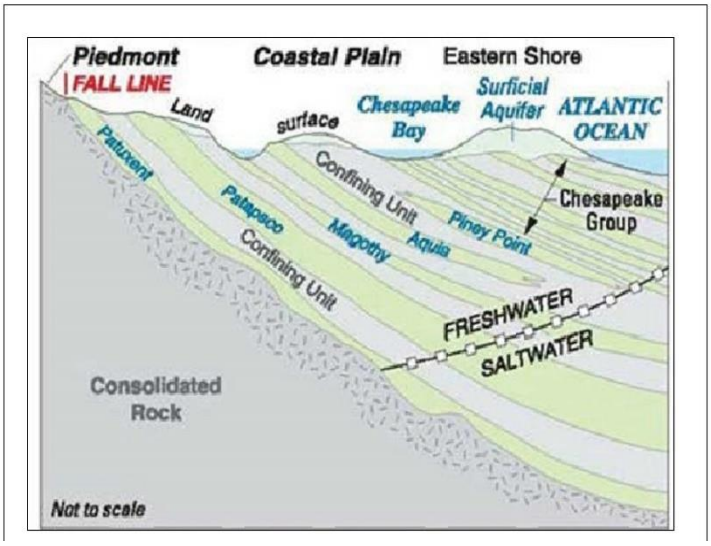
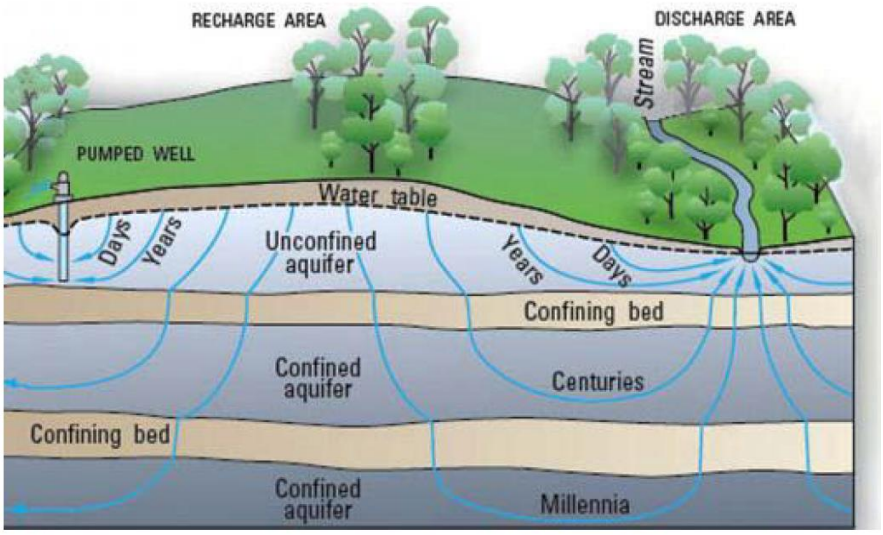


Figure 7-1

Caroline County lies within the Northern Atlantic Coastal Plain (NACP) aquifer system (Figure 7-1). The NACP system extends from the North/South Carolina border to Long Island, New York. In Maryland, the NACP is bounded west by the Fall Line and east by the Atlantic Ocean.

The Coastal Plain system consists of sand and gravel aquifers interspersed with layers of silt and clay called confining beds. Beneath this system lies a layer of consolidated rock at depths ranging from zero at the Fall Line (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 it infiltrates into the soil. The area over which water infiltrates an aquifer is called the "recharge zone." The recharge zone above unconfined aquifers is generally above the aquifer because water can move directly from the surface into the aquifer. However, the recharge zone may be limited to the range where the impermeable layer reaches the surface of a confined

aquifer. 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 7-2 illustrates the difference between unconfined and confined aquifers.



Source: Google Images, artmax_388.jpg

Figure 7-2 Confined Aquifer

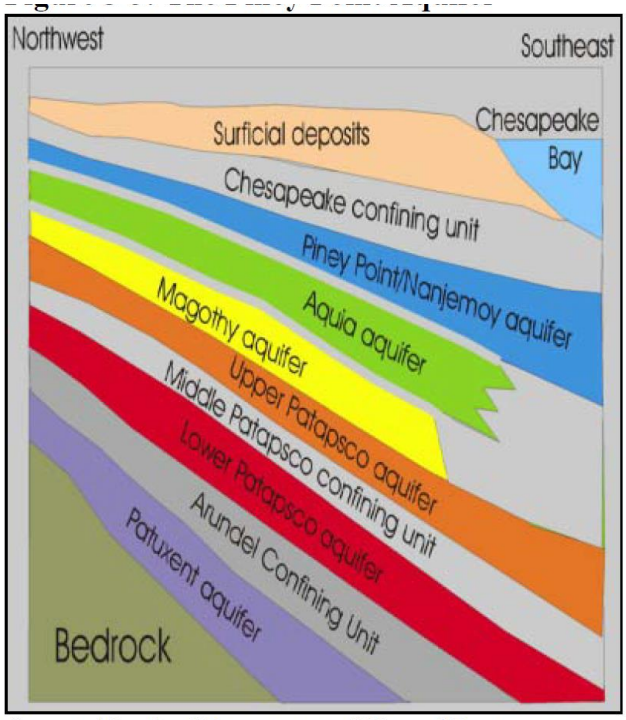
The major aquifers in the Coastal Plain system in Maryland are the Patuxent, Patapsco, Columbia (a surficial aquifer), Magothy, Aquia, Piney Point, and the Chesapeake Group. Except for the Columbia Aquifer, the Coastal Plain aquifers generally are confined.

Withdrawals from Maryland Coastal Plain aquifers have caused groundwater 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 two feet per year. The declines are substantial in southern Maryland and parts of the Eastern Shore. Continued water-level declines at current rates could affect the long-term sustainability of groundwater 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. First, contamination by saltwater intrusion is a significant water quality issue for 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 little data is available. Second, 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. Finally, elevated nutrients and agricultural chemicals in the surficial aquifer are a significant concern, especially on the Eastern Shore, where shallow groundwater is the water supply source for many homeowners and provides much of the base flow to streams.

Groundwater sources in Caroline County include the Piney Point, Columbia, Aquia Aquifers, and the Chesapeake Group, including 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 of about 40 miles wide between Caroline and St. Mary's Counties and is a significant water source for Caroline County. The Aquia is a significant water source for parts of the Eastern Shore (including northern Caroline County), southern Maryland, and Anne Arundel County. 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 county's eastern half is flat with poorly drained land, and the water table is generally within ten feet of the surface.



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

Figure 7-3

Potential sources of contamination in confined aquifers include leaking storage tanks, landfills, sewer treatment discharges, and large-scale animal feeding operations. However, wells drawn from confined aquifers can only be contaminated by directly injecting a pollutant into the aquifer from poorly constructed or abandoned wells and underground injection wells.

The Piney Point aquifer supplies Denton's water system (Figure 7-3). The Piney Point aquifer is one of the principal aquifers underlying the Delmarva Peninsula. This 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 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.

The Maryland Department of the Environment reported that water resource indicators for Maryland suggest abundant water to meet present and future needs.[9] At the same time, there are some localized problems, including naturally occurring arsenic above the federal drinking water standard in the Piney Point aquifer in southern Maryland and the central Eastern Shore. Denton's Annual Drinking Quality Report for 2020 states that drinking water meets all Federal and State requirements.

[9] Groundwater Protection Program Annual Report to the Maryland General Assembly, Maryland Department of the Environment, Water Supply Program, July 2013, pg. 7. https://mde.maryland.gov/programs/Water/Water_Supply/Source_Water_Assessment_Program/Documents/SJR25-JR5_1985%282013%29.pdf

Water Systems

Denton's water source is three potable wells in the Piney Point Aquifer. Two are active wells. Well #3, drilled in 1970, is off Kerr Avenue and MD Rt. 404 has a pumping capacity of 500 gallons per minute (gpm). Well #5, drilled in 2000, is located south of Engerman Avenue and West of Park Lane and has a pumping capacity of 600 gpm. Well #6, located on Old Camp Road, has a pumping capacity of 500 gallons per minute (gpm) (see Figure 7-3). Well #1, located off Fifth and Gay Streets, has been abandoned because of silting problems, and Well #4, a test well collocated with Well #5, is capped.

In 2017, 2018, and 2019 (3-year average), the average daily demand for Denton's water system was 317,250 gallons per day (gpd), about 51% of the system's permitted daily capacity. 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 daily. Under the current maximum daily demand of 1,000,000 gallons per day and a pumping capacity of 500 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.

Water Storage Capacity

Denton has three water storage tanks. One tank has a storage capacity of 100,000 gallons, and two tanks have 300,000 gallons each (see Map 7-1).

Water Distribution System

The water distribution system has 2 to 12 inches of main lines, two operational artesian wells, and three elevated storage towers. Presently, the Town produces its water from two active artesian wells. For pathogenic disinfection, the water is treated with Sodium Hypochlorite. However, the natural water quality warrants no other treatment methods. The water passes through the water meter at the main well and is distributed between the Town's three storage tanks. The water is then distributed via gravity flows through an estimated 20-mile pipe system.

Wastewater System

Denton's Wastewater Treatment Plant (WWTP) is designed for an average daily flow of 800,000 gallons and a peak daily flow of 2.67 million gallons. The plant operates at a three-year rolling average of 455,034 gallons daily, 57% of the design capacity. In addition, the WWTP is an enhanced nutrient removal (ENR) compliant facility. With ENR technologies, the WWTP can achieve annual average nutrient goals of wastewater effluent quality of Total Nitrogen (TN) at three mg/l and Total Phosphorus (TP) at 0.3 mg/l. In addition, the Town's National Pollutant Discharge Elimination System (NPDES) permit for the facility stipulates that the quality of the total nitrogen and phosphorus discharged by the facility is limited to 9,746 lbs/yr for nitrogen and 731 lbs/yr for phosphorus.

Denton completed a Preliminary Engineering Report (PER) that evaluated sludge process upgrades for the Town's wastewater treatment plant in March 2023. The evaluation focused on selecting a preferred alternative for sludge processing and dewatering because the current sludge management system has nearly reached capacity, leaving no room for delay.

Currently, the WWTP utilizes reed beds for sludge dewatering. Historically, these reed beds have operated well and have been the sole form of sludge treatment. However, the reed beds have become challenging to maintain over the last ten years and have limited sludge processing capacity. All sludge removed from the reed drying beds is hauled to a landfill for disposal. Because the debris removed is blended with phragmites plants, considered invasive species, it cannot be land-applied, and only landfill disposal is allowable.

Sludge upgrade alternatives were evaluated, including providing a new mechanical dewatering system or additional reed beds, as the current reed beds operate at design capacity. However, the facility is operating at approximately half the design flow.

Four mechanical dewatering equipment types were considered: a belt filter press (BFP), screw press, volute press, and rotary press. The equipment manufacturers performed bench-scale tests to estimate potential cake total solids and polymer consumption requirements.

The mechanical systems would be paired with a covered cake storage area to store dewatered cake before hauling. The mechanical dewatering systems were evaluated in comparison to doubling the size of the reed bed system. No upgrades for stabilization or drying were considered, and continued disposal at the landfill was assumed. Construction cost and project cost estimates were developed. Operating and maintenance costs were also estimated and used to develop net present value estimates of the alternatives.

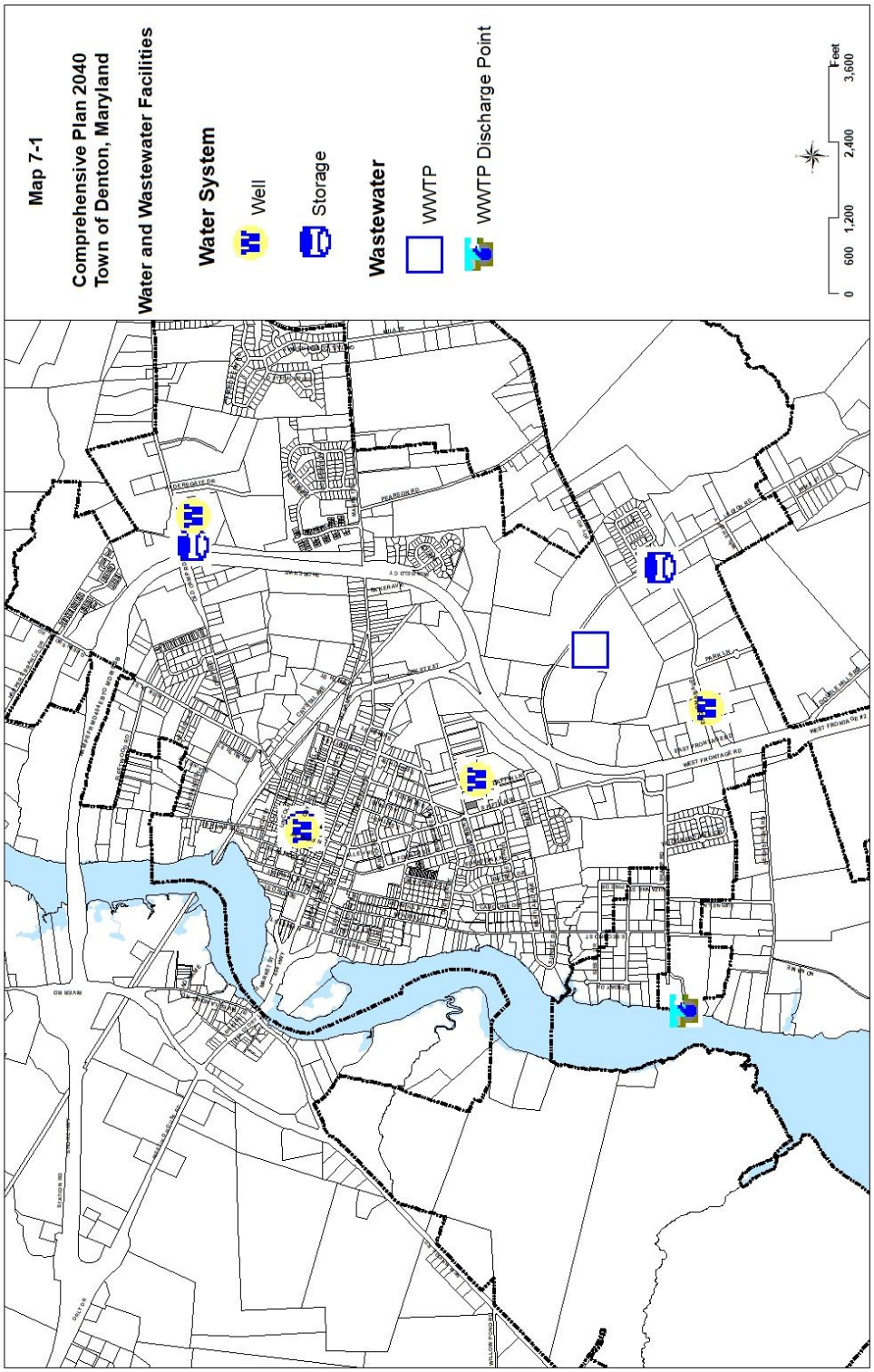
The consultant that prepared the PER recommended the Town consider the volute press and the rotary press alternatives for piloting. They pointed out that both technologies are fully enclosed and require little operator attention when running. Based on implementing mechanical dewatering, the following components would be included in the Denton WWTP sludge processing upgrades project:

- New sludge feed pumps
- New dewatering building housing dewatering equipment, polymer system, electrical room, and sludge cake conveyor
- New yard piping for conveyance of sludge, filtrate, and utility water
- New utility water system
- New covered cake storage pad
- Rehabilitation of the existing reed beds
- Rehabilitation of Biolac No. 1
- All associated site improvements, including stormwater management structures
- All associated electrical and I&C upgrades

While user rates and connection fees may need to be increased to fund these improvements, the Town will seek assistance through loan and grant funding provided through the State Revolving Loan fund administered by the Maryland Department of the Environment (MDE) or through funding by United States Department of Agriculture (USDA) Rural Utilities Services (RUS) funds.

Figure 7-3 Wells

Map 7-1 Water and Wastewater Facilities



Water and Sewer Service Plan

Maps of planned water and sewer service areas are contained in the Caroline County Master Water and Sewer Plan. Service areas are delineated as water and sewer services categories (see Table 7-1). Denton's Water and Sewer Service Plan, Map 7-2, illustrates the existing and projected service areas. Therefore, the service areas shown on Map 7-2 should be reflected in the Caroline County Master Water and Sewer Plan.

Table 7-1: Service Area Categories Water and Sewer Plan Delineation

Classification	Description
W-1 and S-1	Existing or under-construction
W-2 and S-2	Areas to be served by extensions of the existing community and multi-use water supply and sewerage systems that are in the final planning stages
W-3 and S-3	Areas where improvements to, or construction of, new community and multi-use water supply and sewerage systems will be given immediate priority
W-4 and S-4	Areas where improvements to, or construction of, new community and multi-use water supply and sewerage systems will be programmed for the 3 to 5/6-year period
W-5 and S-5	Areas where improvements to, or construction of, new community and multi-use water supply and sewerage systems are programmed for inclusion within the 6/7 through 10 years
W-6 and S-6	No planned service

Projected Water and Sewer Demand

The Municipal Growth Element demonstrated Denton has sufficient land available to accommodate substantial growth in the future. The water and wastewater systems have functional and permitted capacities (Table 7-2) to support projected growth in the planning period (2040). The water system capacity is 620,000 gallons per day (gpd). The wastewater treatment plant capacity is 800,000 gpd. The averages from 2017 through 2019 were 317,250 gpd and 455,034 gpd, respectively, for the water and sewer systems.

In projecting demand for water and sewer services, each dwelling unit (household) equals 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 Denton; one EDU is estimated to consume 225 gpd of drinking water and contribute 225 gpd to wastewater flow.

There is adequate existing reserve water and sewer capacity to serve projected residential and nonresidential growth in the planning period under either of the growth scenarios evaluated in the Municipal Growth Element. In addition, there is adequate water and sewer capacity to serve the buildout in the Municipal PFA, depending on variables such as growth rates, the average density of residential development, and how much capacity is used to serve nonresidential uses. However, there is insufficient sewer and water capacity to serve all development outside the Municipal PFA, including properties on the west side of the Choptank River.

Map 7-2 Water and Sewer Service Plan

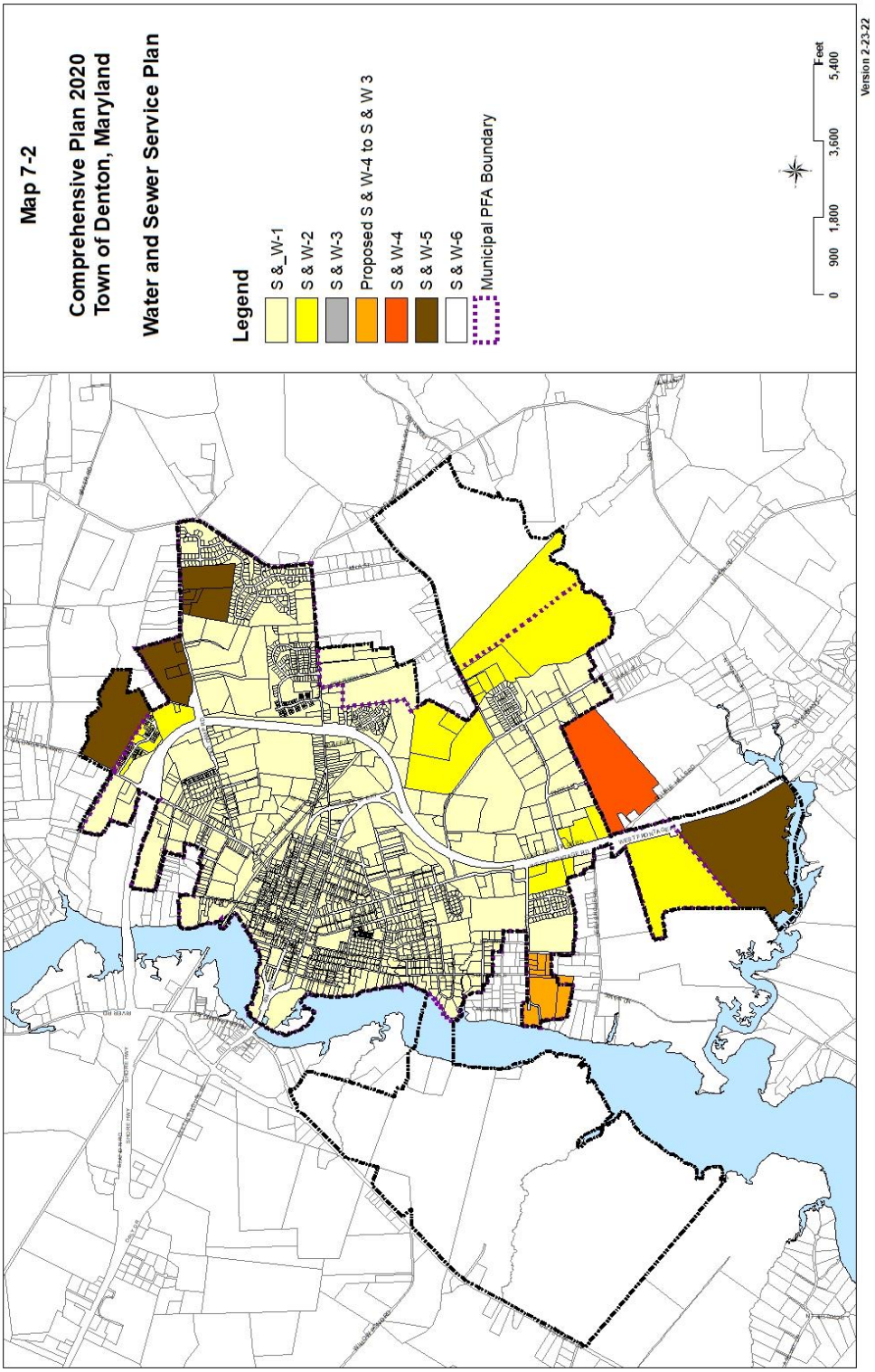


Table 7-2: Sewer and Water Demand					
		Projected 2040		Build Out within PFA	
Reserve Capacity		Scenario 1	Scenario 2	Scenario 1	Scenario 2
Water	302,750	75,484	101,925	272,925	329,400
Sewer	344,966	75,484	101,925	272,925	329,400

Should the West Denton village be annexed, sewer and water demand may increase an additional 10,000 gallons daily.

Water Quality Issues

The Upper Choptank Watershed

Hydrologic units (HU) define drainage areas within a multi-level, hierarchical drainage system. Its boundaries are defined by hydrographic and topographic criteria that delineate an area of land upstream from a specific point on a river, stream, or similar surface water. The United States is divided into successively smaller hydrologic units classified into four levels: regions, subregions, accounting units, and cataloging units. This WRE focuses on the Maryland portion of the Upper Choptank Watershed (8-digit HU) and sub-watersheds (12-digit HU) into which urban runoff and discharge from the WWTP from Denton enter receiving waters.

The Chesapeake Bay Program, a partnership among federal and state agencies, local governments, non-profit organizations, and academic institutions, uses HUs in water quality modeling. In the model, the maximum allowable loading of point and nonpoint source pollutants such as nitrogen, phosphorus, or sediment may be assigned at the subbasin lever (eight-digit HU). In addition, HUs may define geographic areas to which specific regulations or policies apply.

The Upper Choptank watershed is part of the 6-digit Choptank River basin, including the Lower Choptank, Little Choptank, Tuckahoe Creek, and Honga River watersheds (see Figure 7-4). The Upper Choptank extends through three Maryland counties and into Delaware. Most of the Maryland 8-digit watershed is located in Talbot and Caroline Counties, with only 3 square miles within Queen Anne's County. Approximately 61,369

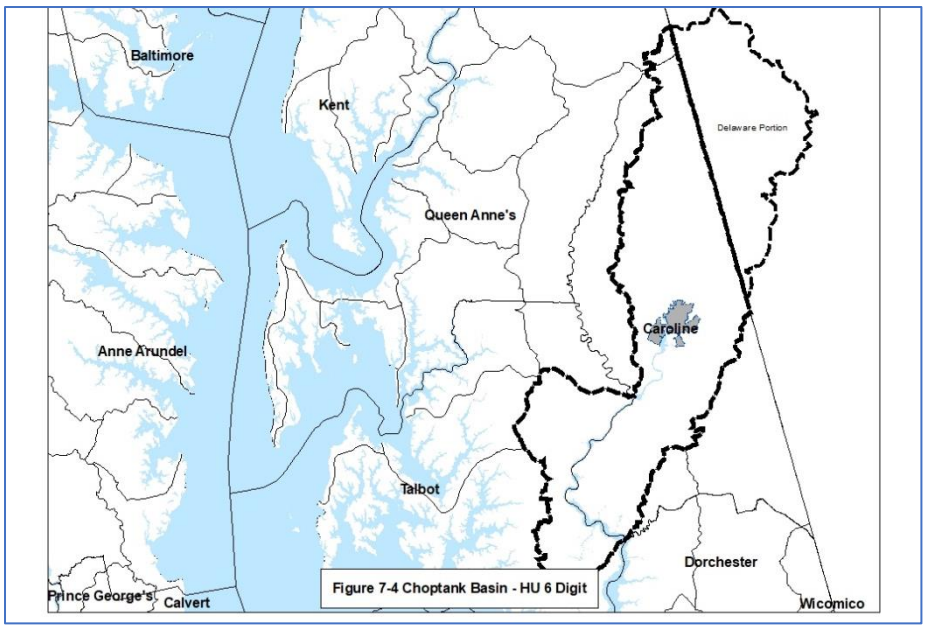


Figure 7-4 Choptank Basin - HU 6 Digit

acres, or twenty-seven percent of the Upper Choptank River watershed, are in Delaware (see Map 7-3). The Upper Choptank River is tidal throughout its navigable reach, extending from its boundary with the Lower Choptank River watershed for approximately 35 miles upstream to an area north of the Town of Greensboro. The total drainage area of the Maryland 8-digit watershed is approximately 159,000 acres, not including water/wetlands.

Larger water bodies in the Choptank River Basin include the Choptank, Little Choptank, Tred Avon Rivers, Broad, Harris, and Tuckahoe Creeks. The basin supports over 80 fish species in its freshwater streams and brackish waters, including striped bass, largemouth bass, and flounder. In addition, the lower portion of the watershed is a concentration area for waterfowl.

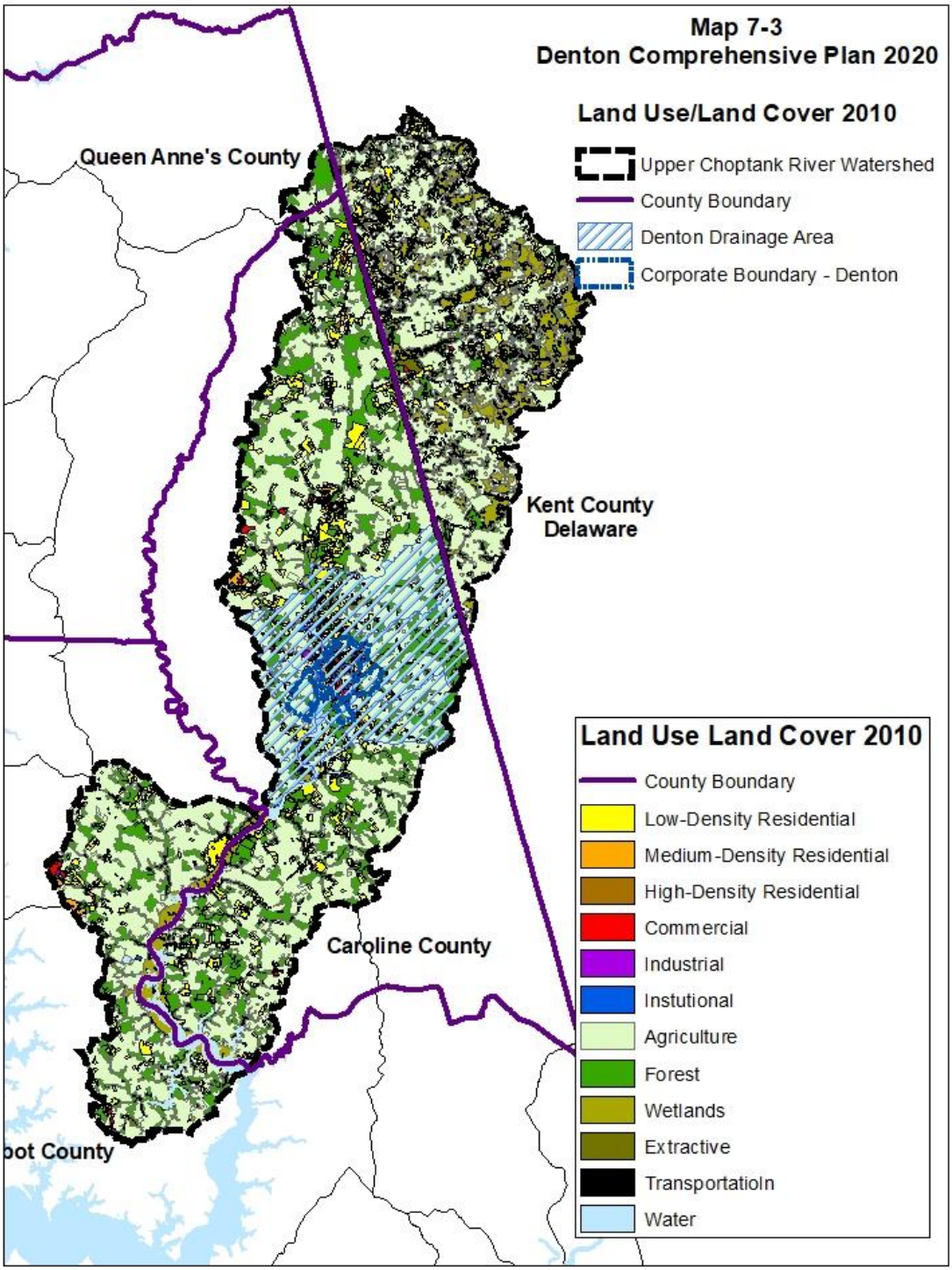
Table 7-3 summarizes the various land uses and cover types in the watershed, based on 2010 data for Maryland and 2007 data for Delaware. Agriculture remains the dominant land use in the Upper Choptank River watershed. As can be seen, over half of the watershed was in agricultural use in 2007 and 2010.

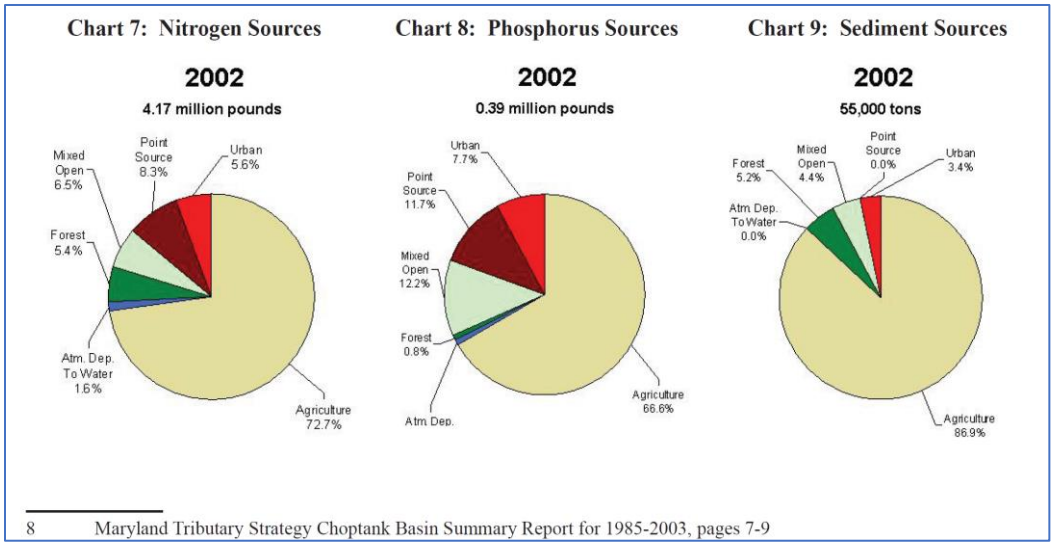
Table 7-3: Upper Choptank Watershed Land Use Land Cover (LULC) 2010

Land use, Land Cover	Maryland 2010	Delaware 2007	Combined	Percent of Total
Low-Density Residential	17,766	5,512	23,278	10.34%
Medium-Density Residential	1,322	39	1,361	0.60%
High-Density Residential	181	0	181	0.08%
Commercial	837	76	913	0.41%
Industrial	293	11	303	0.13%
Institutional	492	20	512	0.23%
Agriculture	90,741	30,714	121,455	53.97%
Forest	42,361	7,739	50,100	22.26%
Wetlands	4,887	16,517	21,403	9.51%
Open Water	4,448	230	4,677	2.08%
Transportation	132	13	146	0.06%
Extractive	242	455	697	0.31%
Total	163,702	61,325	225,027	100.00%

Agriculture's nonpoint source loading was disproportionate to its portion of the watershed. For example, the Maryland Tributary Strategy Choptank Basin Summary Report for 1985-2003 data reported agriculture was responsible for 72 percent of nitrogen, 66 percent of phosphorus, and 86 percent of sediment nonpoint source loading in the Maryland portion of the Upper Choptank River watershed (see Figure 7-5).

Map 7-3 Land Use Land Cover 2010





8 Maryland Tributary Strategy Choptank Basin Summary Report for 1985-2003, pages 7-9

Figure 7-5

Federal Clean Water Act (CWA)

The Clean Water Act (CWA) is the primary federal law in the United States governing water pollution. The Federal Water Pollution Control Act passed in 1972, aims to restore and maintain the nation's waters' chemical, physical, and biological integrity by preventing point and nonpoint pollution sources. The US Environmental Protection Agency (EPA) delegated authority for implementing the Federal Clean Water Act (33 USC §§ 1251-1387) to Maryland, requiring the State to implement a systematic technical and administrative framework for managing water quality. Delegated responsibilities include setting water quality standards, assessing water quality, identifying waters that do not meet standards, establishing limits on impairing substances, and issuing permits to ensure consistency with those pollutant limits.

Maryland must submit a list of impaired waterbodies and proposed management measures for EPA approval every two years. In addition, the State must conduct scientific studies for waters that do not meet water quality standards due to an excessive pollutant load and determine the maximum amount of the pollutant that can be introduced to a water body and still meet standards. That maximum amount of pollutant is called a Total Maximum Daily Load (TMDL), and the studies are called "TMDL Analyses," or simply TMDLs. TMDLs are a regulatory mechanism to identify and implement additional controls on point and nonpoint sources that discharge into water bodies that are impaired from one or more pollutants and are not expected to be restored through normal source controls.

In compliance with Sections 303(d), 305(b), and 314 of the Clean Water Act, the Maryland Department of the Environment (MDE) published its Final 2018 Integrated Report of Surface Water Quality (IR), which EPA approved on April 9, 2019. Maryland's Integrated Report (IR) combines water quality reports required under Sections 305(b), 314, and 303(d) of the federal Clean Water Act. Section 305(b) requires states to perform annual water quality assessments to determine the status of jurisdictional waters. Section 314 requires states to classify lakes according to eutrophic conditions and identify lakes that do not meet water quality standards. Section 303(d)

requires states to identify waters assessed as not meeting water quality standards. Waters that do not meet standards may require a TMDL to determine the maximum amount of an impairing substance or pollutant that a particular water body can assimilate and still meet water quality criteria.

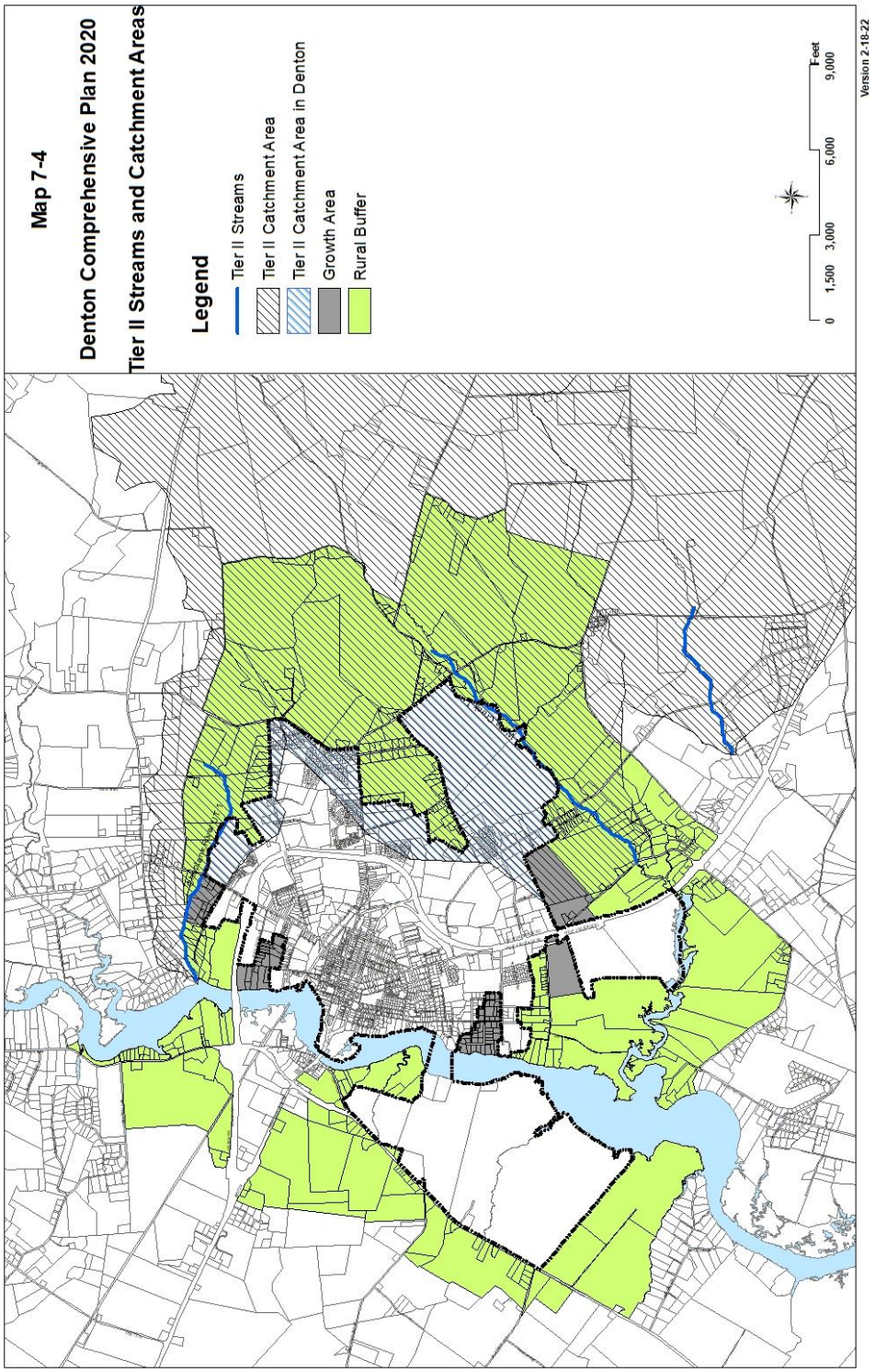
Water quality issues in the 2018 IR are reported in several categories. Category 2 waterbodies meet the standards for which they have been assessed. Category 3 includes water bodies with insufficient data or information to determine whether any water quality standard is being attained. Category 4 includes three subsets. Category 4a is waterbodies still impaired but have a TMDL that establishes pollutant loading limits. Category 4b is water bodies impaired, but a technological remedy should correct the impairment. Category 4c includes waterbodies impaired but not from a conventional pollutant. Finally, Category 5 is water bodies historically on the 303(d) list and includes water bodies that may require a TMDL.

The Upper Choptank River is included in most of these categories. In Category 2, the IR report states the Upper Choptank River meets PCBs and fecal coliform standards. In Category 3, there is insufficient data to determine compliance with Benthic standards (related to animals and plants living on or at the bottom of the river). Category 4a includes TMDLs applicable to the Upper Choptank River for nitrogen and phosphorus. These TMDLs are designed to bring the water body into compliance. The Upper Choptank River is not listed in Category 4b. In Category 4c, the Upper Choptank River is cited for habitat alteration in 1st through 4th-order streams due to channelization associated with agriculture. Category 5, historically listed impaired waters, includes the Upper Choptank River for excess sediment.

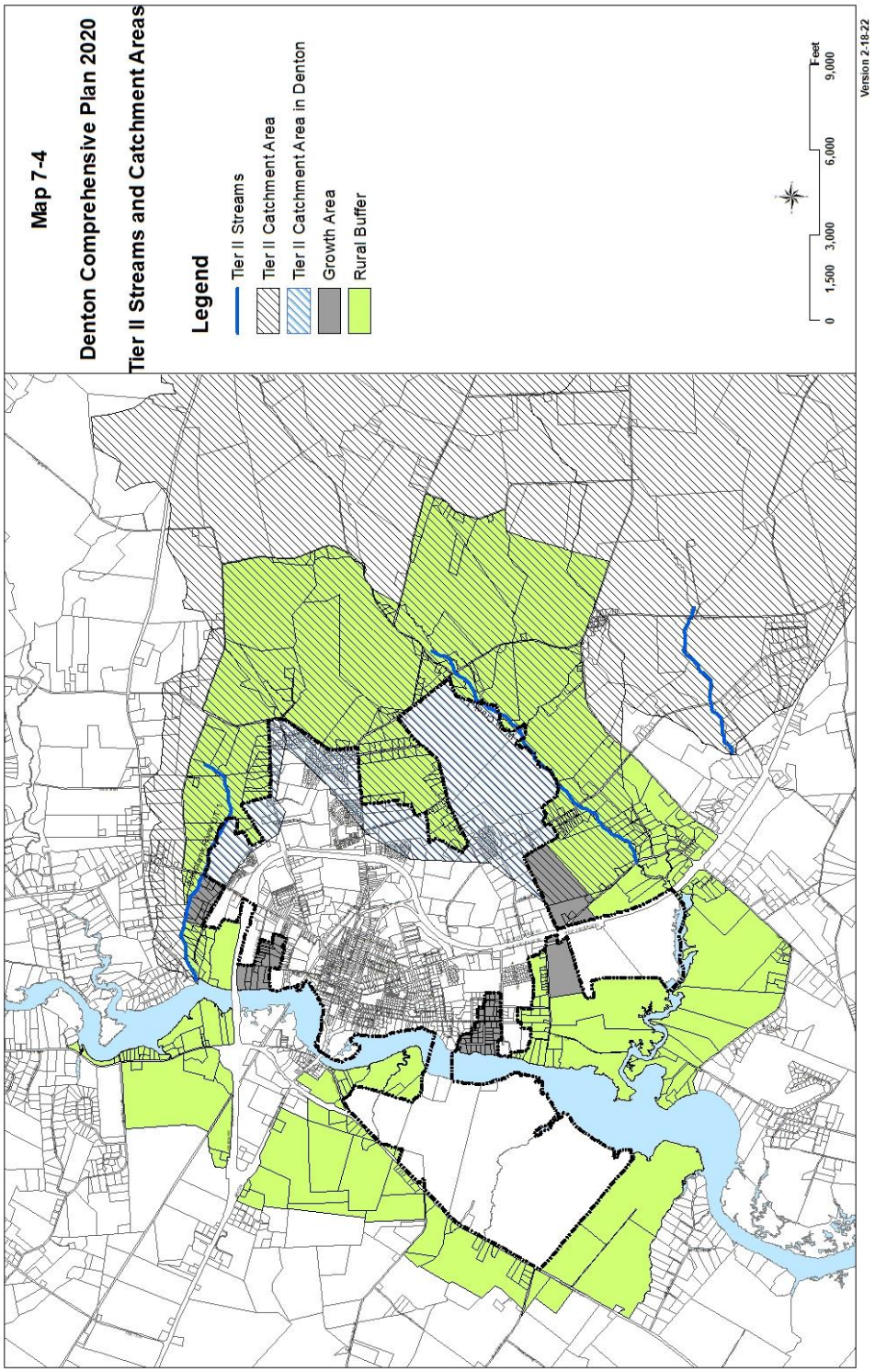
With approval from the EPA, the Maryland Department of the Environment (MDE) established total maximum daily loads (TMDLs) in the Upper Choptank River for total suspended solids in 2019 and total nitrogen and phosphorus in 2010. A TMDL analysis calculates the maximum amount of point sources and nonpoint source pollutants a waterbody can receive and meets water quality standards. An allocation system establishes limits or "caps" on pollutant loads permitted from sources. TMDLs are expressed as allowable loads of a specified pollutant by point and nonpoint sources. Point sources include wastewater treatment plants with direct discharge permits into waterways (National Pollutant Discharge Elimination System Permits-NPDES) and urban storm sewer systems. For example, TMDLs for the Upper Choptank River limit total nitrogen loading from the Denton WWTP to 9,746 and 731 pounds per year of total phosphorus. Nonpoint sources include discharges other than point source discharges, including stormwater runoff from land and erosion of streams and riverbanks.

The Federal Clean Water Act requires the State of Maryland to identify water bodies that are high in quality (Tier II water bodies). Two Tier II designated water bodies are proximate to Denton's corporate boundary and include catchment areas within the Town, proposed growth areas, and the Rural Buffer (See Map 7-4). Potential developments in the catchment areas of these streams must address potential impacts on water quality. If a discharge permit is required, the discharge permit process requirement will follow Maryland's antidegradation policy.

Map 7-4 Tier II Streams and Catchment Areas



Map 7-4 Tier II Streams and Catchment Areas



Legal responsibilities for water quality management broadly fall to local government. This responsibility includes regulation of sediment and erosion control, stormwater, and land use that strongly affect water quality. "To maintain control over decisions that affect their communities, local jurisdictions have a stake in how the State's legal responsibilities for maintaining water quality standards are executed. In particular, local governments have an interest in the implementation of TMDLs. They are also best situated to address many implementation aspects due to their proximity to the impaired water bodies and their direct role in decisions that affect local water quality."[10]

Point Source Pollution

Two types of pollution characterize sources affecting receiving waters: point and nonpoint. 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 discharged into streams, rivers, and lakes. Nonpoint sources are all discharges other than point source discharges, including stormwater runoff from land and erosion from streams and riverbanks.

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

A TMDL relates output from a point source to a public policy concerning receiving water's assimilative capacity. TMDLs address a single pollutant for each water body. TMDLs are a tool for compliance with the CWA and implementing Maryland's water quality standard. As discussed previously, a TMDL calculates the maximum amount of pollutant that a body of water can receive and still meets water quality standards. TMDLs also allocate that load (amount) among pollution contributors. For example, 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 Total Nitrogen (TN) and Total Phosphorus (TP).

A portion of a TMDL is allocated to a point source through limits established in the NPDES. For example, Denton's WWTP NPDES caps TN loading from the plant at 9,746 pounds annually. TP is capped at 731 pounds per year, and TSS at 73,000 per year. Table 7-4 demonstrates that concentrations and loadings for the last four years (2018-2021) are well within the TN and TP caps.

[10] MD's 2006 TMDL Implementation Guidance for Local Governments, Maryland Department of the Environment, Document version: May 24, 2006

Table 7-4: Reported TN and TP, Denton WWTP 2018-2019						
	TN		TP		Percent of TMDL	
	Average Monthly (mg/L)	Total (lbs./M)	Average Monthly (mg/L)	Total (lbs./M)	Total N	Total P
2021	3.06	4365	0.24	304	45%	42%
2020	2.35	4044	0.21	361	41%	49%
2019	3.08	4425	0.16	222	45%	30%
2018	2.22	3407	0.16	229	35%	31%

Table 7-5 summarizes the estimated Denton WWTP load based on the projected residential and nonresidential growth in the two scenarios outlined in the Municipal Growth Element. The table demonstrates that provided current efficiencies are maintained, Denton's WWTP can treat effluent through the planning period and remain below the caps established under the NDPES permit. Estimates also indicate the WWTP could continue to operate below the caps in the NPDES with the buildout of the corporate area on the east side of the Choptank River but not the full buildout of the corporate area when the west side of the Choptank River is included.

Table 7-5: Point Source Loading		
	Total Nitrogen (TN)	Total Phosphorus (TP)
	(lbs/yr)	(lbs/yr)
Scenario 01	4,158	291
Scenario 02	5,090	356
Buildout	19,188	1,343
Buildout East Side Only	8,029	652
TMDL, NPDES Permit Limits	9,746	731

Nonpoint Source Pollution and Stormwater Management

Nonpoint source pollution occurs when surface runoff generated by rainfall, snowmelt, or irrigation is conveyed over the land, gathering pollutants along the way. The collected pollutants are deposited directly into waterways or infiltrated into native soils. The primary source of nonpoint loading from Denton is stormwater runoff. Stormwater runoff is part of the natural hydrologic process. Still, human activities and the urbanization created by both new and infill development can alter natural drainage patterns and add pollutants to local waterways.

Denton's contributions (loading) of point and nonpoint source pollutants to receiving waters in the Upper Choptank River are of particular concern. Estimating the loading impacts of existing and projected land-use changes is influenced by many variables, such as annual rainfall, soil characteristics, vegetative cover, and best management practices (BMP) applied.

Although model calculations can be refined, for example, with sample data to verify a formula, in the end, the results of modeling at the watershed level remain an estimate. Analysis of nonpoint loading for this WRE was based on a spreadsheet model that applies loading rates by land use and adjusts for implementing best management measures.

Denton's immediate drainage area encompasses approximately 35,853 acres, about 23 percent of the Upper Choptank River watershed. The drainage area is included in the sub-basins shown on Map 7-3. In 2010, Denton's loading was estimated at two percent of total Nitrogen and Phosphorus in the Maryland portion of Upper Choptank Watershed and nearly ten percent in the drainage area (see Table 7-6).[11]

Table 7-6: TN and TP Loading Comparison – Denton and the Upper Choptank River Basin, 2010		
	Total Nitrogen (TN) (lbs./yr.)	**Total Phosphorus (TP) (lbs./yr.)**
Upper Choptank River Watershed	1,076,223	95,091
Denton	21,986	1,889
Percent of Watershed	2.04%	1.99%
Percent of Subwatershed	10.35%	9.32%

Table 7-7 summarizes TN and TP loadings from nonpoint source runoff based on the projected 2040 growth in the two scenarios outlined in the Municipal Growth Element and the buildout of the corporate area. These estimated nonpoint TN and TP loadings are compared to the base 2010 conditions in the watershed and drainage area. The 2010 data was adjusted to reflect ENR capabilities at the Denton WWTP for comparison purposes. The analysis indicates that growth in the planning period will decrease TN and TP loading. The relative decreases are minor compared to the watershed but significant when considered in Denton's immediate drainage area. It also indicates that the buildout of the corporate area growth may increase TP loadings to the watershed and drainage area.

The TN and TP decrease in Table 7-8 result from assuming that a significant portion of the developed land will replace agricultural cropland. Conversion from cropland to residential use reduces TN and TP loading. Estimated per-acre loading rates for agriculture are thirty and fifty-six percent higher than residential loading rates.

Table 7-7: TN and TP Loading 2040 scenarios and buildout		
	Total Nitrogen (TN) (lbs/yr)	**Total Phosphorus (TP) (lbs/yr)**
Projected Loading from Denton		
Scenario 01	21,048	1,747
Scenario 02	20,534	1,770
Buildout	18,867	1,245
Estimated Change		
Scenario 01	-938	-143
Scenario 02	-1,452	-644
Buildout	-3,119	644
Percent Change		
Watershed		
Scenario 01	-0.09%	-0.01%

[11] Based on desktop spreadsheet model with loading rates from the Chesapeake Bay Program data hub and other inputs from the Department of Natural Resources publication, A User's Guide to Watershed Planning in Maryland.

Table 7-7: TN and TP Loading 2040 scenarios and buildout		
	Total Nitrogen (TN) (lbs/yr)	**Total Phosphorus (TP) (lbs/yr)**
Scenario 02	-0.13%	-0.06%
Buildout	-0.29%	0.06%
Subwatershed		
Scenario 01	-4.26%	-0.65%
Scenario 02	-6.60%	-2.93%
Buildout	-14.19%	2.93%

Should the West Denton village be annexed and included in the buildout estimates, with the elimination of existing septic systems, TN loading would be reduced by approximately 355 pounds per year. Conversely, TS loading would increase by approximately 17 pounds per year.

Impervious Surfaces

"Roads, parking areas, roofs, and other human constructions are collectively called impervious surface. Impervious surface blocks the natural seepage of rain into the ground. Unlike natural surfaces, impervious surface concentrates stormwater runoff and accelerates flow rates to receiving streams. Watersheds with small amounts of impervious surface tend to have better water quality in local streams than watersheds with greater amounts of impervious surface. Side effects of impervious surfaces become increasingly significant and negative as the percentage of impervious area increases. Examples of related problems include reduction of groundwater infiltration, increased soil and stream bank erosion, sedimentation, destabilization or loss of aquatic habitat, and "flashy" stream flows (reduced flow between storms and excessive flows associated with storms.) The Maryland Biological Stream Survey has related the percentage of impervious surface in a watershed to the health of aquatic resources. For areas with less than 4% impervious cover, streams generally rate "Fair" to "Good" for both fish and in-stream invertebrates. Beyond about 12% impervious surface, streams generally rate "Poor" to "Fair" for both."[12]

The drainage area for Denton is within 12-digit subbasins, totaling 35,764 or about sixteen percent of the Upper Choptank watershed. Based on 2010 Land Use Land Cover (LULC) data, impervious surfaces were approximately three percent of the drainage area. Growth scenarios through 2040 remain at this level. Buildout of the corporate area would increase the percentage of impervious surfaces in the drainage area to nearly five percent.

[12] Upper Choptank River & Tuckahoe Creek Watershed Characterization, Caroline County Planning & Codes Administration, November 2007

Summary

Point and Nonpoint Source Loads

The Chesapeake Bay Programs' EPA's annual progress report for 2018-2019, Bay Barometer, discusses progress on Bay cleanup. The Bay Barometer reported that as of 2018, "pollution-reducing practices are in place across the Chesapeake Bay watershed to achieve 39% of the nitrogen reductions and 77% of the phosphorus reductions necessary to attain applicable water quality standards as compared to the 2009 baseline established by the EPA as part of the Bay TMDL. Pollution controls between 2009 and 2018 have lowered nitrogen loads by 10% and phosphorus loads by 13%, mainly attributed to upgrades to wastewater treatment plants. For the short term, between 2017 and 2018, most nitrogen load reductions (55%) came from the agricultural sector." [13]

Drinking Water

Denton's water supply source and infrastructure are adequate for existing and future development needs in the two scenarios outlined in the Municipal Growth Element. However, additional withdrawal will need to be permitted in Scenario 2. There are no significant limiting issues with groundwater supply from the Piney Point aquifer. The only apparent limiting factors are those associated with the current Water Appropriation Permits.

In addition, there is sufficient drinking water supply and infrastructure capacity to service most of the buildout of the corporate area and identified growth areas east of the Choptank River. However, with the possible exception of the West Denton village, Denton's water system capacity is insufficient to support significant growth in the corporate area west of the Choptank River.

Wastewater Treatment

There is adequate treatment capacity in the Denton WWTP to meet the disposal needs of existing and future development in the two scenarios outlined in the Municipal Growth Element and remain within the TMDL caps for TN and TP. In addition, the WWTP has sufficient capacity to meet the disposal need associated with the buildout of the corporate area and identified growth areas east of the Choptank River. However, as shown in Table 7-6, insufficient treatment capacity exists to serve significant growth in the corporate area west of the Choptank River and meet the TMDL caps for TN and TP.

Stormwater Management

The results of the spreadsheet model used to evaluate nonpoint source loading associated with the growth scenarios outlined in the Municipal Growth Element indicate an overall reduction in nonpoint source TP and TN loading to receiving waters, primarily through the conversion of

[13] https://www.chesapeakebay.net/documents/bay-barometer-18-19_final.pdf

agricultural land for development. However, any conclusions based on the spreadsheet model employed in the evaluation or any model must be tempered by the shortcomings of applying simple formulas to evaluate complex systems. For example, this evaluation does not factor in growth that may have occurred elsewhere in Caroline, Talbot, or Queen Anne's counties.

Suffice it to say that even though Denton's nonpoint loading contributions to the watershed are a small percentage of the total, the Town should continue to ensure that all best management practices are rigorously applied to land under the Town's jurisdiction. In addition, Denton's role in restoring and maintaining healthy water, natural systems, and living resources requires collaboration to balance efficient growth with resource protection. This collaboration includes inter-jurisdictional coordination and cooperation with Caroline County and other municipalities in the watershed that are responsible for implementing land use and growth management strategies based on sound watershed planning principles to reduce nonpoint loadings.

Climate Change

Climate change encompasses a wide range of policy considerations, including the actions taken by communities to tackle greenhouse gas emissions. According to the Environmental Protection Agency (EPA) and the Maryland Department of the Environment (MDE), climate change challenges infrastructure planning and management. It may necessitate adjustments, as infrastructure and systems designed for past climate conditions could be overwhelmed or damaged. There are various potential changes associated with climate change, each presenting distinct challenges:

- Increased temperatures - By 2060, there could be a 5.4-degree Fahrenheit rise in the average annual temperature and an increase of nine days with temperatures exceeding 100 degrees Fahrenheit yearly.
- Greater precipitation - Predictions suggest an 11.76% change in annual precipitation and a 20.17% increase in the occurrence of 100-year storms by 2060.
- Decreased precipitation - There might be a 2.96% reduction in annual precipitation by 2060.
- Rising sea levels - Projections indicate a sea level rise from 9.92 to 31.18 inches by 2060.

Environment Article §2-1301 through 1306 mandates State agencies evaluate their planning, regulatory, and fiscal programs to identify and propose actions for better incorporating Maryland's greenhouse gas reduction objective and the impacts of climate change. Specifically, the law addresses sea level rise, storm surges, flooding, increased temperatures, precipitation, and extreme weather events. State agencies are also directed to assist local governments in conducting climate vulnerability assessments at the community level and in developing and integrating climate strategies into local plans and ordinances.

Additionally, the Comprehensive Plan's Water Resource Element (WRE) must now address the effects of climate change to meet the Land Use Article requirements fully. The WRE assesses the quantity and quality of water needed to ensure that drinking water, wastewater, and stormwater

management programs can support planned growth while safeguarding public health and safety from known or reasonably foreseeable climate-related hazards, among other considerations.

Assessment

Denton identified property and infrastructure potentially vulnerable to climate change's effects, including storm surge, sea level rise, and nuisance flooding, utilizing data from the National Weather Service's SLOSH (Sea, Lake, and Overland Surge from Hurricanes) Model, the Maryland Department of Transportation, State Highway Administration's Climate Change Vulnerability, and the Maryland Department of the Environment's Maryland Coastal Smart – Climate Ready Action Boundary (CRAB) Inundated Zones data product (See Map 7-8) which represent the areas of Caroline County impacted by inundation (0 to 1ft, 1 to 2ft, and 2ft or more).

From this data, the Town has identified critical infrastructure components, including water, sewer, stormwater components, street segments, and land and structures at risk during a catastrophic event and over time. Storm event information will be used to assess emergency response protocols. Sea level rise information will be used in the Town's facilities planning and management processes.

Water Hazard Risks

An objective of the WRE is to maintain water quality in receiving waters from the impacts of stormwater runoff and wastewater discharge. Receiving waters most impacted by what happens in Denton include the Choptank River and tributary streams. The Choptank River is a designated Use Class II water that supports estuarine and marine aquatic life and shellfish harvesting. Tributary streams included are Saulsbury, Poor House Run, and Watts Creeks, all designated Use Class I Waters managed for contact recreation and protection of nontidal warm water aquatic life.

The WRE should be used to plan for more frequent floods caused by climate change and reduce flood-induced pollutants to local waters and the Chesapeake Bay. In this context, the following Department of Environment and Department of Planning checklist outlines potential climate change adaptation issues Denton should consider:

Water supply availability – Based on current data, climate change will have minimal effect on source potable water supply, treatment, and delivery. Wells and treatment facilities are outside areas potentially vulnerable to inundation. However, studies performed by state and/or federal agencies on aquifer recharge under climate change conditions may be required.

Water demand projection – Projected water demand under buildout conditions is addressed in the WRE chapter.

Wastewater flow projection – Wastewater flows in the planning period and at buildout are addressed, including in the context of the current TMDLs for the Choptank River.

Stormwater quantity (local flooding impacts) – Urban flooding has been modeled and is addressed in Denton's Nuisance Flooding Plan.

Stormwater quality (pollutant impacts) – Stormwater quality is addressed through the planning period and buildout. Meeting the plan objectives depends on implementing State and local Watershed Implementation Plans (WIPs). WIP strategies may have to be revised in response to climate change conditions.

Sensitive Areas Element – The Sensitive Areas Element and the WRE identify Tier II streams and catchment areas. Tier II streams are high-quality waters with an existing water quality significantly better than the minimum requirements specified in water quality standards. Managing land use in the Tier II stream catchment is essential to protect wetland and coastal forest adaptation areas (i.e., corridors along which coastal habitats are expected to migrate naturally as sea level rises). It is significant for the Tier II streams near Denton because, according to DNR, the Tier II stream catchment areas have no assimilative capacity remaining.

The MGE identifies a Rural Buffer with several sensitive and vital environmental areas, including Tier II stream catchment areas. Successfully managing these areas will require the Town and Caroline County to work together to protect wetland and coastal forest adaptation areas.

Wellhead protection – Wellheads will not be impacted by sea level rise and storm surge events.

Flood Management Process - The WRE should identify recurrent urban flooding areas and evaluate whether climate change and planned development exacerbate those conditions. Urban flooding areas are identified in Denton's Nuisance Flooding Plan. In addition, Denton has identified infrastructure, properties, and structures potentially impacted by climate change, which will be incorporated into facilities planning and management and emergency response protocols.

Sea Level Rise Impacts

Maryland's Sea Level Rise (SLR) Projection (2018 Report) states a 66% chance of a 0.8-1.6 ft SLR in MD between 2000 and 2050, roughly equivalent to the comprehensive plan time horizons. Fortunately, the potential impacts of moderate sea-level rise should result in minimal property loss and damage to infrastructure. The report states that the likely range of sea-level rise experienced in Maryland is 2.0 to 4.2 feet over the century. The following discusses the potential effects of sea level on Denton's flood-prone areas, including a two-foot increase by 2050 and the extreme potential of a five-foot increase in sea level by 2300.

100-Year Floodplain

The 100-year floodplain includes land predicted to flood during a 100-year storm, a storm event with a one percent chance of occurring in any given year. Floodplain properties are subject to this periodic flooding, which poses risks to public health and safety and potential property loss. To adhere to the minimum federal requirements, the Town requires development and new structures in the floodplain to meet specific flood protection measures, including elevating the first floor of structures a minimum of one foot above 100-year flood elevations and utilizing specified flood-proof construction techniques.

While protecting life and property is the legislative basis for protecting floodplains, limiting disturbances within floodplains can serve various additional functions with critical public purposes and benefits. For example, floodplains moderate and store floodwaters, absorb wave energies and reduce erosion and sedimentation, critical to protecting water quality in receiving waters. In addition, floodplain wetlands help maintain water quality, recharge groundwater supplies, protect fisheries, and provide habitat and natural corridors for wildlife.

There are about 161 acres, 88 parcels, and twenty-nine structures with an assessed value of approximately $2.19 million within Denton's 100-year floodplain. Of the total land in the floodplain, slightly less than twenty percent is publicly owned. Structures include the Crouse Park Visitor and Heritage Center, the Caroline County Detention Center, and the County Road facility. In addition, the Town owns two other properties in the floodplain, including a recreation area and a sewer pumping station. Also included are sixteen detached residential units, most located southeast of Town off Sunset Drive and South Second Street.

The 100-year floodplain is collocated with sensitive environmental areas, including Tier II streams. Over half of the 100-year floodplain in Denton is wetlands, and over sixty percent is forested. Preserving floodplains for their multiple roles in maintaining water quality, protecting fisheries, and providing habitat and natural corridors for wildlife should be an objective of the WRE and SAE elements of the Comprehensive Plan.

Sea Level Rise

Rising sea levels extend the reach of impacts associated with flooding and extreme storm events in the 100-year floodplain. A sea-level rise of two feet increases the area of the Town's potential impact from approximately 160 to 209 acres, or about a 31 percent increase. The potential impact area from a sea-level rise of five feet increases to approximately 215 acres or about a 35 percent increase. Fortunately for Denton, the additional area affected does not include any additional structures. With the possible exception of the 2nd Street sewer pump station and the WWTP outfall, the Town's sewer, stormwater, and water systems have little infrastructure within projected sea-level rise limits through the end of the century.

Nuisance Flooding

Nuisance flooding is currently limited to Crouse Park and the boat ramp. However, according to the Town of Denton Nuisance Flooding Plan prepared in July 2020, the Crouse Park property experiences the following types and frequency of nuisance flooding:

- During normal high tide, 3-4 inches of flooding occur in the boat ramp parking lot.
- A south wind blowing from the north holds the tide in the boat ramp area during certain weather conditions. As a result, one to one and a half feet of flooding occurs in the boat ramp parking lot area and ends at the sidewalk at the Crouse Park Visitor and Heritage Center.
- Crouse Park Lane is closed six times yearly for approximately 4-5 hours due to these flooding events.

- The Water Quality Garden at the Crouse Park Visitor and Heritage Center receives daily tidal influence from the Choptank River.
- Due to the changing tidal conditions, the Water Quality Garden has been converted into a stormwater pond.

The first floor of the Crouse Park Visitor and Heritage Center building is raised well above base flood elevation and should not be affected by sea level rise. However, nuisance flooding may increase, resulting in extended parking areas and boat ramp shutdowns.

Water Resource Strategies and Recommendations

Existing Regulations and Programs

Several existing ordinances and permits contain specific best management practices to minimize nonpoint source loading to receiving water that Denton will continue to apply. These are described below:

Sediment and Erosion Control - Construction activities that disturb at least 5,000 square feet or 100 cubic yards of the earth must follow a plan approved by the Soil Conservation District (SCD). The plans outline erosion and sediment control practices that protect water resources from the impacts of construction activities. These practices prevent rainwater from carrying soil particles as water flows off a construction site. Practices generally work by filtering sediment or allowing sediment to settle out of the runoff. By retaining the soil on the site, sediment and nutrients are prevented from polluting streams and the Chesapeake Bay.

Stormwater Management Ordinance – Denton's Stormwater Management Ordinance implements criteria and procedures for stormwater management, including environmental site design (ESD) to the maximum extent practicable (MEP). ESD uses small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources. It also includes conserving natural features, drainage patterns, and vegetation, minimizing impervious surfaces, slowing runoff, and increasing infiltration.

Forest Conservation Ordinance – Nonpoint source loading rates for forest lands are the lowest of all land use or cover types. The primary purpose of Denton's Forest Conservation Ordinance is to minimize the loss of forest resources during land development by making the identification and protection of forests and other sensitive areas an integral part of the site planning process. Identification of priority areas before development makes their retention possible. Of primary interest are areas adjacent to streams or wetlands, those on steep or erodible soils, or those adjacent to large contiguous blocks of forest or wildlife corridors.

NPDES permit - MDE's Wastewater Permits Program (WWPP) issues an NPDES permit to jurisdictions to operate facilities. Discharge parameters established in individual plant NPDES permits are set to protect Maryland's water resources by controlling wastewater discharges. Denton's NPDES permit limits total TN and TP discharge to a maximum level consistent with

TMDLs established for the Upper Choptank watershed. These are caps the WWTP is not permitted to exceed. The caps also set an upper limit on the feasible capacity of Denton's WWTP without resorting to nutrient trading. This cap is the primary limiting factor for development on the west side of the Choptank River. The primary limiting factor is TP, which at 0.21 mg/L limits the WWTP capacity to about 600,000 gpd or approximately 950 additional dwelling units. When completed, the WWTP Facilities Management Plan will evaluate alternative strategies to address limitations.

Comprehensive Soil Conservation Plans

The Town should consider requiring properties that benefit from preferential assessments to implement a comprehensive soil conservation plan as a condition for maintaining that status.

Agriculture is the most significant contributor to nonpoint source nitrogen and phosphorus loading in the Choptank River Basin. An effective means of addressing nonpoint loading from agricultural land is implementing agricultural best management practices outlined in comprehensive soil conservation plans that meet the USDA-NRCS Field Office Technical Guide (USDA 1983).

As mentioned earlier, Denton's plan to limit development on the west side of the Choptank River due to water constraints will keep more agricultural land in production. According to the 2010 Land Use Land Cover data, 1,446 acres, or 42 percent of Denton's corporate area, were in agricultural use. Even after the buildout of the corporate area on the east side of the Choptank River, approximately 850 acres of agricultural land will remain.

Tier II Streams

Two Tier II stream segments are located at Denton's corporate boundary. Approximately six percent of the catchment area for these streams is within the Denton corporate limits. Nearly twenty percent of these streams' catchment area is Denton's rural buffer (see Map 7-4). Inside the corporate limits, development reviews (stormwater management, sediment and erosion control, and forest conservation) should emphasize measures that prevent potential stormwater runoff loading to Watts Creek and the unnamed creek along the northern corporate boundary. For example, vegetative buffering along primary drainage ways may be required, and forest clearing in these areas is prohibited.

Climate Changes

The climate change assessment identified infrastructure, land, and structures potentially impacted by climate change, including sea level rise and extreme weather vents. This information should be incorporated into the Town's facilities planning and management processes and emergency response protocols.

Map 7-5 MDE Coastal Smart – Climate Ready Action Boundary (CRAB) Inundated Zones