CAROLINE COUNTY

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Background

The following information is based on the 1986 (with recent amendments) Caroline County Comprehensive Plan. Caroline County has roughly 208,000 acres. Agriculture is still the most important industry in the County, covering about 60% of the land. Topography is flat or gently rolling, with the majority of land having slopes < 5%. Most of the County is between 40 and 70 feet above sea level, with elevations decreasing going south. Although poor soil drainage limits residential or agricultural production in some areas, recent projects have resulted in extensive artificial drainage for agriculture. Forest cover (~30%) is spread throughout the County. As more forested land is converted to agriculture or development, remaining forest tends to be on marginal land. Developed land is also spread through the County, including in Ridgely, Denton, and Federalsburg. There is a slightly higher density of developed land around the Choptank River. Mineral resources include sand and gravel. While these resources are scattered through the County, they tend to be focused around the waterways. The most frequently used aquifers are the two confined aquifers Piney Point and Calvert, and the unconfined Columbia aquifer. Since the Columbia aquifer is becoming more contaminated, water usage is shifting to the confined aquifers. The County wants to encourage ecotourism along its surface waters (Vitech Services, 1986).

There is a lot of soil considered to be Prime Farmland in this County. Prime Farmland is spread throughout most of the County, with the exception of lower Tuckahoe Creek, the Choptank River, and Hope Creek. Some of this Prime Farmland needs to be drained in order to be productive. Wetland creation/restoration should avoid soil designated as Prime Farmland, especially Prime Farmland that does not need to be drained.

Caroline County drains into two different State-designated 6-digit watersheds: Nanticoke River (021303) and Choptank River (021304). The 8-digit watersheds within the Caroline portion of the Nanticoke River watershed include: Nanticoke River (02130305) and Marshyhope Creek (02130306). The 8-digit watersheds within the Caroline portion of the Choptank River watershed include: Lower Choptank (02130403), Upper Choptank (02130404), and Tuckahoe Creek (02130405).

Streams

Most of the streams have steep banks (Vitech Services, 1986).

The following information is based on the Maryland Tributary Strategies 2004 document entitled *Maryland's Lower Eastern Shore*. Maryland's Lower Eastern Shore basin includes areas in Wicomico, Caroline, Somerset, Worcester, and Dorchester Counties and the waterways Pocomoke, Wicomico, Nanticoke and Big Annemessex Rivers, Fishing Bay, Pocomoke and Tangier Sounds. For the entire basin, land cover is 61% forest/wetlands and 32% agriculture. About 60% of the houses are on septic. Point sources are not a major source of pollution. In 2002, sources of nitrogen, phosphorus, and sediments were from agriculture (60%, 58%, 70% respectively). Based on water quality sampling, nitrogen was good or fair in the southern portion and poor in Wicomico and Nanticoke Rivers. Phosphorus was good or fair throughout. Total suspended solids (TSS) was poor in the majority of the area, with only three samples having fair or good TSS (South Tangier Sound, Big Annemessex River, and Pocomoke River). All areas were below the SAV restoration goal. Benthic communities were generally good, with the best communities located in Nanticoke and Wicomico Rivers. Degraded communities were likely impacted by high sedimentation. This document describes the success of implementing BMPs like this:

> Implementation of animal waste management plans, nutrient management plans,
> conservation tillage, treatment of highly erodible land, forest conservation and buffers, marine pumpouts, and structural shore erosion control and erosion and sediment control are all making good progress toward Tributary Strategy goals. For other issues, such as stormwater and urban nutrient management, cover crops, tree plantings and nonstructural shore erosion control, progress has been slower.

The following information is based on the Maryland Tributary Strategies 2004 document entitled *Choptank River Basin Summary: Final Version for 1985-2002 data*. The Choptank River basin includes land in Caroline, Dorchester, Queen Anne's and Talbot

Counties. The basin supports over 80 fish species and the bottom section of the basin is important for waterfowl. This basin has a large amount of agriculture (58%) and a high number of agricultural ditches. Roughly half of the houses are on septic systems. Main water quality impairments are from non-point nutrients and sediments. In 2002, the main nitrogen, phosphorus, and sediment sources within the Choptank River basin were from agriculture (73%, 67%, and 87%, respectively). Based on tributary stations, nitrogen, phosphorus, and sediments were generally better at the mouth of the Little Choptank and Choptank Rivers than upstream Choptank River. In 2001, SAV along the Choptank River from Castle Haven Point to Bow Knee Point was much lower than the SAV goal, SAV in the outer Choptank River was roughly three-quarters of the SAV goal, and SAV in the Little Choptank River exceeded the SAV goal. The benthic community was generally good, but there were some differences in the different areas. Some samples within the lower mesohaline portion were slightly degraded, the upper mesohaline portion were moderately to severely degraded (due to nutrient enrichment, with many poor sites upstream of Cabin Creek), and the oligohaline portion was the best. This document describes the mixed success of BMP implementation as follows:

> In some cases, such as shore erosion controls, forest conservation, forest buffers, and nutrient management plans, the goals set in the Choptank Tributary Strategy have nearly been met or have been exceeded. For other BMPs, notably those dealing with stormwater management, implementation is falling short of the Tributary Strategy goals.

Wetlands

Wetlands occur along floodplains of streams, at the heads of drainageways, and in isolated depressions. Large wetland systems occur along the Choptank River, Tuckahoe Creek, and Marshyhope Creek.

While Caroline County does not directly border the Chesapeake Bay, there are 9,089 acres within the Chespeake Bay Critical Area, including 2,020 acres wetlands. The tidal portion of the Choptank River (to Greensboro) and Tuckahoe River (above Hillsboro) and tributaries are surrounded by extensive tidal wetlands. Additional tidal wetlands occur around the other tidal waterways. In the past, the County estimated that the main threat to wetlands is from agricultural drainage. USDA Soil Conservation Service and Caroline County Soil Conservation District have sponsored projects resulting in extensive channelization to the Upper Choptank River and Marshyhope Creek watersheds (Vitech Services, 1986).

According to Tiner and Burke (1995), in 1981-1982 there were 30,514 acres of wetlands (5.1% of the State total). The wetland types were Estuarine (2,121 acres), Palustrine (28,027 acres), Riverine (351 acres), and Lacustrine (15 acres). Comparisons of this 1981-1982 wetland acreage with historic wetland acreage (based on hydric soils) represents a 56%, or 38,444 acre, loss (MDE, 2002a).

The following wetland plant community descriptions are based on Tiner and Burke (1995).

- Estuarine wetlands can be salt or brackish tidal wetlands. Vegetation is largely dependent upon salinity and hydrology, with plant diversity increasing with decreased salinity and decreased flooding. They can be classified into five groups:
    - Estuarine intertidal flats are mud or sand shores that are exposed twice a day (at low tide) or less. These areas have sparse macrophytic vegetation.
    - Estuarine emergent wetlands have vegetation composition that is strongly influenced by salinity level and duration/frequency of inundation.
        - Brackish marshes are the most common type of Maryland Estuarine wetland, found along the Chesapeake Bay and tidal rivers. Low brackish marsh is often dominated by smooth cordgrass-tall form and water hemp while the high brackish marsh is often dominated by salt hay grass, salt grass, black needlerush, smooth cordgrass-short form, Olney three-square, switchgrass, common three-square, big cordgrass, common reed, salt marsh bulrush, seaside goldenrod, rose mallow, and narrow-leaved cattail.
        - Oligohaline marshes are only slightly saline and are located in the upper tidal rivers. Low oligohaline marshes are often dominated by arrow arum, pickerelweed, spatterdock, wild rice, soft-stemmed bulrush, narrow-leaved cattail, water hemp, and common three-square while high oligohaline marshes are often dominated by big cordgrass, common reed, narrow-leaved cattail, wild rice, broad-leaved cattail, and sweet flag.
    - Estuarine scrub-shrub swamps are often dominated by high-tide bush and groundsel bush.
    - Estuarine forested swamps are often dominated by loblolly pine. Due to sea level rise bringing in more salinity, some of these systems are being converted into salt marshes.
    - Estuarine Aquatic beds generally contain submerged aquatic vegetation, including eelgrass and widgeongrass in high salinity areas and widgeongrass and other species in lower salinity areas.
- Palustrine wetlands can be classified into four major groups depending on the dominant vegetation type: forested, scrub-shrub, emergent, and aquatic. These wetlands were described for the Maryland Coastal Plain Province.
    - Palustrine forested wetlands are the dominant palustrine wetland type on the Coastal Plain and are located in floodplains, depressions, and drainage divides. They can be classified into four main groups:
        - Tidally flooded wetlands are freshwater wetlands that are tidally influenced. Common tree species may include red maple, green ash, black willow and black gum.
        - Semipermanently flooded wetlands are nontidal wetlands that are flooded for much of the growing season. These are uncommon in Maryland. Some examples, dominated by bald cypress, are along Battle Creek and the Pocomoke River. Higher elevations may be dominated by red maple, black gum, sweet bay, swamp black gum, fringe tree, ironwood, and swamp cottonwood.

        - Seasonally flooded wetlands are nontidal wetlands that are flooded for generally longer than two weeks during the growing season. Some of the more common tree dominants include red maple, sweet gum, pin oak, willow oak, loblolly pine, or swamp chestnut oak. There is often a thick shrub understory.
        - Temporarily flooded wetlands are nontidal wetlands that are flooded the least of the four types, about a week. Seasonally saturated wetlands, wetlands having a high water table during the cooler months, are also included in this category. Some of these areas are managed for loblolly pine harvesting. Other tree dominants include red maple, sweet gum, black gum, willow oak, water oak, basket oak, swamp white oak, southern red oak, sycamore, black willow, American holly, sweet bay.
    - Scrub-Shrub wetlands are less common than forested wetlands on the Coastal Plain. They are often dominated by buttonbush (in the wetter systems), silky dogwood, arrowwood, alder and tree saplings.
    - Emergent wetlands are very diverse in the Coastal Plain region due to the occurrence of both tidal and nontidal wetlands. They can be categorized into several different types:
        - Tidal fresh marshes occur along the large coastal waterways, between the brackish marshes and tidal freshwater swamps. It is speculated that in addition to tidal flooding, temporary periods of salt water in these areas may discourage woody succession. These freshwater wetlands are often more diverse than wetlands with higher salinity levels. Vegetative dominance changes seasonally. There is often a distinct vegetative zonation pattern based on elevation. Some common dominance types according to McCormick and Somes (1982) are arrowheads, big cordgrass, bulrushes, bur-marigold, cattails, common reed, giant ragweed, golden club, pickerelweed/arrow arum, purple loosestrife, reed canary grass, rose mallow, and smartweed/rice cutgrass
        - Interdunal wet swales have a very high water table, allowing hydrophytic plants to grow adjacent to dunes having xeric plant species. These sites are often dominated by common three-square, salt hay grass, and rabbit-foot grass.
        - Semipermanently flooded marshes are often dominated by cattail, spatterdock, arrow arum, water willow, and bur-reeds.
        - Seasonally flooded marshes include isolated depressional wetlands called “potholes” or “Delmarva Bays” (mostly in Caroline, Kent, and Queen Anne’s)
        - Temporarily flooded wet meadows include areas recently timber harvested that will soon revert back to woody vegetation.
    - Aquatic beds include small ponds with vegetation on the bottom and/or surface. These are the wettest of the Palustrine types.
- Riverine wetlands are found within the channel and include nonpersistent vegetation.

- Lacustrine wetlands are associated with deepwater habitat (e.g. freshwater lakes, deep ponds, and reservoirs). They can be classified into lacustrine aquatic beds (wetlands are located in the shallow water) and lacustrine emergent wetlands (wetlands are located along the shoreline).

This same document (*Wetlands of Maryland*) provides numerous examples of various wetland communities found within each County and complete plant lists for certain wetland types.

Tidal wetland acreage was also estimated in *The Coastal Wetlands of Maryland* (Table 1). Caroline County had 3,367 acres of vegetated tidally-influenced wetlands (plus an additional 25 acres open water and mudflat). The majority of the vegetated wetlands were freshwater, with the remainder being brackish. Freshwater marsh characterized half of the tidal wetlands. Most of the remaining tidal wetlands were composed of wooded swamp (26%) and brackish high marsh (23%). Freshwater marsh often has higher species richness and species diversity than marsh with higher salinity levels. Freshwater marsh may also have taller plants and there may be less distinct plant zonation than found in brackish or saline marsh. Wooded swamp vegetation is often found in the upper tidal reaches and may form a continuum with nontidal swamp. Tidal forest swamp may contain abundant hummocks and often has smaller trees than found in nontidal forest swamp. Red maple/Ash species, the most common forest swamp vegetation category in Maryland, was the only forest swamp type found in this County.

Table 1. Tidal wetland acreage within Caroline County based on vegetation type (McCormick and Somes, 1982).

Major Vegetation Type	Vegetation Type	Acreage
Shrub Swamp *(Fresh)*	Swamp rose	3
	Smooth alder/Black willow	0
	Red maple/Ash	2
Swamp forest *(fresh except pine, which is often brackish)*	Bald cypress	0
	Red maple/Ash	871
	Loblolly pine	0
Fresh marsh	Smartweed/Rice cutgrass	196
	Spatterdock	466
	Pickerelweed/Arrow arum	572
	Sweetflag	2
	Cattail	393
	Rosemallow	7
	Wildrice	6
	Bulrush	35
	Big cordgrass	12
	Common reed	1
Brackish High Marsh	Meadow cordgrass/Spikegrass	1
	Marshelder/Groundselbush	13
	Needlerush	0
	Cattail	196
	Rosemallow	1
	Switchgrass	120
	Threesquare	203
	Big cordgrass	232
	Common reed	0
Brackish Low Marsh	Smooth cordgrass	35
Saline High Marsh	Meadow cordgrass/Spikegrass	0
	Marshelder/Groundselbush	0
	Needlerush	0
Saline Low Marsh	Smooth cordgrass, tall growth form	0
	Smooth cordgrass, short growth form	0
Submerged Aquatic Vegetation	Submerged aquatic plants	0

Numerous tidal wetlands in Caroline County have been identified as reference sites as the best examples of certain herbaceous, shrub, and forested community types. These wetlands range of tidal inundation and salinity from irregularly flooded, freshwater systems to wetlands flooded daily with slightly brackish, oligahaline waters. One community is the Marsh elder (*Iva frutescens)* /Big cordgrass (*Spartina cynosuroides)* tidal shrubland, which is flooded daily or irregularly in oligohaline or mesohaline waters. Several examples are found in the Choptank River and Hunting Creek. Another reference tidal shrub community, Groundsel tree – Marsh elder/Switchgrass (*Baccharis halmifolia-Iva frutescens/Panicum virgatum)* is found on Frazier Point on the Choptank River. The

community is subject to a range of tidal inundation, from daily to irregularly flooding. There is a diverse herbaceous layer (Harrison and Stango, 2003).

A reference freshwater forested tidal wetland community is the Pumpkin ash-Swamp black Gum/Winterberry/Halberd-leaf Tearthumb (*Fraxinus profunda-Nyssa biflora/Ilex verticillata/Polygonum arifolium),* found along the Choptank River.

The 1984 document entitled *Uncommon Wetlands in the Coastal Plain of Maryland* describes the Eastern Shore potholes, also known as Carolina or Delmarva Bays, including some in Caroline County, as being uncommon. These wetlands are generally isolated depressions around the MD/DE border. These seasonal ponds are often surrounded by forest. They are ponded in the spring and relatively dry in late summer and fall. Ponded areas may have no vegetation during the wet season but may have herbaceous vegetation during the drier season. Vegetation types include glades, shrub swamp, and forested swamp. Glades are the least common and are dominated by herbaceous vegetation often including a grass (*Erianthus giganteus*), sedge (*Carex walteriana*), twig-rush (*Cladium mariscoides*), smartweeds (*Polygonum* sp.), and sphagnum moss beneath. The shrub swamps may be dominated by *Cephalanthus occidentalis* and *Decodon verticillatus* but may have abundant herbaceous vegetation during certain seasons. The forested swamp may be dominated by *Acer rubrum*, *Liquidambar styraciflua*, *Quercus palustris*, and *Q. phellos*. Multiple vegetation types may be present at the same site. These sites may act as ecological "islands," being very important habitat for rare species including the Carpenter frog. These wetlands are vulnerable to drainage, conversion to agriculture, and clearing of the surrounding buffer. Altering the existing hydrology or hydrological fluctuations would be detrimental to the system. Examples of these wetlands are located: north of Coolspring Branch off Tiday Island Creek and west of Marvel Road near Mt. Zion; west side of Templeville Road, a mile north of Mt. Zion; and two sites about one mile north of Hollingsworth Crossroads, along a dirt road extending from Jones Road. Due partly to the abundance of Delmarva bays in this region, they are important for local flood attenuation and provide groundwater recharge during drier seasons (Brown and Jung, 2005).

Wetland Functions

Stormwater and Flood Control

Wetlands are often credited with providing natural stormwater and flood control benefits. Inland wetlands adjacent to rivers, streams and creeks hold excess discharge and runoff during periods of increased precipitation such as tropical storms and hurricanes and during periods of rapid snow-melt in mountainous regions. Coastal wetlands also hold excess discharge from inland drainage networks as well as tidal waters during storms.

Several factors influence the effectiveness of a wetland in reducing adverse effects of stormwater and floods. Factors include the characteristics of the wetland, local land conditions, and landscape features in the surrounding larger watershed, as well as the type of storm itself. The physical structure of many wetlands, with dense vegetation,

fallen trees, topography (hummocks, depressions), and complexity of stream channel systems serve as resistance features to slow flow of surface water from floods and surface runoff, the height of peak floods, and delay the timing of the flood crest. Wetlands are typically in topographically low position, which provides a natural basin for water storage. The depth of the basin and soil characteristics affect the wetland's storage capacity at surface and subsurface levels. Water is released more slowly from the wetlands, thereby reducing both erosion and damage to property and structures farther downstream. In the surrounding areas, the ability of the land to also reduce runoff may aid the wetland in its flow retention/reduction function. At the landscape level, the position of the wetland in the watershed and the ratio of size of the wetland to the size of the watershed also affect the function. Wetlands higher in the landscape and of large in size in relation to the watershed are most effective. While wetlands retain surface flows that enter the wetlands at a gradual rate, they are considered to be more effective at reducing damages from short duration storms.

Also, some water will be removed from the wetland through ground water recharge, soil retention and evapotranspiration.

The associated value of this function can be summarized as follows:

a A decrease in the volume and velocity of flowing water.
Value: Helps prevent stream channel and shoreline erosion, and habitat destruction.
b. Deposition and retention of fine sediment.
Value: Helps maintain water quality and aquatic ecosystems.
c. Water storage by extending the period of time during which flood waters are released back into the drainage system.
Value: Helps prevent the flooding of homes, property, agricultural lands, and structures such as dams, bridges, and roads.

The ditching and channelization of streams has reduced the ability of some floodplain wetlands to perform a flood attenuation function. However, due to the relatively limited development in this County, there are opportunities to re-establish a more natural floodplain and wetland system, as described in the Town of Federalsburg project in the Marshyhope Creek watershed.

Groundwater Recharge and Discharge

Functions

Wetlands facilitate the flow of water between the ground water system and surface water system. Wetlands periodically perform different functions, depending on the gradient of the groundwater table and the topography of the land surface. The relationship of the groundwater table and the land surface dictates which function - groundwater recharge or discharge - a wetland performs.

Nearly all of Maryland's wetlands are ground water discharge areas, at least for some portion of the year (Fugro East, Inc., 1995). Variations in the depth of the ground water

table, resulting from seasonal changes in climate, dictate which of these functions - discharge or recharge - a wetland will perform at a given time.

Values

Ground water discharge helps maintain a wetland's water balance and water chemistry. This wetland function is also critical to the formation of hydric soils and the maintenance of ecosystem habitats in different types of wetlands.
Ground water recharge is the primary mechanism for aquifer replenishment which ensures future sources of groundwater for commercial and residential use.

Studies have been conducted on the groundwater recharge/discharge processes in the isolated seasonal pond wetlands and Delmarva Bays of the type found in this County. Phillips and Shedlock (1993) found that unlike may areas, the ground water table around these wetlands did not mimic surface topography and the flow reversed direction throughout the year. The water table adjacent to and beneath the wetland was higher than in nearby ridges, from August through January, the water table was highest in the ponds and sloped downward into the upland ridges. From February through May, the water table was nearly level. However, during dry periods in this time, the water table was higher in the uplands. By the end of May, the water levels were decreasing and again began to assume the form shown in August-January, with water levels in the pond higher than in the pond margin and surrounding upland. Recharge of the surficial aquifer was believed to occur during this time.

Modification of Water Quality

Water Quality Improvement

Wetlands are valued for their ability to maintain or improve quality of adjacent surface waters. This ability is primarily accomplished by the following processes:

- Nutrient removal, transformation, and retention
- Retention of toxic materials
- Storage of the sediment transported by runoff or floods.

Hydrophytic vegetation (adapted to live in water) and microbial activity in soils help remove toxic substances and excess nutrients from surface water. Dissolved solids and other constituents may be removed or degraded, such that they become inactive, or incorporated into biomass. This occurs through adsorption and absorption by soil particles, uptake by vegetation and loss to the atmosphere through decomposition and exchange between atmosphere and water.

Nutrient Cycling: Addition, Removal and Transformation

Nutrients are carried into wetlands by hydrologic pathways of precipitation, river flooding, tides, and surface and ground water inflows. Outflows of nutrients are controlled primarily by outflow pathways of waters. The inflow and outflow of water and nutrients are important processes that effect wetland productivity.

Wetland biological and chemical processes remove suspended and dissolved solids and nutrients from surface and ground water and convert them into other forms, such as plant

or animal biomass or gases. Debris and suspended solids (fine sediment or organic matter) may be removed by physical processes, such as filtering and sedimentation.

Soil characteristics, landscape position, and hydrology all contribute to the relative ability of a wetland to perform nutrient removal and transformation. Sufficient organic matter must be present for microorganisms in the soil to consume or transform the nutrients. Wetlands are often depressions in the landscape that hold water, transported sediment, and attached or dissolved nutrients for a longer period of time than a sloping area or areas with relatively higher elevations. A longer retention time allows for chemical interactions and plant uptake to occur.

Nitrogen undergoes some chemical transformations and may be taken up in soluble form, absorbed by plants through their roots, or consumed by anaerobic microorganisms that convert the nitrogen to organic matter (Mitsch and Gosselink, 2000). Anaerobic microbes may also convert the nitrogen from a nitrate form to nitrogen gas. Phosphorus is often bound to clay particles, and these fine sediments are transported into wetlands by riparian flooding and tidal action. Phosphorus may be stored in a wetland attached to the clay particles, however, phosphorus becomes available for plant uptake in its soluble form after flooding, saturation and anaerobic conditions typical of a wetland occur. Nutrient processes vary seasonally. Cooler temperatures slow microbial activity and plant uptake while higher flows of water transport more materials out of non-isolated wetland systems. The transported organic material is critical for downstream food chain support.

Tidal wetlands are highly effective sinks and/or transformers of nutrients, as nutrients are taken up and stored by plants or released as nitrogen gas into the atmosphere. However, the uptake and transformation occurs on a seasonal basis during the growing season. At the end of the growing season, as plants die and decompose, nutrients are released back into the aquatic system.

Wetlands are most effective at nutrient transformation and uptake when there are seasonal fluctuations in water levels (Tiner and Burke, 1995). Wetlands that are temporarily flooded (saturated or inundated for brief periods early in the growing season) and those that are permanently inundated would generally be less effective than seasonally wet areas (saturated or inundated for longer periods during the early-mid growing season but are drier by the end of the growing season).

Toxics Retention

Retention of heavy metals has been reported most often in studies of tidal wetlands, though most wetlands are believed to serve as sinks for heavy metals. Accumulation is primarily in soils, with plants playing a more limited role (Mitsch and Gosselink, 2000). Plants such as cattails, bulrushes, and *Phragmites* are among the more effective and commonly used plants for uptake of toxic materials such as metals. As is the case for nutrient transformation and sediment retention, soil characteristics, landscape position, vegetation, and hydrology all contribute the relative ability of a wetland to retain toxic materials. The longer the duration that water and transported materials remain in the wetland, the greater the likelihood that the materials will be retained. Many wetlands have been constructed as part of stormwater management facilities to treat surface runoff.

Sediment Reduction

Wetlands along rivers, streams and coastal areas are important for removing sediment from surface and tidal waters. During large flood events, rivers frequently overtop their banks and water flows through adjacent floodplains and wetlands. Flood waters carry large volumes of suspended sediment, mostly fine sand, silt and clay. Because floodplains and wetlands provide resistance to flow - from dense vegetation, microtopography, and woody debris - the flow of water is slowed and sediment is deposited and stored in these areas. Similarly, coastal marshes and estuaries retain sediment brought in by tides and residual suspended sediment from rivers.

The ditching and channelization of streams has limited the access of flood waters to floodplains and adjacent wetlands in Caroline County. Lack of dense vegetation in some floodplains, and narrow width of floodplains, would reduce the ability of wetlands to slow velocities of floodwaters and allow settling of transported sediments.

Wildlife Habitat/Biodiversity

Wetlands provide important habitat for fish, wildlife, and plant species, including rare species. Large contiguous areas of wetland, forest or other relatively undisturbed land are most likely to support sensitive species and diverse, microhabitats. Habitat and biodiversity are threatened not only by direct impacts such as filling, drainage, sediment, and land clearing, but by introduction of exotic and invasive species. Wetlands that are important for habitat and biodiversity often require a relatively undisturbed adjacent buffer to protect the species and habitat from direct and indirect disturbance.

Nontidal Wetlands of Special State Concern (WSSC)

There are several State-designated Nontidal Wetlands of Special State Concern (WSSC) and potential WSSC scattered through the County. These are described in the section for the individual watersheds.

Wetland Restoration Considerations

In order to protect some of these important systems, Sipple (1999) recommended acquiring sites “preferably where representative examples of each type occurred in a matrix of upland forest.”

Hydric soils are located throughout the County. These soils suggest where wetlands currently exist or where they historically existed. “Very poorly drained” soils are located along the major waterways (Tuckahoe Creek, Choptank River, and Hope Creek). There is also a fair amount in the northern portion of the County. “Poorly drained” soils are scattered more evenly throughout the County. There is a fair amount of hydric soil that is not mapped wetlands (based on NRCS SSURGO GIS data and NWI/DNR wetlands). Hydric soils that are not currently wetlands may be good potential sites for wetland restoration. There are also some spots of “somewhat poorly drained” soils. While not considered hydric soils in this case, “somewhat poorly drained” soils may still provide

good opportunities for wetland creation, since the wetland hydrology should be easy to establish.

Vegetated stream buffers have the potential to intercept and remove nutrients, sediments, and other pollutants. Peterson et al. (2001) found that the smallest headwater streams, which are often found in association with springs and groundwater discharge wetlands, have the most rapid uptake and transformation of inorganic nitrogen (ammonium and nitrate) in comparison with other surface waters. The authors believed that the large surface to volume ratio in small streams resulted in rapid nitrogen uptake and processing. An excess of discharges to overload these systems would result in nitrogen being transported farther down the drainage systems to rivers and estuaries. Forested stream buffers can also improve down steam biodiversity by contributing organic matter to the food web, providing woody debris which increases diversity of physical habitat, and reducing stream temperature. Headwater streams are thought to be the most beneficial at these processes. Therefore, wetlands adjacent to streams should be high priority for restoration/preservation, with emphasis on headwater stream systems. Wetlands around all tributaries of waterways used for drinking water (COMAR Use P) should also be ranked higher.

DNR assessed the development risk for all land within Maryland. Wetlands within areas of high development risk should be higher priority for preservation.

In order to maintain water quality of surface water reservoirs, wetlands within the watersheds of surface water reservoirs should be higher priority for preservation.

Wetland restoration may be more desirable in land uses that contribute high pollution, currently provide relatively low amounts of biodiversity, and are easy to convert to wetlands. As a general rule, agriculture fits these criteria more than other land use types. Forested land is generally not as high of a pollutant source and it also provides better habitat for plants and wildlife. For these reasons, converting upland forest to wetland may provide fewer benefits than converting agriculture to wetlands. However, projects that have converted artificially drained forest to wetland have resulted in beautiful wetlands with diverse ecology. Additionally, wetlands may be built in urban land use, but they are generally much smaller and sometimes more costly. Urban areas may provide good potential for wetlands designed for storm water management.

MDE has designated some areas as Wellhead Protection Areas (WPAs). In some WPAs, the water table is near the surface, with only a few feet of soil to filter any water entering the ground. Excavation of a few feet would significantly reduce the filtering capacity of the soil, allowing the wetland to act as a direct pathway for nutrients and other pollutants to enter the groundwater. Therefore, wetland creation designs within WPAs should consider the impact to groundwater quality.

Sensitive Resources

Sensitive areas requiring special consideration:

- *Floodplains*. Flooding is generally not extreme, with the exception of Federalsburg, having roughly a third of the community within Marshyhope Creek floodplain, and a portion of Greensboro within the Choptank River floodplain. No new development on lots created after 1980 is allowed within the floodplain (Vitech Services, 1986).
- *Steep slopes*. Only 1% of the County has slopes greater than 15%. These should be protected from development (Vitech Services, 1986).
- *RTE species*. 5 animals and 36 plants are listed as rare, threatened, or endangered (RTE).
- *Stream buffers*. The County plans to create and maintain a database listing the perennial and intermittent streams that require a buffer and encourage property owners to establish a buffer (Vitech Services, 1986).
- *Millponds*. Of the roughly 20 millponds in the County a century ago, only six remained as of 1986, with two owned by the State. Since millponds provide habitat and recreation, they should be maintained and protected (Vitech Services, 1986).

Source water assessments were completed for several water systems within this County. From the 58 transient systems studied, some withdrawing from unconfined aquifers were susceptible to nitrates, VOCs, and microbiological contaminants. Information on the community water systems is in the individual watershed section. Community water systems withdraw from the confined aquifer, so are naturally protected from human-induced contaminants. They are susceptible to contamination from natural sources including arsenic, fluoride, and radon.

Other Relevant Programs

Green Infrastructure and Greenways

There are numerous Green Infrastructure hubs and corridors within this County, with few being protected. Areas within the Green Infrastructure network that are currently unprotected should be protected since these areas provide valuable wildlife habitat. There are some gaps, areas without natural vegetation, within this Green Infrastructure layer. These are generally agricultural. It is desirable to restore these areas back to natural vegetation, as they can provide a wildlife corridor, a protective buffer, and may be especially important along the waterways. For more detailed information, refer to the section on the individual watershed.

Ecologically Significant Areas

DNR designates areas that contain habitat for rare, threatened and endangered species and rare natural community types. These areas are buffered to create the “sensitive species project review areas” GIS layer, intented to assist in assessing environmental impacts and reviewing potential development changes. This layer generally includes designated Natural Heritage Areas, Wetlands of Special State Concern, Colonial Waterbird Colonies, and Habitat Protection Areas.

Natural Heritage Areas

There are no State-designated Natural Heritage Areas in this County.

Rural Legacy Program
Designated Rural Legacy land is located along Tuckahoe Creek, the Choptank River and west of Idlywild WMA, in the watersheds Marshyhope Creek, Tuckahoe Creek, and Upper Choptank River. For detailed information on this program, refer to the individual watershed section.

Priority Funding Areas
Small priority funding areas are located throughout the County, around many of the cities and towns (e.g., Preston, Federalsburg, Denton, Ridgely, Greensboro, Goldsboro, and Marydel).

Stakeholders in wetland management may have conflicting goals for wetlands in Priority Funding Areas. Some may advocate preserving wetlands in these areas as greenways, for aesthetics, or as unique communities in a developing area. Other interests may seek flexibility and expedited review of proposals to impact wetlands due to other goals for growth and economic development in a designated area. There may be benefits to protecting and restoring wetlands for water quality in a growth area, particularly as an offset against future or existing TMDLs. Preservation of biodiversity may be more of a challenge due to possible increases in nonpoint source pollution and fragmentation. Stormwater management associated with growth may also reduce certain nonpoint source impacts to wetlands in PFAs.

Protected Areas
There are small parcels of protected land scattered throughout the County, with the largest protected areas being the State-owned Idlywild WMA and Tuckahoe State Park.

Some properties are within agricultural easements. Some are permanent and some are shorter-term. There is some controversy about conducting wetland restoration within agricultural easements. Most would agree that it is desirable to preserve good farmland. However, properties within these easements may also contain spots of soil with lower productivity due to wetness. These low productivity spots may be a hassle to the farmer and may be good areas for wetland restoration. First, the property owner may be able to benefit from an additional program for that low productivity area, resulting in the owner getting more money for the land and utilizing the land to its full extent. Since these property owners are already involved in a preservation program, they may be more likely to consider additional programs. Second, since some of these agricultural easements are temporary, after the agricultural easement expires, the land owner may decide to get out of agriculture, and a wetland program could help to preserve some of the land from development.

Watershed Information

Information on individual State-designated 8-digit watershed basins follows. Detailed information of the watershed Nanticoke River (02130305) was not included in the

following section, due to small size. For more information on this watershed, please see the section for Dorchester County.

Marshyhope Creek (02130306)

Background

The Caroline County portion of this watershed has roughly 39,851 land acres (based on MDP 2002 GIS land use data). Over half is agriculture (55%), a large part is forest (39%), and the remaining is developed (6%). There is a large forested area around Idlywild WMA and a large developed area just south of this WMA in Federalsburg. This waterway is roughly 38 miles long (from the confluence with the Nanticoke River to the headwaters). Headwaters originate in Sussex and Kent Counties, Delaware. For the whole basin, including the Delaware portion, land use is 46% agriculture, 45% forest, and 5% urban (as summarized by MDE TMDL based on data from 1997 Maryland Department of Planning, 1997 Delaware Office of State Planning, and 1997 Farm Service Agency). In the upper watershed of Delaware, poultry farms are common and poultry waste is applied to row crops. There are also many channelized streams draining nontidal wetlands to be used as agricultural land (MDE, 2000).

Hydric soil suggests where wetlands are currently or were historically. Areas having hydric soil, but that are no longer wetlands, have the potential to be good wetland restoration sites. Within the Caroline County portion of this watershed, there is a large amount of hydric soil that is not wetland (based on GIS data: NRCS SSURGO, DNR wetlands, NWI wetlands). This is very poorly drained or poorly drained soil.

A large portion of Marshyhope Creek and some of the tributaries, especially in upstream portions of Delaware, have been channelized with the spoil deposited in spoil banks parallel to the channel, dividing the creek from the historic floodplain swamp. This was done to expedite water movement. In addition to the standard loss of habitat and increase in downstream flooding caused by channelization, it has also resulted in the loss of sediment and nutrient filtering function of the wetland. The stream in certain reaches no longer floods over the banks to deposit sediment in the floodplain. Now, some of the sediments and nutrients are washed downstream, where they cause problems due to sedimentation and nutrient enrichment of those systems (Sipple, 1999). A large stream channel, floodplain and wetland restoration project was completed near the Town of Federalsburg to alleviate flooding problems. A portion of channelized floodplain that was in a landscaped area or mined land was restored to a combination of forested, scrub-shrub, and emergent tidal and nontidal wetland. A channel was created to re-connect Marshyhope Creek to its floodplain and provide the hydrology to support the adjacent wetlands. The channel also connects to a pond and provides access and habitat for spawning anadromous fish.

A tidal freshwater shrub wetland in the Dorchester County portion of Marshyhope Creek was identified as a reference area as the best example of a distinct and rare plant community of Seaside alder (*Alnus maritimus*) and Sweetflag *(Acorus calamus)*. The

community is a distinct ecotone between the tidal freshwater emergent wetland and tidal fresh swamp.

Estimates of wetland acreage for the entire Maryland portion of the watershed, based on DNR mapped wetlands, are as follows:

- Palustrine
    - Emergent: 424 acres
    - Scrub shrub: 453 acres
    - Forested: 10,975 acres
    - Unconsolidated bottom: 254 acres
    - Farmed: 68 acres
- Total: 12,173 acres

The following information is summarized from the document entitled *Watershed-based Wetland Characterization Maryland's Nanticoke River and Coastal Bays Watersheds: A Preliminary Assessment Report* (Tiner et al., 2000)

Tiner et al. (2000) classified wetlands in the 8-digit watersheds Nanticoke River, Marshyhope Creek, and the Coastal Bay watersheds using a classification scheme that bridged the NWI classification to the HGM classification. This method is described in the document entitled *Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors* (Tiner, 2003a). As a base map, they used the wetlands identified in the National Wetland Inventory (NWI). They modified this NWI map by photointerpretating 1998 1:40,000 black and white aerial photography and incorporating State digital wetland maps (from 1989 photography), digital submerged aquatic vegetation data, and Natural Resource Conservation Service digital hydric soil data. Additionally, investigators conducted a limited amount of field surveying. In the Tiner et al. (2000) document, they acknowledge that palustrine forested wetlands may be overestimated using this method due to difficultly in distinguishing between forests that are currently wetlands and ones that were drained but still have hydric soils.

These wetlands were classified into HGM types based on landscape position, landform, and water flow direction of the wetlands, determined by comparing the wetland maps with topographic maps and aerial photos. Wetlands in these watersheds were classified into five groups depending on their landscape positions, or their relationship to an adjacent waterbody: marine, estuarine, lotic (adjacent to freshwater streams and rivers), lenthic (associated with lakes), and terrene (isolated or headwater). Within the Nanticoke and Marshyhope Creek watersheds, over half of the wetlands were classified as terrene (53%), a large percentage as estuarine (35%), and the remaining as lotic (13%) and lentic (<1%). These wetland types were further subdivided based on where they occur within these classifications and their water flow path.

Tiner et al. (2000) then assessed the potential ability of each wetland classification to provide a given function in the process called "Watershed-based Preliminary Assessment of Wetland Function." This assignment of function based on wetland type is described in

the document entitled *Correlating Enhanced National Wetlands Inventory Data with Wetland Functions for Watershed Assessments: A Rationale for Northeastern U.S. Wetlands* (Tiner, 2003b). The evaluated functions included: surface water detention, streamflow maintenance, nutrient transformation, sediment and particulate retention, coastal storm surge detention and shoreline stabilization, inland shoreline stabilization, fish and shellfish habitat, waterfowl and waterbird habitat, other wildlife habitat, and conservation of biodiversity. Wetlands along the Nanticoke River, Marshyhope Creek, and tributaries have a high potential for surface water detention, nutrient transformation, and sediment and particulate retention. The estuarine and lotic river portions had high potential for coastal storm surge detention and shoreline stabilization. Many of the terrene wetlands were estimated to have moderate to high potential for surface water detention. Wetlands along the Marshyhope Creek and tributaries had high potential for streamflow maintenance and inland shoreline stabilization. The Nanticoke River and lower tributaries had high potential for fish and shellfish habitat, and waterfowl and waterbird habitat. They also identified wetlands significant for other wildlife habitat: large wetlands ($\geq$20 acres) and small diverse wetlands (10-20 acres having $\geq$2 different covertypes). Many of the diverse wetlands were already designated as WSSC and were within Marshyhope Creek watershed (Dorchester and Caroline Counties) or associated with Chicone Creek (Dorchester County). They then identified wetlands thought to significant for biodiversity. These included: the large middle and upper estuarine wetlands of Nanticoke River (oligohaline in the middle), the large lotic river wetland along Marshyhope Creek, the large terrene wetland area near Finchville (Dorchester County), the large terrene wetland area between Chicone Creek and Marshyhope Creek (Dorchester County), the large terrene wetland just north of Mardela Springs (Wicomico County), the large terrene wetland important to forest breeding avifauna encompassing Athol, Rewastico, and Quantico (Wicomico County), and the large terrene wetland between Royal Oak, Head of the Creek, and Wetipquin (Wicomico County). More intensive fieldwork may produce different results, since some HGM types are difficult to distinguish from one another. In addition, some functions rely on characteristics only seen in the field, such as micro-topography.

For the combined Nanticoke River and Marshyhope Creek watersheds, the land cover for the 100m buffer around wetlands and waterbodies was estimated to be 34% natural vegetation, 59% agriculture, and 7% developed. There are a large number of channelized streams and ditches (Tiner et al., 2000).

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a slight gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02130306	-2.40	4.40	12.00	0.00	14.00

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a "designated use" in the Code of Maryland Regulations 26.08.02.08. This watershed is designated Use I, recreation contact and fishing.

Water Quality

Source water assessments were completed on some water systems within this watershed. The water system and susceptibility are as follows:

- *Town of Federalsburg*: radionuclides.
- *Meadow Brook Court* (about 2 miles northwest of Federalsburg): fluoride, radionuclides.

The 1998 Clean Water Action Plan classified this watershed as Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. It is also classified as a Category 3, a watershed in need of protection. Failing indicators include high modeled nitrogen and phosphorus loads, low non-tidal benthic IBI, high historic wetland loss (28,117 acres), and being on the 303(d) List for impaired water quality. Indicators for Category 3 include a high imperiled aquatic species indicator, six migratory fish spawning areas, and State-designated Wildlands (3,166 acres).

According to the *2002 Maryland Section 305(b) Water Quality Report*, the lower portion of the tidal Marshyhope Creek supports all designated uses (0.6 $mi.^2$). Some portions of the nontidal wadeable tributaries (i.e. the subwatershed Tommy Wright Branch; DNR, 2000) fail to fully support all designated uses (9.6 mi. support, 6.4 mi. fails to support, 46.0 mi. inconclusive) due to poor biological community from siltation, and changes in habitat and hydrology. Chambers Lake fully supports all uses (9.4 acres), as does Smithville Community Pond (40 acres).

The 2004 303(d) List contains basins and subbasins that have measured water quality impairment and may require a TMDL. The basin/subbasin name, subbasin number (if applicable), and type of impairment are as follows:

- *Marshyhope Creek* (tidal); suspended sediments. Nutrients are also impairing this waterway, but a TMDL has been completed for this pollutant.
- *Tommy Wright Branch* (021303060615 non-tidal in Caroline County); sedimentation.

The following information is based on the MDE document entitled *Total Maximum Daily Loads of Phosphorus for the Marshyhope Creek, Dorchester and Caroline Counties, Maryland*. This waterway is not fully supporting the Use I designation due to dissolved oxygen that likely is <5.0ug/l at night, and high chlorophyll a (eutrophic with high amounts of algae) which limits recreational uses of swimming and fishing. Sources of nutrients include: nitrogen – agriculture (77%), urban (8%), points sources (7%), forest/herbaceous (7%), and atmospheric deposition (1%); phosphorus – agriculture (72%), point sources (24%), urban (3%), forest/herbaceous (0.5%), and atmospheric

deposition (0.5%). Point sources include: Hurlock WWTP, Federalsburg WWTP, Col. Richardson High Scholl WWTP, and W.O. Whyteley and Sons Company (discharging insignificant amounts). Allen Foods, currently discharging into Hurlock WWTP, will have a separate discharge permit in the future. Analysis of water samples found chlorophyll a was higher in the downstream portions (between the mouth and 15 miles upstream). The TMDL requires a 40% decrease in phosphorus during low flow periods.

Of the two MBSS samples taken, BIBI was good and very poor and FIBI was good and fair. The worst sample was at Tommy Wright Branch.

Restoration/Preservation

There is a moderately-sized hub just north of Federalsburg (encompassing Marshyhope Creek) which is mostly protected by Idylwild Wildlife Management Area. There are other smaller hubs and corridors that are unprotected (DNR, 2000-2003). There are also some areas of agriculture within the designated Green Infrastructure hubs and corridors. It may be desirable to restore these gaps back to natural vegetation. According to the 2000 Maryland Greenways Commission document, an existing ecological greenway is the Marshyhope Creek greenway. This greenway follows a Green Infrastructure hub from Federalsburg to the Delaware Line, with potential expansion to other towns. It runs through Idylwild Wildlife Management Area, Marshyhope Ponds (land historically used for extraction), and connects with existing trails in Federalsburg. Parts of the floodplain have been restored into wetland and riparian habitat. In addition to the above-mentioned Idylwild WMA, other relevant protected land includes DNR-owned Chesapeake Forest land, MET holdings, and County land.

The following information is summarized from the document *Rural Legacy FY 2003: Applications and State Agency Review*. Rural Legacy designated areas are sponsored by Eastern Shore Rural Legacy Sponsor Board and Eastern Shore Land Conservancy, Inc. The goal of this preservation effort is to protect agriculture (including important productive soils) and natural resources, including water quality of Marshyhope and Tuckahoe Rivers, other waterways, and habitats. There are 10,393 acres total (based on GIS data) designated as Rural Legacy area. This includes two areas: Tuckahoe and Marshyhope. The Tuckahoe Rural Legacy Area is located on the Western portion of the County, next to Tuckahoe Creek. The Marshyhope Rural Legacy Area is located in the southern part of the County, adjacent to Idylwild Wildlife Management Area. There are 1,576 acres of protected land within the Tuckahoe Rural Legacy Area and 1,543 acres of protected land within the Marshyhope Rural Legacy Area. The report also includes a list of property owners who are interested in selling an easement and the priority of acquiring these easements. Since the Rural Legacy Program funds are not always adequate enough to support all of these requests, other programs should consider preservation of these sites.

There are two State-designated and one potential Nontidal Wetlands of Special State Concern within the Caroline County portion of this watershed. These are described below.

- *Bates Ditch (DNR proposed for deletion)*. This is a roadside wetland, adjacent to a Loblolly Pine Plantation. This site contains a State Endangered sedge, also considered to be a potential candidate for listing under U.S. Endangered Species Act. It is likely that this endangered plant species requires periodic disturbance to thrive, including roadside suppression of woody vegetation (DNR, 1991).
- *Smithville Swamp (DNR name: Marshyhope Creek North; DNR proposed for deletion)*. This large forested swamp contains a sphagnous seep with a healthy population of a State Endangered plant (and also potentially a candidate for listing under the U.S. Endangered Species Act). In 1983, this swamp was partially logged. The logging and resulting wetland canopy opening may have created conditions similar to those historically provided by fire and flooding. Since these wetland canopy openings are now fairly uncommon, they provide habitat for rare species. Since the occurrences of this species are so limited, it is likely this plant requires specific soil and hydrologic conditions to thrive. This site is adjacent to a State Wildlife Management Area (DNR, 1991).
- There is a large potential WSSC along Marshyhope Creek (within and north of Federalsburg). While much of it is protected within Idylwood WMA, some is unprotected.

In the document entitled *Watershed-based Wetland Characterization for Maryland's Nanticoke River and Coastal Bays Watersheds: A Preliminary Assessment Report*, Tiner et al., (2000) proposed wetland restoration sites in the Nanticoke River and Marshyhope Creek watersheds totaling 22,506 acres. These sites were classified into two categories: former wetlands (Type 1) and existing impaired wetlands (Type 2). Type 1 sites included filled wetlands (without any buildings on them), farmed wetlands, and those converted to deepwater. There were only 360 acres of Type 1 sites, scattered throughout the two watersheds. The Type 1 estimate is conservative because they did not include areas having hydric soils that were effectively drained, and now appeared to be productive farmland. These areas were indistinguishable from the surrounding land in aerial photographs and the likelihood of landowner interest is low. However, since identified Type 1 sites are generally surrounded by effectively drained areas, restoration potential acreage is larger than it may first appear. About a third of the existing wetlands within these two watersheds are designated as Type 2 sites, degraded wetlands. Most of these wetlands were ditched palustrine (98%), but some were tidally restricted, impounded, or excavated. There were 22,146 acres classified as Type 2 sites. While these sites are scattered throughout the watersheds, a large Type 2 wetland restoration opportunity is located between the Chicone Creek and Marshyhope Creek (Marshyhope Creek and Nanticoke River watersheds – Dorchester County).

Specific Restoration Recommendations

- Restore natural stream channels in Marshyhope Creek and tributaries to reconnect the creek with the historic floodplain swamp (Sipple, 1999).
- Restore gaps in designated Green Infrastructure back to natural vegetation, especially around waterways (e.g. around Faulkner Branch, Hickman Ditch, and Tommy White Branch).

- Restore/create wetlands designed to retain phosphorus, in order to help achieve TMDL goals for Marshyhope Creek watershed.
- Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations

- Protect currently unprotected Green Infrastructure, especially around waterways (e.g. around Faulkner Branch, Hickman Ditch, and Tommy White Branch).
- Protect high priority areas within the Rural Legacy Area.
- Protect any portions of the WSSCs and surrounding buffer that are not currently protected.
- Protect wetlands that function to remove phosphorus from Marshyhope Creek watershed.
- Protect additional wetlands within designated Ecologically Significant Areas.
- Protect wetlands and streams within the headwaters.

Lower Choptank (02130403)

Background

The Caroline County portion of this watershed has approximately 8,254 land acres (based on MDP 2002 GIS land use data). The majority is agriculture (75%), with the remaining divided between forest (17%) and developed land (6%). There is also some wetland area (2%). Note that wetland acreage based on this land use data may be grossly underestimated. Better estimates of wetland acreage are provided based on DNR wetlands data, as presented below. Wetlands are mostly associated with Hunting Creek and tributaries. These wetland provide the functions of water quality improvement, flood attenuation, stream recharge, and wildlife habitat. Hydric soil suggests where wetlands are currently or were historically. Areas having hydric soil, but that are no longer wetlands, have the potential to be good wetland restoration sites. Within the Caroline County portion of this watershed, there is a large amount of hydric soil that is not wetland (based on GIS data: NRCS SSURGO, DNR wetlands, NWI wetlands). Much of this is poorly drained soil. These areas may be desirable for wetland restoration.

There are extensive freshwater tidal marshes located along meandering portions or on alluvial deposits along the Choptank River. Some of the regions highest densities of transient and wintering waterfowl are located in the Choptank River. Tidal marsh portions along the Choptank River, north of Cambridge, have had very large areas of marsh vegetation destroyed due to overly dense muskrat populations. While it changed the vegetative structure, it also resulted in loss of peat (Sipple, 1999).

Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

- Estuarine
    - Emergent: 3,459 acres
    - Scrub shrub: 6 acres
    - Forested: 6 acres

    - Unconsolidated shore: 320 acres
- Palustrine
    - Aquatic bed: 5 acres
    - Emergent: 292 acres
    - Scrub shrub: 661 acres
    - Forested: 3,686 acres
    - Unconsolidated bottom: 665 acres
    - Unconsolidated shore: 4 acres
    - Farmed: 32 acres
- Riverine unconsolidated shore: 4 acres
- Total: 9,140 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a slight gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02130403	-14.34	5.53	14.00	11.58	16.77

A 14-acre programmatic mitigation site was constructed in this watershed in 1994-95. The site is predominantly forested with a smaller area of emergent wetlands. The site was managed to remove invasive cattails with limited success. A deeper water area was also constructed after 2000 to provide more visible waterfowl habitat (Beston, pers. comm).

A reference tidal wetland community of *Panicum virgatum* (Switchgrass) is found along Hunting Creek. The area is a transition between other wetland types and uplands (Harrison, 2001).

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a "designated use" in the Code of Maryland Regulations 26.08.02.08. All waterways not specifically designated in COMAR are classified Use I, recreation contact and protection of aquatic life. This watershed is designated as follows:

- Choptank River and tributaries above Bow Knee Point and Wright Wharf: Use I, recreation contact and protection of aquatic life.
- Tred Avon River and tributaries above Easton Point: Use I, recreation contact and protection of aquatic life.
- All estuarine portions except those listed above: Use II, shellfish harvesting.

Water Quality

Source water assessments were completed for several water systems in this watershed. The water system and the susceptibility are as follows:

- *Preston Waterworks – Nelphine Heights*: radionuclides.

- *Town of Preston*: radionuclides.
- *Nelphine Mobile Home Park* (~1.5 miles northeast of Preston): radionuclides.

The 1998 Clean Water Action Plan classified this watershed as Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. Failing indicators include high nutrient concentrations, low SAV habitat index, low tidal benthic IBI, low non-tidal benthic IBI, high historic wetland loss (56,918 acres), high percent stream buffer unforested (62%), and being on the 303(d) List for water quality impairment. An indicator suggesting need for protection includes presence of five migratory fish spawning areas.

According to the *2002 Maryland Section 305(b) Water Quality Report*, a portion of the tidal Little Choptank River and tributaries fail to fully support all designated uses (93.1 $mi.^2$ supports, 33.8 $mi.^2$ fails to support) due to low oxygen, bacteria, and poor benthic community from nonpoint, eutrophication, industrial, and natural sources. Portions of the nontidal wadeable tributaries (i.e. East Branch Bolingbroke Creek subwatershed; DNR, 2000) fail to support all designated uses (3.5 mi. support, 2.3 mi. fail to support, 20.9 mi. inconclusive) due to poor fish and benthic community from siltation, agricultural runoff, bank instability and stream alteration.

The 2004 303(d) List contains basins and subbasins that have measured water quality impairment and may require a TMDL. The basin/subbasin name, subbasin number (if applicable), and type of impairment are as follows:

- *Lower Choptank* (tidal); fecal coliform, nutrients, suspended sediments, poor biological community.
- *Unnamed tributary to Trappe Creek* (021304030463 non-tidal in Talbot); poor biological community. This waterway is also impaired by biochemical oxygen demand and phosphorus, but TMDLs have been completed for these pollutants.
- *Tred Avon River* (021304030462 tidal in Talbot); fecal coliform.
- *Tar Creek* (021304030461 tidal in Talbot); fecal coliform.
- *San Domingo Creek* (021304030457 tidal in Talbot); fecal coliform.
- *Jenkins Creek* (021304030458 tidal in Dorchester County); fecal coliform.
- *Indian Creek* (021304030458 tidal in Dorchester County); fecal coliform.
- *Warwick River* (021304030466 tidal in Dorchester County); fecal coliform.
- *Cummings Creek* (021304030455 tidal in Talbot); fecal coliform.
- *Northeast Branch* (021304030455 tidal in Talbot); fecal coliform.
- *Whitehall Creek* (021304030458 tidal in Dorchester County); fecal coliform.
- *Goose Creek* (021304030458 tidal in Dorchester County); fecal coliform.
- *Town Creek*; This waterway is impaired by biochemical oxygen demand, but a TMDL has been completed for this pollutant.
- *Unnamed tributary to Windmill Branch* (021304030464 non-tidal in Talbot); poor biological community.
- *Eastern Branch Bolingbroke Creek* (021304030459 non-tidal in Talbot); poor biological community.

- *Hunting Creek* (021304030471 non-tidal in Caroline); poor biological community.

MBSS data found BIBI of good and poor and FIBI of fair.

Restoration/Preservation

This watershed has a small amount of Green Infrastructure, all unprotected (DNR, 2000-2003). DNR owns a nursery in this watershed.

Specific Restoration Recommendations

- Restore gaps in designated Green Infrastructure back to natural vegetation, especially around Hunting Creek and tributaries.
- Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations

- Protect currently unprotected Green Infrastructure, especially around Hunting Creek and tributaries.
- Protect areas used as reference sites for DNR's tidal vegetative community study (*Panicum virgatum* marsh on Hunting Creek).
- Protect wetlands and streams within the headwaters.

Upper Choptank (02130404)

Background

This watershed is located partially in Caroline County, Queen Anne County, and Delaware. The entire Maryland portion of the watershed has roughly 60% agriculture, 30% forest/brush, and 8% developed. The Delaware portion of this watershed has less intense land use, with more forest (45%) and less agriculture (50%) and developed (3%) land use than Maryland.

The Caroline County portion of this watershed has roughly 120,501 land acres (based on MDP 2002 land use GIS data). Over half is agriculture (58%), about a third is forest (30%), and the remaining is developed (9%), and wetland (2%). Note that wetland acreage estimates based on this land use data are grossly underestimated, so we provide estimates from the DNR wetland survey (as found below). Developed areas are of higher density around the Choptank River. Most wetlands are associated with the Choptank River or tributaries. These wetlands provide the functions of water quality improvement, flood attenuation, stream recharge, and wildlife habitat. Some smaller wetlands that are not directly associated with waterways are scattered throughout the watershed, with a concentration in the northern portion of the watershed, in the headwaters of the Choptank River. These wetlands are also very important for water quality improvement, including removing/cycling nutrients, removing sediment and other pollutants, and for wildlife habitat. Hydric soil suggests where wetlands are currently or were historically. A large amount of developed land and agriculture are on hydric soils. Since many agricultural

areas are on wet soils, many have PDA ditches, which are critical to their production. Areas having hydric soil, but that are no longer wetlands, have the potential to be good wetland restoration sites. Within the Caroline County portion of this watershed, there is a large amount of hydric soil that is not wetland (based on GIS data: NRCS SSURGO, DNR wetlands, NWI wetlands).

Sipple (1999) noted that the Choptank River, like other middle sections of estuaries, has a strong meandering pattern, with the outside of the river bend abutting uplands and the inside of the bend being covered in extensive fresh to slightly brackish tidal marsh. During the twice daily tides, the river overflows to the smaller stream banks and over the marsh surface. As the water recedes, the marshes act as a sediment trap, with sediment being deposited throughout the marsh. The spatially heterogeneous wetland vegetation also provides important habitat for bald eagles, various ducks, muskrat, and other wildlife.

As part of an ongoing project to classify the vegetative communities in Maryland, MDNR created the document entitled *Shrubland Tidal Wetland Communities of Maryland's Eastern Shore*. In this document, they categorize nine shrubland tidal wetland communities, including some in Caroline County. One of the reference sites, the best example of a particular community type, is the *Iva frutescens/Spartina cynosuroides* tidal wetland on the Choptank River (Frazier Point). This relatively secure community type is ranked S4: "more than 100 occurrences are known in the State or fewer occurrences if they contain a large number of individuals." This site is at risk for invasion by *Phragmites.*

During this same project, MDNR also created the document entitled *Herbaceous Tidal Wetland Communities of Maryland's Eastern Shore*. In this document, they characterized 14 community types, with some being found in this County. There are several reference tidal wetland communities that are flooded daily with fresh or slightly brackish (oligohaline) water. Two reference sites, the best example of two particular community types, are *Peltandra virginica-Pontederia cordata* tidal herbaceous vegetation in a fresh to oligohaline system and *Nuphar lutea ssp. advena* freshwater tidal herbaceous vegetation. Both sites are on Watts Branch (a tributary to the Choptank River, NW of Williston). Both these community types were designated S4, a community type being "secure under present conditions in Maryland". Other sites in the watershed include the Sweetflag (*Acorus calamus*)-dominated community in Denton Marsh and a Wild rice (*Zizania aquatica*) community near Greensboro.

Community wells generally draw from deep aquifers. Fish populations seem fairly healthy. The Upper Choptank River is the third most important spawning and nursery for striped bass, with the most important spawning and nursery area being from Denton to Bow Knee Point (Shanks, 2002).

Estimates of wetland acreage for the entire Maryland portion of the watershed, based on DNR mapped wetlands, are as follows:

- Estuarine

    - Emergent: 3,265 acres
    - Scrub shrub: 2 acres
    - Unconsolidated shore: 109 acres
- Palustrine
    - Aquatic bed: 2 acres
    - Emergent: 519 acres
    - Scrub shrub: 931 acres
    - Forested: 10,045 acres
    - Unconsolidated bottom: 604 acres
    - Farmed: 620 acres
- Riverine: 176 acres
- Total: 16,272 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02130404	-6.27	1.06	80.00	12.59	87.38

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a "designated use" in the Code of Maryland Regulations 26.08.02.08. This watershed is designated Use I, recreation contact and fishing.

Water Quality

Source water assessments were completed for several water systems in this watershed. The water system and susceptibility are as follows:

- *Town of Denton*: fluoride, arsenic, and radionuclides.
- *Greensboro*: fluoride and radionuclides.
- *Ridgely*: radionuclides.
- *Harman Subdivision*: fluoride, arsenic, and radionuclides.
- *Henderson*: fluoride, arsenic.
- *Caroline Acres Mobile Home Park*: arsenic and radionuclides.
- *Cedar Mobile Home Park*: fluoride, arsenic, and radionuclides.
- *Holly Cove Harbor Mobile Home Park*: fluoride.
- *Prettyman Manor Mobile Home Park*: radionuclides.
- *Hilltop Mobile Home Park*: radionuclides.
- *Tower Court Mobile Home Park*: radionuclides.
- *Denny Taylor Mobile Home Park*: radionuclides.
- *Marsh Creek Mobile Home Park*: fluoride.
- *Blue Heron Assisted Living*: radionuclides.

The 1998 Clean Water Action Plan classified this watershed as Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. It is also classified as a Category 3, a watershed in need of protection. Failing indicators include high modeled phosphorus loads, low SAV habitat index, low tidal benthic IBI, low non-tidal benthic IBI, high historic wetland loss (48,169 acres), high soil erodibility (0.28), and being on the 303(d) List for water quality impairments. Indicators for Category 3 include a high imperiled aquatic species indicator and six migratory fish spawning areas.

According to the *2002 Maryland Section 305(b) Water Quality Report*, the tidal and nontidal Upper Choptank River and tidal tributaries fully supports all designated uses (14.1 mi.^{2}). Nontidal wadeable tributaries fail to support all designated uses (127.5 mi.) due to poor biological community from siltation, low oxygen, channelization and changes in hydrology.

The 2004 303(d) List contains basins and subbasins that have measured water quality impairment and may require a TMDL. The basin/subbasin name, subbasin number (if applicable), and type of impairment are as follows:

- *Upper Choptank* (tidal); nutrients, suspended sediment.
- *Choptank River Unnamed Tributary 1* (021304040487 non-tidal in Caroline); poor biological community.
- *Choptank River Unnamed Tributary* (021304040496 non-tidal in Caroline); poor biological community.
- *Miles Creek Unnamed Tributary* (021304040473 non-tidal in Talbot); poor biological community.
- *Beaverdam Branch* (021304040483 non-tidal in Talbot); poor biological community.
- *Herring Run Unnamed Tributary* (021304040490 non-tidal in Caroline); sedimentation.
- *Broadway Branch* (021304040509 non-tidal in Caroline); poor biological community.
- *Forge Branch* (021304040505 non-tidal in Caroline); poor biological community.
- *Forge Branch Unnamed tributary* (021304040505 non-tidal in Caroline); poor biological community.
- *Forge Branch Unnamed tributary* (021304040504 non-tidal in Caroline); sedimentation.
- *Oldtown Branch* (021304040508 non-tidal in Caroline); poor biological community.
- *Oldtown Branch Unnamed Tributary 1* (021304040508 non-tidal in Caroline); poor biological community.
- *Fowling Creek Unnamed Tributary 1* (021304040485 non-tidal in Caroline); poor biological community.
- *Harrington Beaverdam Ditch Unnamed Tributary 1* (021304040515 non-tidal); poor biological community.

- *Tidy Island Creek* (021304040512 non-tidal in Caroline); poor biological community.
- *Tidy Island Creek Unnamed Tributary* (021304040509 non-tidal in Caroline); sedimentation.
- *Tidy Island Creek Unnamed Tributary 1* (021304040514 non-tidal in Caroline); poor biological community.
- *Coolspring Branch* (021304040514 non-tidal in Caroline); poor biological community.
- *Robins Creek Unnamed Tributary* (021304040486 non-tidal in Caroline); poor biological community.
- *Andover Branch Unnamed Tributary* (021304040515 non-tidal); poor biological community.

The following information is based on the 2002 DNR document entitled *Upper Choptank River Watershed Characterization*. In addition to problems with nutrients and sediments, there are areas of high chlorophyll levels, poor water clarity, and high fecal coliform. There is a fish consumption advisory in the Choptank River regarding contamination by PCB and pesticides in catfish and white perch (Shanks, 2002). Approximately 60% of the sites were rated as poor or very poor for benthic macroinvertebrates and good or fair for fish. This suggests that fish may be more tolerant of agricultural ditches than benthic macroinvertebrates. SAV is fairly sparse, likely due to limited water clarity and depth of the river, and are located along the shoreline.

The following is based on TURPA, Creek Watchers, CISNET, TMDL, and Chesapeake Bay Program data as compiled by Horn Point Laboratory and summarized by Shanks (2002). Although DO is generally above 5mg/L in this watershed, as unnamed tributary at North Dover Road (in Talbot County) had a reading below 2mg/L and the site at Old Town Branch had a reading of 3mg/L. Total suspended solids were higher downstream of Tuckahoe Creek and lower upstream of Denton. Chlorophyll a is generally higher between Denton and Tuckahoe Creek. Tributary strategy teams sampled two sites. Ganey Wharf had poor nitrogen and suspended sediments and fair phosphorus while Red Bridges had fair nitrogen and phosphorus.

The Maryland Biological Stream Survey sampled streams between 1994 and 2000. The benthic IBI rankings ranged from good to very poor. Those ranked good and fair were generally downstream of Denton, while those ranked very poor tended to be upstream of Denton.

The DNR document entitled *Report on Nutrient and Biological Synoptic Surveys in the Upper Choptank Watershed, March/April 2002* explains the water conditions:

> Broadway Branch had baseline to moderate nutrient concentrations and yields. The macroinvertebrate sample and habitat assessment at the watershed outlet indicated habitat as the primary problem. Chicken Branch had excessive nutrient concentrations and yields throughout the watershed. The macroinvertebrate sample and habitat assessment at the watershed outlet indicated both habitat and water quality problems. Forge Branch

had a full range of nutrient concentrations and yields, with moderate yields at the watershed outlet. Macroinvertebrate sampling and habitat assessment indicated only minor habitat problems. Watts Creek had some areas of elevated nutrients, but all yields were baseline at the watershed outlet. Macroinvertebrate sampling and habitat assessment indicated this stream was in excellent condition. Nutrient concentrations and yields in Long Branch were moderate at worst. Macroinvertebrate sampling and habitat assessment indicated a possible water quality problem from something other than nutrients. Little Creek had the full range of nutrient concentrations and yields. Low flow limited the impact of excessive concentrations. The macroinvertebrate sampling and habitat assessment indicated a water quality problem that could be associated with low pH. The Talbot County watersheds also had a full range of nutrient concentrations and yields. The upper portion of the Beaverdam watershed was the focus of the elevated concentrations and yields. Macroinvertebrate sampling and habitat assessment indicated habitat degradation was the primary impact on the benthic community rather than water quality. Sampling in untargeted subwatersheds found the full range of nutrient concentrations and yields. Contributions from Delaware into the upper portion of the watershed were minimal. Seven other subwatersheds, two originating in Delaware, had excessive nutrient yields.

Restoration/Preservation

The *Upper Choptank River Strategic Watershed Restoration Action Plan* was completed in 2003. Some recommendations included in this plan are as follows:

- Preserve land in order to protect natural resources and water quality
- Protect wetlands, buffers, and forests
- Preserve the most productive agricultural land

This watershed has a moderate amount of Green Infrastructure throughout the watershed. There are few noticeably large sections, but instead the main Green Infrastructure follows the Choptank River and tributary stream corridors. A moderately-sized unprotected hub is located along Skeleton Creek (at the southwestern end of this watershed). The density of Green Infrastructure is higher in the northern portion of this watershed. An example of an area with possible restoration potential includes an agricultural gap southwest of Bethlehem that, if restored to natural vegetation, would enlarge the hub area along the Choptank River (DNR, 2000-2003). According to the 2000 Maryland Greenways Commission document, potential greenways include:

- *Denton Municipal Greenway*. This trail would connect Martinak State Park to public land within Denton. This trail may also be extended to Rehoboth Beach.
- *Hillsboro Rail Trail*. This trail would follow an inactive railroad line, connecting Denton with Hillsboro (and also with Tuckahoe State Park).
- *Easton-Clayton Rail Trail*. This trail would connect Tuckahoe State Park to Ridgely and Greenboro, and eventually to Goldspboro and the Delaware State

line, along the Chesapeake Railroad right-of-way. This trail is a smaller part of the future plan to connect Easton (Talbot County) to Delaware.

- *Upper Choptank River Greenway*. This trail would follow the river or a utility corridor to connect the Christian Park with the Greenboro boat ramp.
- *Choptank River Water Trail*. This water trail would follow the Upper Choptank River, in an effort to establish water routes along the Choptank and Tuckahoe Rivers.

The following information is summarized from the document *Rural Legacy FY 2003: Applications and State Agency Review*. Rural Legacy designated areas are sponsored by Eastern Shore Rural Legacy Sponsor Board and Eastern Shore Land Conservancy, Inc. The goal of this preservation effort is to protect agriculture (including important productive soils) and natural resources, including water quality of Marshyhope and Tuckahoe Rivers, other waterways, and habitats. There are 10,393 acres total (based on GIS data) designated as Rural Legacy area. This includes two areas: Tuckahoe and Marshyhope. The Tuckahoe Rural Legacy Area is located on the western portion of the County, next to Tuckahoe Creek. The Marshyhope Rural Legacy Area is located in the southern part of the County, adjacent to Idylwild Wildlife Management Area. There are 1,576 acres of protected land within the Tuckahoe Rural Legacy Area and 1,543 acres of protected land within the Marshyhope Rural Legacy Area. The report also includes a list of property owners who are interested in selling an easement and the priority of acquiring these easements. Since the Rural Legacy Program funds are not always adequate enough to support all of these requests, other programs should consider preservation of these sites.

In addition to the above-mentioned protected land, there are some TNC properties (Jackson Lane/Eaton's Pond Preserve, Choptank Wetlands Preserve, Persimmon, and Pelot Bird Sanctuary), DNR-owned land (including some Chesapeake Forest land), County land, and MET holdings.

The tidal wetland reference communities on Watts Creek, Denton Marsh, and Greensboro are recommended for preservation.

There are several designated Nontidal Wetlands of Special State Concern (WSSC) and some additional potential WSSC within the Caroline County portion of this watershed. They are described as follows:

- *Central Avenue Corner*. This diverse forested wetland contains eleven small Delmarva bays with four rare species (three endangered plant species emerging in the drier summer months and one tree species in the adjacent upland area). Since these bays were surveyed in the fall, additional surveying should be conducted to encompass the seasonality of the system. Delmarva bays are seasonal groundwater fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development (DNR, 1991). Main threats include reductions in groundwater quality and quantity (from nearby wells and drainage ditches) and development

construction (on the west side). Forested buffers should be maintained, but encroachment by woody species into the rare species habitat should be monitored (Ludwig et al., 1987). This site is unprotected.

- *East Melville Pond*. This is 1–acre Delmarva bay is dominated by shrub and herbaceous species and is adjacent to a Red maple/Sweet Gum swamp on the east. In the fall, this bay contains four RTE species. Of these, three are State Endangered herbaceous species, all candidates for listing under the U.S. Endangered Species Act. The fourth species is a State rare plant. Delmarva bays are seasonal groundwater fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development (DNR, 1991). This site is unprotected.
- *Floral Swale (DNR combined this site with Persimmon Preserve Site)*. This wetland is within a powerline right-of-way and contains a State Endangered and nationally rare plant. This species may require very specific soil and hydrologic conditions in order to thrive, limiting its distribution elsewhere. The maintenance for the powerline right-of-way includes suppression of woody species, allowing the wetland to be dominated by herbaceous species. These wetland openings were historically created through fires and floods, which are now uncommon due to human intervention. Therefore, these right-of-ways can create uncommon habitats for rare species (DNR, 1991). This site is unprotected.
- *Greer's Pond (DNR combined this site with Mount Zion Wetlands)*. This wetland complex contains shrub swamp and Delmarva bays with three RTE plant species. Delmarva bays are seasonal groundwater fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development. Since these bays were surveyed in the fall, additional surveying should be conducted to encompass the seasonality of the system (DNR, 1991). Main threats includes alteration of hydrology and encroachment by woody species and common sedges. The forested buffer should also be maintained (Ludwig et al., 1987). This site is unprotected.
- *Hourglass Pond (DNR combined this site with Jackson Lane Pond)*. This is a 2-acre Delmarva bay dominated by herbaceous species including a State Endangered plant species, which is also a candidate for listing under the U.S. Endangered Species Act. Delmarva bays are seasonal groundwater fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development. Since these bays were surveyed in the fall, additional surveying should be conducted to encompass the seasonality of the system (DNR, 1991). Mowing of an adjacent powerline is allowing encroachment of non-native plant species into the western section of the pond. The main threats are alteration of the hydrology and invasion by non-native plant species. The forested buffer should be maintained (Ludwig et al., 1987). This site is unprotected.
- *Jackson Lane Site*. This site contains several Delmarva bays dominated by herbaceous species, containing three State Endangered plant species. One of these

species is a candidate for listing under the U.S. Endangered Species Act. Delmarva bays are seasonal groundwater fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development. Much of this wetland system, including 167 acres, is owned by a private conservation organization. However, half of the important Delmarva bay is still unprotected (DNR, 1991). A portion of this site is protected by TNC. The Nature Conservancy, U.S. Fish and Wildlife Service, Maryland Department of Natural Resources, Natural Resources Conservation Service, and Maryland Department of the Environment have constructed a large restoration site and protection area for Delmarva Bays and amphibians. Berms were constructed and subsurface tile drains were remove to increase hydrology. Restoration of a unique component, Pasture Pond, was accomplished by removing numerous red maple trees to allow natural revegetation of an herbaceous plant community. Extensive tree and shrub plantings were also done in the wetland and surrounding uplands. Coarse woody debris was also placed in the site to provide cover and resting places for reptiles, amphibians, and small mammals. Extensive monitoring is being conducted for the Nature Conservancy by the University of Maryland and Towson State University (Mason, pers. comm. 2005)

- *Marydel East (DNR combined this site with Mount Zion Wetlands)*. This small Delmarva bay is dominated by herbaceous species and contains an amphibian listed as In Need of Conservation. Delmarva bays are seasonal groundwater-fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development (DNR, 1991). This site is unprotected.
- *Marvel Pond (DNR proposed this site for deletion)*. This small Delmarva bay contains a State rare plant species in the center of the pond. Delmarva bays are seasonal groundwater fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development. This pond is surrounded by a narrow forested buffer (DNR, 1991). This site is unprotected.
- *Mill Creek Woods.* This site is unprotected.
- *Mount Zion South Pond*. This Delmarva bay contains a State Endangered amphibian species. Delmarva bays are seasonal groundwater fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development. Future surveying during the drier months may find rare plant species as well (DNR, 1991). This site is unprotected.
- *Oldtown Pond*. This seasonal pond contains a healthy population of a State Endangered sedge species. This groundwater-fed seasonal pond has fairly deep water during the wet season and only shallow water in the center during the dry season. Seasonal ponds provide unique habitat and therefore often rare plant and animal species. These ponds were once more common on the Eastern Shore, but

many have been destroyed due to drainage and filling for agriculture and development (DNR, 1991). This site is unprotected.

- *Opossum Hill Powerline*. This site contains a bog-like habitat with four RTE plant species. Bogs contains unusual plant species especially adapted to the acidic, saturated soils. Many bogs on the Eastern Shore have been destroyed by ditching and draining for agriculture and development. The site is located in a powerline right-of-way. The woody plant suppression in the right-of-way maintains an open canopy, allowing the rare species to establish. This woody plant suppression is similar to the periodic disturbances historically created by fire and beaver activity. This now uncommon vegetative community provides habitat for rare species. The protection area also includes part of the headwaters of the tributary stream. Preserving this local hydrology is important in preserving the water quality of the lake (DNR, 1991). Main threats include changes in the quality or quantity of the water, clearing or ditching the adjacent forest, or ditching the right-of-way. Right-of-way maintenance should take precautions to preserve the rare species (Ludwig et al., 1987). This site is unprotected.
- *Pasture Pond (DNR combined with Jackson Lane Site)*. This is a ditched and grazed Delmarva bay dominated by herbaceous species. It contains four rare or uncommon plant species (three State Endangered and one uncommon). Delmarva bays are seasonal groundwater-fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development. Currently, Delmarva bays dominated by herbaceous species are relatively uncommon in the Eastern Shore (DNR, 1991). This site is protected by TNC.
- *Persimmon East (DNR combined this site with Persimmon Preserve Site)*. This is a small sphagnous seasonal pond that is dominated by Red Maple and Sweet Gum. It contains a healthy population of a rare amphibian that is listed as being In Need of Conservation. Seasonal ponds are groundwater fed and provide unique habitat and therefore often rare plant and animal species. These ponds were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development (DNR, 1991). This site is unprotected.
- *Persimmon Preserve Site*. This wetland complex includes an open Delmarva bay and an adjacent persimmon-dominated wetland. There are five RTE plant species, including two that are candidates for listing under the U.S. Endangered Species Act. Delmarva bays are seasonal groundwater fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development. The 8-acre persimmon wetland is owned by a private conservation group, but the Delmarva bay is not protected (DNR, 1991). This site is partially protected by The Nature Conservancy.
- *R and M Bay (DNR combined this site with Mount Zion Wetlands)*. This Delmarva bay is open, with relatively deep water. This Delmarva bay contains a State Endangered plant species, also being a candidate for listing under the U.S.

Endangered Species Act, and another uncommon plant species. Delmarva bays are seasonal groundwater fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development. Future surveying during other seasons may find additional rare species (DNR, 1991). This site is unprotected.

- *Red Bridges Road Crossing (DNR name: Upper Choptank River)*. This fairly undisturbed swamp is located in the Choptank River headwaters. It contains a State Endangered shrub species. Undisturbed swamps are rare in the region, due to removal of the surrounding forested buffer and the resulting invasion by exotic species, siltation, and degraded water quality. Since this species is found so infrequently in Maryland, it is likely this species requires very specific soil and hydrologic conditions to thrive. A portion of this wetland is within County parkland (DNR, 1991). A small portion of this site is protected by Greensboro Christian Park.
- *Schuyler Road Pond (DNR name: Hollingsworth Ponds)*. This 1.5-acre herbaceous seasonal pond contains a healthy population of a State Endangered plant species. Seasonal ponds are groundwater fed and provide unique habitat and therefore often rare plant and animal species. This pond contains a dense sphagnum mat around the perimeter. It is inundated in the winter and early spring and dries up in the summer, leaving moist depressions where specially-adapted herbaceous species thrive. Historically, these ponds were more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development. Since this site was surveyed in late summer, rare amphibian species may have been missed (DNR, 1991). It is surrounded by agriculture. The main threat is pond excavation, which has been proposed by the landowner to create a permanent pond. Additional threats include other types of alterations in hydrology and runoff of agricultural pollutants (Ludwig et al., 1987). This site is unprotected.
- *South Melville Crossroads Pothole (DNR combined this site with Persimmon Preserve Site)*. This Delmarva bay is dominated by emergent herbaceous plant species and contains five RTE plant species. Delmarva bays are seasonal groundwater fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development. They are important for groundwater recharge and groundwater water quality (DNR, 1991). Main threats include alteration of hydrology, disturbance by all-terrain vehicles, and woody species encroachment. The forested buffer should also be protected (Ludwig et al., 1987). This site is unprotected.
- *South Pealiquor Landing Cove.* This site is along the Choptank River shoreline and is unprotected.
- There is a large potential WSSC along the Choptank River, Gravelly Branch, and Little Gravelly Branch (near Red Bridges Road Crossing WSSC). Parts of this site are protected by Greensboro Christian Park and MD Ornithological Society.
- There is a potential WSSC near Schuyler Road Pond WSSC that is unprotected.

The document entitled *Upper Choptank River Watershed Characterization* made several restoration recommendations including:

- Headwaters
- Stream buffers
- Hydric soils
- Within 300 feet of existing wetlands
- On agricultural land
- Restore fish passages. There were 21 identified fish blockages in 2001.

Specific Restoration Recommendations

- Restore gaps in designated Green Infrastructure back to natural vegetation, especially around waterways (e.g. an agricultural gap southwest of Bethlehem).
- Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations

- Protect currently unprotected Green Infrastructure, especially around waterways.
- Protect high priority areas within the Rural Legacy Area.
- Protect any portions of the WSSCs and surrounding buffer that are not currently protected.
- Protect additional wetlands within designated Ecologically Significant Areas.
- Protect wetlands used as reference sites in the DNR study of tidal wetland vegetative communities (these are along the Choptank River, Watts Creek, and Chapel Branch).
- Protect wetlands and streams within the headwaters.

Tuckahoe Creek (02130405)

Background

The Caroline County portion of this watershed has 35,920 land acres (based on MDP 2002 land use GIS data). Of this, the majority is agriculture (64%), followed by forest (29%), developed (6%) and wetland (1%). Note that wetland acreage based on this data may be grossly underestimated, so more accurate estimates based on DNR wetland data are presented below. Many of the wetlands are associated with Tuckahoe Creek, and tributaries. These wetlands provide the functions of water quality improvement, flood attenuation, stream recharge, and wildlife habitat. There is a concentration of wetlands not directly associated with a waterway located in the Tuckahoe Creek headwaters (in the northern portion of the watershed). These wetlands are also very important for water quality improvement, including removing/cycling nutrients, removing sediment and other pollutants, and for wildlife habitat. Hydric soil suggests where wetlands are currently or were historically. Areas having hydric soil, but that are no longer wetlands, have the potential to be good wetland restoration sites. Within the Wicomico County portion of this watershed, there is a large amount of hydric soil that is not wetland (based on GIS data: NRCS SSURGO, DNR wetlands, NWI wetlands).

Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

- Estuarine
  - Emergent: 44 acres
  - Unconsolidated shore: 2 acres
- Palustrine
  - Emergent: 724 acres
  - Scrub shrub: 283 acres
  - Forested: 10,898 acres
  - Unconsolidated bottom: 270 acres
  - Farmed: 1023 acres
- Riverine
  - Emergent: 21 acres
  - Unconsolidated shore: 33 acres
- Total: 13,298 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a slight gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02130405	-1.44	1.12	2.30	0	1.98

One acre of forested, emergent, and scrub-shrub wetland was constructed in a pond at Adkins Arboretum in 2000-2001 as programmatic mitigation.

Numerous acres of Delmarva Bays and other Nontidal Wetlands of Special State Concern were managed for invasive species control as a programmatic mitigation project in this watershed. Sites were initially treated in 2002 and 2003 and monitoring will continue for five years.

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a "designated use" in the Code of Maryland Regulations 26.08.02.08. This watershed is designated Use I, recreation contact and fishing.

Water Quality

The 1998 Clean Water Action Plan classified this watershed as "Priority" Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. Since it is a "Priority" Category 1 watershed, this watershed was selected as being one of the most in need of restoration within the next two years since it failed to meet at least half of the goals. It is also classified as a Category 3, a watershed in need of protection. Failing indicators include high modeled nitrogen and phosphorus

loads, low non-tidal benthic IBI, high historic wetland loss (35,689), high percent stream buffer unforested (63%), high soil erodibility (0.30), and being on the 303(d) List for water quality impairments. Indicators for Category 3 include a high non-tidal fish IBI, a high imperiled aquatic species indicator, and six migratory fish spawning areas.

According to the *2002 Maryland Section 305(b) Water Quality Report*, water quality results for the tidal portion of the Tuckahoe Creek were inconclusive. A portion of the nontidal wadeable tributaries (unnamed tributary to Tuckahoe Creek, Blockston Branch, Mason Branch, unnamed tributary to Mason Branch; DNR, 2000) failed to fully support all designated uses (2.5 mi. fully support, 31.1 mi. fail to support, 56.8 mi. were inconclusive) due to a poor benthic community. Possible reasons for this poor community include low dissolved oxygen, siltation, changes in habitat, channelization, and sewer/septic systems. Tuckahoe Lake (86.0 acres) fully supports all designated uses.

The 2004 303(d) List contains basins and subbasins that have measured water quality impairment and may require a TMDL. The basin/subbasin name, subbasin number (if applicable), and type of impairment are as follows:

- *Tuckahoe Creek*; nutrients, suspended sediments.
- *Tuckahoe Creek Impoundment*; While methylmercury in fish tissue (from atmospheric deposition) is an impairment to this waterway, a TMDL has been completed for this contaminant.
- *Unnamed tributary to Tuckahoe Creek* (021304050517 in Talbot); sedimentation.
- *Blockston Branch* (021304050529 in Queen Anne); sedimentation.
- *Mason Branch* (021304050534); sedimentation.
- *Mason Branch* (021304050537); sedimentation.
- *Unnamed tributary to Mason Branch* (021304050536 in Queen Anne); poor biological community.

MDE completed a TMDL for mercury in Tuckahoe Lake, as summarized below. Tuckahoe Lake lies on Tuckahoe Creek, west of Ridgely. It is owned by DNR and is within Tuckahoe State Park. It is designated as Use I – water contact recreation and protection of aquatic life. Since MDE has issued a fish consumption advisory for fish from this lake, due to high levels of mercury in fish tissue, it does not support the designated use. High mercury levels are common throughout the State, since the main source of mercury is atmospheric. While some sources of mercury are within the State, many come from outside the State. EPA estimates that coal-fired electric power plants generate the largest amount of mercury. Maryland atmospheric sources are: power plants (43%), municipal waste combustors (31%), medical waste incinerators (19%), Portland Cement plants (6%), other (1%). It is estimated that enforcement of proposed and existing Clean Air Act regulations will help in the implementation of the mercury TMDL.

MBSS found FIBI were generally ranked good. BIBI were more variable, ranging from fair to very poor.

Restoration/Preservation

There is a moderate amount of Green Infrastructure, largely following the Tuckahoe Creek corridor and tributaries. There are denser amounts of Green Infrastructure in the northern portion of the watershed. Few areas are protected, with the largest area being Tuckahoe State Park (DNR, 2000-2003). According to the 2000 Maryland Greenways Commission document, an existing ecological and recreational greenways is the Tuckahoe State Park greenway. This trail (within the park) would connect with the proposed Hillsboro Rail Trail to Denton or with the proposed Easton-Clayton Rail Trail. Potential greenways include:

- *Hillsboro Rail Trail*. This trail would follow an inactive railroad line, connecting Denton with Hillsboro (and also with Tuckahoe State Park).
- *Easton-Clayton Rail Trail*. This trail would connect Tuckahoe State Park to Ridgely and Greenboro, and eventually to Goldsboro and the Delaware State line, along the Chesapeake Railroad right-of-way. This trail is a smaller part of the future plan to connect Easton (Talbot County) to Delaware.

In addition to the above-mentioned protected land, land is also protected by TNC (Baltimore Corner Preserve), DNR, and METs.

The following information is summarized from the document *Rural Legacy FY 2003: Applications and State Agency Review*. Rural Legacy designated areas are sponsored by Eastern Shore Rural Legacy Sponsor Board and Eastern Shore Land Conservancy, Inc. The goal of this preservation effort is to protect agriculture (including important productive soils) and natural resources, including water quality of Marshyhope and Tuckahoe Rivers, other waterways, and habitats. There are 10,393 acres total (based on GIS data) designated as Rural Legacy area. This includes two areas: Tuckahoe and Marshyhope. The Tuckahoe Rural Legacy Area is located on the western portion of the County, next to Tuckahoe Creek. The Marshyhope Rural Legacy Area is located in the southern part of the County, adjacent to Idylwild Wildlife Management Area. There are 1,576 acres of protected land within the Tuckahoe Rural Legacy Area and 1,543 acres of protected land within the Marshyhope Rural Legacy Area. The report also includes a list of property owners who are interested in selling an easement and the priority of acquiring these easements. Since the Rural Legacy Program funds are not always adequate enough to support all of these requests, other programs should consider preservation of these sites.

There are several Nontidal Wetlands of Special State Concern (WSSC) within the Caroline County portion of this watershed, as described below.

- *Baltimore Corner*. This wetland complex includes several Delmarva bays, some dominated by herbaceous vegetation and others dominated by shrubby vegetation. These Delmarva bays are seasonal groundwater fed pools that provide unique habitat for amphibians, songbirds, and other wildlife. Delmarva bays were once much more common on the Eastern Shore, but have mostly been destroyed due to drainage and filling for agriculture and development. Since these bays provide uncommon habitat, they often contain rare plant and animal species. At this site, two of the bays, both dominated by grasses and sedges, contain five rare plant species. Within one of these bays also resides a rare amphibian. This wetland is

protected by a private conservation organization (DNR, 1991). While much of this site is within TNC property, some of the site remains unprotected.

- *Bridgetown Ponds NRMA*. This wetland complex includes a series of Delmarva bays. These seasonal groundwater-fed wetlands are ponded in the winter and early spring, providing habitat for amphibians, songbirds, and other wildlife, and drying up in the summer, allowing specially-adapted herbaceous plants to colonize. Since these bays provide unusual habitat, they often contain rare plant and animal species. This wetland complex contains three rare plant species and two rare animal species. Delmarva bays were historically much more common in this region, but have been largely destroyed due to drainage and filling for agriculture and development. This system is owned by the State (DNR, 1991). Most of this site is within Bridgetown Ponds NHCP, with the exception of the southern portion.
- *Long Marsh Ditch*. This site is unprotected.
- *Mt. Zion Pothole (DNR name: Mount Zion Wetlands)*. This shrub-dominated Delmarva bay contains a good diversity of herbaceous species, including a State Endangered plant. An amphibian species listed as In Need of Conservation also uses this bay for breeding habitat in the spring. Delmarva bays are seasonal groundwater fed ponds that provide unique habitat and therefore often rare plant and animal species. These bays were once more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development (DNR, 1991). This site is unprotected.
- *Petroski Bog (DNR combined with Baltimore Corner)*. This is a sphagnous bog containing a State Endangered plant species. This species resides is the sunny wetland openings. Bogs contains unusual plant species especially adapted to the acidic, nutrient-poor, saturated soils. Many bogs on the Eastern Shore have been destroyed by ditching and draining for agriculture and development. Historically, bogs were created by fire and beaver activity. Since these disturbances are now much less common, this habitat type is becoming increasingly rare on the Eastern Shore. This now uncommon vegetative community provides habitat for rare species (DNR, 1991). While much of this site is within TNC property, some of the site remains unprotected.
- *Schuyler Road Pond (DNR name: Hollingsworth Ponds)*. This 1.5-acre herbaceous seasonal pond contains a healthy population of a State Endangered plant species. Seasonal ponds are groundwater fed and provide unique habitat and therefore often rare plant and animal species. This pond contains a dense sphagnum mat around the perimeter. It is inundated in the winter and early spring and dries up in the summer, leaving moist depressions where specially-adapted herbaceous species thrive. Historically, these ponds were more common on the Eastern Shore, but many have been destroyed due to drainage and filling for agriculture and development. Since this site was surveyed in late summer, rare amphibian species may have been missed (DNR, 1991). It is surrounded by agriculture. The main threat is pond excavation, which has been proposed by the landowner to create a permanent pond. Additional threats include other types of alterations in hydrology and runoff of agricultural pollutants (Ludwig et al., 1987). This site is unprotected.

- *Tuckahoe Creek Hemlock.* This site is along the inside bend of Tuckahoe Creek and is unprotected.
- *Tuckahoe Creek North*. This wetland complex includes shrub and forest swamps, and ponds. The riparian habitat contains a large population of a State Threatened shrub. This site is adjacent to (and feeds into) Tuckahoe Creek North Natural Heritage Area. This wetland provides water quality improvement (reducing sediment and chemical pollutants entering the waterway), flood attenuation, and increased productivity and species diversity in the adjacent tidal wetlands. The adjacent upland forest should also be maintained as a buffer to disturbance. This site should be maintained in order to preserve the hydrology, water quality, and species composition of the downstream Natural Heritage Area (DNR, 1991). The majority of this site is within Tuckahoe State Park. Unprotected areas include along Piney Branch and another tributary of Tuckahoe Creek.
- There is a large complex of potential WSSCs south of Baltimore Corner. While some of these are protected within Tuckahoe State Park, the majority are unprotected.

Specific Restoration Recommendations

- Restore gaps in designated Green Infrastructure back to natural vegetation, especially around waterways.
- Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations

- Protect currently unprotected Green Infrastructure, especially around waterways.
- Protect high priority areas within the Rural Legacy Area.
- Protect any portions of the WSSCs and surrounding buffer that are not currently protected.
- Protect additional wetlands within designated Ecologically Significant Areas.
- Protect wetlands used as reference sites in the DNR study of tidal wetland vegetative communities (these are along the Tuckahoe Creek).
- Protect wetlands and streams within the headwaters.