City of Chesapeake: A Plan for the Northwest River Watershed

PEP10-05

Prepared by the staff of the Hampton Roads Planning District Commission

March 2010

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PLANNING DISTRICT COMMISSION

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CITY OF CHESAPEAKE:
A PLAN FOR THE NORTHWEST RIVER WATERSHED

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ABSTRACT

The Northwest River watershed plays a key role in providing essential services and quality of life in the City of Chesapeake. Despite a great deal of prior research and recommendations and the adoption of programs by the City, threats to the watershed remain. This report attempts to assemble and synthesize prior work and current land use policies to identify opportunities for improvements. As part of this report, a GIS-based build-out analysis was conducted to illustrate potential development patterns and threats graphically. As a result, areas for improvement and tools for protection have been identified and recommended to the City.

ACKNOWLEDGMENTS

The staff of the Hampton Roads Planning District Commission wishes to acknowledge the cooperation and assistance extended by the staffs of the City of Chesapeake and The Nature Conservancy in the completion of this project.

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Chesapeake VIRGINIA

The Nature Conservancy
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EXECUTIVE SUMMARY

A Plan for the Northwest River Watershed is the result of a team effort between the staffs of the Hampton Roads Planning District Commission (HRPDC), The Nature Conservancy (TNC) and the City of Chesapeake. The Plan summarizes existing knowledge about the watershed and provides guidance on future management actions that will help to maintain and enhance the watershed.

The Northwest River watershed is important to the City of Chesapeake for a number of reasons. The River is an important drinking water supply for the City, is surrounded by an area valued for its rural and agricultural heritage, and is home to rare and unique wetland habitats. For these reasons, maintaining the ecological integrity and rural character of the watershed are important goals for both the City and TNC. This Plan draws on several previous studies and planning efforts and attempts to identify tools that both support the achievement of the planning goals for the watershed and respect the property rights of the land owners in the watershed.

Goals of the Report

For the entire Northwest River watershed, which extends beyond Chesapeake to include land within the City of Virginia Beach and Currituck and Camden Counties in North Carolina, this Plan provides an overview of locality planning and land use trends, a scientific description of the watershed, and a synopsis of previous technical and planning reports. For the portion of the watershed located within the City of Chesapeake, the Plan addresses the topics applicable in the wider watershed and augments that discussion with identification of key issues and associated management recommendations for the City. The Plan is intended as a reference document for a broad range of stakeholders concerned with the future of the Northwest River, including city staff, elected city officials, state and federal agencies, nonprofit groups, and the citizens of the watershed.

Management Goals for the Watershed

The City of Chesapeake's comprehensive plan, Forward Chesapeake 2026, provides a valuable synopsis of management goals for the watershed, which were identified through an extensive stakeholder involvement process and inform the structure of this watershed plan. Primary goals identified in the 2026 Comprehensive Plan include protection of water quality, protection of critical habitat, flood hazard mitigation, provision of opportunities for limited residential and commercial development, preservation of rural character and control of encroachment on Naval Support Activity Northwest Annex. The 2026 Plan calls for the development and implementation of a strategy to coordinate the City's rural design guidelines, public facilities manual, open space and agricultural preservation program, subdivision

ordinance, zoning ordinance, and cluster ordinance as they apply to the rural tier of the City.

Key Findings and Recommendations

Chesapeake's portion of the Northwest River watershed has been studied extensively through the cooperative Southern Watershed Area Management Program that began in the 1990s, through various city-sponsored plans and studies, and through the efforts of TNC. Pertinent studies include the Conservation Plan for the Southern Watershed Area (Erdle, Weber, Myers, & Carter-Lovejoy, 2001) developed by the Virginia Department of Conservation and Recreation, the Rural Area Preservation Program (Siemon & Larsen, P.A., 2001) produced by Seimon and Larsen, P.A., an analysis of Chesapeake's development controls by Randall Arendt (Arendt, 2001), and the City of Chesapeake Design Guidelines developed by EDAW, Inc. (AECOM, EDAW, 2007). Many of the studies reach similar conclusions on planning tools that should be used to achieve the long-term goals for the watershed.

IMPORTANT THEMES IN THE NORTHWEST RIVER WATERSHED MANAGEMENT PLAN

- Identification and protection of a Conservation Corridor network as a method of achieving multiple benefits including maintaining the viability of critical wetlands habitats, protecting water quality from nonpoint source pollution and providing a network of open space for recreation,
- Utilization of a nodal development pattern in the Watershed to minimize the footprint of new development and limit encroachment on and conflicts with agriculture, the Northwest Annex and the Conservation Corridor network,
- Maintenance of rural character through preservation of open space and agricultural lands and the associated viewsheds,
- Elimination of the practice of "stripping out" the road network with new development.

A significant common message in the existing plans and studies developed for the Northwest River watershed lies in the possibility that a variety of different land uses and associated activities can be successfully accommodated here if the various uses are located to minimize adverse impacts and conflicts. In particular, utilization of clustering for residential development and nodal patterns for commercial and mixed-use development will accommodate levels of growth equivalent to those possible under existing land use controls. Moreover, this development pattern will

help to minimize rural viewshed impacts, protect the viability of agriculture, and limit adverse impacts on water quality and the natural environment. The pending update of Chesapeake's comprehensive plan will present an opportunity to revisit planning for the watershed and to create a map that clearly depicts the areas that should be designated for particular uses. Ultimately, achieving the City's planning goals for the watershed will require revision of development controls to require clustering and nodal development patterns.

Protection of the Drinking Water Supply

The Northwest River has been an important source of drinking water for the City of Chesapeake since the Northwest River Water Treatment Plant (NWRWTP) went into service in 1980. The river has historically presented several difficulties as a drinking water supply, including fluctuations in salinity and periodic loading with organic material associated with storm events. A reverse osmosis facility was installed at the NWRWTP in 1999, primarily to deal with the fluctuations in salinity levels. The salinity fluctuations are a natural condition resulting from a combination of drought, which limits freshwater input into the river, and wind tides that can push salt water into the northern section of the Currituck Sound and the Northwest River. Major storm events have resulted in high levels of organic material being flushed into the river, leading to difficulties in the water treatment process. In 1999 Hurricanes Floyd and Dennis flooded the Dismal Swamp, forcing huge quantities of water over U.S. Route 17 and causing extensive flooding in the watershed. Total organic carbon (TOC) levels, an indicator of decaying organic matter, rose from normal levels of 25-30 milligrams per liter to 75 milligrams per liter and remained high for several years following the storms. Both the salinity and organic material problems have been managed successfully through the water treatment process, allowing the City to deliver high quality drinking water from the river. Unfortunately, in the case of the high TOC levels associated with the storm events, it is difficult to differentiate between natural and manmade sources of organic compounds and therefore difficult to identify management solutions.

The Virginia Department of Environmental Quality (DEQ) maintains a water quality monitoring network throughout the state of Virginia, including eight stations in the Northwest River. Several water quality issues have been identified in the river, including low dissolved oxygen, bacterial contamination, and mercury in fish tissue. Because the source of these problems is difficult to identify, management solutions are also difficult to identify. For example, low dissolved oxygen levels may be a natural condition of the Northwest River, but a final decision on development of a Total Maximum Daily Load (TMDL) for dissolved oxygen has not been made by the state. High bacteria levels are likely caused by a mix of natural and human sources, but again DEQ has not identified specific sources. Mercury in fish tissue is a problem in several rivers in the Southern Watersheds of Virginia. Again, the exact source of the mercury is unknown, making management decisions difficult.

Given the lack of certainty about the sources of these problems, what is the best strategy for managing water quality? One solution is additional scientific study to determine the sources of the various water quality problems. Until that work is done, and funding it will be a difficult given the scope of the effort, the City should continue to employ a best management practices (BMP) approach to dealing with known pollution sources. Water quality management goals for the Northwest River should be designed to meet the broad range of uses that the river supports. Beyond its use as a drinking water supply, the river is used for fishing, swimming, and boating and supports a broad range of rare wetlands habitats. Each of these uses suggests slightly different water quality goals, but in all cases minimizing pollution from manmade sources is a shared theme. Manmade sources of water pollution are typically categorized as either point source or non-point source. Examples of point sources include discharges from sewage treatment facilities and industrial processes. Non-point sources include stormwater runoff from paved surfaces, agricultural, and residential lands. The Northwest River watershed contains few point sources, so managing pollution is largely a matter of dealing effectively with non-point sources.

Non-point Source Pollution

The City has several tools and methods available to manage nonpoint source pollution in the watershed. Management efforts can be divided into two categories: techniques targeted at existing land uses in the watershed and planning for future land use patterns and urban design elements that minimize increases in nonpoint source loadings associated with new development.

Recommendations for Existing Land Uses:

- Continue and expand programs to upgrade stormwater BMPs, enhance agricultural BMPs, and inspect and pump out of septic systems.

- Restore vegetated buffers adjacent to the River and its tributaries. Buffer width will depend on site characteristics, but a minimum buffer width of 100ft from the river and any adjacent wetlands should be adopted.

Recommendations for Future Development:

- Limit development adjacent to the River and its tributaries.

- Expand the Conservation Corridor network to buffer all of the Northwest River's tributaries.

- Establish a Transfer of Development Rights program that facilitates directing future development outside the watershed.

- Continue efforts to protect the Conservation Corridor network from development through purchase of development rights, establishment of a transfer of development rights program, conservation easements, and other appropriate measures.

- Minimize increases in impervious surface area by requiring nodal or cluster development patterns and Low impact Development (LID) techniques.

Point Source Pollution

Point source water pollution is not a major problem within the Northwest River watershed. Permitted point sources include three small sewage treatment facilities that have Virginia Pollution Discharge Elimination System (VPDES) permits (Map 6, page 32).

Recommendations:

- Continue to monitor existing point sources for any violations.

- Limit introduction of new point sources through the development approval process.

Protection of Natural Resources

The City, TNC, and the state have worked together extensively to protect the natural resources in the Northwest River Watershed. Continuation and expansion of these efforts are needed to meet the planning goals established by the City. In particular, continuing efforts to protect lands within the Conservation Corridor network (Map 19) will contribute to the achievement of multiple benefits that encompass protection of natural resources, protection of water quality, and preservation of the rural character in the watershed.

The natural resources in the Northwest River watershed have been studied extensively as part of the many plans and studies previously conducted by the Virginia Department of Conservation and Recreation/Division of Natural Heritage (DCR), the City, and others. One of these documents, DCR's Conservation Plan for the Southern Watershed Area (Erdle, Weber, Myers, & Carter-Lovejoy, 2001), provides an excellent guide to the protection and management of those resources. The Conservation Corridor system for the Southern Watershed Area was initially developed as part of the Conservation Plan. The Corridor system was designed to include high priority Natural Heritage Resources and link them together into a network of protected lands. Due to the fact that the majority of the Natural Heritage Resource areas in southern Chesapeake front the Northwest River, the system also has the potential to be an effective barrier against nonpoint source water pollution.

In addition to its natural resource value, the Corridor system also provides opportunities for passive recreation and trails systems. More broadly, the Conservation Corridor system is part of a regional green infrastructure network. Green infrastructure is an approach to conservation planning that emphasizes identification of the most important natural features and establishes a linked system of protected lands to achieve multiple benefits.

Recommendations:

- Continue to protect and buffer land within the Corridor system, which is among the most effective strategies for natural resource protection in the Watershed.

- Expand the Conservation Corridor system to include riparian buffers along the tributary streams to the Northwest River.

- Implement the management recommendations contained in the Conservation Plan for the Southern Watershed Area.

Preservation of Rural Character

Among the most consistently identified planning goals for the watershed is preservation of rural character. Rural character includes both aesthetic and functional characteristics. Among the aesthetic characteristics are viewsheds that include natural landscapes and agricultural areas that are largely unobstructed by the built environment. Functional elements include economically viable agricultural and forestal operations and healthy natural systems. The City's 2026 Comprehensive Plan acknowledges that the existing development controls fail to protect either the aesthetic or functional elements of rural character by encouraging residential development that strips out the road frontage. The resulting "piano key" development pattern impedes visual and functional access to open space and agricultural operations and creates visual clutter along the roadways. This placement of houses also sets up conflicts between residential uses and agricultural and forestal uses by placing residents directly adjacent to these operations. Additionally, the low density development prescribed by the zoning ordinance requires larger lot sizes, resulting in more land consumption.

The City already has a cluster ordinance in its zoning ordinance. When used effectively, clustering can help direct growth to more compact areas and protect larger tracts of land from development. However, in practice the City's current ordinance falls short on two counts. First, the ordinance is provided as an option to the by-right development pattern and is rarely used. Effecting a significant change in the residential development patterns in the watershed will require making the utilization of the cluster ordinance mandatory. Second, the ordinance lacks a requirement for the creation of a linked system of open space when land is

subdivided. Modification of the cluster ordinance to require the dedication of open space that contributes to protection of the Conservation Corridor system when the land in question is in or adjacent to the Corridor system would make it more effective in protecting rural character.

In addition to modifying the cluster ordinance, the City should consider establishing a Transfer of Development Rights (TDR) program. A TDR program involves establishing sending and receiving areas for development rights within the City. Land owners in the sending areas, those areas within which a reduction of development density is desired, are allowed to sever the development rights from their property and sell them to land owners in the receiving areas. Land owners in the receiving areas are allowed to purchase the development rights, thereby increasing the development density allowed on their land. Thus a TDR program, allowed by §15.2-2316.1 of the Code of Virginia, would considerably increase the ability of the City to control development density in various sections of the City. This system would support preservation of rural character in the Northwest River watershed while insuring that land owners are able to extract value from their land equivalent to the by-right development potential.

Recommendations:

- Modify the development controls in the Watershed to require clustering of new development.
- Require dedication of open space that contributes to the Conservation Corridor network when land adjacent to the Corridor system is developed.
- Create modified development requirements in the rural tier through updates to the zoning and cluster ordinances.
- Establish a TDR program for the City.
- Create specific design specifications in the Public Facility Manual (PFM) for development that occurs in the Rural Overlay.

Limiting Encroachment around NSA Northwest Annex

The Naval Support Activity Northwest Annex (Northwest Annex) in southern Chesapeake is home to a variety of facilities and activities that are dependent on the rural nature of that part of the City for long-term viability. The City has entered into a partnership agreement with the Northwest Annex to limit encroachment by purchasing lands that buffer the facility, and the Conservation Corridor network is being used in the mapping and prioritization of lands considered for purchase. Continuing to pursue funding for acquisition of lands that both contribute to protection of the Corridor system and buffer the Northwest Annex is an example of a

strategy for achieving multiple benefits.

Recommendations:

- Continue to partner with the Department of Defense to purchase lands or easements that both buffer the Northwest Annex and protect the Conservation Corridor system.

- Utilize clustering and TDR programs to limit encroachment on the Northwest Annex by new development.

Climate Change and Sea Level Rise

Climate change and associated sea level rise have the potential for significant impacts on the Northwest River watershed. Hampton Roads is among the most vulnerable communities in the United States to sea level rise due to a combination of rising sea levels resulting from thermal expansion of sea water and polar ice melt and from land subsidence due to geological processes and groundwater removal. These factors combine to give Hampton Roads one of the highest relative sea level rise rates on the east cost of the United States. Rising sea level will impact the Northwest River in two different but related ways. In the short term, rising water levels will gradually flood wetlands and development adjacent to the river. Over the long term, sea level rise combined with storm surge has the potential to breach the barrier island system that separates the Currituck Sound from the Atlantic Ocean and convert the river to a tidal, salt water system. This change will have significant ramifications for the river as a drinking water supply and will dramatically change the nature of the wetlands ecosystems in the area.

Recommendations:

- Identify areas in the watershed that are most vulnerable to sea level rise and storm surge flooding.

- Limit future development in those areas most vulnerable to sea level rise and storm surge flooding.

- Reassess the Conservation Corridor system on a regular schedule to adjust for impacts of sea level rise.

- Increase the width of the Conservation Corridor system as needed to accommodate upslope migration of wetlands as sea level rises.

Build-out Analysis

To better understand the implications of the existing development controls, a "business as usual" build-out analysis was performed for the watershed. This analysis assumes the application of the existing zoning and subdivision ordinances to all of the qualifying undeveloped land. Using Geographic Information System (GIS) mapping and CommunityVIZ software, a map of the watershed showing the approximate location of new residential and commercial development was generated. The results illustrate the potential for future development to negatively impact each of the areas of concern previously discussed. As anticipated, the majority of the road frontage in the watershed is stripped out with residential development, setting up a conflict with much of the agricultural land in the watershed and disrupting the rural viewshed. Additionally, a comparison of the stormwater impacts of the business as usual development pattern with a cluster development scenario indicates a significant decrease in stormwater runoff and an associated decrease in pollutant loading in the cluster scenario.

A PLAN FOR THE NORTHWEST RIVER WATERSHED

Background and Introduction

Chesapeake's Northwest River serves many purposes for a growing city in need of drinking water, open natural spaces, and links with its past. The watershed occupies the majority of the rural tier of the City, an area with a long history as an agricultural center characterized by limited development patterns and an abundance of open space. The long-term viability of the water supply is a high priority for the City. Moreover, the City has identified preservation of its rural attributes, including its natural resource base, as a guiding principle in planning for the southern section of Chesapeake.

The City of Chesapeake Comprehensive Plan, Forward Chesapeake 2026, describes the planning goals and design guidelines for the watershed and outlines a process to improve the coordination of the various development controls that apply to it (City of Chesapeake Planning Department, 2005). The 2026 Plan acknowledges the role of previous planning efforts, such as the creation of the Open Space and Agriculture Preservation Program (OSAP) and the cluster ordinance, as important steps toward achieving the City's goals for the watershed. The plan also acknowledges that other conflicting regulations and policies have resulted in a gradual erosion of the rural character of the area. Existing subdivision regulations that result in the "stripping" of rural roadways are used as an example of development controls that do not support the stated planning goals. The development of a comprehensive strategy to coordinate the City's ordinances and policies, including the OSAP program, the rural design guidelines, the public facilities manual, and the zoning, subdivision, and cluster ordinances is identified as the needed step beyond the completion of the new comprehensive plan.

A Plan for the Northwest River Watershed is intended to support the City in the development of a comprehensive strategy for the watershed. Previous studies of the watershed and existing development controls have been analyzed to provide insight on the needed elements of the strategy. In addition, a build-out analysis for the watershed provides quantitative and spatial results based on existing development controls.

Page 29 of the 2026 Comprehensive Plan includes design principles for the Rural Character District, which encompasses the entire Northwest River watershed. These include:

- Preservation of farmland, natural areas and small-scale rural communities.
- Mitigation of conflicts between uses.

- Clustering of new residential development to protect the viability of agriculture and connected natural areas.

- Identification and Preservation of important natural features such as waterways and wooded corridors whenever possible.

A number of competing interests are at work in the watershed, and some of these conflicting forces will make it difficult to meet the City's stated planning goals for the watershed in the coming years. Drawing on previous planning efforts on the local and regional level and on the scientific knowledge that has already been gathered will help to focus on the most critical needs in the watershed and help inform decisions regarding its future of the watershed.

Study of the resources and threats present in the Southern Watershed Area (SWA), which includes the Northwest River, began in earnest nearly two decades ago. To protect natural resources, sensitive lands and water supplies, the cities of Chesapeake and Virginia Beach, in partnership with the Hampton Roads Planning District Commission and the Virginia Coastal Zone Management Program, started developing the Southern Watershed Area Management Program (SWAMP) in 1992. SWAMP's purpose is the development and implementation of collaborative watershed management for the Southern Watershed Area, with the intent to balance protection of critical environmental resources with economic development opportunities (Erdle, Weber, Myers, & Carter-Lovejoy, 2001). This area encompasses the watersheds of Back Bay, the North Landing River, and the Northwest River.

The Southern Watershed Area Management Program (SWAMP) has progressed through several stages. The initial phase of the project involved establishing a set of common goals derived from the Chesapeake and Virginia Beach Comprehensive Plans and developing a Memorandum of Agreement between the cities and the HRPDC to facilitate achievement of the goals. The next major milestone was designation of the project as a Special Area Management Program (SAMP) by the Virginia Coastal Zone Management Program. The significant financial resources made available by the SAMP designation were used primarily to hire a set of consultants to develop technical reports on water quality status and trends in the Southern Watershed, agricultural preservation, protection of rural character, and natural resource protection. In addition, a comprehensive Geographic Information System for the Southern Watershed Area was developed.

SWAMP has resulted in a number of programs that will help to protect resources and guide development in the Southern Watershed Area in the coming years. These programs are already influencing the character of the watershed through cooperative public agreements and innovative private development, and will serve as models for similar efforts in other areas within the Hampton Roads Planning District.

In Chesapeake, the ongoing concern for protection of the water supply and the traditional land uses in the Southern Watershed has led to further studies and the adoption of a number of measures designed to address those concerns. These include the definition in Forward Chesapeake 2026 and its accompanying land use map of distinct urban, suburban, and rural areas within the City. The Comprehensive Plan provides that development patterns and trends should exhibit an orderly transition from urban land uses in the north to rural land uses in the south, and the City has adopted ordinances and design guidelines to support this policy. In addition, the City has adopted an ordinance establishing the Northwest River Watershed Protection District (Chapter 26, Article XII of the Chesapeake City Code) and instituted the Open Space and Agricultural Preservation Program, which involves the purchase of development rights in exchange for preservation easements. And lastly, the City has entered into a multi-year encroachment protection agreement with the Navy to prevent encroachment in the vicinity of the Naval Support Activity, Norfolk, Northwest Annex (NSA Northwest Annex) located on the border of Chesapeake and North Carolina and further, to promote conservation of ecologically and agriculturally significant lands. These efforts by the City of Chesapeake complement the ongoing land protection work in the Northwest River watershed, led by an array of federal and state agencies and non-profit organizations. Over 19,000 acres of forestland, marsh and agricultural land have been protected in the Northwest River watershed, with the bulk (83%) located in Virginia (USGS). These lands, collectively representing nearly 14% of the entire watershed, play an important role in preserving the highest diversity of rare plants and animals and exemplary natural communities in Virginia east of the Blue Ridge.

A Plan for the Northwest River Watershed builds on the accomplishments of local governments, SWAMP, and other partners involved in land protection and management in the watershed to develop a strategy that integrates with and informs evolving land use policies and development controls within the Rural Overlay District in the City of Chesapeake. In addition, this will be an opportunity to integrate the city's watershed plan with regional open space planning efforts to enhance protection of the Northwest River. Given the anticipated increase in development across the watershed and the need to protect its multiple public benefits, there is a compelling need to develop a comprehensive plan for its future. This plan consists of a characterization of the watershed's natural resources, uses, and critical issues; identification of goals to meet natural resource and land use needs; and an assessment and prioritization of strategies to address key challenges.

Natural Features of the Northwest River Watershed

Watershed Setting

Occupying nearly 140,000 acres in southeast Virginia and northeast North Carolina, the Northwest River watershed is situated in a nearly flat landscape characterized by low elevation and broad expanses of relatively poorly drained soils. It was which historically supported a mosaic of wetland habitats and features higher elevation sand ridges associated with scarps representing historic shorelines.

The Northwest River watershed is located in the outer coastal plain physiographic region, in the northern end of the Mid-Atlantic embayment stretching from the Neuse River in North Carolina to Back Bay in Virginia (Map 1). Under normal conditions, the watershed is bounded to the east by the North Landing/Currituck Sound watersheds, to the south by the North River and Pasquotank River drainages, to the west by the Dismal Swamp and the Dismal Swamp Canal, and to the north by the Elizabeth River and Chesapeake Bay watersheds. Hydrologic connections between the Northwest River and the Dismal Swamp may occur under extreme flood conditions. The Northwest River discharges into Currituck Sound, an embayed arm of the Albemarle/Pamlico Sound Estuary, which is the second largest estuarine system in the United States.

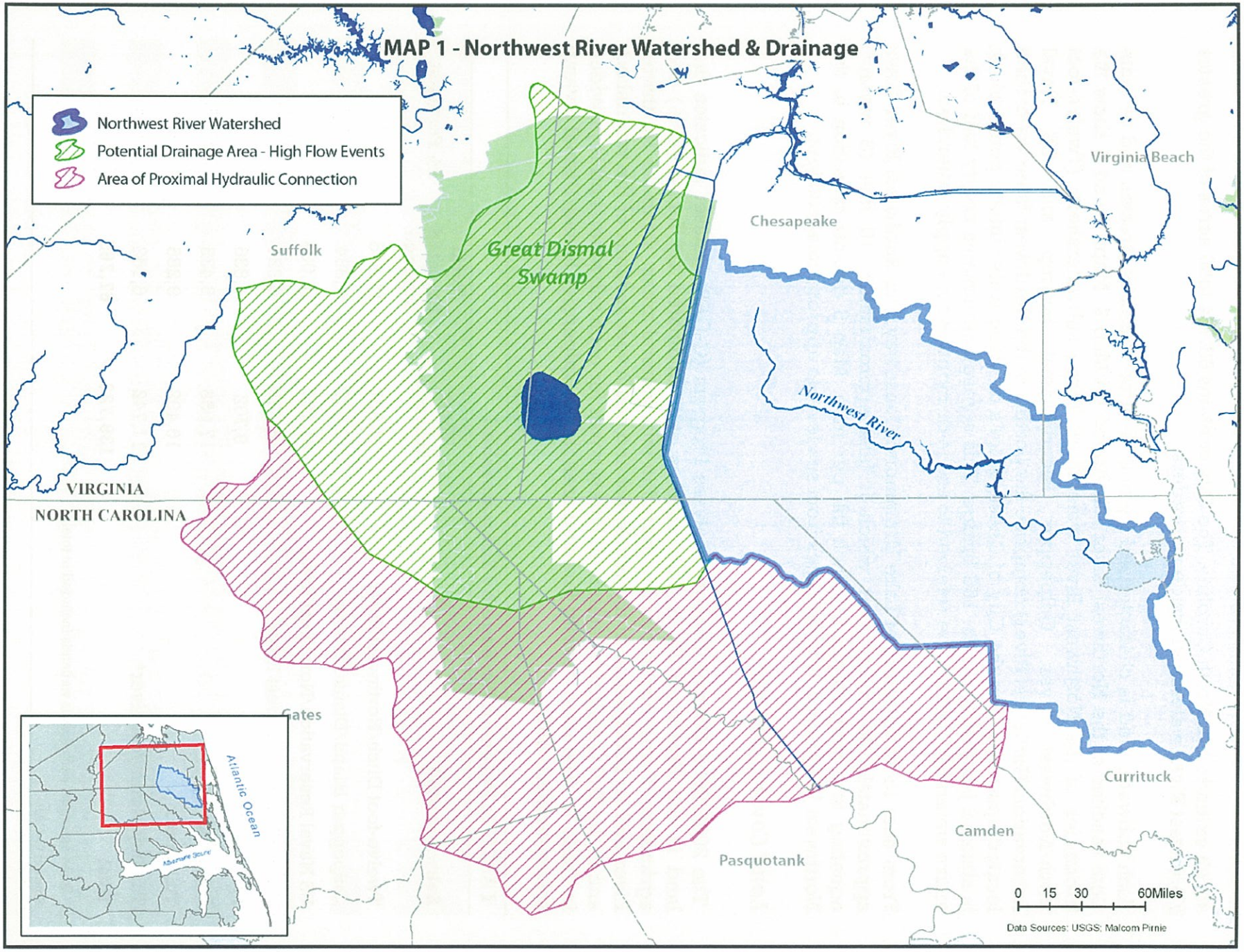
Table 1 lists the 8 subwatersheds (12-digit Hydrologic Units) comprising the Northwest River watershed, as mapped by the United States Geologic Survey (USGS). There are 68,367 acres in Chesapeake's drinking water supply watershed,

TABLE 1: Northwest Watershed Acreage by Subwatershed

Subwatershed	Total Acreage	% of Watershed
*Twelve-foot Ditch/Northwest River	24,551	18%
*Culpepper Island/Dismal Swamp	12,692	9%
*US Naval Reservation/Northwest River	31,124	22%
Indian Creek/Northwest River	16,362	12%
Moyock Run	9,702	7%
Roland Creek	17,058	12%
Tull Creek	16,492	12%
Tull Bay/Northwest River	11,742	8%
Total	**139,723**	**100%**

* Indicates subwatershed located within the City of Chesapeake's drinking water supply watershed. The total size of the water supply watershed is 68,367 acres (49% of the entire watershed).

Source: USGS


MAP 1 - Northwest River Watershed & Drainage
Northwest River Watershed
Potential Drainage Area - High Flow Events
Area of Proximal Hydraulic Connection
Great Dismal Swamp
Suffolk
Chesapeake
Virginia Beach
Northwest River
VIRGINIA
NORTH CAROLINA
Gates
Currituck
Camden
Pasquotank
Atlantic Ocean
0 15 30 60Miles
Data Sources: USGS; Malcom Pirnie

which extends into North Carolina. The City contains 68,764 total acres of the greater Northwest River watershed inside its borders.

Each subwatershed is characterized by one or more tributary streams and or main stem reaches of the Northwest River, illustrated on Map 2. Maps 3 and 4 show the tributaries of the Northwest River watershed. Three subwatersheds (Twelve-foot Ditch/Northwest River, Culpepper Island/Dismal Swamp and US Naval Reservation/Northwest River) comprise the portion of the Northwest River watershed located upstream from the City of Chesapeake's drinking water intake point, which is situated just below the Rt. 168 bridge. This acreage represents nearly half of the entire watershed and will be referred to as the drinking water supply watershed.

From near its headwaters at Lake Drummond Causeway, the Northwest River flows approximately 20 miles, over which it falls approximately 10 feet (3 meters) equating to a very sluggish 6 inch fall per mile. Map 5 depicts elevation in the Northwest Watershed, which ranges from sea level to approximately 30 feet.

Land Cover/Land Use

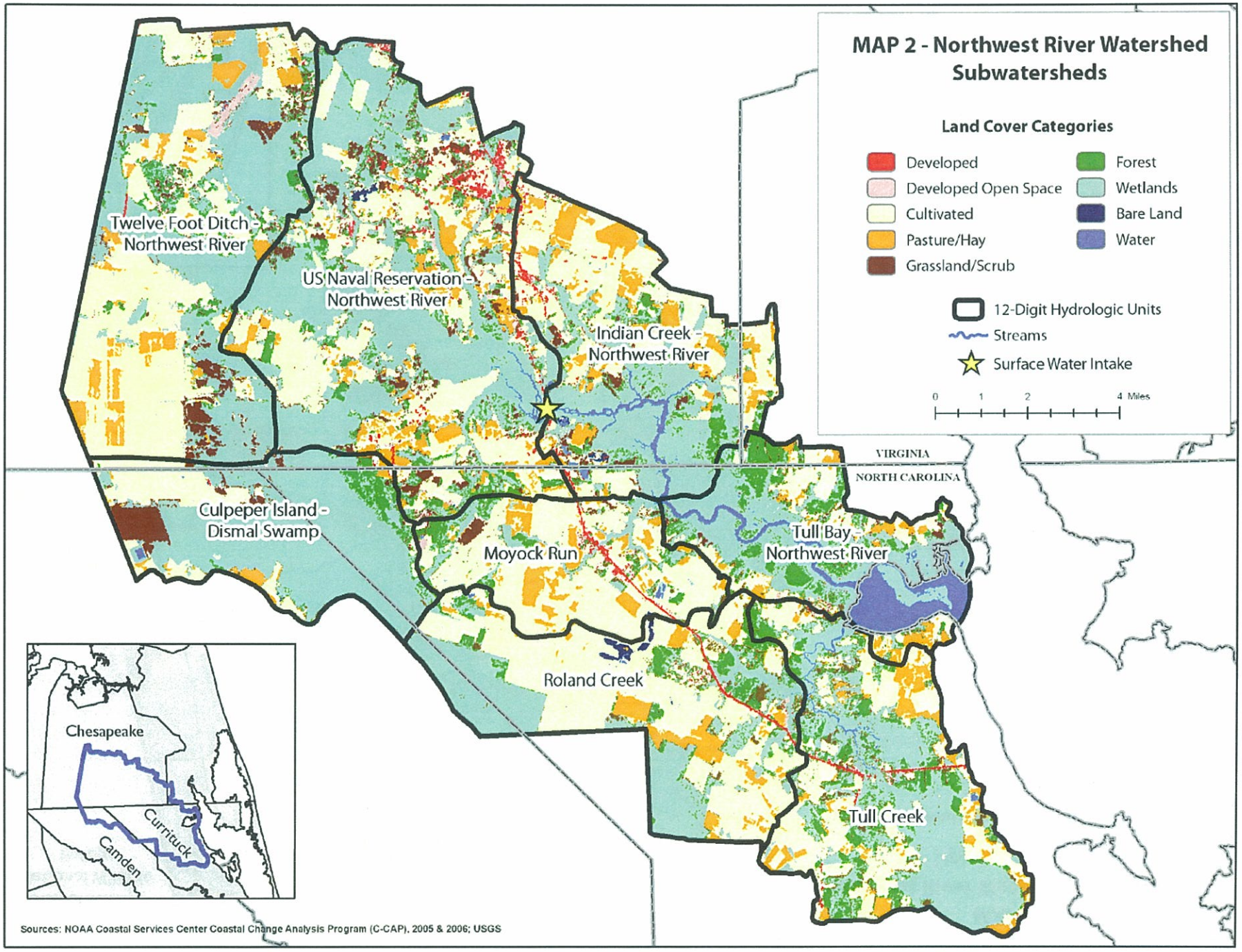
The 2005/2006 Coastal Change Analyses Program (C-CAP) Dataset indicates that land in the Northwest River watershed is still dominated by forest (48%) and agriculture. Forest cover is concentrated in four general areas: along the Northwest River and its floodplains, in the northwest and southwest sections of the watershed, and in the Tull Creek subwatershed. Forest cover for each subwatershed is provided in Table 2. The most heavily forested area is the Culpepper Island/Dismal Swamp subwatershed, with

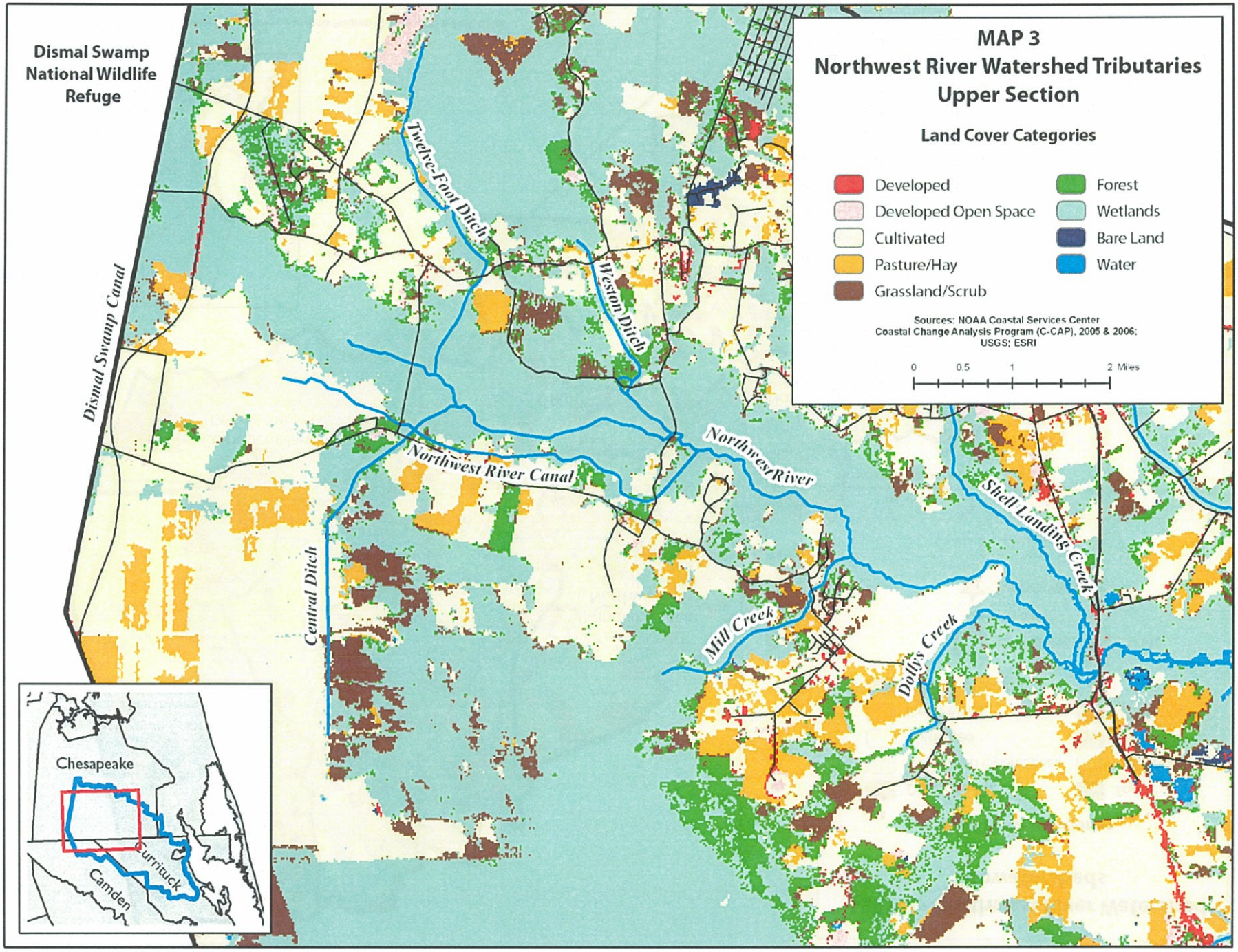
TABLE 2: Forested Acreage by Subwatershed

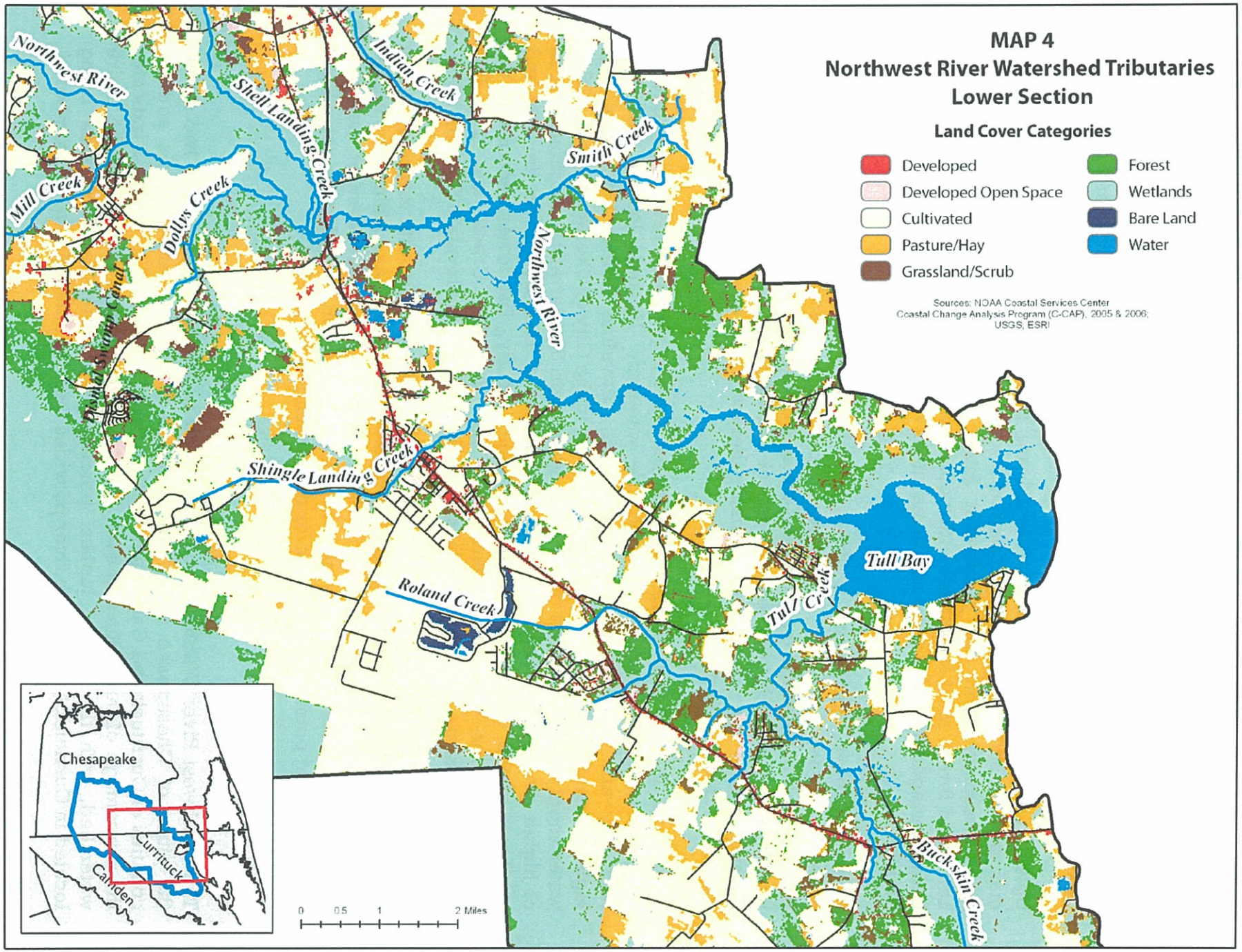
Subwatershed	Total Acreage	Total Forested Acreage	% Forested
Twelve-foot Ditch/Northwest River	24,551	11,245	46%
Culpepper Island/Dismal Swamp	12,692	9,384	74%
US Naval Reservation/Northwest River	31,124	16,004	51%
Indian Creek/Northwest River	16,362	6,824	42%
Moyock Run	9,702	1,836	19%
Roland Creek	17,058	6,435	38%
Tull Creek	16,492	9,285	56%
Tull Bay/Northwest River*	11,742	6,752	58%
Total	**139,723**	**67,765**	**48%**

* Some emergent herbaceous wetlands included in total.

Source: C-CAP


MAP 2 - Northwest River Watershed Subwatersheds
Land Cover Categories
Developed
Developed Open Space
Cultivated
Pasture/Hay
Grassland/Scrub
Forest
Wetlands
Bare Land
Water
12-Digit Hydrologic Units
Streams
Surface Water Intake
0 1 2 4 Miles
Twelve Foot Ditch - Northwest River
US Naval Reservation - Northwest River
Indian Creek - Northwest River
VIRGINIA
NORTH CAROLINA
Culpeper Island - Dismal Swamp
Moyock Run
Tull Bay - Northwest River
Roland Creek
Tull Creek
Chesapeake
Currituck
Camden
Sources: NOAA Coastal Services Center Coastal Change Analysis Program (C-CAP), 2005 & 2006; USGS


MAP 3
Northwest River Watershed Tributaries
Upper Section
Land Cover Categories
Developed
Developed Open Space
Cultivated
Pasture/Hay
Grassland/Scrub
Forest
Wetlands
Bare Land
Water
Sources: NOAA Coastal Services Center
Coastal Change Analysis Program (C-CAP), 2005 & 2006;
USGS; ESRI
0
0.5
1
2 Miles
Dismal Swamp National Wildlife Refuge
Dismal Swamp Canal
Twelve-Foot Ditch
Weston Ditch
Northwest River Canal
Northwest River
Central Ditch
Shell Landing Creek
Mill Creek
Dolly's Creek
Chesapeake
Currituck
Camden


MAP 4
Northwest River Watershed Tributaries
Lower Section
Land Cover Categories
Developed
Developed Open Space
Cultivated
Pasture/Hay
Grassland/Scrub
Forest
Wetlands
Bare Land
Water
Sources: NOAA Coastal Services Center
Coastal Change Analysis Program (C-CAP), 2005 & 2006;
USGS; ESRI
Northwest River
Shell Landing Creek
Indian Creek
Smith Creek
Mill Creek
Dollys Creek
Dismal Swamp Canal
Northwest River
Shingle Landing Creek
Roland Creek
Tull Bay
Tull Creek
Buckskin Creek
Chesapeake
Currituck
Camden
0 0.5 1 2 Miles

over 74% forest cover. In contrast, only about 19% of the Moyock Run subwatershed has forest cover. The U.S. Naval Reservation/Northwest River subwatershed has the greatest number of acres (16,004) of forest cover in the drinking water supply watershed and contributes significantly to its total forest cover. Results of a more recent canopy cover study conducted by the City are presented in Appendix A (p.108).

Upland forested areas in the watershed are dominated by loblolly pine stands managed on short (20-30 year) rotations for pulpwood and sawtimber. Wetland areas associated with the Northwest River floodplain support predominantly hardwood forest. Most forestland under conservation ownership in the watershed is being managed for old-growth attributes and is unlikely to be harvested to any large degree.

As noted above, agriculture is still a common land use in the Northwest River watershed, with corn and soybeans being the primary crops in production. Parcelization of farmland over the past several decades in the upper portion of the watershed has steadily reduced the acreage of land in production. The rise of no-till farming across the watershed has likely helped reduce soil loss and sediment discharge into waterways.

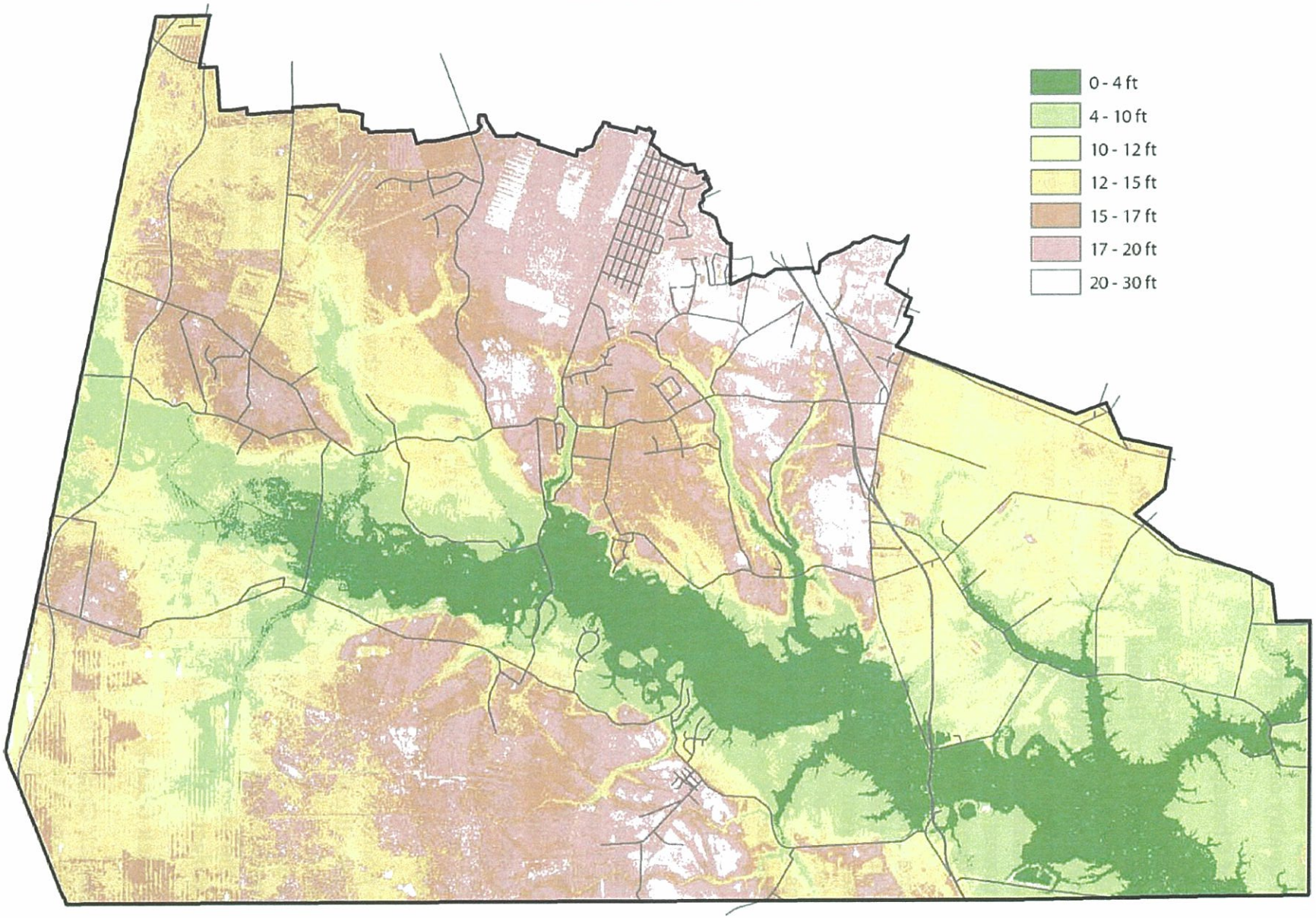
Waterfront development along the Northwest River is highly limited, due primarily to the expansive floodplain flanking the waterway. Uplands located near the waterway are prone to occasional flooding, providing further limitations. The highest elevations in the watershed are located in the City of Chesapeake's drinking water supply subwatersheds of the Northwest River. The largest contiguous blocks of higher-elevation lands are located to the west of Hickory and to the east and southeast of the U.S. Navy's Northwest Annex facility. The lower sections of the Northwest River watershed, particularly the Buckskin Creek and Tull Bay subwatersheds, are dominated by lands less than 6.5 feet in elevation (Map 5).

Population density across the watershed varies considerably, with low to very low densities in the upper and lower portions of the basin and relatively higher population densities concentrated in between. Unlike the main stem of the river, headwater reaches of tributary streams may be found in high-density residential areas, creating potential challenges for maintaining water quality.

Watershed Localities

The Northwest River Watershed occupies land in four localities across two states: the cities of Chesapeake and Virginia Beach in southeastern Virginia and the counties of Currituck and Camden in northeastern North Carolina. Table 3 indicates the percentage of land found in each. Chesapeake contains nearly half the entire watershed, with the second highest percentage of watershed land area being located in Currituck County. The river provides these communities with a number of

MAP 5 - Elevation



Source: City of Chesapeake LiDAR, 2006

services – drinking water, recreation, ecosystem services – each contributing to local quality of life in growing communities.

City of Chesapeake

The City of Chesapeake is a primarily suburban community located in the south central portion of Hampton Roads, with an estimated 2009 population of 225,255 people and a total area of approximately 353 square miles. Most of the population is located in the northern half of the City, which is relatively urbanized and close to employment centers. Conversely, the southern half of the City retains much of its rural character and is more sparsely populated. The City is home to nearly half of the Northwest River watershed and utilizes the river for a greater array of uses, including as a source of drinking water, than its neighboring localities do.

Zoning in the southern portion of Chesapeake is primarily agricultural, with some conservation, residential, and commercial areas. The City's concern for the preservation of the ecological and cultural heritage of the area, as well as for the protection of an important water source, has precipitated development of multiple plans and policies designed to protect it. These are discussed in further detail in the Critical Issues section of this plan.

City of Virginia Beach

Virginia Beach is the most populous city in the Commonwealth of Virginia, with an estimated 2008 population of 431,451 residents and a total area of about 248 square miles. The Northwest River Watershed occupies a small area in the City's southern region, below the designated Green Line. The Green Line was established in 1979 to protect the area's rural character, and the land below the line has remained predominantly rural while the rest of the City has grown into a largely suburban area. Although development in the southern part of the City has intensified in recent years, the City plans for agriculture and low-density residential development to remain the principal land uses.

The portions of Virginia Beach located in the Northwest River watershed are zoned as agricultural districts. The City's zoning ordinance states that the purpose of these districts is "to protect and preserve agricultural lands for agricultural functions and to protect and preserve agricultural lands and activities in the rural areas of the City in harmony with reasonable levels of rural residential development and in keeping with the special rural character, environmental protection needs and limited rural infrastructure available."

Currituck County

Currituck County is a fast-growing community with an estimated 2008 population of 24,183 and a total area of approximately 262 square miles. It is located in the lower portion of the Northwest River watershed and contains over 40% of the land draining

to the system (Table 3). Currituck County has experienced considerable residential growth over the past decade, but land use in the watershed is still primarily rural.

According to its 2006 Land Use Plan, Currituck County was the fourth fastest growing county of the Coastal Area Management Act (CAMA) counties and eleventh in overall growth of the 100 counties in North Carolina (Currituck County, 2006). Current zoning in the Northwest River Watershed portion of Currituck County generally falls into two categories: agricultural and residential. The former applies primarily to the portions of the watershed north of the main stem of the river while the latter occupies most of the land south of the river. Flooding has been a problem in portions of the watershed due to flat topography and poorly drained soils. However, the Moyock planning area just south of the North Carolina-Virginia border is projected to continue to grow as a higher density area containing both residential and commercial development.

Camden County

Camden County is a sparsely populated rural locality with an estimated 2008 population of 9,682 and a total area of around 241 square miles. It is located to the south of the City of Chesapeake and is the southern terminus of the Dismal Swamp Canal. The County also contains a portion of the headwater tributaries of the Northwest River watershed, which is still dominated by forest and fields.

Zoning classifications in Camden's portion of the Northwest River Watershed are more varied and call for higher intensity development than in the other three localities. Access to U.S. Route 17 is a driving force in the proposed development of this area, which includes light industrial, highway business, and residential areas. Increasing rates of population growth in the late 1990s and early 2000s led the County to pass a moratorium on conventional residential subdivision development in November 2003. The moratorium was lifted in April 2007, but the lack of a prohibition on large lot subdivision during the time that it was in effect led to more conventional development. Since 2006, the County has been operated under a unified government structure that places all land use decisions under the purview of the County Board of Commissioners.

TABLE 3: Acreage by Locality

Locality	Acres in Watershed	% of Northwest River Watershed
City of Chesapeake	68,764	49%
City of Virginia Beach	1,861	1%
Camden County	8,757	6%
Currituck County	60,210	43%

Biological Resources

The biological resources of the Northwest River watershed have been characterized in a number of studies conducted primarily by Virginia DCR's Division of Natural Heritage and the North Carolina Natural Heritage Program (Fleming & Moorhead, 1998). These studies have identified the Northwest River (along with the North Landing River and Back Bay) as home to the highest concentration of rare plant and animal species in Virginia east of the Blue Ridge. The bulk of the watershed's rare species occurrences are associated with wetland habitats, which represent areas least impacted by land conversion, ditching, and other anthropogenic disturbances.

Only scattered examples of mature upland forests occur in the watershed. Dominant wetland community types found in the watershed include non-riverine swamp forest, water tupelo/bald cypress swamp forest, estuarine fringe swamp forest, tidal shrub swamp, pond pine woodland and various marsh habitats dominated by herbaceous vegetation. Also found in the watershed is a marsh type known as spikerush-Olney threesquare, which is considered most rare and at a high to very high risk of extinction. This community type is confined to the oligohaline, or slightly brackish, marsh settings in the lower Chesapeake Bay and Mid-Atlantic embayed regions. Another significantly rare habitat type is the estuarine fringe swamp forest, which is considered vulnerable to extinction at a global scale and imperiled at the state level. This community type is restricted to upper estuarine habitats of the mid-Atlantic embayed region.

A total of twenty-four species of rare plants and seven species of rare animals are found in the watershed in both Virginia and North Carolina. Table 4 lists species of concern (SOC) found in the Virginia portion of the watershed. None of these species are federally listed as an endangered or threatened species, although the Bald Eagle is afforded federal protection under the Bald Eagle Protection Act. In addition to rare species, the Virginia and North Carolina Heritage Programs document eleven rare

Table 4: Virginia Natural Heritage Resource Status

Species Name	Type	Federal Status	State Status
Virginia Least Trillium	Vascular Plant	SOC	
Blue Witch Grass	Vascular Plant	SOC	
Raven's Seedbox	Vascular Plant	SOC	
Swainson's Warbler	Birds		SOC
Eastern Big Eared Bat	Mammals		Endangered
Dismal Swamp Southeastern Shrew	Mammals		Threatened
Canebrake Rattlesnake	Reptiles		Endangered

Source: Virginia Department of Conservation and Recreation

plant community types. Nearly all of these are associated with low elevation wetland habitats. Out of eighty-two rare plant, animal, or natural community occurrences, sixty-two (75%) are located in areas less than 3 feet in elevation. Nearly 70% of the 82 known rare species occurrences in the watershed are located on managed lands under city, state, federal, or non-profit ownership. Most of these are located in sites less than 3 ft. in elevation, putting them at potential risk to future sea level rise. The lower section of the Northwest River watershed, comprised chiefly of the Indian Creek/Northwest River and Tull Bay/Northwest River subwatersheds, supports the highest density and diversity of rare elements, primarily associated with extensive marshes found in the area. The City of Chesapeake's drinking water supply watershed contains twenty rare element occurrences, twelve of which are located on managed lands.

In addition to its resident biological diversity, the Northwest River and its associated floodplain are recognized as an important wildlife corridor. The floodplain of the main stem of the Northwest River is the only remaining strip of forestland linking Dismal Swamp National Wildlife Refuge with other protected lands to the east such as Back Bay and Mackay Island National Wildlife Refuges, North Landing River Preserve, and False Cape State Park. Protecting natural communities in the watershed will benefit a wide range of species including the black bear, amphibians, and various invertebrates.

Managed Lands

Managed lands, or properties under local, state, federal or non-profit ownership, occupy a total of 19,430 acres in the Northwest River watershed (Table 5). State agencies hold the most land (52%), followed by non-profits (TNC, 17%) and the U.S. Department of Defense (15%). Most of these lands (83%) are located in Virginia. Over 65% of the protected land (12,900 acres) is located in the City of Chesapeake's drinking water supply watershed. This acreage represents nearly 20% of the entire drinking water supply watershed. Other areas of significant conservation ownership are located in the Indian Creek/Northwest River and Tull Bay/Northwest River subwatersheds. Much of this land is located at lower elevations. Close to 30% (5,400 acres) of all managed land is located below 3 feet in elevation and a total of 7,300 acres (38%) is located below 6.5 feet in elevation. Sea level rise is likely to significantly influence the condition and amount of protected land over the next 100 years.

Managed lands in the watershed are used for multiple purposes. State Natural Area Preserves managed by Virginia DCR as well as tracts owned by The Nature Conservancy are protected primarily for biodiversity conservation and have limited public access. Wildlife Management Areas run by the Virginia Department of Game and Inland Fisheries (DGIF) and the North Carolina Wildlife Resources Commission blend habitat protection, wildlife management, and public recreation. Over 1,500 acres of the Navy's 2,836-acre Northwest Annex is forested; the balance contains a

mix of open fields, training grounds, barracks, and administrative buildings. The 758-acre Northwest River Park managed by the City of Chesapeake offers a number of public uses including camping and equestrian activities. Many of these uses are highly compatible with watershed protection.

Table 5: Managed Lands by Owner

Owner	Acreage	%
City of Chesapeake	1,337	7%
Elizabeth City State University	646	3%
NC Department of Transportation	408	2%
NC Wildlife Resources Commission	2,176	11%
Private	1,963	10%
The Nature Conservancy	3,258	17%
US Department of Defense	2,836	15%
US Fish and Wildlife Service	9	<1%
Virginia Dept. of Conservation & Recreation	2,257	12%
Virginia Dept. of Game & Inland Fisheries	4,540	23%
Total	**19,430**	

Hydrology

The Northwest River is located in the upstream limit of the Albemarle Sound estuary. While the effect of lunar tides on water levels is negligible, the river experiences high and low tide events resulting from wind-driven currents. Strong winds from the north to west drive water in Currituck Sound southward, resulting in lower water levels for tributary branches such as the Northwest River. Conversely, sustained winds from the south and east move Currituck Sound water northward, flooding marshes and swamps. The frequency, duration, and amplitude of wind tide events are variable. Flooding effects can extend far upstream if high riverine flows are accompanied by powerful southerly wind-tide events. Similar wind tides have caused as much as 4 foot variation in the Chowan River in North Carolina and a 3 foot variation in Back Bay, Virginia (Daniel, 1977). The upstream currents associated with wind-driven high-tide events can override river flows on a short term basis, particularly in summer when freshwater input is low and water loss due to evapotranspiration is high. The occurrence of upstream flow for sustained periods of time suggests that the effective boundary of the City of Chesapeake's drinking water supply watershed should include acreage below the water withdrawal site at the Rt. 168 bridge. Non-point source pollution discharge into the lower reaches of the river, for example, has the potential for migrating upstream, depending on the timing of the pollutant release and the prevailing current flows.

A comprehensive water budget model has yet to be developed for the Northwest River due in part to lack of flow data, poor understanding of groundwater dynamics, and general difficulty characterizing wind-tide systems.

The river's hydrology has been altered considerably over the past two centuries by land clearing, wetland drainage, and canal construction. The first major ditch project influencing the river was the creation of the Dismal Swamp Canal in 1805, which resulted in a substantial decrease in surface water input in what is now considered the river's headwaters area. Approximately 30 years after the Dismal Swamp Canal was opened, a new canal was constructed linking the Dismal Swamp Canal with the Northwest River channel. The canal, named the Northwest River Canal, extended seven miles from Wallaceton, located approximately four miles north of the state line, to what is now the Bunch Walnuts Bridge area. Constructed for transporting timber products from the Dismal Swamp Canal to Currituck Sound and Currituck Inlet, the canal was abandoned in 1871 due to the closure of Currituck Inlet and the rise of railroad transportation (Trout, 2000).

Two-thirds of the former Dismal Swamp ecosystem, which likely included much of the upper portion of the Northwest River watershed, is thought to have been drained since European settlement in the region (Pettie, 1976). While the timeline of wetland loss is not well established for the region, historic topographic maps from the USGS indicate that many of the major ditches currently in place, such as Central Ditch, the lower portion of Twelve-foot Ditch, and much of the headwaters of Shingle Landing Creek were created before 1945. One of the largest wetland conversion projects in the last 50 years in the Virginia portion of the Northwest River watershed occurred in the 1980s on roughly 4,000 acres in the southwestern corner of the City of Chesapeake, prior to the establishment of federal wetland regulations.

As mapped by the National Hydrology Dataset (NHD), a total of roughly 500 miles of waterway exist in the Northwest River watershed. A considerable portion of this waterway network is in the form of drainage ditches. In the Shingle Landing Creek subwatershed, for example, approximately 80 miles of waterway are mapped by the NHD dataset. Based on topographic information and liberal estimates on the location of natural stream channels, over 50% of this waterway network appears to be associated with constructed ditches. Other subwatersheds, such as the U.S. Naval Reservation/Northwest River subwatershed, also have a relatively high density of constructed waterways.

Waterways in the Northwest River watershed are predominantly situated in cleared agricultural land, with minimal to no vegetated buffers surrounding the channels. Within the City of Chesapeake's drinking water supply watershed, approximately 70% of 100-foot buffer zones around natural and constructed waterways consist of open land. The balance is forested land. Ditch maintenance (clearing of debris and vegetation to remove flow barriers) generally occurs more frequently in farmlands, as they are more easily accessible. Easements defining property drainage rights are common across the Northwest River watershed. The City of Chesapeake controls

drainage easements along many of the watershed's major ditches and has stormwater management regulations in place to guide the placement and type of new drainage easements associated with developments.

Increases in impervious surface area driven by new residential development in the Northwest River watershed present significant challenges for managing stormwater runoff in the City's drainage ditch network. A 2007 stormwater management modeling study conducted for the City by URS Corporation indicates that the Southern Chesapeake watershed (which includes much of the northern portion of the U.S. Naval Reservation/Northwest River subwatershed) will increase from 8.81% to 12.61% imperviousness in the future (URS, 2007). This increase in impervious cover will produce greater volumes of stormwater runoff. The URS report recommends ditch widening as one strategy to accommodate increased runoff. Complicating this planning effort is the likelihood of higher surface water levels in the Northwest River and lower tributaries due to the effects of sea-level rise. Such changes may influence the effective elevation gradient for drainage purposes and for some ditch networks impede discharge. Detailed flow studies incorporating predicted sea level rise parameters are needed to assess the near and long-term impacts of this pending shift in the river's hydraulics.

Water Quality

The Northwest River has a history of water quality problems based on monitoring and analysis by the Virginia Department of Environmental Quality (DEQ) and the Applied Marine Resources Laboratory at Old Dominion University. Identified problems include bacterial contamination, mercury in fish tissue, low dissolved oxygen and high organic loading. Unfortunately little is known about the source of the pollution. In particular, the low dissolved oxygen and high organic loading issues may be due to natural causes.

TABLE 6: DEQ Monitoring Stations Listed Downstream to Upstream

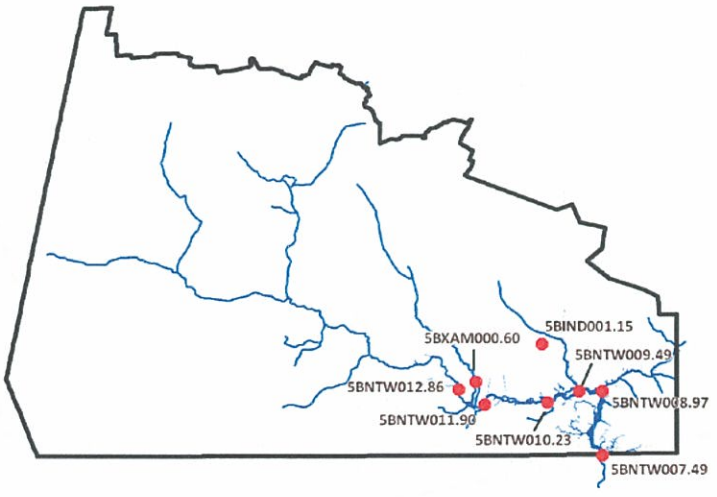
Station ID	Waterbody	Location Description
5BNTW007.49	Northwest River	At North Carolina Line
5BNTW008.97	Northwest River	At Confluence of Smith Creek
5BNTW009.49	Northwest River	At Confluence of Indian Creek
5BIND001.15	Indian Creek	Indian Creek Road Bridge
5BNTW010.23	Northwest River	E. of Island approx. 1.5 mi. downstream
5BNTW011.90	Northwest River	Rt. 168/170 Bridge
5BNTW012.86	Northwest River	At Fork approx. 1 mile Upstream of Bridge
5BXAM000.60	Unnamed Tributary	Near Gallbush Rd.

DEQ operates eight water quality monitoring stations on the Northwest River and its tributaries (Table 6). All are ambient monitors, and one includes fish tissue (Map 6). Waters considered to be impaired in the Northwest River watershed are listed because of low dissolved oxygen in several segments (aquatic life concern), bacterial contamination (recreation concern), or mercury in fish tissue (one segment).

The most recent Virginia Water Quality Assessment, published in October of 2008, identifies three types of water quality problems in the Northwest River: low dissolved oxygen, bacterial contamination and mercury in fish tissue. DEQ's 2008 305(b)/303(d) Water Quality Assessment Integrated Report for Virginia shows that all monitored segments of the Northwest River and some of its tributaries are impaired for aquatic life and recreation due to low dissolved oxygen levels and the presence of E. coli (Table 7) (Virginia Department of Environmental Quality, 2008). The report further notes that the cause of the low dissolved oxygen concentrations is suspected to be naturally occurring, although that has not been confirmed by DEQ. Two new segments of the river are listed for not meeting water quality standards: the Upper for recreation/E. coli bacteria and the Middle for fish consumption due to mercury in fish tissue. Map 6 indicates the locations of impaired waters in the Northwest watershed.

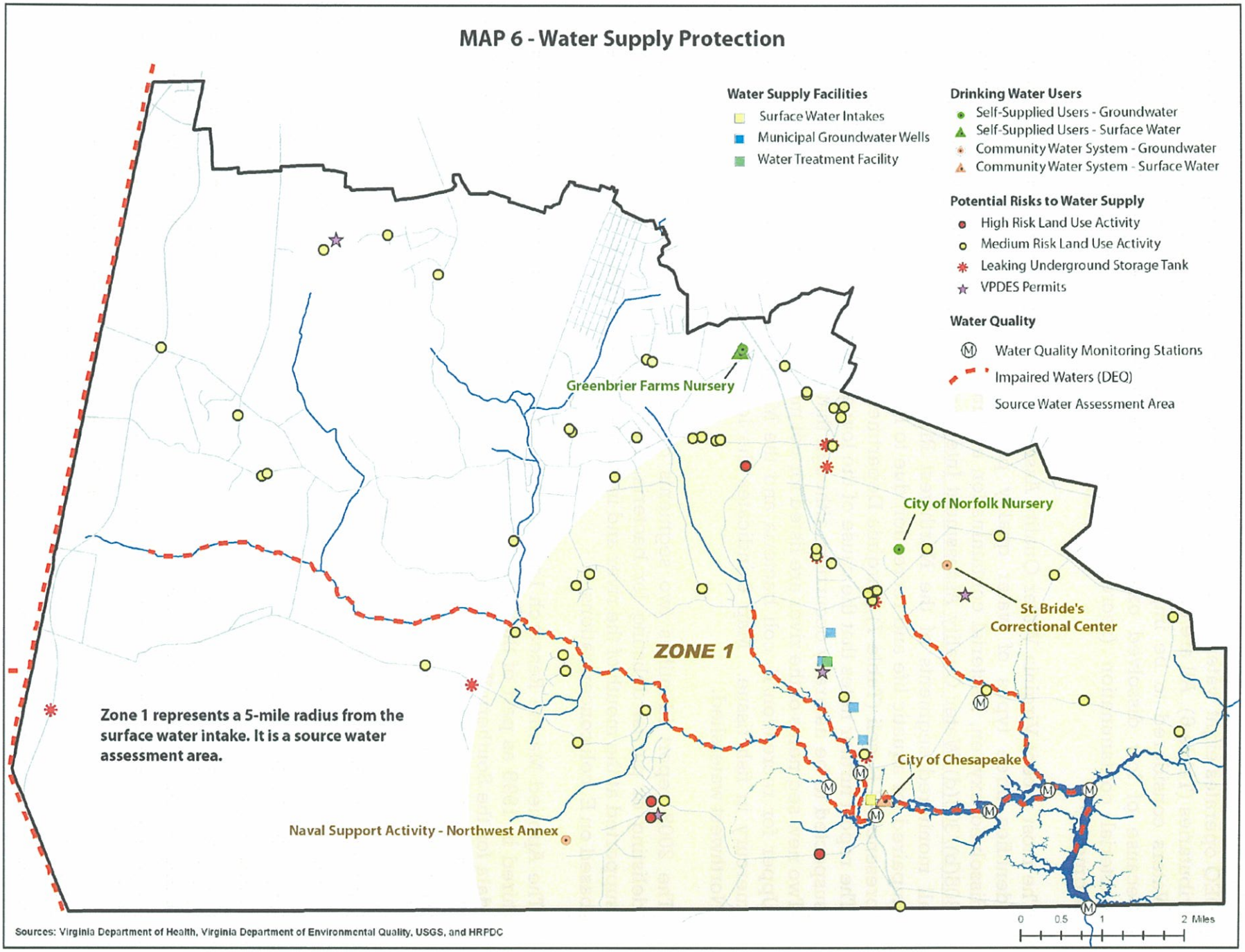
The 2008 report identifies two segments of the Northwest River as eligible for delisting or partial delisting for bacteria. The report finds that recreation use is supported at the mouth of the river and in the lower river segment to varying extents based on E. coli concentrations.

The Applied Marine Research Laboratory (AMRL) at Old Dominion University was hired in 1998 as part of the SWAMP project to analyze the available water quality data for the Southern Watershed Area. The study area included Back Bay, the North Landing River, the Northwest River, Lake Drummond, and Stumpy Lake. Analysis included an evaluation of status and long term trends for each subwatershed area. In addition to the water quality data analysis, AMRL was asked to critique the water quality monitoring network and, to the extent possible, to provide insight into the linkage between land use patterns and water quality.



Water quality monitoring stations in the Northwest River watershed

MAP 6 - Water Supply Protection



Sources: Virginia Department of Health, Virginia Department of Environmental Quality, USGS, and HRPDC

The summary of findings for the Northwest River noted that general conditions in the Northwest River are indicative of increased organic input into the system. Unfortunately, AMRL was not able to determine if the degraded conditions are natural or a result of human activities and land use patterns. Additional studies were suggested for both the North Landing and Northwest Rivers to specifically identify the source of the problem.

TABLE 7: Water Body Segments Not Meeting Quality Standards, 2008

Waterbody	Use Not Being Met	Impairment
Indian Creek	Aquatic life	Dissolved oxygen
Indian Creek	Recreation	E. coli bacteria
Northwest River - Upper	Aquatic life	Dissolved oxygen
Northwest River - Upper	Recreation	E. coli bacteria
Northwest River - Lower	Aquatic life	Dissolved oxygen
Northwest River - Middle	Aquatic life	Dissolved oxygen
Northwest River - Middle	Recreation	E. coli bacteria
Northwest River - Middle	Fish consumption	Mercury
Unnamed tributary to Northwest River	Recreation	E. coli bacteria
Unnamed tributary to Northwest River	Aquatic life	Dissolved oxygen

Concerns identified for the Northwest River included violation of the state dissolved oxygen standard. Other findings included:

- Relative water quality was assessed at the above seven stations from 1995 to 1997 for total nitrogen, dissolved inorganic nitrogen, total phosphorus, dissolved inorganic phosphorus, and total suspended solids.
    - Relative water quality was good at all stations for total nitrogen, dissolved inorganic nitrogen, and total suspended solids.
    - Total phosphorus was good at all stations except Indian Creek where it was poor.
    - Dissolved inorganic phosphorus was poor at the confluence of Indian Creek and downstream at the confluence of Smith Creek. It was rated fair at the North Carolina state line, the Route 168 bridge and the station upstream of the bridge. Dissolved inorganic phosphorus was not assessed at the other two stations.
- For each station, the study determined the number of water quality observations between 1995 and 1997 that exceeded the Federal Primary Maximum Contaminant Levels (MCLs) for drinking water for nitrite, nitrate, chloride, and sulfate. Three observations exceed the nitrite standard: one

each at both Indian Creek stations, and one at the Rt. 168 bridge station. Observations of chloride exceeded the standard 3 times at the Indian Creek station and 4 times at the Rt. 168 bridge station. All other observations met the standards.

- Water quality observations from 1995-1997 for pH, fecal coliform, and dissolved oxygen at all seven stations were compared to the Virginia Water Quality standards to determine if the waterbodies were supporting their designated uses.

    - All stations except the Indian Creek station were found to be supporting the recreational use based on the fecal coliform standard.
    - All stations were supporting or partially supporting the aquatic life use based on the pH standard.
    - Only 3 of the 7 stations were found to be supporting the aquatic life use based on the dissolved oxygen standard: Northwest River downstream of the Rt. 168 bridge, Northwest River at the confluence of Smith Creek, and Northwest River at the North Carolina state line.

- Water quality trends through 1997 were evaluated at the Rt. 168 bridge station for conductivity, hardness, nitrate, total Kjeldahl nitrogen, volatile solids, fixed solids, total suspended solids, fixed suspended solids, total solids, and pH. Results of the trend analysis indicated that water quality conditions were degrading. Increasing trends were significant for total solids, total nitrogen, conductivity, hardness, and pH.

The SWAMP study did not assess sources of pollutants, but suggests that conditions are indicative of increased organic input to the system. The study generalized that there may be a natural origin for the nutrients, but underscored the importance of identifying anthropogenic sources.

Wetland Mitigation

Since the mid 1990s, wetland mitigation has emerged as a significant driver of land protection and wetland restoration in the Northwest River watershed. According to the U.S. Army Corps of Engineers (Corps) and The Nature Conservancy, approximately 2,800 acres of land are tied to mitigation projects in the watershed, all located within in the City of Chesapeake. Wetland mitigation banks are properties on which wetlands have been restored, created, enhanced, or preserved, and then permanently protected to compensate for future wetland impacts due to permitted development activities. Regulations developed by the Corps and DEQ guide the creation and operation of banks and set standards for quantifying the functions or area restored or created in terms of credits. Credits can be sold to land owners needing to compensate for authorized impacts to waters of the U.S. (including wetlands) associated with development activities. Banks often offer a preferred alternative to restoration or creation of wetlands on or near development sites.

Both for-profit and non-profit wetlands banks are active in the watershed. Of the 2,800 total acres of mitigation land in the watershed, nearly 1,300 acres are controlled by several private mitigation bankers. The balance (approximately 1,500 acres) is held by The Nature Conservancy through the Virginia Aquatic Resources Trust Fund (Trust Fund), an in-lieu fee mitigation program administered in partnership by The Nature Conservancy and the Norfolk District of the Army Corps of Engineers. The intent of the Trust Fund is to consolidate the mitigation requirements of multiple small projects to implement large-scale watershed efforts that restore, enhance, and protect water quality. Both for-profit banks and the Trust Fund provide mitigation for impacts in the Chowan Basin associated with Section 404 and 401/Virginia Water Protection permits issued by the Corps and DEQ, respectively.

The prevalence of ditched and drained farmland in historic wetland sites coupled with close proximity to an expanding metropolitan area (and related wetland impacts) make the Northwest River watershed an attractive site for mitigation banking. Restoration typically involves filling drainage ditches to establish wetland hydrology and planting tree species suited for saturated soils. For-profit firms consider overall restoration potential (number of available credits), ease of restoration, and land price in selecting bank sites. In addition to these parameters, TNC targets Trust Fund acquisitions in areas that fall within priority conservation sites. Trust Fund sites in the Northwest River watershed provide important habitat for rare plant and animal species and have helped establish a conservation corridor linking the Dismal Swamp with conservation lands to the east.

In 2001, the Southern Watershed Area Multiple Benefits Conservation Plan (MBCP), focusing on wetland mitigation bank siting, was produced for the Hampton Roads Planning District Commission by the Landmark Group (LandMark Design Group, Inc., 2001). The MBCP identified measures to achieve multiple benefits from wetlands compensation decisions by identifying "focus" areas with regionally important habitat, water quality, flood and erosion control and recreational benefits. The MBCP MOA was designed in part to address the concerns of the cities of Chesapeake and Virginia Beach regarding the need for more effective wetland compensation decisions made by others as well as the need for guidance concerning compensation for their own projects. To date, all of the mitigation bank sites in the Northwest River watershed portion of the Southern Watershed Area fall generally within the focus areas described. This planning effort is supported in part by an ordinance passed by the City of Chesapeake requiring mitigation banks to be sited on lands zoned as C-1 Conservation District. The intent of the ordinance is to site mitigation banks in areas with compatible land uses.

Existing Studies and Plans for the Northwest River Watershed

Chesapeake's portion of the Northwest River watershed has been studied extensively through the cooperative Southern Watershed Area Management Program that began in the 1990s, through various city-sponsored plans and studies, and through the efforts of TNC. These studies include a variety of documents considering everything from agricultural preservation to rural design.

Many of the studies reach similar conclusions on planning tools that should be used to achieve the long-term goals for the watershed. A significant common message in the existing plans and studies developed for the Northwest River watershed lies in the possibility that a variety of different land uses and associated activities can be successfully accommodated here if the various uses are located to minimize adverse impacts and conflicts.

Southern Watershed Area Management Program (SWAMP)

The Southern Watershed Area Management Program (SWAMP), developed by the cities of Chesapeake and Virginia Beach, in partnership with the Hampton Roads Planning District Commission and the Virginia Coastal Zone Management Program, was intended to assist in the protection of natural resources, sensitive lands and water supplies in the headwaters of the Albemarle-Pamlico system. The project study area encompassed the watersheds of Back Bay, the Northwest River and the North Landing River in the cities of Chesapeake and Virginia Beach. The project focused on the development and implementation of a collaborative watershed management program for the Southern Watershed Area. To this end a number of initiatives were pursued, including the development of the Strategic Plan for Agriculture, a conservation plan, analysis of the application of conservation design in the Southern Watershed, and development of recommendations for a Rural Area Preservation Program.

A Strategic Plan for Agriculture in Chesapeake and Virginia Beach

In March 2001, a plan for agriculture in the Southern Watershed Area (SWA) was completed by Virginia Tech. This effort focused on retaining agriculture as a vital component of the economy and landscape of the SWA. It found that the sustainability of agriculture in the SWA depended on economic viability, preventing development from competing with agriculture, and the use of equitable and balanced land use controls and design guidelines.

Several factors that need to be addressed were identified in this plan and still apply. These include:

- Agriculture must be economically sound or provide a return on investment to compete with the potential returns from development.

- Land use policies must direct growth away from land well-suited for agriculture.

- Development standards must be established and enforced regarding the location and type of non-agricultural uses.

This plan noted that a multi-faceted approach would be needed to meet these needs. No one strategy will work on its own to preserve agriculture in the SWA.

Southern Watershed Area Rural Area Preservation Program (RAPP)

The Rural Area Preservation Program, completed in September 2001, was developed as a toolbox for rural landscape management (Siemon & Larsen, P.A., 2001). It recommended steps to be taken in order to preserve the rural character of the SWA and the fiscal integrity of its local governments. Key elements include development of multiple, location-specific planning and regulatory techniques to preserve the form and function of the rural landscape. Techniques should be applied across five rural land management units in which distinct values and resources have been identified as priorities for planning and regulatory protection: (1) agricultural lands, (2) environmentally sensitive lands, (3) scenic resources lands, (4) rural infill lands, and (5) rural development lands. Development should be strictly limited in environmentally sensitive areas.

The two cities were encouraged to incentivize desirable development and development patterns, and to establish disincentives discouraging development patterns that use land and infrastructure in an inefficient manner. Additionally, land uses and patterns should be selected to minimize traffic impacts on rural roads and visual impacts on valued viewsheds.

The Multiple Benefits Conservation Plan Memorandum of Agreement (MBCP)

The Multiple Benefits Conservation Plan Memorandum of Agreement (MBCP MOA) was completed and signed by the Cities of Chesapeake and Virginia Beach, the HRPDC, the Virginia Departments of Conservation and Recreation, Environmental Quality, Game and Inland Fisheries, and Transportation, the Virginia Marine Resources Commission, the United States Army Corps of Engineers, Fish and Wildlife Service, Natural Resources Conservation Service and The Nature Conservancy in June of 2002. The MOA is intended to encourage the achievement of multiple ecological benefits when sites are selected for wetlands restoration or preservation in the Southern Watershed Area. Benefits may include wetlands restoration and protection, water quality protection, wildlife habitat enhancement, storm water management, passive recreational opportunities and other benefits. The Northwest River sub-watershed was identified as an area of opportunity for multiple benefit compensation sites occurring primarily from the Virginia/North

Carolina line northwest along the Northwest River and its tributaries to the Lake Drummond Causeway.

The Conservation Corridor System

One of the major accomplishments of the Southern Watershed Area Management Program was the identification of a green infrastructure network in the Southern Watershed Area. During the time period when the network was under development the term "green infrastructure" was not yet in common use and the network was referred to as a "conservation corridor" system. The corridor system has proven to be a valuable planning tool for the cities of Chesapeake and Virginia Beach and the state and federal agencies working in the SWA. The corridor system has been utilized in comprehensive planning efforts, the creation of a Purchase of Development Rights program in Chesapeake, and is the target area for wetlands mitigation as outlined in the Multiple Benefits Conservation Program Memorandum of Agreement.

The Corridor System was developed through a partnership between the Virginia Department of Conservation and Recreation's Natural Heritage program and the SWAMP Local Government Advisory Committee. A multiple benefits approach was used from the outset to identify a system that would contribute to water quality protection, natural resource protection and provide a framework for wetlands mitigation in the Southern Watershed Area. Map 19 depicts both the corridor system and protected lands within and adjacent to the corridors. The system was designed to capitalize on the existing network of protected lands and highlight opportunities for connectivity. The corridor system provides a framework for the protection of the rich complement of Natural Heritage resources found in the Southern Watershed Area. A 2001 report developed by Natural Heritage entitled Conservation Plan for the Southern Watershed Area documents the natural resources of the SWA, the development of the corridor system and outlines a set of management recommendations (Erdle, Weber, Myers, & Carter-Lovejoy, 2001).

Hampton Roads Conservation Corridor Study

The Hampton Roads Conservation Corridor Study expands the identification of conservation corridors from the Southern Watershed Area to the remainder of the Planning District (HRPDC, 2006). The geographic information system analysis and the stakeholder involvement process employed in the development of the corridor study have resulted in the identification of priority areas for conservation and opportunities for linkage among those areas. Resource protection in the region will complement ongoing conservation work in the Northwest River watershed.

Hampton Roads Source Water Assessment Program (HRSWAP)

Together with CH2M HILL, the HRPDC staff and the Directors of Utilities Committee developed a regional Source Water Assessment Program for Hampton Roads

(HRSWAP) in 2001. The purpose of HRSWAP was to fulfill the technical requirements of the Virginia Department of Health (VDH) Source Water Assessment Program for all publicly owned surface water systems and conjunctive use wells serving the Hampton Roads region and to promote watershed protection. HRSWAP collected and analyzed data to assist with drinking water supply source protection. Within the Northwest River watershed, watershed and well areas were delineated, a database of land use activities that are, or could become, potential sources of contamination to drinking water supplies was compiled, and susceptibility to contamination of each surface water source and conjunctive use well was determined. Land use activities were classified according to VDH criteria as high, medium, or low risk to surface water sources (CH2M HILL, 2001). Examples of each category include tire piles (high risk), pasture (medium risk), and dry cleaning (low risk). Some of this information is found on Map 6 (page 32).

Review of Chesapeake Plans and Codes, Randall Arendt

In 2001, Randall Arendt, a landscape planner and designer and conservation advocate, was contracted by the Hampton Roads Planning District Commission as part of the SWAMP Program to review Chesapeake's comprehensive plan and ordinance provisions, and to make recommendations for changes that would promote land conservation and maintain rural character in the rural tier of the City (Arendt, Memo to Chesapeake City Council Members and Planning Board, 2001). Concept plans and a number of recommendations, including the use of conservation design as a by-right alternative to conventional subdivision layouts, reduction of minimum tract size, alternative density calculations, and increased minimum open space requirements, were provided. Reducing street pavement widths, using shade trees long new subdivision streets, and development of a city-wide map of potential conservation lands were also recommended.

Chesapeake Open Space and Agriculture Preservation (OSAP) Program

In February 2003, Chesapeake City Council created the Open Space and Agriculture Preservation (OSAP) Program in response to the community's concern for the preservation of the City's natural open spaces, rural character, and agricultural resources as an element of the City's overall growth management strategy. Protection of Northwest River watershed lands is an important component of the OSAP program.

The program is a strictly voluntary, city-wide competitive program in which the City purchases development rights from willing landowners in exchange for a preservation easement on their property. The landowner receives fair market value for the development rights of the land, but still retains ownership as well as the ability to have a home on the land and to use the land for agricultural or open space purposes. Funding for the program comes from rollback tax appropriations, street closure revenues, and limited general fund appropriations. This local funding is supplemented with state and federal funding when available.

The first easement was purchased under this program in 2007, resulting in the permanent protection of 108 acres of prime agricultural land within the Northwest River watershed. In addition to the easement enrolled in the OSAP program, the City has purchased land for recreational use within the watershed as well as accepting two donated easements from landowners.

Forward Chesapeake: 2026 Comprehensive Plan

Chesapeake City Council adopted their current comprehensive plan in March 2005. This plan included recommendations from previous plans and studies of the Northwest River watershed. Details from the plan are provided elsewhere in this document.

Design Guidelines Manual

In May 2007, Chesapeake City Council adopted the Design Guidelines Manual, which was prepared by planning consulting firm EDAW, a subsidiary of engineering and architectural design firm AECOM (in 2009 EDAW was renamed Design + Planning at AECOM). The manual provides guidelines specific to mixed-use, infill, gateway, and rural development (AECOM, EDAW, 2007). Features found to be essential to preservation of rural character include distant views of the countryside, topography, natural drainage patterns, country roads, fences and hedgerows, barns and other farm buildings, and open space including agricultural fields and pastures. The Manual recommends avoidance of "piano-key" development and placement of incompatible residential development in suburban or urban districts. The Manual also includes goals and objectives for development in the Rural Overlay District that are intended to minimize both visual impact and site disturbance from rural development. Clustering and density bonuses are suggested as methods to help achieve these goals.

Protecting Rural and Natural Lands in Southern Chesapeake: The Future of the Open Space and Agricultural Preservation Program

This report was produced in November 2007 to evaluate the progress of the OSAP program and to make recommendations for its future (Chesapeake Planning Department, 2007). In order to increase the effectiveness and cost efficiencies of the program, city staff recommended the following:

- Focus, strengthen, and leverage the City's existing PDR Program
    - Address the development rights cost issue within the PDR program
    - Focus the program on achieving multiple benefits with emphasis on rural character and natural areas
    - Maximize state funding
    - Provide for flexibility with the terms of purchase

- Utilize and emphasize fee simple purchase for key priority parcels within Southern Chesapeake
    - Create a targeted program for property within the SWAMP conservation corridor
    - Actively seek partnerships with the State and Federal government for land acquisition within the Interfacility Traffic Area
    - Explore partnership with Public Utility Department for targeted drinking watershed protection acquisition

- Promote the availability of land conservation tax incentives

- Create a dedicated local funding stream for open space protection
    - Identify a general fund revenue source
    - Issue a general obligation bond for land preservation

- Incorporate recently approved Rural Overlay Design Guidelines into City policy/regulations
    - Rewrite the City's Subdivision and Cluster Ordinances
    - Update the City's Public Facilities Manual (PFM) to reflect rural characteristics

- Create a limited, targeted TDR program

- Study the fiscal impact of rural residential growth

Storm Water Management Model: Southern Chesapeake Watershed Master Drainage Plan Update

In 2007, engineers from the U.S. Army Corps of Engineers, City of Chesapeake, and URS Corporation completed a drainage study of the Southern Chesapeake watershed using the Storm Water Management Model (SWMM) computer program (URS, 2007). After analyzing existing and potential problems in this watershed, URS identified twelve specific projects that could alleviate future flooding in the watershed. As part of the agreement between the City and the Corps, proposed improvements had to include habitat restoration or creation opportunities. Four potential projects in the Southern Chesapeake watershed were identified for habitat creation potential:

- Lower Sign Pine Road BMP Habitat Corridor
- Edinburg BMP Habitat Corridor
- East Edinburgh Habitat Corridor
- Hickory High School BMP Habitat Corridor

USACE Dismal Swamp Ecosystem Restoration Feasibility Study

The purpose of the U.S. Army Corps of Engineers Feasibility Report for the Dismal Swamp Canal Ecosystem Restoration Project is to study and analyze the potential for ecosystem restoration in the Deep Creek and New Mill Creek areas of the City of Chesapeake and to provide a recommendation based on the results. Because of previous floods associated with storm events, flood condition connections with the Northwest River watershed were considered as part of the study. The report is still being developed, but the initial findings indicate that the occasional flooding resulting from storm events is a nuisance that does not require systematic response. Two small areas at Hickory Middle School and at City Park are being targeted for tree planting and wetlands restoration as a result of this study.

USACE Currituck Sound Ecosystem Restoration Project

In 2004, the US Army Corps of Engineers launched a study addressing water quality issues in Currituck Sound which have adversely impacted freshwater fisheries and submerged aquatic vegetation. Project partners include Elizabeth State University, the U.S. Geological Survey, ERDC labs – the Waterways Experiment Station and the Coastal and Hydraulics Laboratory Field Research facility, U.S. Fish and Wildlife Service, the N.C. Estuarine Research Reserve, the N.C. Division of Water Resources, Virginia Department of Environmental Quality and the Albemarle-Pamlico National Estuary Program.

Currituck County Conservation Plans

A 2006 conservation plan for Currituck County prepared by the North Carolina Coastal Land Trust identified a number of tracts in the Northwest River with significant water quality protection attributes. Marsh habitat and forested wetlands located in the Tull Bay area were among the most highly ranked sites in the County.

Camden County Conservation Plans

The Currituck Sound Sub-basin, which includes the Northwest River, is addressed in Camden County's 2004 Advanced Core CAMA Land Use Plan (Holland Consulting Planners, Inc., 2004). The Sub-basin contains areas set aside as public land and Significant Natural Heritage Areas, including the Northwest River Marsh Game Land, the North River Game Land, and portions of the Great Marsh.

Critical Issues for the Northwest River Watershed

Because the Northwest River serves multiple functions for the communities that surround it, particularly Chesapeake, it is important to identify those functions that are the most critical in supporting the City's essential services and its quality of life and to identify threats to those functions. Critical issues in the Northwest watershed include the protection of an important drinking water supply, preservation of globally important natural resources, preservation of rural character, and buffering of military facilities in the area. Addressing the potential impact of climate change and sea level rise is also of increasing importance. Additional concerns arise when considering the transportation network, economic development, recreational opportunities, and education of stakeholders in the watershed.

Each of the critical areas and concerns identified above is typically addressed through long-range planning, which includes the comprehensive plan and other plans and studies, and through current planning, which includes the development and enforcement of zoning and other local codes and ordinances. In most cases, the City of Chesapeake has addressed each issue through these methods; however, incomplete rules and enforcement and the lack of integration of development controls with the City's vision of its rural tier may allow many potential threats to continue. This section examines the current plans and codes that address each critical issue and provides recommendations for improving management of the watershed for these essential functions.

Protection of the Drinking Water Supply

The Northwest River has been an important source of drinking water for the City of Chesapeake since the Northwest River Water Treatment Plant (NWRWTP) went into service in 1980. The river has historically presented several difficulties as a drinking water supply, including fluctuations in salinity and periodic loading with organic material associated with storm events. A reverse osmosis (RO) facility was installed at the NWRWTP in 1999, primarily to deal with the fluctuations in salinity levels. The salinity fluctuations are a natural condition resulting from a combination of drought, which limits freshwater input into the river, and wind tides that can push salt water into the northern section of the Currituck Sound and the Northwest River. Major storm events have resulted in high levels of organic material being flushed into the river, leading to difficulties in the water treatment process. In 1999 Hurricanes Floyd and Dennis flooded the Dismal Swamp, forcing huge quantities of water over U.S. Route 17 and causing extensive flooding in the watershed. Total organic carbon (TOC) levels, an indicator of decaying organic matter, rose from normal levels of 25-30 milligrams per liter to 75 milligrams per liter and remained high for several years following the storms. Both the salinity and organic material problems have been managed successfully through the water treatment process, allowing the City to deliver high quality drinking water from the river. Unfortunately, in the case of the

high TOC levels associated with the storm events, it is difficult to differentiate between natural and manmade sources of organic compounds and therefore difficult to identify management solutions.

The intake point for Northwest River water being treated by the City of Chesapeake is located downstream from the bridge on Route 168. The water is purified at a water treatment plant located several miles north of the intake point. It is first treated through the conventional process of coagulation, flocculation, sedimentation, and filtration. Then the water is filtered through the RO membrane plant as necessary, to maintain high quality and to mitigate salt-water intrusion events. The substantial volume (1.7 to 2.4 MGD in 2009) of brine generated by the RO filtering process is discharged via a 15-mile pipeline into the Elizabeth River, a brackish tributary of the Chesapeake Bay estuary.

The Northwest River provided an average of 3.7 million gallons per day in 2009, which is less than 40% of its peak volume in 2006 (Chesapeake Department of Public Utilities, Water Production Record 1980-2009). The City's average withdrawal rate of 6 million gallons per day (MGD) in 1980 climbed to 9-10 MGD by 2006. At its peak, the plant supplied over 60% of Chesapeake's drinking water needs. In 2006, a new water treatment plant for Lake Gaston pipeline water opened in the northern portion of the City. The availability of water from this source led to a decline in demand for Northwest River water, and by 2009 the City's withdrawal rates from the Northwest River dropped to current levels of 3-4 MGD. The Lake Gaston water treatment facility is now considered the City's base load facility, with the Northwest River treatment plant being used to deliver water for peak demand.

Key Issues

- **Water Quality**

  As noted above, DEQ maintains eight water quality monitoring stations in the Northwest River. Water quality issues identified through this network include low dissolved oxygen, bacterial contamination, and mercury in fish tissue. Because neither DEQ monitoring nor the 1998 AMRL study has been able to identify the sources of these problems, management solutions are also difficult to identify. For example, low dissolved oxygen levels may be a natural condition of the Northwest River, but a final decision on development of a Total Maximum Daily Load (TMDL) for dissolved oxygen has not been made by the state. High bacteria levels are likely caused by a mix of natural and human sources, but again DEQ has not identified specific sources. The exact source of mercury found in fish tissue is also unknown.

  Water quality management goals for the Northwest River should be designed to meet the broad range of uses that the river supports. Beyond its use as a drinking water supply, the river is used for fishing, swimming, and boating

and supports a broad range of rare wetlands habitats. Each of these uses suggests slightly different water quality goals, but in all cases minimizing pollution from manmade sources is a shared theme.

- **Water Pollution**

  Manmade sources of water pollution are typically categorized as either point source or non-point source. Examples of point sources include discharges from sewage treatment facilities and industrial processes. Permitted point sources within the Northwest River watershed include three sewage treatment facilities that have Virginia Pollution Discharge Elimination System (VPDES) permits. Point source water pollution is generally not a major problem, although overflows have occurred on rare occasions.

  Non-point sources include stormwater runoff from paved surfaces, agricultural, and residential lands. The Northwest River watershed contains few point sources, so managing pollution is largely a matter of dealing effectively with non-point sources. The City has several tools and methods available to manage non-point source pollution in the watershed. Management efforts can be divided into two categories: techniques targeted at existing land uses in the watershed and planning for future land use patterns and urban design elements that minimize increases in non-point source loadings associated with new development.

Land Use Planning and Studies

Forward Chesapeake 2026 Comprehensive Plan

Chesapeake's current comprehensive plan identifies safe drinking water as a health and safety issue and outlines some strategies to protect the City's water sources. These include maintenance of an adequate buffer around drinking water supplies, consideration of impacts from increasing impervious surface and projects affecting hydrology in the watershed, and adherence to water quality standards.

The Water and Sewer chapter of the Plan states that the City Planning Department will coordinate the development of a water supply watershed management program, such as that found in the Hampton Roads Planning District's report titled Water Supply Watershed Management in Hampton Roads (HRPDC, 1997).

OSAP

One of the stated purposes of the voluntary OSAP program is the conservation and protection of water resources and environmentally sensitive areas in the Northwest River Watershed. Protection of the drinking water supply is included in the 2007 OSAP program report to City Council, which noted that conservation corridors generally identify areas most critical to protect within the watershed that includes

the City's main drinking water supply (Chesapeake Planning Department, 2007). It also noted that, at the time, 9,800 acres (11% of Rural Overlay District) within the SWAMP conservation corridor remained unprotected.

SWAMP

The goals and objectives identified as part of the SWAMP effort included protection of the water supply of the Northwest River Treatment Plant, preservation of critical edge habitat areas and wetlands, and encouragement to preserve agricultural and forest lands. A number of subsequent studies and plans evolving from the SWAMP process have reinforced and expanded on those ideas. Water supply protection was a specific consideration in the identification of multiple benefits compensation sites in the MBCP, which included a number of forested wetlands sites in the southern and western parts of the watershed.

HRSWAP

The HRSWAP study indicated that the 85,564-acre Northwest River watershed/wellhead area was highly susceptible to contamination, due to the exposure of surface waters to contaminants, changing hydrologic, hydraulic and atmospheric conditions, and land use activities of concern located in the Zone 1 assessment area (CH2M HILL, 2001). For the Northwest River, Zone 1 comprises the watershed upgradient and downgradient of an intake bounded by a 5-mile radius. HRSWAP is a data collection tool, and identified potential threats to the water supply instead of offering management solutions.

Map 6 depicts locations of interest regarding drinking water supply use and protection, including information collected as part of HRSWAP. The major drinking water users in the Northwest River watershed are public (community water systems) and private (self-supplied) entities that access both surface and groundwater sources. Several potential pollution sources are highlighted, including VPDES locations and leaking underground storage tanks. Also shown are locations with high and medium risk land use activities. The level of risk is measured based on potential contaminants and risk to surface and groundwater resources.

Hampton Roads Regional Water Supply Plan

The Hampton Roads Regional Water Supply Plan is currently being developed to comply with 9 VAC 25-780, which establishes a planning process and criteria all local governments must use in the development of local or regional water supply plans. The plans must include the following elements: a description of existing water sources, a description of existing water use, an assessment of projected water demand, a statement of need, an alternatives analysis to address projected deficits in water supplies, a description of water management actions, and a drought response plan.

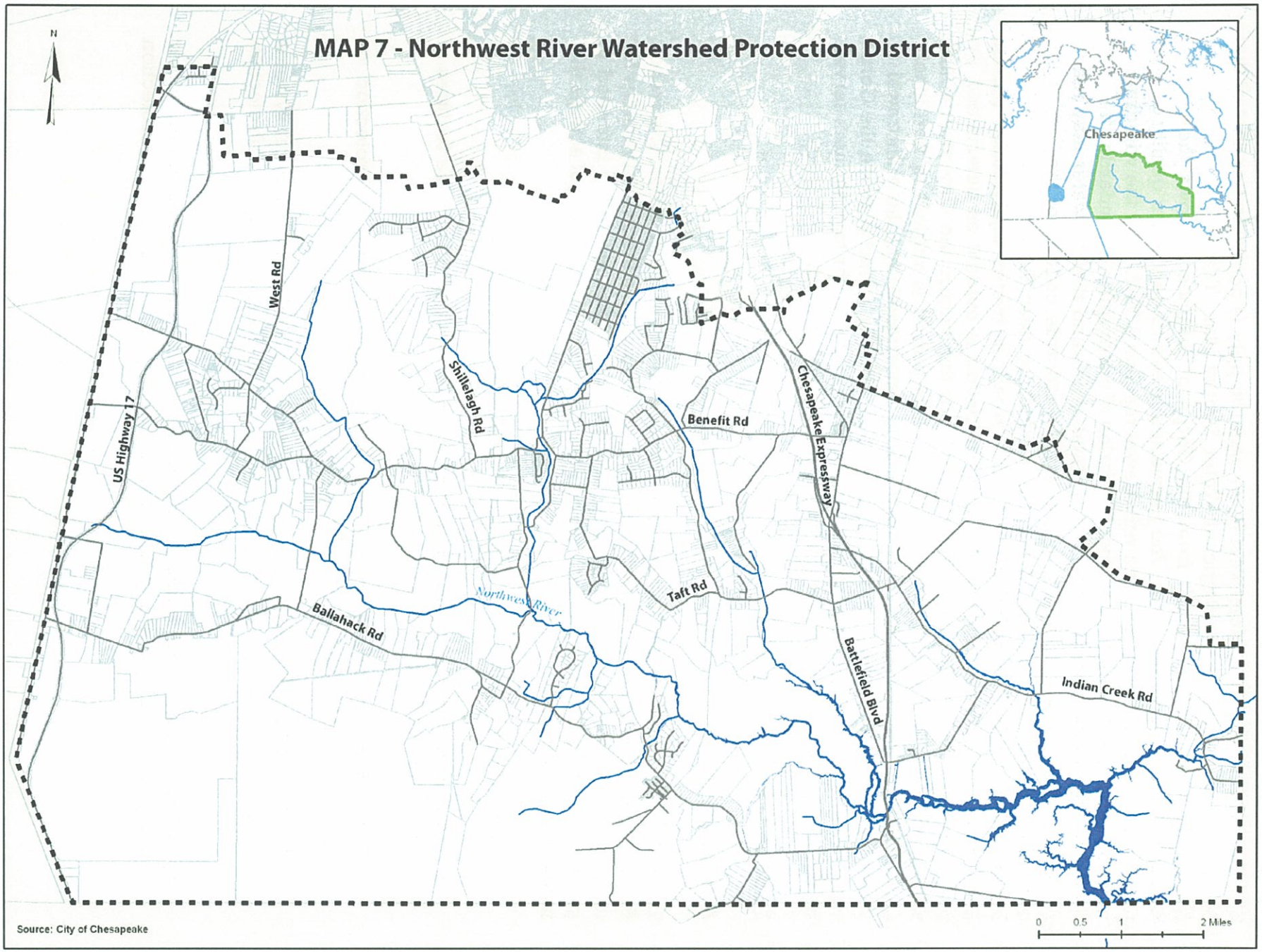
The City of Chesapeake's Northwest River water supply is addressed as part of the Southside Sub-region in the Regional Water Supply Plan. The plan notes that the Northwest River System permit from the Corps of Engineers allows the City to withdraw 10 MGD from the river. The permit requires stringent water quality control monitoring when the daily average withdrawal reaches 6 MGD, and the withdrawals must be reduced as necessary to avoid violation of water quality standards. It is also noted that the river is slightly affected by tidal action and that saltwater may reach the intake. The permit states that whenever the chloride content of the raw water exceeds 250 parts per million (ppm), the monitoring near the mouth of the North Landing River indicates salinities over 7.5 percent seawater equivalency (about 2,600 ppm), or sufficient environmental degradation is evident as determined by State agencies or the Corps of Engineers. When this occurs the City must cease withdrawing water and notify the agencies. This permit is subject to permanent cancellation or modification at any time if it is determined that the withdrawal of water has resulted in environmental degradation. The City must provide the Corps with a contingency plan that insures a continued supply of water to customers served by the Northwest River in the event that the permit is cancelled.

Code and Ordinance Review

Northwest River Watershed Protection Ordinance

In June 2005, the City of Chesapeake adopted the Northwest River Watershed Protection District (Map 7). The establishment of the district is the primary means for addressing water supply quality issues through city ordinances and is intended to prevent water quality degradation and contamination through a series of actions that include the following:

- Establishing the boundaries of the Watershed Protection District;
- Continuing the study and analysis of environmental and land use features of the Watershed Protection District;
- Identifying critical resources and areas most in need of protection or preservation within the Watershed Protection District;
- Implementing measures to avoid and minimize disruption of natural systems that are essential to maintaining water quality in the Watershed Protection District;
- Developing and implementing regulations to prevent contaminants and other substances that pose a threat to water quality in the Watershed Protection District;


MAP 7 - Northwest River Watershed Protection District
N
Chesapeake
West Rd
US Highway 17
Shillelagh Rd
Benefit Rd
Chesapeake Expressway
Northwest River
Ballahack Rd
Taft Rd
Battlefield Blvd
Indian Creek Rd
Source: City of Chesapeake
0
0.5
1
2 Miles

- Acquiring real property and real property interests, including but not limited to, conservation and drainage easements, for the purpose of protecting water quality in the Northwest River Watershed;

- Purchasing or constructing improvements as necessary to accomplish the goals and objectives of this article; and

- Cooperating with state agencies, neighboring jurisdictions and private organizations towards more effectively managing regional and cumulative impact on the Northwest River Watershed (Sec. 26-602).

Stormwater Regulations

The City of Chesapeake first obtained a permit to discharge stormwater from its municipal separate storm sewer system (MS4) in 1996, under Phase I of the National Stormwater Program, administered in Virginia at that time by the Department of Environmental Quality (DEQ). DEQ re-issued Chesapeake's permit in 2001. In October 2005, Chesapeake submitted a re-application for its MS4 permit. Chesapeake was one of six communities (including Virginia Beach) that were the first to apply for MS4 coverage since permitting authority moved from DEQ to the Department of Conservation and Recreation (DCR). The City's 2001 permit has been administratively continued.

The City of Chesapeake acknowledges the potential impacts of stormwater runoff on water quality in receiving water bodies, and it states that protection of water supply facilities is one of the purposes of its stormwater ordinance (Sec. 26-342). The ordinance requires a stormwater management plan and permit for construction disturbing an area greater than 10,000 square feet or significantly altering a drainage system (Sec. 26-351).

Virginia Beach also has an MS4 permit and similar ordinances supporting stormwater management and water quality protection in that city.

Cluster Development Ordinance

Although Chesapeake has adopted a cluster ordinance, its limitations regarding the size and scope of potential developments created under its provisions reduce its utility. Cluster development is rarely used in the Northwest River watershed when compared to piano key development.

Subdivision Ordinance/Design Guidelines

The extent of development, and therefore its impact on water quality, in the rural southern part of the City of Chesapeake is limited by two factors: the street frontage requirement and the lack of support for approving new streets and subdivisions in

the City's plans addressing the area. The current ordinance requires the installation of sidewalks on both sides of new streets; more sidewalks increase the amount of impervious surface from development, which leads to more runoff and non-point source pollution. The ordinance also requires a stormwater drainage system, although the type of system may vary. The City does not require new subdivisions to connect to the public water supply. City staff also notes that the Planning Commission can grant variances for the sidewalk requirement in the rural overlay district.

Recommendations:

Protection of the Northwest River as a high quality drinking water supply will require continued efforts to monitor and manage both non-point and point sources of water pollution. The Northwest River Watershed Protection Ordinance provides a strong framework for this effort, but the City's zoning and subdivision ordinances will need to be revised to ensure that future development patterns minimize non-point source pollution loading. Research discussed in the next chapter indicates that conventional, low-density development produces more runoff and non-point source pollution than cluster development. The City should establish polices that discourage or prevent those forms of development in vulnerable or critical areas. In particular, the zoning and subdivision ordinances should be modified to require clustering of new development and to specifically identify those nodes where new development will be allowed.

Stormwater runoff affects receiving water bodies by increasing water flow and increasing water pollution. Unimpeded runoff can result in severe erosion of riparian areas and harm aquatic habitats. Pollutants carried in runoff can other harmful effects on species found in streams. Establishing effective riparian buffers along rivers and streams can help mitigate the impacts of stormwater runoff. These buffers can reduce concentrated water flows to sheet flows that have more time to infiltrate into the ground. Buffers can also filter out harmful pollutants such as phosphorus, nitrogen, and suspended solids.

Necessary buffer width will vary based on several site-specific factors, including stream width, riparian vegetation, the presence and size of adjacent wetlands, bank slope, and soil type. These factors vary considerably along the Northwest River, so a uniform buffer width from the water's edge may not be appropriate. The Natural Resources Conservation Service recommends a buffer width of 100ft or 30 percent of the floodplain width, whichever is less (National Research Council, 2002). Because of the presence of significant wetlands adjacent to the Northwest River, a buffer of 100ft from those wetlands is recommended.

Non-Point Source Pollution

Recommendations for Existing Land Uses:

- Continue and expand programs to upgrade stormwater BMPs, enhance agricultural BMPs, and inspect and pump out septic systems.

- Restore vegetated buffers adjacent to the River and its tributaries. Buffer width will depend on site characteristics, but a minimum buffer width of 100ft from the river and any adjacent wetlands should be adopted.

Recommendations for Future Development:

- Limit development adjacent to the River and its tributaries.

- Expand the Conservation Corridor network to buffer all of the Northwest River's tributaries.

- Continue efforts to protect the Conservation Corridor network from development through purchase of development rights, establishment of a transfer of development rights program, conservation easements, and other appropriate measures.

- Minimize increases in impervious surface area by requiring nodal or cluster development patterns and Low impact Development (LID) techniques.

- Establish a TDR program that facilitates directing future development outside the watershed.

Point Source Pollution

- Continue to monitor existing point sources for any violations.

- Limit introduction of new point sources through the development approval process.

Protection of Natural Resources

The natural resources in the Northwest River watershed have been studied extensively as part of the many plans and studies previously conducted by the City, the Virginia Department of Conservation and Recreation, and others. Natural resource protection policies are featured in the plans and studies of all of the communities located in the Northwest River watershed, recognizing the need to

promote cleaner air and water and to provide recreational opportunities for residents of each locality. Protection of natural resources is addressed by many of these plans as well as by ordinances adopted by the City of Chesapeake, other communities, and the Commonwealth of Virginia.

Natural resource protection policies enhance other efforts that aim to protect rural landscapes and drinking water supplies, and they help to attract visitors and improve quality of life for city residents. The City, state, and TNC have worked together extensively to protect the natural resources in the Northwest River Watershed. Continuation and expansion of these efforts is needed to meet the planning goals established by the City. In particular, continuing efforts to protect lands within the Conservation Corridor network will contribute to the achievement of multiple benefits that encompass protection of natural resources, protection of water quality, and preservation of the rural character in the watershed.

Despite the protection measures already in place, threats to natural resources still exist from current and future development. These include habitat destruction and fragmentation and water quality degradation from non-point sources such as driveways and farm fields. Most of the land in the watershed is in private ownership, meaning that is vulnerable to development under current land use controls. Map 8 depicts lands within the watershed that are currently protected from development in some capacity. Federal, state and local agencies all own tracts of land in this area.

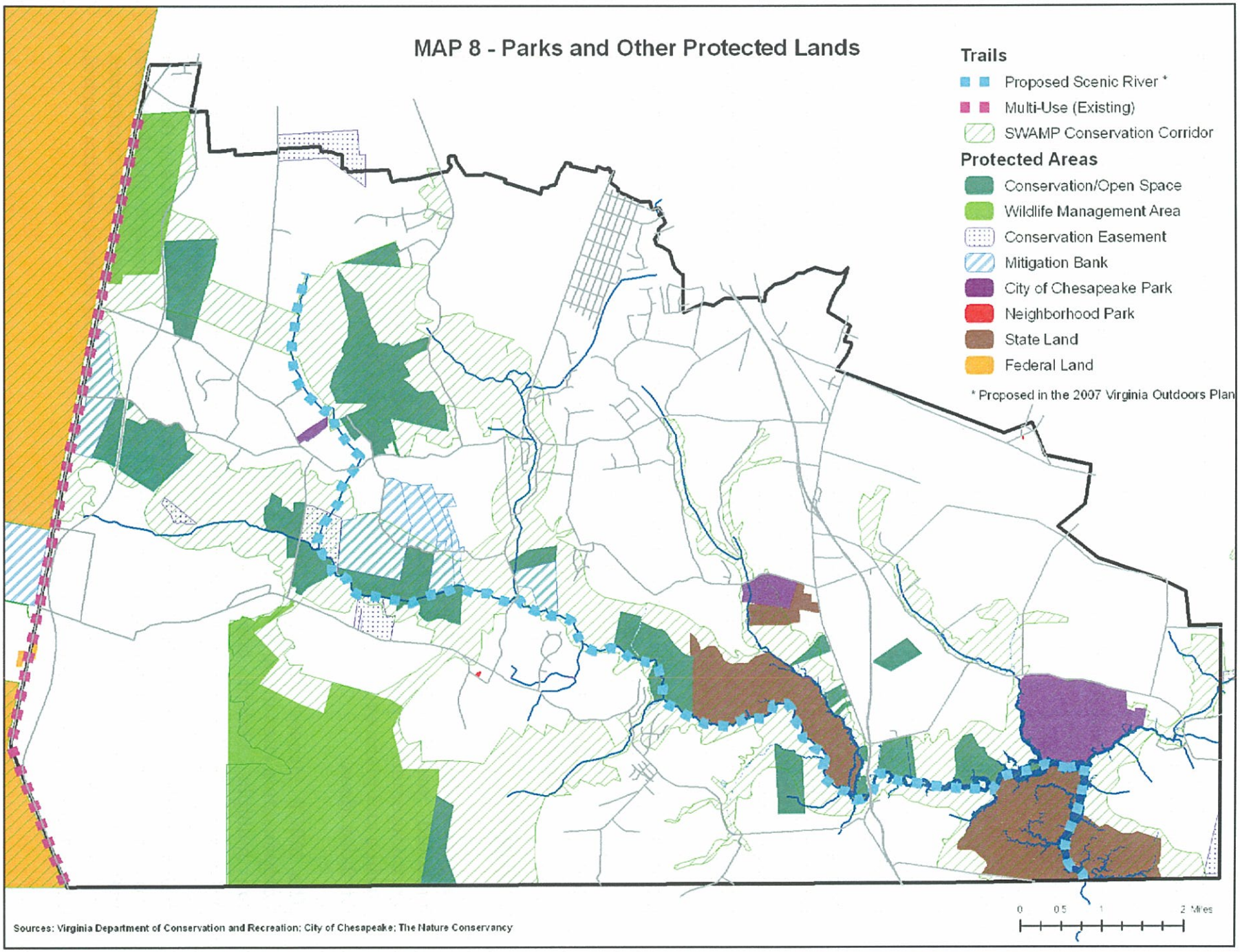
Key Issues

- **Habitat loss and fragmentation**
- **Loss of wetlands**
- **Water quality degradation**

Land Use Planning and Studies

Forward Chesapeake 2026 Comprehensive Plan

Chesapeake's 2026 Comprehensive Plan includes a list of plan goals at the beginning of the plan development process. Both the Land Use and Development and Natural Environment goals identify natural resource protection as a priority. Moreover, the Design chapter calls for the creation of an integrated network of open space and preserved natural areas. The Natural Resources chapter states that conservation design requirements should be incorporated in the City's zoning and subdivision ordinances to require preservation of areas within the potential conservation corridors.


MAP 8 - Parks and Other Protected Lands
Trails
Proposed Scenic River *
Multi-Use (Existing)
SWAMP Conservation Corridor
Protected Areas
Conservation/Open Space
Wildlife Management Area
Conservation Easement
Mitigation Bank
City of Chesapeake Park
Neighborhood Park
State Land
Federal Land
* Proposed in the 2007 Virginia Outdoors Plan
0 0.5 1 2 Miles
Sources: Virginia Department of Conservation and Recreation; City of Chesapeake; The Nature Conservancy

Page 116 of the 2026 Comprehensive Plan identifies the following goals for the City's natural resources:

- Balance land development with environmental preservation so that unique or essential natural resources are preserved in a pristine condition while citizens and businesses are also able to use and enjoy the benefits of high quality natural areas.

- Maintain and improve the quality of the natural environmental systems - air, water, natural habitats and wetlands.

- The City will require the minimization of the impact of development on natural resources to include buffering and screening where appropriate.

The Rural Character District – Design Principles description included on page 86 of the 2026 Plan notes that important natural features such as waterways and wooded corridors should be identified and preserved whenever possible and these areas should be a priority for future public and private land protection efforts. It also notes that priority should also be given to the areas and corridors identified in the region's Southern Watershed Area Management Plan.

Page 87 of the Plan also contains design principles for its open space system. Preserved open spaces are to be part of an integrated framework with connective elements and are to relate as much as possible to identified natural resources. Finally, a Scenic Waterway designation is suggested on page 236 for key recreational waterways, including the Northwest River.

SWAMP

As previously stated, the goals and objectives identified as part of the SWAMP effort included preservation of critical edge habitat areas and wetlands, and encouragement to preserve agricultural and forest lands. A number of subsequent studies and plans evolving from the SWAMP process have reinforced and expanded on those ideas.

The MBCP focused on wetlands preservation and the identification of suitable compensation sites in the SWA. In the Northwest River sub-watershed, opportunities for multiple benefit compensation sites were noted primarily from the Virginia/North Carolina line northwest along the Northwest River and its tributaries to the Lake Drummond Causeway. A second area was identified in the western portion of the sub-watershed near U.S. Highway 17. Several large farms in this area were noted to contain no vegetated buffers along ditches draining to the Northwest River. This area was the location of signification flooding during the 1999 hurricanes. Re-vegetation of portions of this area could improve flood control, erosion control, and recreational/educational opportunities.

DCR, Conservation Plan for the Southern Watershed Area

The Conservation Plan for the Southern Watershed Area provides an excellent guide to the protection and management of those resources. The Conservation Corridor system for the Southern Watershed Area was initially developed as part of the Conservation Plan. The Corridor system was designed to include the high priority Natural Heritage Resources identified by the Virginia Department of Conservation and Recreation (DCR) and link them together into a network of protected lands. Due to the fact that the majority of the Natural Heritage Resource areas in southern Chesapeake front the Northwest River, the system also has the potential to be an effective barrier against nonpoint source water pollution.

Hampton Roads Conservation Corridor Study

The geographic information system (GIS) analysis and the stakeholder involvement process employed in the development of the corridor study have resulted in the identification of priority areas for conservation and opportunities for linkage among those areas (HRPDC, 2006). These recommendations are currently being revised to reflect the need to protect additional sensitive areas, such as headwater streams. Implementation of the additional recommendations would help to protect more contiguous natural areas and would contribute to better air and water quality in the Northwest Watershed.

OSAP

The OSAP program report enumerates resources to be targeted for protection, including open space, forest lands, water resources, environmentally sensitive lands, and other natural resources. The OSAP utilized SWAMP studies to create a draft map of potential preservation lands. The potential preservation areas are based on lands identified as prime farmland in the Strategic Plan for Agriculture, a collaborative effort between Chesapeake, Virginia Beach, HRPDC, and Virginia Tech, and those lands falling within the medium density conservation corridor in Conservation Plan for the Southern Watershed Area (Heatwole, Purcell, Chandler, Halili, Wolfe, & Yagow, 2001).

Virginia Department of Game & Inland Fisheries – State Wildlife Action Plan

Virginia's Wildlife Action Plan prepared by the Virginia Department of Game and Inland Fisheries (DGIF) identifies the Dismal Swamp/Northwest River/North Landing River/Back Bay area as a significant resource area in coastal Virginia for "Tier 1" species (Virginia Department of Game and Inland Fisheries, 2005). These are defined as species with critical conservation needs due to an extremely high risk of extinction or extirpation. Ecological information presented in this plan is used by DGIF to guide development of land acquisition priorities across the state.

The Nature Conservancy

The Nature Conservancy's land acquisition efforts have been guided by various conservation plans. A 2001 Site Conservation Plan prepared by TNC for its "Green Sea Wetlands" program area (comprised of the Dismal Swamp, Northwest and North Landing Rivers and associated wetlands and waterways in North Carolina) identifies seven habitats, most of which are found in the Northwest River watershed, that collectively support the range of species of concern identified by DCR. TNC's plan identifies a number of threats to the ecological integrity of these systems, including incompatible development and forestry practices, invasive species and fire suppression.

Tracts prioritized for protection, restoration and management were identified in a supplemental plan based on the goal of protecting a continuous corridor of native plant habitat along the entire length of the Northwest River. The plan proposes protecting a corridor at least 766 yards (700 meters) wide to encompass a 109-yard (100-meter) wide belt of forestland buffered on each side with an additional 328 yards (300 meters) of forested land. In addition to pursuing land protection opportunities along the main stem of the river, TNC also identified the need to secure conservation linkages between preserves located north and south of the river near the eastern edge of the Dismal Swamp.

Code and Ordinance Review

Protection of natural resources is addressed in several city ordinances and is a stated purpose of the Erosion and Sediment Control (E&S) and OSAP ordinances. It is also addressed by the City's residential cluster development standards.

Erosion and Sediment Control

The City's E&S ordinance is authorized by the Code of Virginia, Title 10.1, Chapter 5, Article 4, known as the Erosion and Sediment Control Law. The purpose of the Law and the city ordinance is to conserve the land, water, air and other natural resources of the city by establishing requirements for the control of erosion and sedimentation arising from land disturbing activities (Sec. 26-52).

Cluster Development Ordinance

The first purpose of the cluster ordinance provisions adopted by the City of Chesapeake is the conservation of open land, including areas containing unique or sensitive environmental features. It is intended to supply landowners with multiple development options that will facilitate minimization of impacts on environmental resources and disturbance of natural or cultural features (Sec. 6-2200).

Recommendations:

Maintaining the long-term viability of the valuable natural resources in the Northwest River watershed is largely a matter of minimizing the extent to which new development fragments or encroaches on the Conservation Corridor system (Map 8). The Corridor system is included in the City's future land map as a conservation area, but more specific protections are needed. Updating the zoning and subdivision ordinance to require clustering of new development and identifying the location of development nodes to minimize encroachment on the Corridor system are important steps in the protection of the valuable natural resource base.

- Continue to protect and buffer land within the Corridor system, which is among the most effective strategies for natural resource protection in the Watershed.

- Expand the Conservation Corridor system to include riparian buffers along the tributary streams to the Northwest River.

- Implement the management recommendations contained in the Conservation Plan for the Southern Watershed Area.

Preservation of Rural Character

Among the most consistently identified planning goals for the watershed is preservation of rural character. Rural character includes both aesthetic and functional characteristics. Among the aesthetic characteristics are viewsheds that include natural landscapes and agricultural areas that are largely unimpeded by the built environment. Functional elements include economically viable agricultural and forestal operations and healthy natural systems. The City's 2026 Comprehensive Plan acknowledges that the existing development controls fail to protect either the aesthetic or functional elements of rural character by encouraging residential development that strips out the road frontage. The resulting "piano key" development pattern impedes access to open space and agricultural operations and creates visual clutter along the roadways. This placement of houses also sets up conflicts between residential uses and agricultural and forestal uses by placing residents directly adjacent to these operations.

Key Issues

- **Loss of working lands and important agricultural soils**
- **Loss of economic viability of farming**
- **Loss of rural viewshed**

Land Use Planning and Studies

Forward Chesapeake 2026 Comprehensive Plan

The 2026 Comprehensive Plan, Forward Chesapeake, includes protection of the City's rural landscapes as a priority in several sections, including Land Use and Development, City Form and Development, and Land Use and Design (City of Chesapeake Planning Department, 2005). The Land Use chapter further states that a comprehensive strategy will be developed and implemented to synchronize the City's rural preservation efforts.

The City Form and Development section of the Comprehensive Plan, found on page 20, contains a specific provision to retain a well-defined and protected belt of rural landscape surrounding the more developed portions of the City. The rural area will not be a mere buffer zone, but a thriving working landscape, with programs that encourage new farming economy enterprises and rural industries that are compatible with the preserved rural character of the area.

On page 26, the Plan also defines the Rural Overlay District, which is an adopted part of the City's zoning ordinance. The purpose of the Rural Overlay District is to preserve and protect the rural character of the southern portion of the City. Chesapeake adds to this a set of design principles known as the Rural Character District; these are described on page 86. They indicate that the Rural Character District should be an area of preserved farmland, natural areas and small-scale rural communities, and compatible employment uses. The intent of the design principles is to support the protection of working farmland and provision of an open, rural landscape as a relief to the built up and developed areas of the City. Principles include:

- Farmland preservation, environmental protection and the maintenance of an open, rural landscape and community structure should be the priorities for this district.

- Consideration should always be given to the mitigation of any undesired impacts between adjacent uses; good design practices should be used to ensure land use compatibility.

- New residential development should only be permitted if it is very low density, compatible with the rural design character and is clustered in such a way as to preserve meaningful areas of viable farmland or connected natural habitats.

- Public and institutional uses should be designed to blend harmoniously with the rural landscape and to support the traditional design character of the area.

- Existing rural settlements should be preserved and only small-scale, compatible new infill development that doesn't change the traditional visual character of the community or surroundings should be permitted within them.

- Farming, forestry and compatible rural economic development should be encouraged as a way to make the district economically self-sufficient and part of a "working rural landscape."

The Plan recognizes rural preservation efforts such as the creation of the OSAP Program and the creation of a clustering ordinance intended to help minimize development impacts in rural areas. It also notes on page 73 deficiencies arising from conflicting regulations and policies that have resulted in a gradual erosion of rural character.

SWAMP/Agriculture Plan/RAPP

As previously stated, the goals and objectives identified as part of the SWAMP effort included preservation of critical edge habitat areas and wetlands, and encouragement to preserve agricultural and forest lands. A number of subsequent studies and plans evolving from the SWAMP process have reinforced and expanded on those ideas.

The 2001 Agriculture Plan recommended the development of local markets for high-value crops and cultivation of large acreage field crops to help sustain agriculture in the SWA (Heatwole, Purcell, Chandler, Halili, Wolfe, & Yagow, 2001). It also suggested growth policies and development controls that were echoed in the Rural Area Preservation Plan (Siemon & Larsen, P.A., 2001). The latter recommended limited development, multiple location-specific planning and regulatory techniques, incentives to encourage desirable development and development patterns, and disincentives that discourage development and development patterns that use land and infrastructure in an inefficient manner.

OSAP

Agricultural preservation was one of the twin purposes (along with open space preservation) for developing Chesapeake's OSAP Program. The 2003 OSAP Report to City Council provided details on the loss of agricultural land in the City, which totaled 23% between 1964 and 1997 (Chesapeake Planning Department, 2003). The City's OSAP Task Force found that there was an immediate threat and concluded that preservation of both open space and agriculture would help the City to prepare for and meet the challenges of providing additional public services, supporting the agricultural community, and preserving the character and quality of life of the City. Voluntary purchase of land development rights was found to be a viable and publicly acceptable method for limiting the loss of open space and agricultural land.

The 2007 OSAP report also noted the potential impact of street requirements on the consumption of rural land (Chesapeake Planning Department, 2007).

Design Guidelines Manual

In May 2007, Chesapeake City Council adopted the Design Guidelines Manual prepared by EDAW/AECOM. The manual provides guidelines specific to mixed-use, infill, gateway, and rural development (AECOM, EDAW, 2007). Features found to be essential to preservation of rural character include distant views of the countryside, topography, natural drainage patterns, country roads, fences and hedgerows, barns and other farm buildings, and open space including agricultural fields and pastures. The Manual recommends avoidance of "piano-key" development and placement of incompatible residential development in suburban or urban districts.

The Manual also includes goals and objectives for development in the Rural Overlay District that are intended to minimize both visual impact and site disturbance from rural development. Clustering and density bonuses are suggested as methods to help achieve these goals.

Code and Ordinance Review

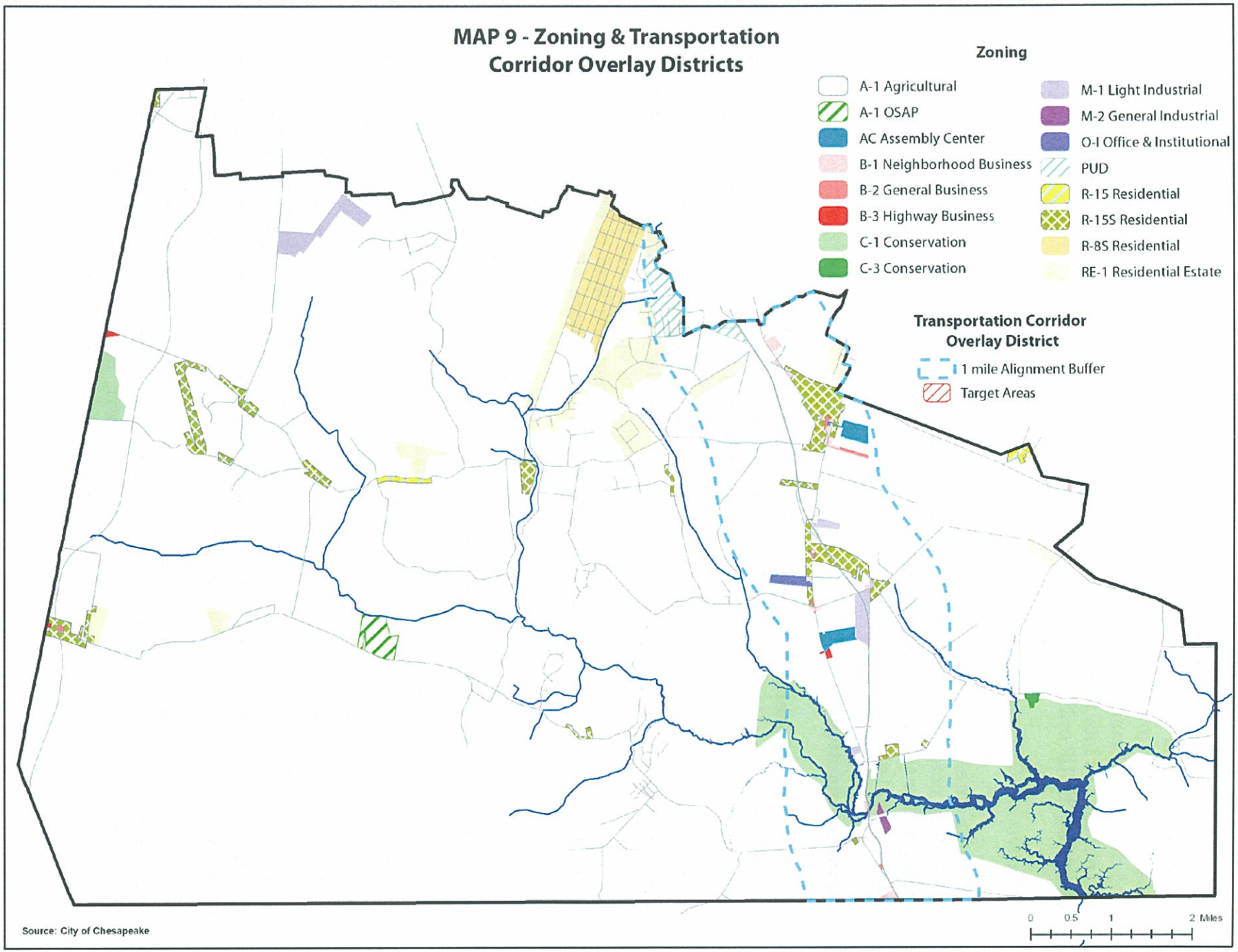
Zoning Ordinance

Nearly all of the land in the Northwest River watershed is zoned A-1, Agriculture. The next most common land uses are Conservation and various types of residential zoning. According to current parcel data, land use in the watershed is distributed as follows: Agriculture: 89%; Conservation: 6%; Residential: 4%; Commercial: 0.2%; Industrial/assembly center: 0.6 % (Map 9).

The Northwest River also lies within the Rural Overlay District, which prescribes low density, rural development patterns, primarily devoted to agriculture and related uses (Sec. 5-200). The district is not intended as a suitable location for major residential subdivisions or widespread industrial development. The current Zoning Ordinance provides for densities no greater that one unit per three acres, regardless of lot size. This is a common way to address density in rural areas throughout Virginia, but it has resulted in faster land consumption rates in rural areas that are under development pressure from expanding suburbs. It does not work in conjunction with the City's existing land preservation programs and policies.

Cluster Development Ordinance

All cluster developments in the City of Chesapeake are intended to avoid or minimize adverse impacts on the city's natural, cultural, and historic resources (Sec. 70-209). Specific provisions are included in the ordinance for the protection of woodland and upland rural agricultural areas as part of conservation lands. Because


MAP 9 - Zoning & Transportation Corridor Overlay Districts
Zoning
A-1 Agricultural
A-1 OSAP
AC Assembly Center
B-1 Neighborhood Business
B-2 General Business
B-3 Highway Business
C-1 Conservation
C-3 Conservation
M-1 Light Industrial
M-2 General Industrial
O-I Office & Institutional
PUD
R-15 Residential
R-15S Residential
R-8S Residential
RE-1 Residential Estate
Transportation Corridor Overlay District
1 mile Alignment Buffer
Target Areas
0 0.5 1 2 Miles
Source: City of Chesapeake

these are the primary landscapes found in the rural southern portion of the City, these provisions pose some difficulties in designing cluster subdivisions to be located there. Moreover, the number of lots in a cluster subdivision is limited to five and density is limited to .33 units per acre as in the overlying zoning. An increase of the number of lots requires a conditional use permit (CUP) from City Council, and obtaining a CUP only yields two additional lots.

Subdivision Ordinance

Although rural character is not directly addressed by the Subdivision Ordinance, the 2026 Plan notes that the street requirements contained in the ordinance help to compromise the rural landscape and lead to incompatible land use and inefficient consumption of land resources.

Recommendations:

The City has a cluster ordinance in its zoning ordinance, but the ordinance falls short on two counts. First, the ordinance is provided as an option to the by-right development pattern and rarely used. Effecting a significant change in the residential development patterns in the watershed will require making the utilization of the cluster ordinance mandatory. Second, the ordinance lacks a requirement for the creation of a linked system of open space when land is subdivided. Modification of the cluster ordinance to require the dedication of open space that contributes to protection of the Conservation Corridor system when the land in question is in or adjacent to the Corridor system would allow it to be more effective in protecting rural character.

In addition to modifying the cluster ordinance, the City should consider establishing a Transfer of Development Rights (TDR) program. A TDR program involves establishing sending and receiving areas for development rights within the City. Land owners in the sending areas, those areas within which a reduction of development density is desired, are allowed to sever the development rights from their property and sell them to land owners in the receiving areas. Land owners in the receiving areas are allowed to purchase the development rights, thereby increasing the development density allowed on their land. Thus a TDR program would considerably increase the ability of the City to control development density in various sections of the City. This system would support preservation of rural character in the Northwest River watershed while insuring that land owners are able to extract value from their land equivalent to the by-right development potential.

Both the Rural Area Preservation Program and the development control analysis performed by Randall Arendt provide excellent guidance on the benefits and methods of moving from a development pattern that builds out the rural road frontage to a development pattern that protects rural character and rural viewsheds.

- Modify the development controls in the watershed to require clustering of new development.

- Require dedication of open space that contributes to the Conservation Corridor network when land adjacent to the Corridor system is developed.

- Allow for density bonuses/adjust density requirements in the rural tier of the City through modifications to the zoning and cluster ordinances.

- Establish a TDR program for the City.

Buffering of Military Facilities

The military is a large and integral part of the Hampton Roads community. The City of Chesapeake hosts three U.S. Navy installations: St. Julien's Creek Annex, Naval Support Activity Northwest Annex, and Naval Auxiliary Landing Field Fentress. Of these, only Northwest Annex is located in the Northwest River watershed. Northwest Annex is an installation with varied and expanding missions that are sensitive to encroachment, particularly from electro-magnetic interference. As a result, the City has entered into a partnership agreement with the Northwest Annex to limit encroachment by purchasing lands that buffer the facility. The Conservation Corridor network is being used in the mapping and prioritization of lands considered for purchase. Continuing to pursue funding for acquisition of lands that both contribute to protection of the Corridor system and buffer the Northwest Annex is an example of a strategy for achieving multiple benefits.

The Navy has established a military influence area of 5 miles around the Northwest Annex (Map 10).

Key Issue

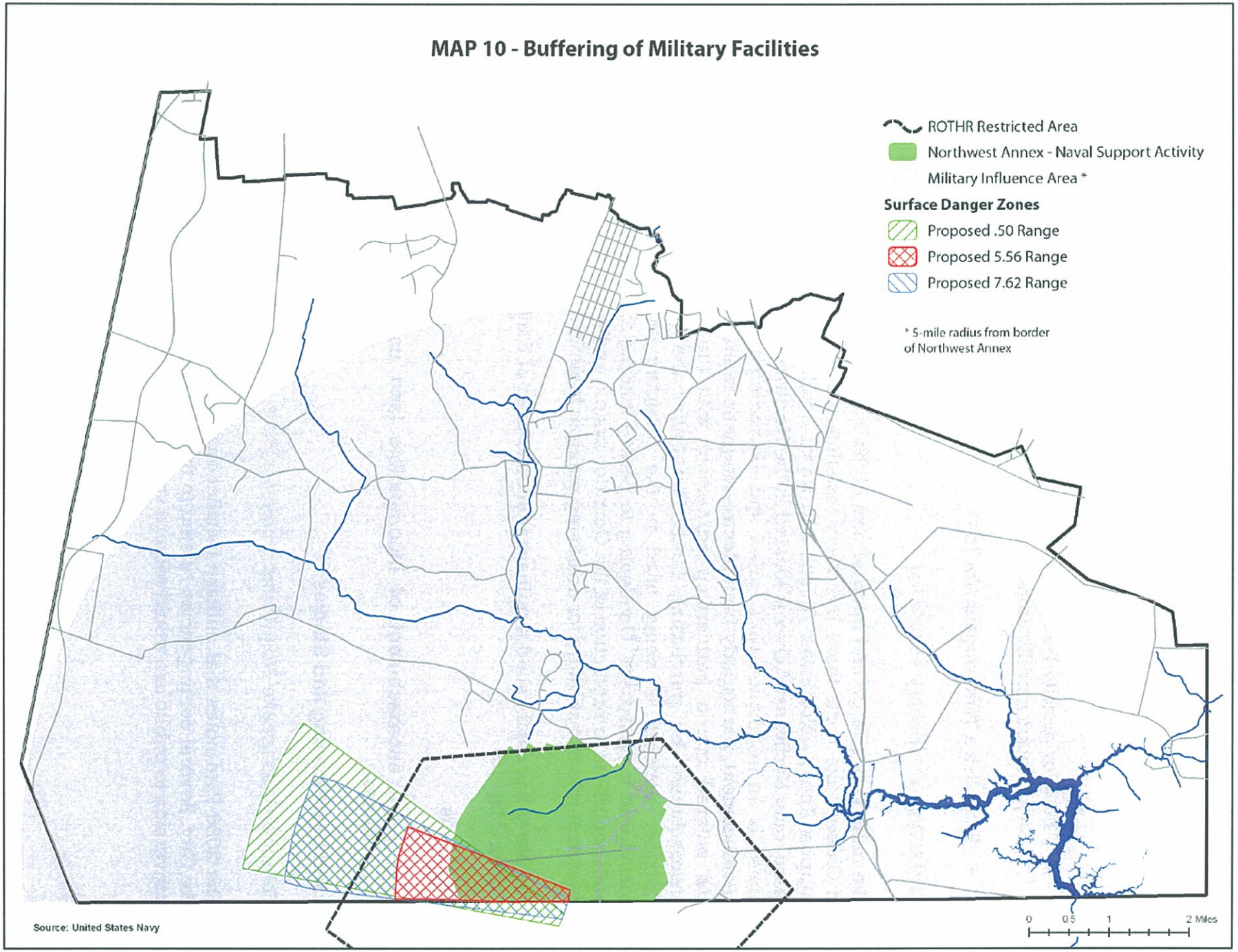
- **Limit encroachment of incompatible land uses around the Northwest Annex.**

Land Use Planning and Studies

Forward Chesapeake 2026 Comprehensive Plan

The 2026 Plan notes that military installations occupy important land resources for the City. Several contingencies related to the possible closing of these facilities and conversion to public use would require special study, as indicated in the plan.

MAP 10 - Buffering of Military Facilities



Source: United States Navy

Hampton Roads Joint Land Use Study

Although the Hampton Roads Joint Land Use Study (JLUS) completed in April 2005 does not directly address the Northwest Annex, it does offer suggestions for limiting encroachment around sensitive military installations (EDAW, Inc, 2005). The JLUS Study was the result of a partnership between the cities of Chesapeake, Norfolk, and Virginia Beach, HRPDC, and the U.S. Navy to study opportunities to reduce noise impacts on communities surrounding NAS Oceana, NALF Fentress, and Chambers Field in Norfolk. While the study addressed a limited geographic area, the recommendations arising from JLUS are generally compatible with the goal of preserving water quality, natural resources, and rural character. JLUS identified policy tools to protect existing quality of life as well as military operations, and recommended use of these tools at the regional, Navy, or city level. Recommendations for the City of Chesapeake included revision of the zoning and cluster ordinances for AICUZ (Air Installation Compatible Use Zone) compatibility and supporting integrated preservation planning policies in the city comprehensive plan.

Partnership Agreement

In September 2009, the City of Chesapeake and the U.S. Navy signed a multi-year agreement to limit encroachment around the Northwest Annex. Both parties agreed to the identification and purchase of multiple parcels of land around the installation to help prevent encroachment and stop incompatible development, and also to promote conservation of ecologically and agriculturally significant lands.

Code and Ordinance Review

None of the City's current codes and ordinances directly addresses encroachment around the Northwest Annex.

Recommendations:

- Continue to partner with the Department of Defense to purchase lands that both buffer the Northwest Annex and protect the Conservation Corridor system.

- Utilize clustering and Transfer of Development Rights (TDR) programs to limit encroachment on the Northwest Annex by new development.

- Continue to work with Navy to identify incompatible land uses around the Northwest Annex.

Climate Change and Sea Level Rise

As part of the Hampton Roads region, the Northwest River watershed is likely to experience significant environmental and watershed management issues as a result of climate change. Sea level rise, changes in precipitation patterns, and increasing water and air temperatures all have the potential to present challenges.

The Mid-Atlantic region is subject to globally high sea level rise rates owing to the dual impact of rising seas and subsiding land. Tide-gauge observations indicate that relative sea-level rise rates in the region were higher than the global mean during the 20th century (2.4 – 4.4 mm per year) and totaled roughly 1 foot. The Sewell's Point tide gage at the mouth of the Chesapeake Bay has recorded a higher rate of sea level rise at 1.45 feet per hundred years. Recent studies suggest the potential for an additional rise of one meter (3.3 feet) or more by the year 2100. From the perspective of maintaining the viability of the Northwest River as a drinking water supply, sea level rise is the most problematic issue. Sea level rise will eventually result in a major increase in salinity of the entire Albemarle/Pamlico system when the barrier island system in Virginia and North Carolina begins to disintegrate.

A January 2009 U.S. EPA study, Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region, includes analysis of sea level rise on both the North Carolina/Virginia barrier island system and the adjacent wetlands (CCSP, 2009). Three different sea level rise rate scenarios are examined: the 20th Century sea level rise rate, the 20th Century rate plus an additional 2mm per year, and the 20th Century rate plus an additional 7mm per year. Even under the most conservative sea level rise estimate, it is possible that much of the North Carolina barrier island system will reach a threshold condition where the islands will be breached. Under the 20th Century scenario, the Virginia barrier islands adjacent to Back Bay would suffer breaching and overwash. In the more aggressive sea level rise scenarios, it is more likely that the Virginia and North Carolina barrier island systems will be permanently breached. Sea level rise could fundamentally change the state of the coast, particularly in areas where the coastal systems cannot keep pace. Sandy shore environments are especially vulnerable and many features like coastal headlands, spits, and barrier islands will erode at a faster pace than in other environments.

All three of the sea level rise scenarios will also create problems for the extensive wetlands found in the Northwest River watershed. The EPA study also notes the vulnerability of wetlands to stress under a 2mm per year acceleration in sea level rise per year, and states that most wetlands would be unlikely to survive a 7 mm per year acceleration in sea level rise.

Sea level rise can be expected to significantly impact rare plant, animal or natural community occurrences, as tracked by Virginia and North Carolina Natural Heritage Programs. Of the 82 known occurrences in the watershed, 62 (75%) are located in

areas less than 1 meter in elevation. Close to 30% (5,400 acres) of all managed land is located below 1 meter in elevation and a total of 7,300 acres (38%) is located below 2 meters in elevation.

The most profound changes to the Mid-Atlantic coast and its associated ecosystems will likely be in response to storm surge coupled with higher sea levels. A large hurricane could essentially convert the Currituck Sound to a salt water system by opening substantial new inlets to the ocean. While it might be possible to repair the breaches in the short run, eventually the combination of storm events and sea level rise will create a series of new inlets. Much of the freshwater wetlands ecosystem in Currituck Sound will be lost and replaced to some extent by tidal saltwater wetlands. Wetlands will be lost entirely in areas where inland migration of wetlands is not possible due to shoreline development. The stress placed on the wetlands by these changes will also create opportunities for invasive species, leading to potential displacement of native species.

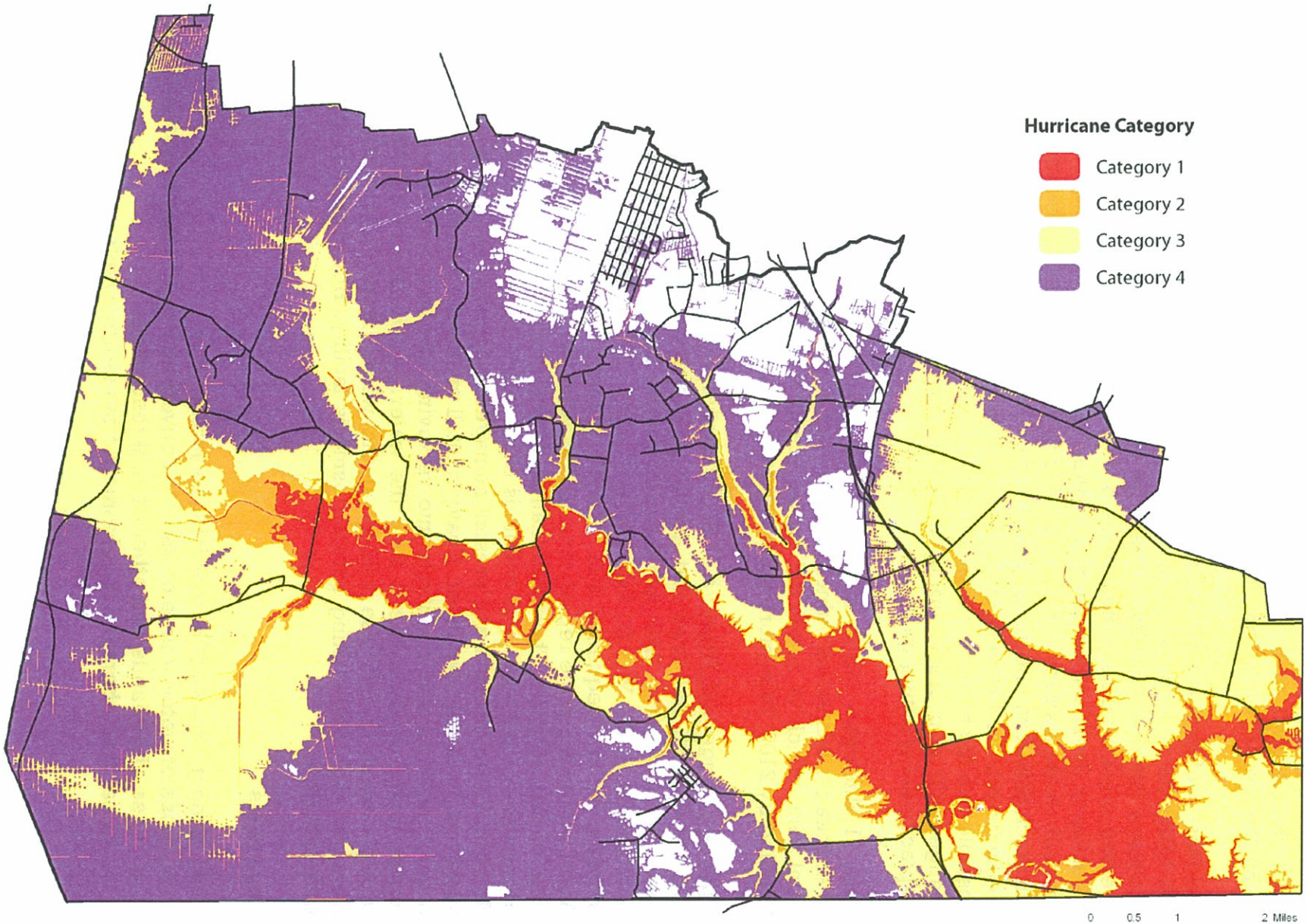
Map 11 illustrates storm surge potential in the Northwest River watershed in Chesapeake. Increased vulnerability to storm surge flooding will result from sea level rise, which is predicted to be roughly equivalent to current Category 1 flooding by 2100. Thus more areas will experience flooding due to storm surge.

Climate Change and Water, a 2008 publication by the Intergovernmental Panel on Climate Change indicates that annual precipitation and the frequency of heavy precipitation events will increase for most of North America (Bates, B. C.; Kundzewicz, Z. W.; Wu, S.; Palutikof, J. P., Eds., 2008). These changes will mean an increase in the frequency and severity of significant stormwater runoff events. According to the same report, stream flow will also increase in much of the eastern part of the country. The combination of increased total rainfall and increased occurrence of intense storm events is expected to be interspersed with periods of drought. These changes will present management challenges for the drinking water supply in the Northwest River. Heavy rainfall events tend to flush elevated levels of organic material and pollutants into receiving streams, resulting in the need for higher levels of chemicals to treat the water. In the case of the Northwest River, drought tends to increase salinity at the water intake, a problem that can be managed with the existing reverse osmosis facility. However, this facility cannot treat salt water.

Key Issues

- **Breach or loss of barrier island system.**
- **Loss of water source or need to convert treatment plant to desalination.**
- **Loss of wetlands and other natural resources.**
- **Impacts to shoreline development from storm events.**

MAP 11 - Storm Surge Inundation



Source: Virginia Department of Emergency Management

Land Use Planning and Studies

There is little local land use planning in Hampton Roads that currently addresses climate change and sea level rise issues. In one case where storm surge has been a recent problem, the City of Poquoson adopted higher standards for floor elevations in residential structures after Hurricane Isabel. However, such actions are still rare and only address part of the problem. HRPDC is currently undertaking a multi-year regional climate change study.

In December 2008, the Virginia Governor's Commission on Climate Change released its Final Report: A Climate Change Action Plan (Governor's Commission on Climate Change, 2008). The report includes recommendations for the state to achieve its 30 percent greenhouse gas reduction goal as well as a several measures for Virginia to prepare for and adapt to the likely consequences of climate change. Other recommendations address the Renewable Portfolio Standard, reductions in vehicle miles traveled, and corresponding priorities in the Virginia Energy Plan. The Commission's recommendations also address adaptation to climate change, including shoreline protection and adjusting transportation infrastructure and other development in coastal areas to account for sea level rise and flooding possibilities. Federal actions to address climate change include the proposed adoption of a cap-and-trade program, stronger nation-wide vehicle efficiency standards, and federal funding for renewable energy, energy efficiency and conservation, and carbon capture and storage.

Code and Ordinance Review

At this time, the City has no codes or ordinances that specifically address climate change or sea level rise issues.

The single most effective adaptation measure for sea level rise in the Northwest River watershed will be limiting development in areas that will be subject to flooding as water levels rise. This could be accomplished by expanding the Conservation Corridor system to include all of the tributary streams in the Northwest River system and modifying the development controls to insure that development does not take place within the Corridor system.

Recommendations:

- Identify areas in the watershed that are most vulnerable to sea level rise and storm surge flooding.

- Limit future development in those areas most vulnerable to sea level rise and storm surge flooding.

- Reassess the Conservation Corridor system on a regular schedule to adjust for impacts of sea level rise.

- Increase the width of the Conservation Corridor system as needed to accommodate upslope migration of wetlands as sea level rises.

Other Issues of Concern

Transportation/Level of Service

The 2026 Comprehensive Plan identifies the 2050 Transportation Plan as the primary guidance on future transportation improvements in the City of Chesapeake. The 2050 Plan is mainly concerned with improvements to the road network, but it also touches on transit and trails issues. The majority of the transportation improvements highlighted in the 2050 Plan are in the northern portion of the City. The only improvements identified for the Northwest River watershed are upgrades to Ballahack Road, Benefit Road, Pleasant Grove Road/Hillcrest Parkway, Edinburgh Parkway, and Waters Road.

Projected afternoon peak hour level of service (LOS) for the year 2021 is A, B, or C for the majority of roads in the watershed. Battlefield Boulevard (Route 168) is the most notable exception with a projected LOS of E or F for most of its length within the watershed. In addition, sections of Ballahack Road and Centerville Turnpike are projected to have an LOS of D.

Future development plans in Currituck County may exacerbate the LOS problems on Route 168. The Moyock planning area just south of the North Carolina border is projected to continue to develop as both a residential and commercial center. This area is a popular bedroom community for workers with jobs in adjacent Virginia localities. Due to the projected growth, Currituck County has included a proposed Route 168 bypass in the Moyock Area as part of its recently adopted comprehensive plan.

The intersections of Route 17 and Route 168 with the North Carolina border are identified as gateways to Chesapeake in the City's 2026 Comprehensive Plan. This designation will eventually result in design guidelines for those areas but does not necessarily indicate any particular type of development. It should also be noted that, under existing development controls, any transportation improvements that increase the road frontage in the watershed will also increase commercial and residential development potential.

Economic Development

With two major transportation routes in the Northwest River watershed connecting Virginia with North Carolina, the potential exists for a growing concentration of

commercial development along these roads. The Moyock Planning Area, just south of the state line in Currituck County, is growing rapidly as a commercial and residential center and is projected to continue to do so in the County's comprehensive plan. Route 17 in Camden County is also poised to develop as a major commercial and residential center and is already zoned for such development. In Chesapeake, the Transportation Corridor Overlay District adopted by the City in 2000 and referenced in the 2026 Comprehensive Plan, includes the Chesapeake Expressway/Battlefield Boulevard corridor as a focal area for economic development. Three economic development nodes are identified in the Northwest River watershed, one at the intersection with Hillcrest Parkway, a second at the intersection with Centerville Turnpike, and a third just south of the crossing of the Northwest River. The 2026 Plan removed the southernmost node as a focal area for economic development and refers to it as a gateway. It should also be noted that the 2050 Development Pattern Map in the comprehensive plan identifies the area adjacent to the Route 17 intersection with the North Carolina state line as both a gateway and an "Auto Oriented Major Activity Center". However, the development of this area is not reflected in the 2026 future land use map.

Given that the Chesapeake Expressway/Battlefield Boulevard corridor is a focal area for current and future residential and commercial development, it is likely that rezoning requests and development proposals will present challenges from a watershed management perspective. To the extent that new development can be contained in nodes and outside the Conservation Corridor network, the water quality and environmental impacts can be minimized. Application of the Northwest River Watershed Protection District regulations will also help minimize water quality impacts.

Provision of Recreational Opportunities

The 2026 Comprehensive Plan identifies the southern portion of Chesapeake as an ideal location for the creation of an open space network along the Northwest River and its tributaries. The Plan advocates the identification and preservation of waterways and wooded corridors whenever possible, and indicates that these areas should be a priority for future public and private land protection efforts. Corridors identified as part of SWAMP are also indentified as priority areas for conservation.

The creation of a network of protected corridors offers the opportunity to connect many parts of the watershed and to accommodate trails and passive recreation. The watershed is currently home to a number of parks and trails including the Northwest River Park, the Dismal Swamp Canal Trail, Cornland Park, South Chesapeake Park and the Gallbush Road property. In addition to the parks, a high percentage of the land in the Conservation Corridor system has been protected by The Nature Conservancy and the state through conservation easements and as part of wetlands mitigation banks. Adaptation of the development controls in the watershed to require the dedication of open space that contributes to the Corridor System and the linking of trail segments as part of the development approval process could

contribute to protecting additional land and linking existing protected lands. In this way, it may be possible to eventually create a trail system through the Conservation Corridor system that links the Dismal Swamp Canal Trail to the Northwest River Park.

Education of Stakeholders on Watershed Management

Education is a key component in garnering support for watershed preservation efforts from a variety of stakeholders. Existing programs at the state and regional levels may offer materials and assistance in disseminating information about the Northwest River watershed and its unique attributes.

The Virginia Office of Environmental Education, housed at DEQ, is the state clearinghouse for environmental education and information (Virginia Office of Environmental Education, 2010). Major programs include:

- Virginia Naturally, a virtual association of public and private agencies, schools, and individuals working together to deliver environmental education programs.

- Project WET (Water Education for Teachers), a statewide program that includes professional development for teachers, sixth grade science institutes, and training for community educators.

- Virginia Classroom Grants, providing mini-grants of $500 to $1,000 for meaningful environmental and watershed education.

- Love-A-Tree and sixth grade science resources, providing teachers and educators with additional resources based on the Standards of Learning.

- The Community Involvement Initiative, encouraging citizens and stakeholders to work collaboratively to address environmental issues.

- The Environmental Educators Leadership Program (EELP), developing and enhancing the professional skills and abilities of Virginia educators for the protection of the environment (Virginia Department of Environmental Quality, Office of Environmental Education).

The City of Chesapeake already participates in a number of regional environmental education initiatives housed at the Hampton Roads Planning District Commission. The HRPDC coordinates these initiatives to address identified needs throughout the region. The main initiatives center on the issues of water conservation, stormwater pollution prevention, litter prevention, recycling, and beautification. Monthly meetings of the Hampton Roads Water Efficiency Team (HR WET), the Regional Stormwater Management Public Information and Education Subcommittee (HR STORM), and HR CLEAN (the region's committee on litter prevention, recycling, and

beautification) allow for regional program coordination, idea exchange, and networking. Additional education initiatives cover Green Infrastructure and Conservation Corridors, the Southern Watershed Area Management Program (SWAMP), and HR FOG (Fats, Oils, and Grease).

Committee deliberations and discussions have influenced the evolution of the various regional environmental education initiatives. The regional programs (HR FOG, HR WET, HR STORM, and HR CLEAN) all enhance and support, rather than duplicate local program efforts. Program coordination includes active participation from staff in each of the affected localities, as well as other regional entities, and involves partnerships with federal and state agencies and the private sector in some cases. Continued participation in these efforts will help the City to address water quality issues in the Northwest River and beyond.

Modeling Future Development Patterns and Associated Water Quality Impacts in the Northwest River Watershed

Scenario Planning

Zoning and subdivision regulations have a profound effect on the character of development in a community. The Northwest River watershed has historically been a rural area of Chesapeake; however, what is allowed in the watershed by right is quite different from what has been practiced in the past, so future development patterns in the watershed are difficult to forecast. One way in which the total impacts of development under those present conditions can be estimated is through the use of scenario planning. This method uses scenarios – detailed visions of future development patterns – to project the impacts of various decisions. Scenario planning is widely used in environmental assessment reviews and by localities and regions looking to take a more active role in guiding their futures. This chapter will look at two broad visions for the watershed's future:

- Business as usual: In this scenario, zoning regulations remain unchanged and development continues along current trajectories.
- Nodal development: Under this scenario, the City establishes a transfer of development rights (TDR) program in the watershed, focusing development into nodes that help preserve the area's rural character and ecological health while allowing for residential development.

The impetus for considering these possibilities for the Northwest River watershed's future is the concern that the City of Chesapeake has regarding current development practices in the area. Under existing regulations, parcels zoned for agriculture can be subdivided over time into residential lots. This leads to low-density, single-family residential development, which, due to the City's site planning requirements, takes the form of "piano key" development along roadways. This form of development leads to several negative consequences. These include disruption of rural viewsheds, water quality degradation, and limitations on the viability of agriculture. Considering multiple scenarios in addition to the "business as usual" approach allows the City of Chesapeake to measure the impacts of current trends against alternate potential futures.

Build-Out Analysis

Methodology

One of the key tools used in scenario planning is the build-out analysis. A build-out analysis calculates how much development can take place given existing conditions and zoning regulations, such as density and site planning requirements. Using a build-out analysis allows a community to first estimate how much development may occur, and then what the impacts of that increased development will be. A projection of future development trends can help communities identify potential issues before they occur and propose alternatives to current trends. GIS is a powerful tool that can be used to provide both numeric build-out estimates and potential spatial arrangements of future development. An EPA description of build-out analyses served as a guide and CommunityViz, a software extension for ArcGIS, was used to perform the build-out analysis for the Northwest River watershed (U.S. Environmental Protection Agency, 2009). CommunityViz allows users to input simple zoning and site layout requirements for designated areas and then calculates the maximum allowable quantity of dwelling units and non-residential structures. CommunityViz can also use user-created site layout rules to arrange units and buildings spatially. The combination of numeric and spatial build-outs allows users to generate projections necessary for impact analyses and to see the pattern of projected development. CommunityViz also allows for the creation of multiple build-out scenarios using different settings that can be compared to each other quantitatively and spatially.

CommunityViz was developed by the Orton Family Foundation and Placeways to allow localities to visualize how growth may occur and what its potential economic, environmental, and social impacts could be (Placeways, LLC, 2009). *It allows communities to model several scenarios that incorporate different growth assumptions. CommunityViz has been used in communities throughout the United States and in countries around the world. Applications include modeling future land use scenarios for comprehensive plans, visualization of infrastructure, natural resources planning, and long range transportation plans. More information is available at http://placeways.com.*

Once the spatial build-out analyses were completed, ArcGIS Spatial Analyst was used to create density maps showing relative concentrations of expected development for each scenario. These concentrations were measured in units per square mile and calculated using a ½-mile search radius. A map was created for the base scenario and a National Wetlands Inventory (NWI) build-out scenario. These were then set to the same scale, that of the base scenario, to make the visuals directly comparable. Critical area layers (sea-level rise, military facilities, natural

resources, and drinking water supply) were then used as overlays on top of these density maps to show how future development might cause conflicts.

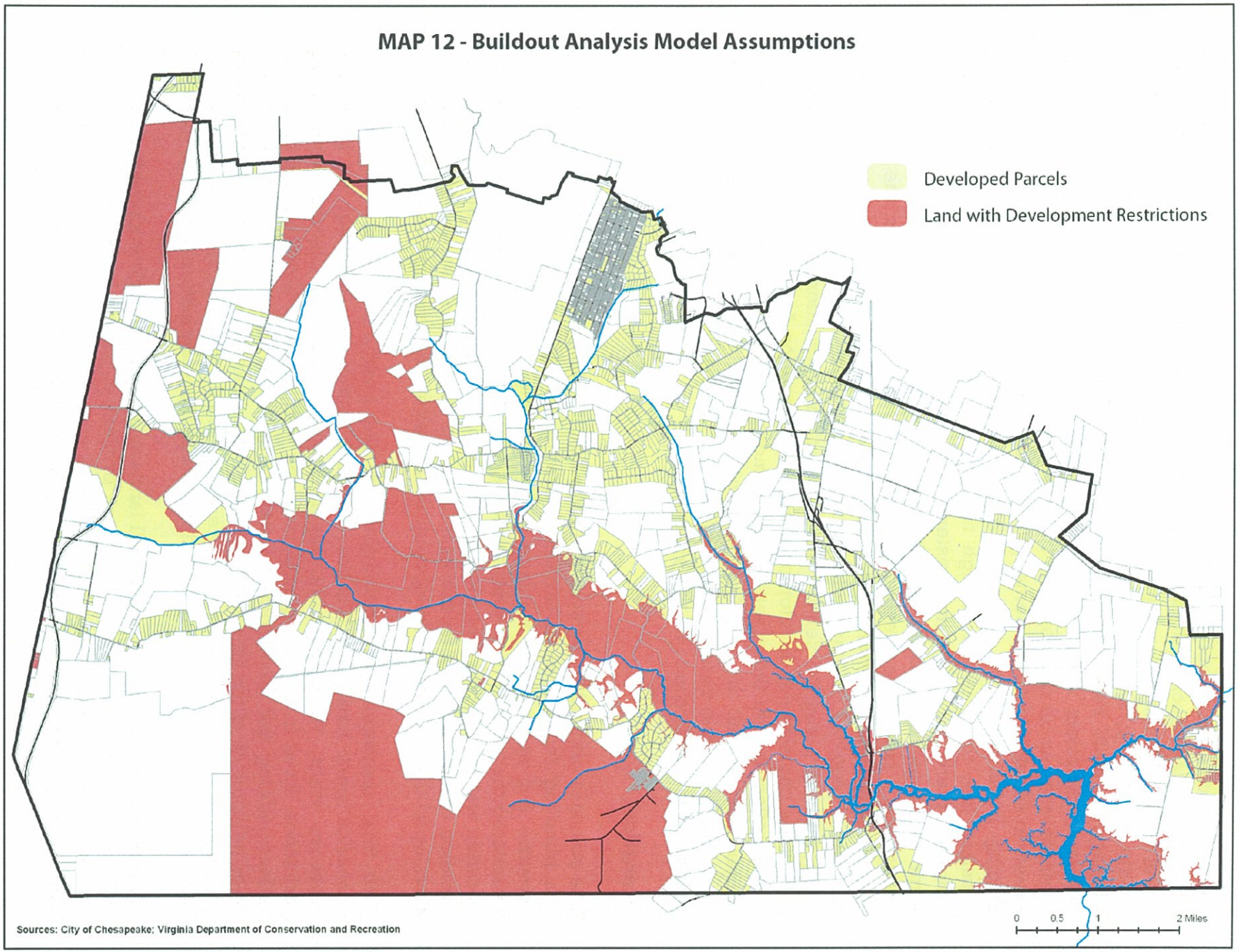
Data and Assumptions

The first step in performing a build-out analysis is to identify existing physical conditions and the relevant zoning and site planning regulations in the area under consideration. A build-out analysis requires several sets of data for modeling of an area's future development pattern. These data needs include basic information about the area in question, such as the study area's boundaries and property lines, natural environment information for purposes of excluding various areas from development, and regulatory information such as zoning that is coded geographically. Datasets were obtained from several sources. Boundary lines for parcels and the Northwest River Watershed Protection District were obtained from the City of Chesapeake, as were zoning regulations and maps, current land use, hydrology (streams, canals, and rivers), airport-owned lands, and conservation easements. More data on conservation easements was obtained from the Virginia Department of Conservation and Recreation. Layers of protected lands and mitigation banks were obtained from The Nature Conservancy. Flood zones were obtained from the Federal Emergency Management Agency. National Wetlands Inventory data was obtained from the United States Fish & Wildlife Service.

Several assumptions were made when developing the model scenarios for the build-out analysis. The model uses overlays to constrain new development to those areas where development is possible. The overlays used for the base scenario were hydrology, flood zones, conservation easements, mitigation banks, protected lands, airport-owned lands, and existing development. An existing development layer was developed by removing vacant areas and agricultural lands from the provided current land use layer (Map 12). No new development was allowed for any of these areas, nor was any existing construction in those areas counted. For these scenarios developable areas were considered to be open and ready for development. Similarly, parcels designated as existing development were excluded entirely from new development. Partially developed areas were not considered for additional development. For the NWI scenario the inventory layer from USFWS was used as an additional development constraint. In this case, even though the NWI map does not definitively eliminate the possibility of development, those lands were assumed to be off-limits for this scenario. In addition, the build-out analysis did not account for the City's existing cluster ordinance. This was partially due to technical limitations but also due to the limited number of additional units allowed for clustering and its limited use in practice.

Once these constraints were identified, the next step was to apply zoning and site planning restrictions to the developable areas. These include density and minimum lot size requirements, efficiency factors, and front and side setbacks. The density, lot size, and efficiency factor settings contribute to a numerical analysis, which calculates the maximum number of new buildings that could be built in each

MAP 12 - Buildout Analysis Model Assumptions



Sources: City of Chesapeake; Virginia Department of Conservation and Recreation

undeveloped parcel. Applying the setbacks results in a spatial analysis; this analysis attempts to place each building in its parcel according to a specified development pattern. Density and other regulations were taken from the City of Chesapeake's zoning ordinance. Other settings were developed in consultation with City of Chesapeake staff. For example, currently the City is not planning to add to the public road system in the watershed. Residential lots have public road frontage requirements, so all development in the scenarios was required to follow adjacent streets to simulate the requirement. In the model this results in the spatial build-out placing buildings at the setback distance along the streets layer. If that is not possible (i.e. there is not enough road frontage), the parcel is not developed. However, there were some inconsistencies between the streets and parcel layers; in some cases parcel boundaries did not parallel adjacent streets, and in all cases streets were actually centerlines, so parcels were setback from the streets. To accommodate these factors, the setbacks for all units were increased from the minimum required in the zoning ordinance. Also, City of Chesapeake staff suggested that using the density and site planning regulations would not accurately reflect the character of development in areas zoned for Assembly Centers (AC); to better reflect reality those settings were modified to allow for only one assembly center per parcel. In addition, the analysis was based on current land use designations. While rezoning is possible and will have to be considered in future plans, it was not factored into this analysis.

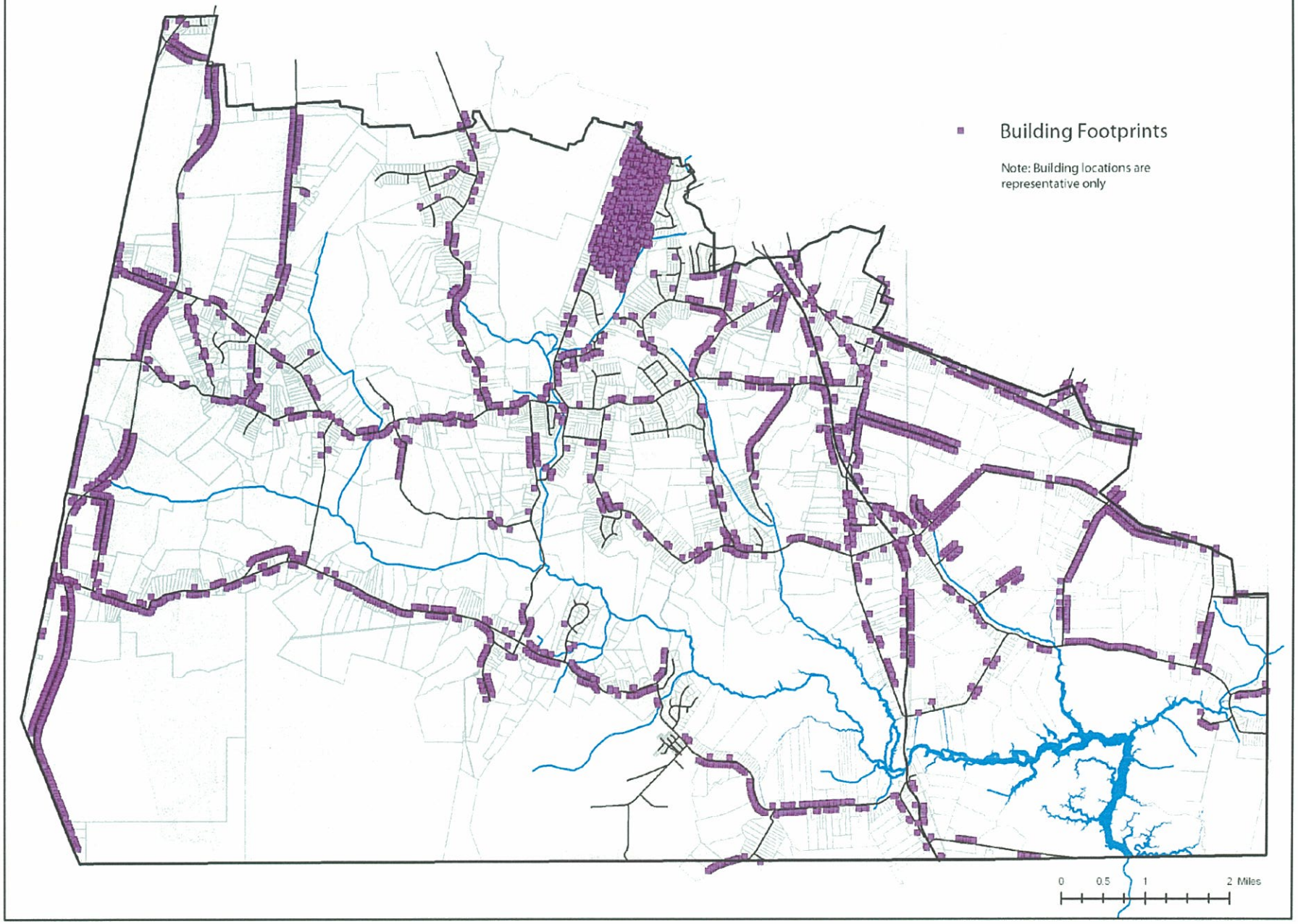
Scenarios

The scenario originally devised for the build-out analysis used existing zoning and site planning regulations to project a maximum build-out for the watershed. This scenario did not require frontage along existing roads, so this analysis vastly overstated the amount of development that could occur in the watershed. A second iteration was developed that required road frontage on existing roads. This second iteration eventually became the base scenario for the analysis. A variant was also developed that analyzed development without allowing development on wetlands.

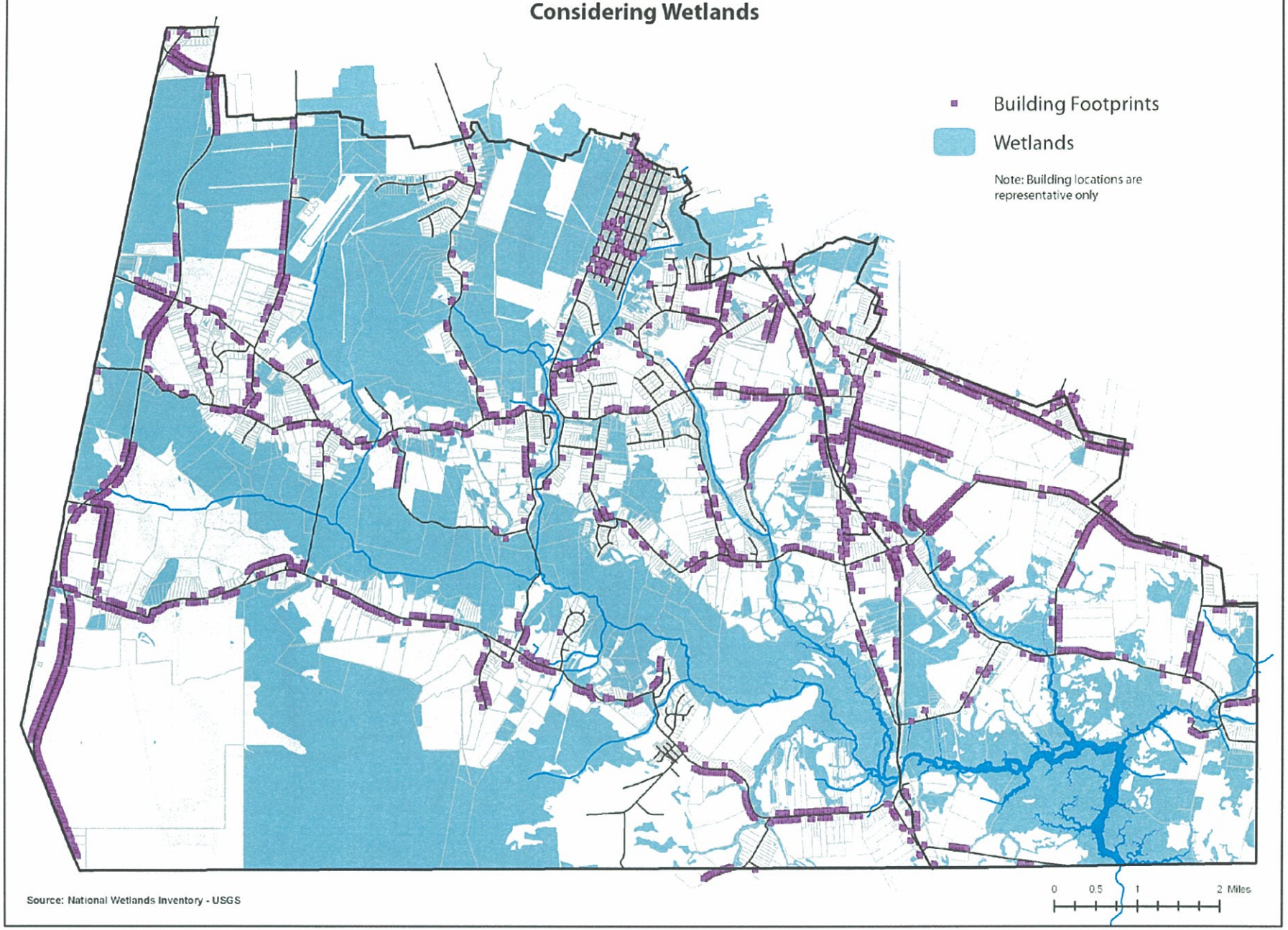
Two final scenarios were developed for the build-out analysis. Both of these scenarios were based on business-as-usual conditions. Densities, lot sizes, and setbacks were, when possible, taken from the City of Chesapeake's zoning ordinance. Input from Chesapeake planning staff was also used to more accurately reflect building and development trends in the watershed. In some cases setbacks were adjusted to allow for inconsistencies where parcel boundaries did not closely match adjacent streets; setbacks were increased for some zones to account for this discrepancy. The base scenario used these default constraints and settings (Map 13).

A second scenario was run using NWI lands as an additional development constraint (Map 14). While NWI status does not prevent a parcel from being developed automatically, it does require more careful site planning and may result in some areas being undeveloped. NWI designation indicates the need for wetlands delineation to determine the actual development potential of a site. Removing NWI

MAP 13 - Buildout Analysis Under Existing Conditions



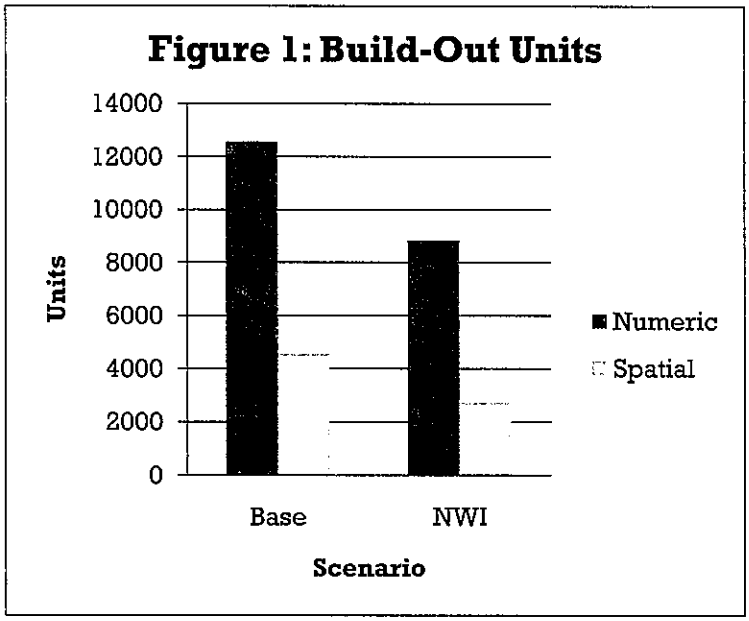
MAP 14 - Buildout Analysis Under Existing Conditions & Considering Wetlands



lands from the area that is available for development further reduces the number of units projected to be built. Much of the Northwest River watershed is included in the wetlands inventory, resulting in some parcels that are not able to develop or that have significant sections rendered undevelopable.

Results

There is a significant difference between the results of the numeric and spatial build-out analyses (Figure 1). The numeric analysis for the base scenario, which does not include NWI lands, results in over 12,000 new residential units and nearly 300 non-residential structures. This includes over 10,000 residential units in the A-1 agricultural areas. A key assumption in this analysis is that all agricultural lands which have the required frontage will be developed, since they can be subdivided to individual 3-acre lots. This process requires multiple years and subdivisions before completion; larger A-1 parcels are first subdivided into smaller, 15-acre farms, which are then subdivided at least one year later into 3-acre lots (the minimum lot size for A-1 parcels) for development. The numeric analysis also includes nearly 1,600 units in the R-8S area and over 400 R-15S units. The R-8S area, Hillcrest, is considered a "paper" subdivision, in that it has been platted but not developed. The spatial build-out results in a reduction of almost 8,000 buildings of all types, or over sixty percent. A-1 units were reduced to fewer than 3,000, a decrease of over seventy percent.



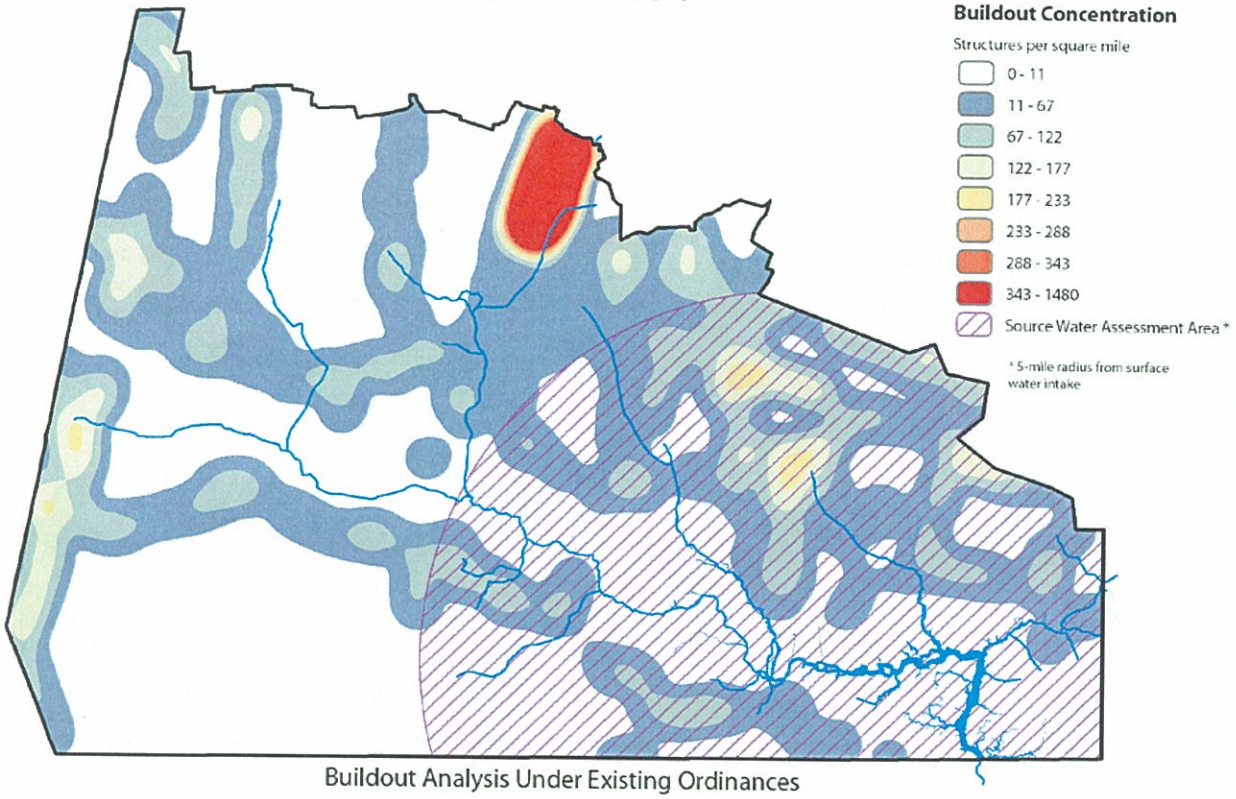
Total numeric build-out for the watershed excluding NWI lands results in over 8,500 new residential units and almost 250 new non-residential structures. This includes over 7,500 units in A-1 areas. However, as with the base scenario, the spatial build-out results in a reduction of nearly seventy percent of the total projected buildings. Total new development in the NWI spatial analysis is approximately 2,700 buildings, with the vast majority being new residential units. Less than one hundred non-residential buildings occur. The main difference between the base and NWI scenarios, aside from the overall decrease in development, is in the Hillcrest area. Whereas the base scenario experiences a huge amount of development even in the spatial build-out analysis, the NWI scenario results only in approximately 450 numeric units (compared to almost 1,600 in the base scenario) and less than one hundred spatial units (compared to over 1,300 in the base scenario).

The chief cause of the drop between the numeric and spatial analyses was the City's road frontage requirement. The City of Chesapeake is not currently planning to add more public roads to the watershed, so the existing road system is all that is available for new development. Private roads also cannot satisfy the road frontage requirement. Several large parcels in the watershed are zoned for A-1 but only have enough road frontage for a fraction of the units allowed in the numeric analysis. The road frontage requirement, in addition to reducing the overall amount of development, also encourages "piano key" development along roads.

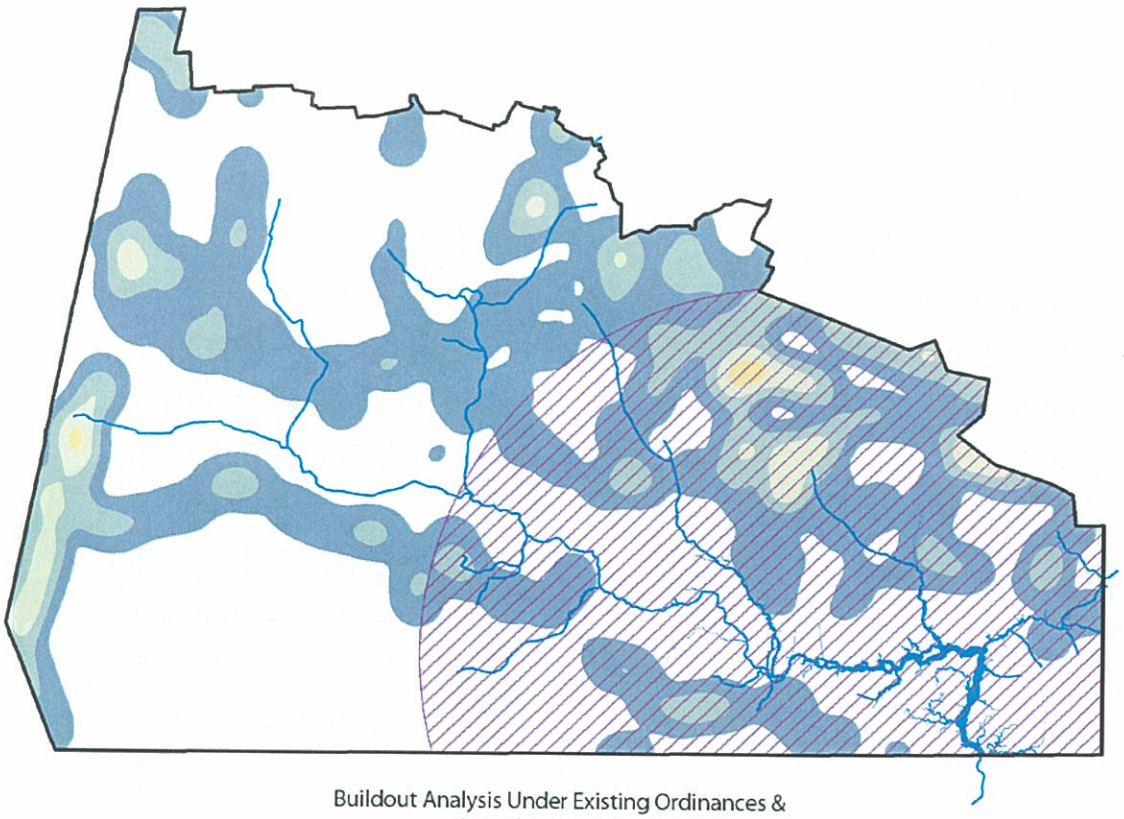
The cause of the decrease in development between the base and NWI scenarios is the location within the watershed of the areas in the wetlands inventory. Most of one of the major potential developments in the watershed, Hillcrest, is potentially covered by wetlands (NWI data indicates the presence of wetlands), so it is not eligible for development under this scenario. Since NWI lands are not necessarily prevented from development but do provide a constraining factor, the actual amount of future development, absent any rezoning or regulatory changes, is probably somewhere between the two spatial results. A more accurate assessment of a site's potential development that accounts for wetlands will be available once wetlands delineation occurs and development proposals are processed. The type of development that occurs in this area will have a large impact on the watershed's health and character.

Using the build-out density maps with critical area overlays shows the potential for several use conflicts between future development and other uses in both the base and NWI scenarios. A series of maps illustrates this: Potential Buildout Concentration in Drinking Water Supply Area; Potential Buildout Concentration and Protection of Natural Resources; Potential Buildout Concentration and Buffering of Military Facilities; and Potential Buildout Concentration and Sea Level Rise (Maps 15-18). Development concentrations were similar under both scenarios, with the major exception being the huge concentration in Hillcrest under the base scenario that is almost absent under the NWI scenario. Concentrations in both scenarios were found along Routes 17 and 168. In both scenarios, sea-level rise did not present much of a conflict with future development. This was mainly due to most of the areas affected by sea-level rise also being floodplains or other areas where development was not allowed under either scenario. However, as discussed previously in this report (p. 66-70), sea-level rise does have the potential to limit future development in low-lying areas and could adversely impact the drinking water supply as a result of increased salinity in the Northwest River. More conflicts were present with the other critical areas. Natural resource protection conflicts were present along several of the northern tributaries of the river in both scenarios. A significant concentration of future development along Route 168 lies within the water intake's Zone 1 (a Virginia Department of Health Source Water Assessment designation referring to the area within 5 miles of the intake). A lower but still significant amount of development occurs inside the region of interest around the Northwest River Annex in both scenarios, specifically along Ballahack Road, St. Brides Road, and Taft Road. The

MAP 15 - Potential Buildout Concentration in Drinking Water Supply Area

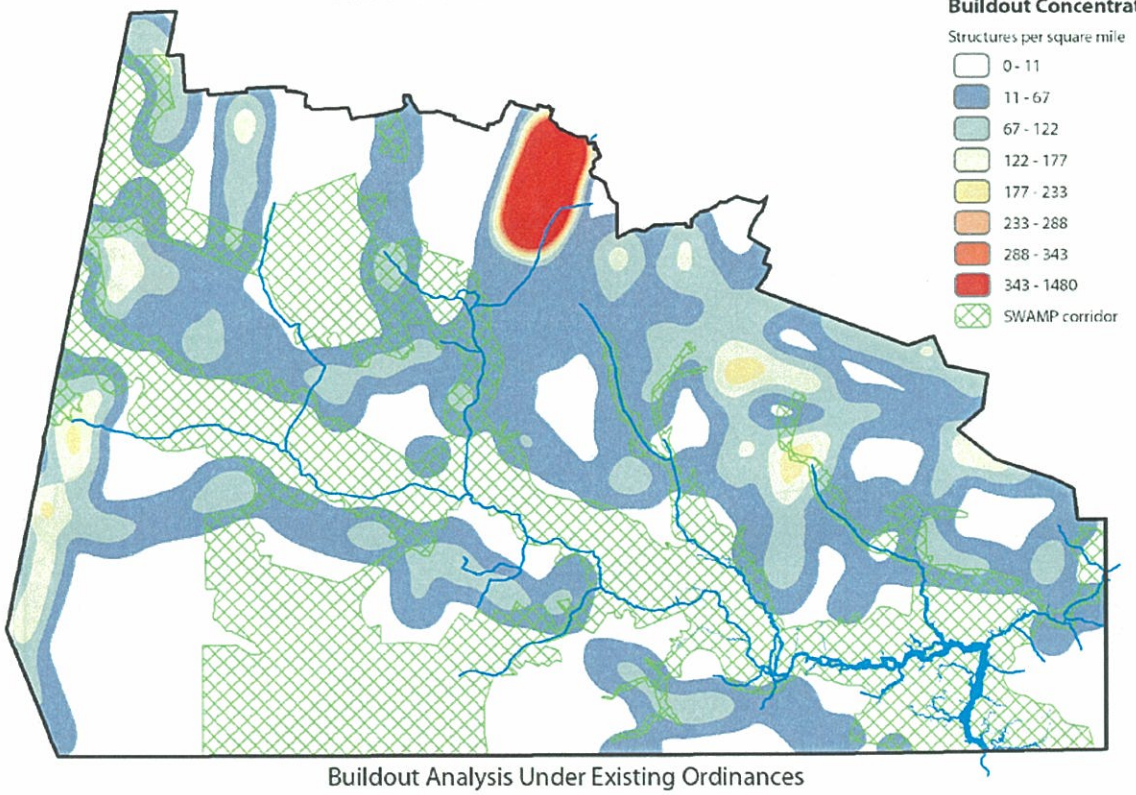


Buildout Analysis Under Existing Ordinances

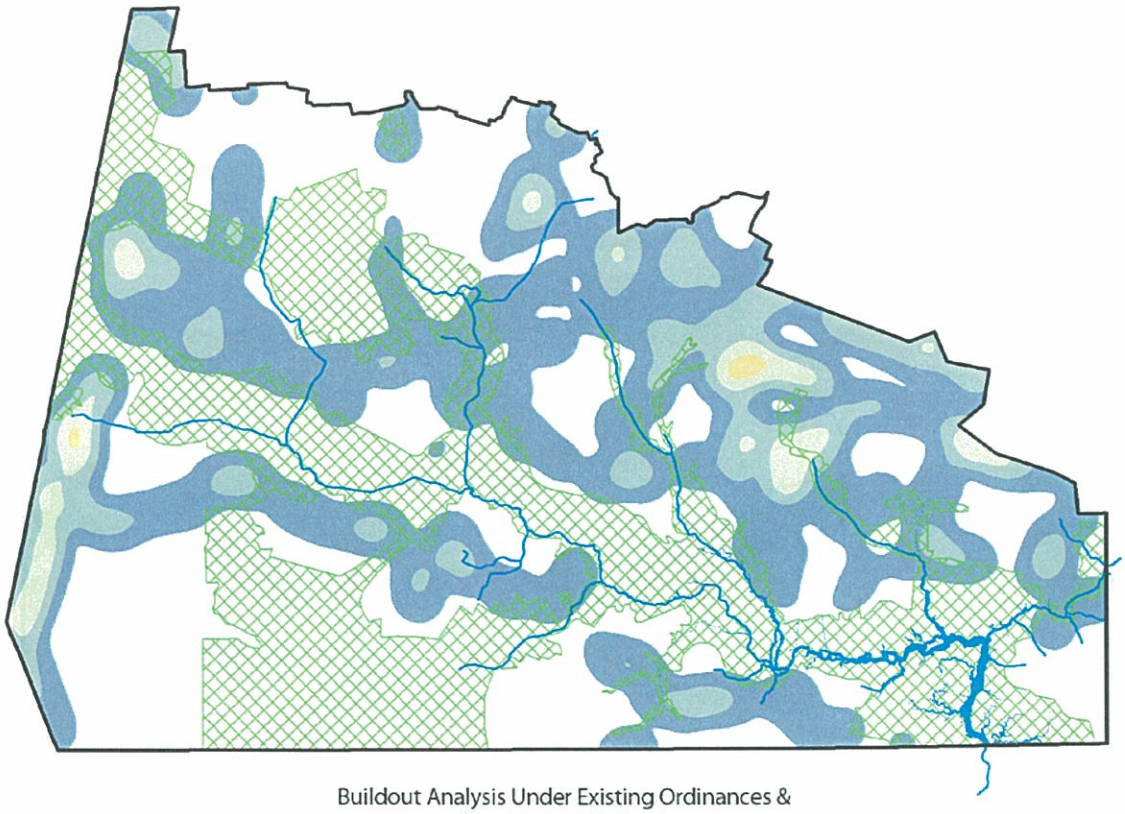


Buildout Analysis Under Existing Ordinances & Considering Wetlands

MAP 16 - Potential Buildout Concentration and Protection of Natural Resources

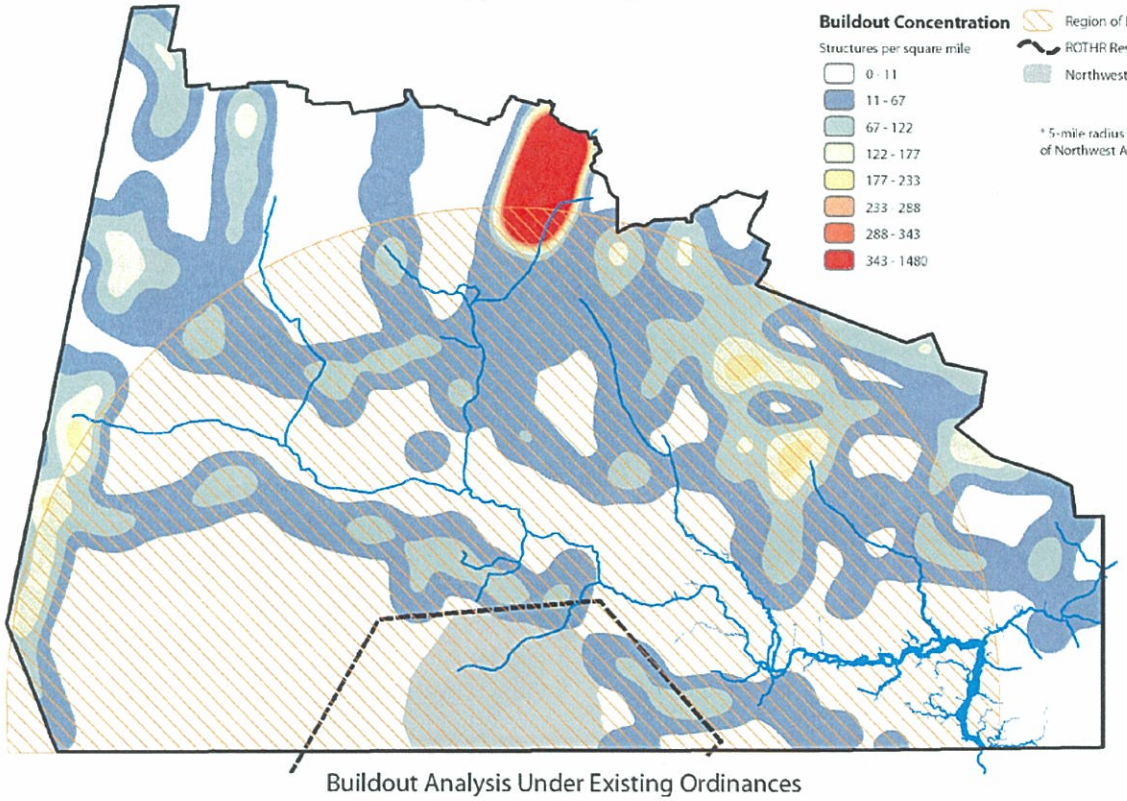


Buildout Analysis Under Existing Ordinances

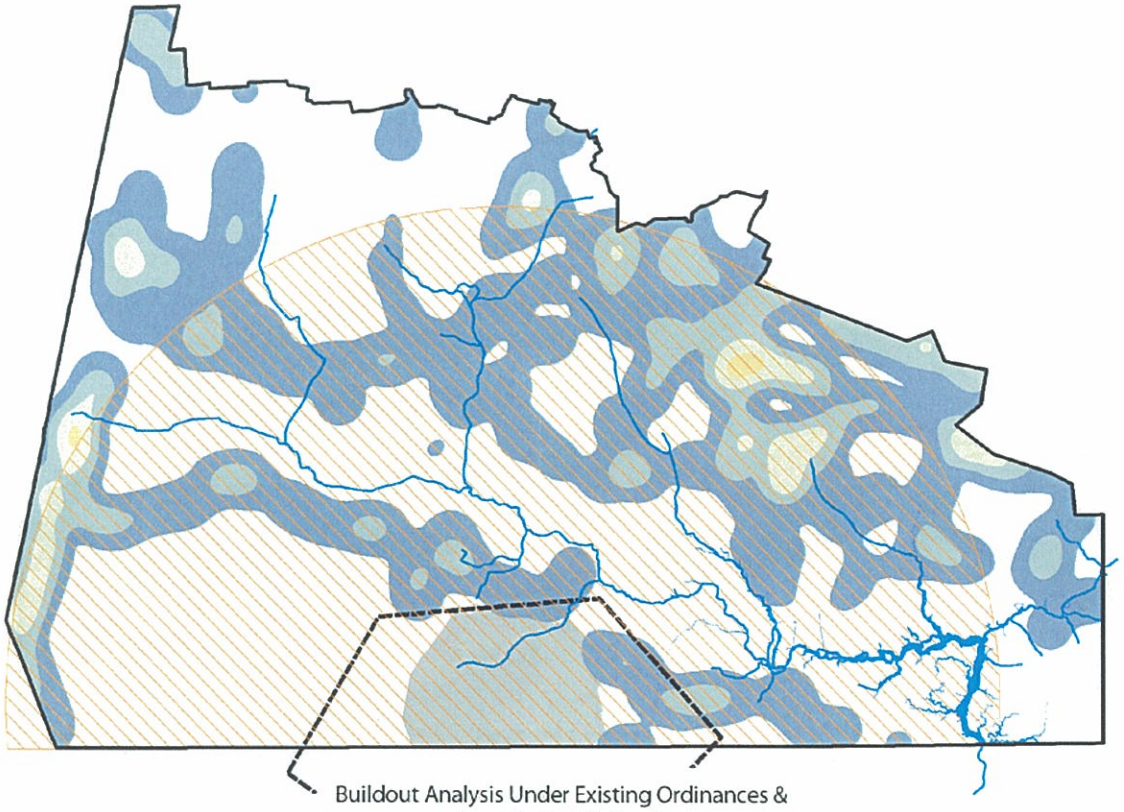


Buildout Analysis Under Existing Ordinances & Considering Wetlands

MAP 17 - Potential Buildout Concentration and Buffering of Military Facilities

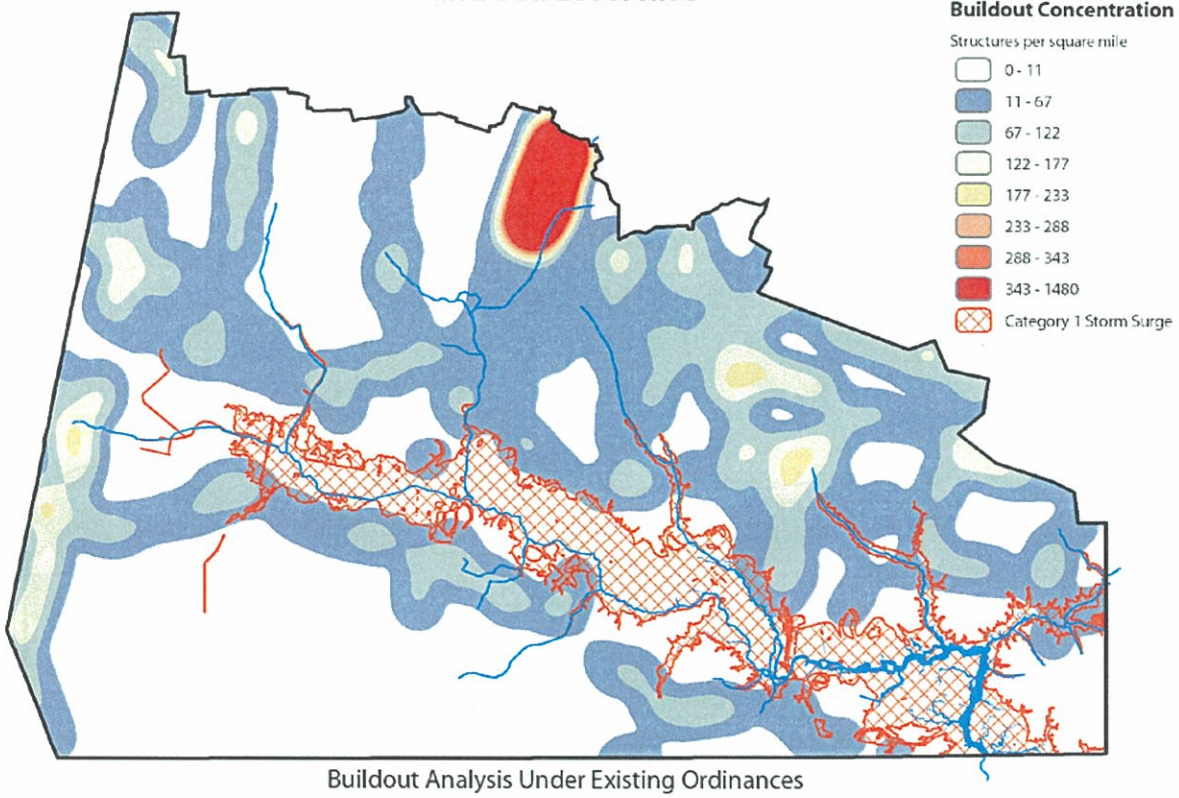


Buildout Analysis Under Existing Ordinances

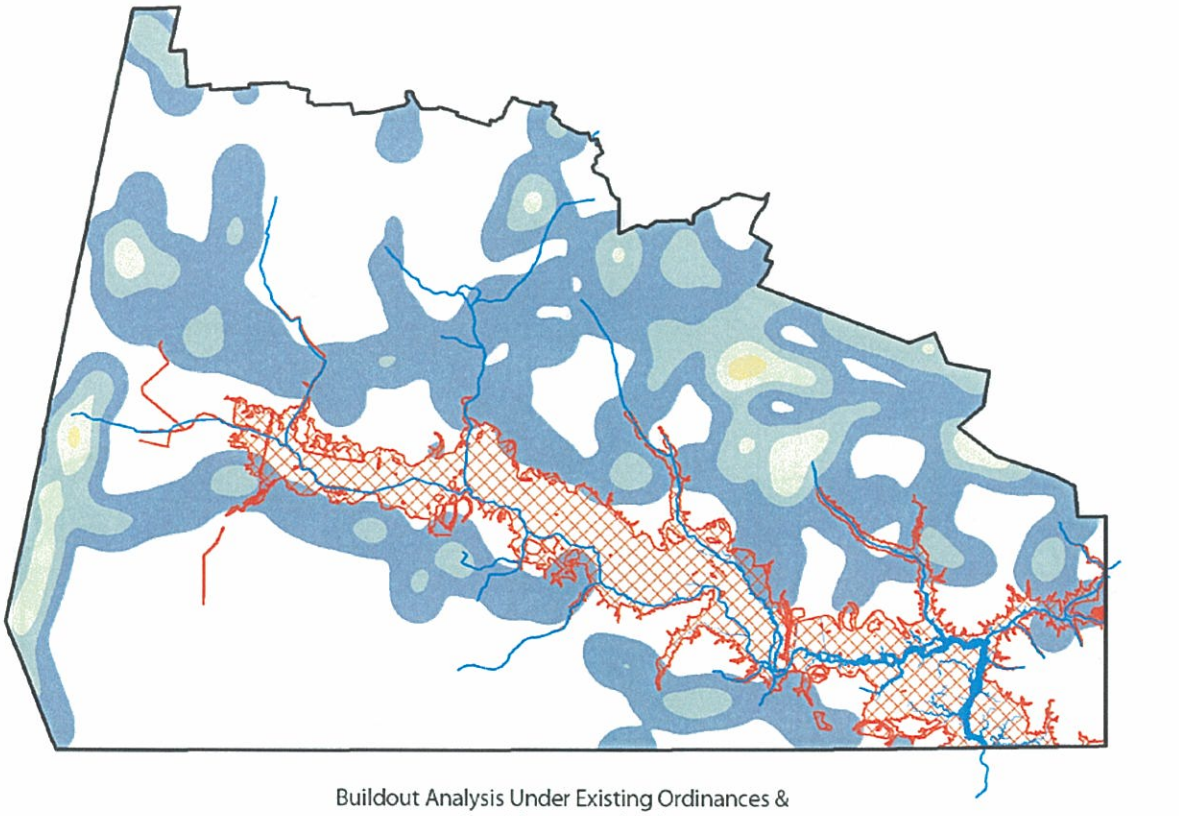


Buildout Analysis Under Existing Ordinances & Considering Wetlands

MAP 18 - Potential Buildout Concentration and Sea Level Rise



Buildout Analysis Under Existing Ordinances



Buildout Analysis Under Existing Ordinances & Considering Wetlands

major Hillcrest development does not present any conflicts with the critical areas under the criteria used in this analysis, though high-density development could lead to indirect impacts on water quality due to stormwater runoff.

Impact Analysis

Once a build-out analysis is completed, the next step is to calculate the impacts of future development. New development can result in significant changes to communities, including financial impacts such as increased infrastructure costs and tax revenue changes, and environmental impacts such as reduced open space and water quality impacts.

Methodology

For the Northwest River watershed build-out analysis an environmental impact analysis was conducted based on the CommunityViz spatial build-out analyses and a stormwater development model developed by Thomas Schueler (Ohrel, 2000). The Simple Method uses basic equations and few data requirements to generate estimated pollutant loads. One principle use of the Simple Method is to compare different types of development for a given quantity of development. The Simple Method incorporates three major inputs:

- Stormwater runoff, calculating using localized precipitation quantities and land use-based impervious surface percentages.
- Event mean concentrations for each pollutant to be measured and for each land use.
- Land area.

Runoff is calculated first by determining the runoff coefficient and then the total amount of runoff. Once the amount of runoff is determined the result can be inserted into the pollutant load calculation to determine how much actual pollutant is entering the watershed. Runoff calculations and pollutant loads were developed for both the base

The Center for Watershed Protection is an organization that "works to protect, restore, and enhance" inland and coastal water bodies (Center for Watershed Protection, 2008). *The organization engages in advocacy and research dedicated to development with "minimal impacts on water resources," making planning and infrastructure decisions at the watershed-level, and reducing the overall impacts of human behavior on watersheds. To this end CWP produces several tools that communities can use to protect their watersheds and develop responsibly. Publications by CWP include the Better Site Design Handbook, The Practice of Watershed Protection, and the Urban Subwatershed Restoration Manual series. More information can be found on the Center's website: http://www.cwp.org*

and NWI build-out scenarios from the CommunityViz analysis. These calculations were based on the amount of developed land in each parcel, which was a function of the number of units calculated in the spatial analyses. Calculations were performed separately for winter and summer and then summed to obtain annual totals. Three pollutant loads were calculated for the watershed: total phosphorus, total suspended solids, and total nitrogen. Total nitrogen was calculated as the sum of nitrogen oxide and total Kjeldahl nitrogen. Calculations were run for each developable parcel in the watershed, as determined by the CommunityViz build-out analysis.

Each analysis used the same number of new residential units as its parent development scenario – the number calculated in the CommunityViz spatial build-out analysis – for each zoning category and parcel (for example, the three NWI runoff analyses used the units calculated in the NWI spatial build-out analysis). Event mean concentrations, rainfall quantities, and impervious surface percentages were taken from the City of Chesapeake section of the Regional Stormwater Loading Study (CH2M Hill, 1999). The Simple Method was incorporated into the CommunityViz spatial analysis as a series of formulas that calculated developed area, annual pollutant loads for total phosphorus, total nitrogen, and total suspended solids, as well as annual pollutant loads/acre. These calculations were done for each parcel and were then summed to obtain total watershed impacts for each development scenario.

Table 8: Percent Impervious Cover by Land Use for the City of Chesapeake

Land Use	% Impervious
Single Family Residential – Semi-Rural	10
Single Family Residential – Suburban Low	15
Single Family Residential – Suburban Medium	25
Single Family Residential – Urban	40
Office/Light Industrial	60
Commercial	85
Industrial	85

Data and Assumptions

The Simple Method analysis described here incorporates data from two main sources. The main driver of the water quality impacts calculated by the Simple Method is the impervious cover percentage of a development type (Table 8). Values for impervious cover of various development patterns as well as event mean concentrations for each pollutant were taken from the Regional Stormwater Loading Study (CH2M Hill, 1999). Seasonal rainfall totals for the watershed were also taken from the same study and based on values obtain at Norfolk International Airport;

average precipitation in winter (October to March) is 20.05 inches, and average precipitation in summer (April to September) is 24.52 inches. Land area was calculated for each parcel by dividing the number of spatial build-out units by the density of units in the parcel, which was derived from the minimum lot size according to the City of Chesapeake's zoning ordinance. The entire lot size was assumed to be developed for all calculations.

Low-Density vs. Cluster Development

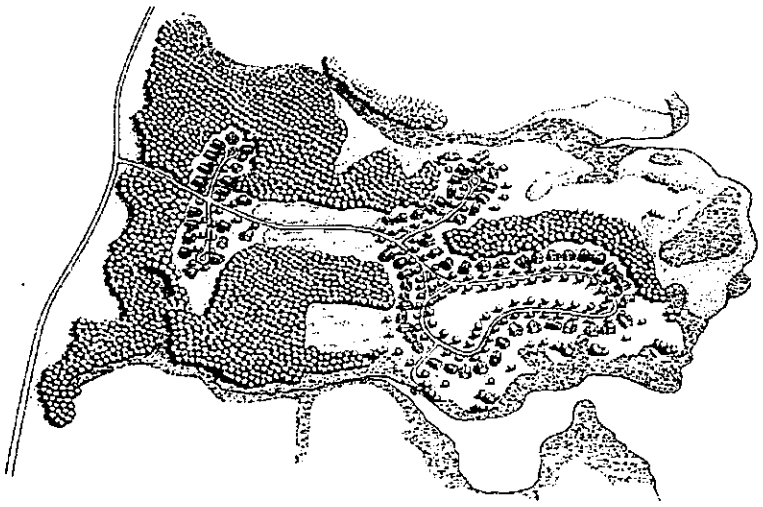
Development results in an increase in the percentage of a watershed that is covered by impervious surfaces. This additional cover results in more runoff during storm events and corresponding increases in the quantities of bacteria and pollutants that are carried into waterways. Increased impervious cover can also result in increases in erosion, stream instability, and stream temperature, all of which negatively affect the watershed. Communities can attempt to mitigate these impacts by influencing growth patterns and restricting growth in particularly sensitive or significant areas. Clustering new development together on smaller areas is one way in which communities can effectively reduce the impacts new development has on its host watershed. An EPA study, Protecting Water Resources with Higher-Density Development, modeled development at several densities and found that while higher-density development had greater impacts per acre, clustering development in higher-density nodes reduced the overall impact (including total runoff, runoff per unit, and amount of land developed) due to the significant decrease in the area developed (Richards, 2006).

A common perception of low-density or large lot development is that it is also low-impact. However, typical development practices often result in low-density areas having significant impacts that may not always be readily apparent. The quality of development is such that the pervious surfaces in low-density areas such as lawns, athletic fields, and landscaped open spaces often are so compacted that they cause nearly as much runoff as paved surfaces. Also, houses in low-density areas can often have more impervious area than those in higher-density areas due to the size of the house, its driveways and parking areas, and other site requirements. Additional off-site roadways and other impervious surfaces are often required for low-density developments (Richards, 2006). Limiting an area to low-density development does not preserve open

Conventional Residential Development
Drawing by Randall Arendt (Green Neighborhood Alliance)

space on its own. In contrast, one of the main goals of clustering or open space design is to preserve large areas of open space from development.

Clustering, sometimes referred to as open space or conservation development, is a form of development that encourages open space conservation and the preservation of rural character. Cluster development is more compact than typical suburban development, with smaller lot sizes and setback requirements. Housing units are concentrated on a portion of the total area. Net density is increased for a portion of the total site but overall density remains the same through the preservation of significant open space that is integrated into the development or preserved in its natural condition. Key characteristics of cluster development are narrower streets, smaller lots, the absence of curbs and gutters, and the protection of ecologically significant features such as stream buffers or sizeable wooded areas. Cluster development benefits communities in several ways. It can reduce stormwater runoff, pollution into waterways, and impervious cover. It can also contribute to natural land preservation (Zielinkski, 2000). Clustering can also help localities preserve rural character (Arendt, Rural by Design: Maintaining Small Town Character, 1994). One of the main requirements of successful cluster development is that it preserves large areas of open space as opposed to simply increasing density. It is this preservation of "large, continuous areas of open space" that aids in runoff reduction, pollution and sediment absorption, and protecting water quality (Richards, 2006).



Cluster/Open Space Residential Development
Drawing by Randall Arendt (Green Neighborhood Alliance)

The City of Chesapeake has incorporated a clustering provision into its zoning ordinance. It allows for the development of land in the rural overlay district while also preserving the area's open space and agricultural and natural heritage. The ordinance allows developers to cluster dwellings units on a portion of the site in exchange for leaving a certain portion of the site in its natural state in perpetuity. The ordinance allows for some additional units on the site if specified criteria are met. By clustering the dwelling units the City avoids undesired development and preserves important conservation areas. Chesapeake's Design Guidelines list five keys to effective cluster design: it preserves in perpetuity open space; it buffers residential areas from adjacent agricultural activities; it locates development in such a way to minimize its visual impact on its surroundings; it maximizes compatibility between new structures and the rural landscape; and it ensures that residential

vehicular traffic does not conflict with agricultural traffic (AECOM, EDAW, 2007). The goals of the Cluster Development Standards, as described by the Chesapeake Zoning Ordinance, include conserving open land, providing design flexibility and efficiency, providing a diversity of lot and housing choices, and protecting agricultural areas of the city for current and future use.

Scenarios

Three scenarios were developed to measure the effects of different densities on the watershed. Each scenario was assigned a different density for the currently-zoned A-1 parcels that would reflect the different visions of the watershed outlined at the beginning of this chapter. The set of three stormwater runoff scenarios was run for both of the CommunityViz build-out scenarios. The first scenario was based on the City of Chesapeake's existing building and site planning requirements. Under this scenario the density in A-1 areas was one dwelling unit for every three acres. The impervious cover percentage for A-1 areas in this scenario was set at 10%. A second scenario was developed based on the City of Chesapeake's existing cluster development ordinance. Under this scenario the minimum lot size in an A-1 parcel is one acre. The impervious cover percentage for developed portions of the cluster development in this scenario was set at 15%. A third scenario was developed based on research into cluster development and watershed management by the Center for Watershed Protection (Schueler, 2000). Under this scenario the minimum parcel size in A-1 areas was set at 10,000 square feet, for a density of roughly 4.4 units per acre. The impervious cover percentage for developed portions of the cluster development areas in this scenario was set at 25%. Each set of scenarios used the same number of units. The only

Figure 2: Land Consumption

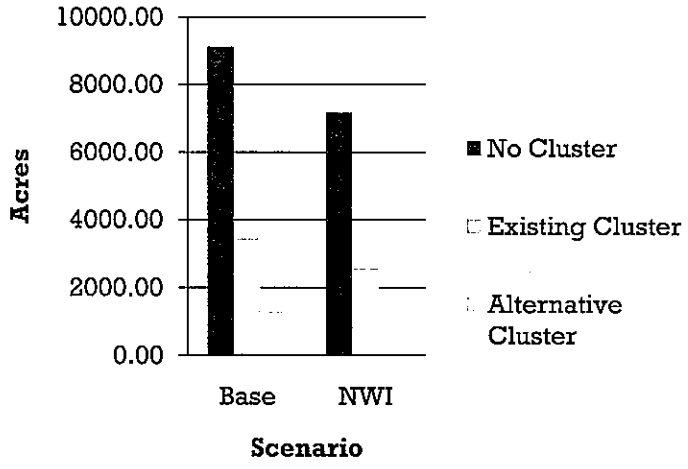
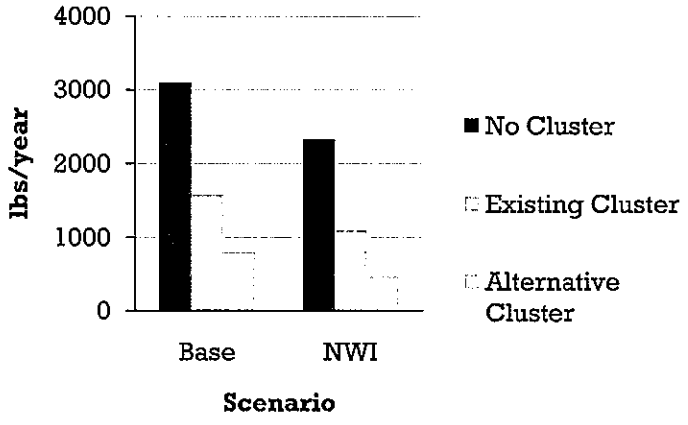


Figure 3: Annual Total Phosphorus Loads



changes were in the A-1 densities and the changes made to the impervious cover percentages to reflect those increased densities.

Results

Both of the cluster cases resulted in decreases in land consumption and pollutant loads for both the base and NWI scenarios, with the alternative cluster case having a the greatest decrease. For the base scenario, clustering resulted in a decrease of pollutant loads of approximately 49% under the existing cluster ordinance, and a decrease of approximately 73-74% under the CWP prototype. Land consumption decreased by about 62% and 86% under the two alternatives. For the NWI scenario, clustering resulted in pollutant load decreases of approximately 52-53% under the first cluster prototype, and 79-80% under the second cluster prototype, with land consumption decreasing by 64% and 89%. These analyses show that the clustering of new development can be used as one technique to reduce impacts on the development's watershed. However, clustering alone is not sufficient to protect an area's watershed. Proper site selection, based on soils, slopes, and location within the watershed, must also be practiced (Richards, 2006). Clustering development on smaller sites within a watershed allows ecologically significant areas to be protected, for land to be used more efficiently, and for communities to shape themselves to protect those areas they wish to see preserved, all while minimizing their impact on the environment. In order to achieve the benefits of higher-density development it is vital that those areas that perform important water quality and quantity functions be specifically protected. These areas, including wetlands, riparian corridors, and floodplains, naturally provide ecological services such as

Figure 4: Annual Total Nitrogen Loads

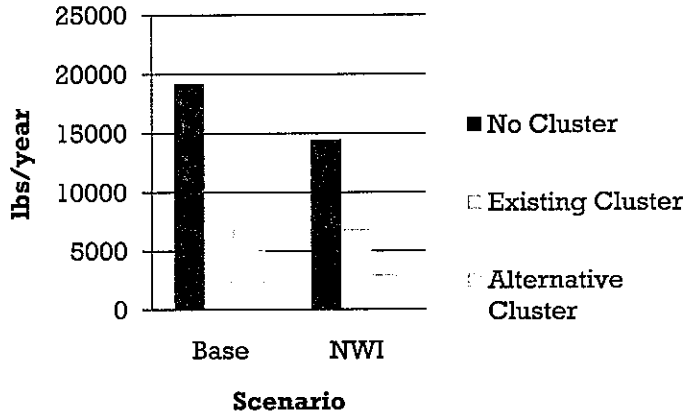
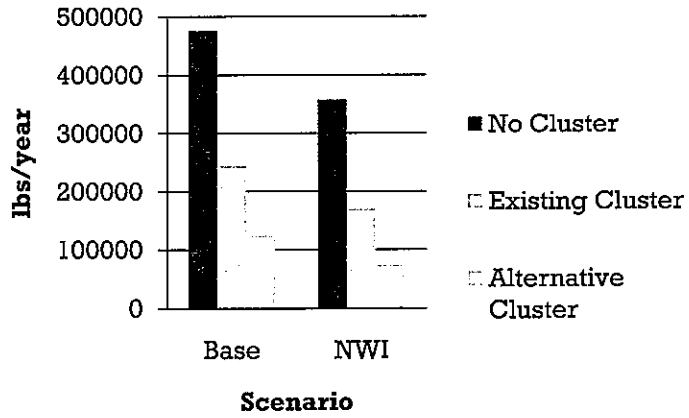


Figure 5: Annual Total Suspended Solids Loads



water filtration and runoff detainment and infiltration (Richards, 2006). Concentrating development in areas that are more suitable and protecting areas that provide the greatest value in their natural state can magnify the stormwater and open space benefits of increased density. Identifying those areas that are ideal for conservation is an important step to implementing a successful clustering program for mitigating watershed impacts.

Implications

Considering the build-out and stormwater analyses together has several implications for decisions about the watershed's development. The stormwater analyses suggest that clustering development could result in fewer impacts on the quality of the watershed's water bodies. The build-out and critical area conflict analyses show that a significant amount of growth can be expected in the watershed under existing regulations and that it may result in conflicts with other important watershed concerns. Taken together, these analyses suggest that the City of Chesapeake may want to look at alternative development patterns that promote overall watershed health and avoid critical area use conflicts.

CASE STUDIES

As part of the Northwest River watershed study, several case studies considered in past efforts were revisited. In 1997, the HRPDC published Water Supply Watershed Management in Hampton Roads, a guidance manual for watershed management in the region (HRPDC, 1997). The study was intended to provide insight on the broad range of options available for regional coordination of water supply watershed management initiatives. Several case studies were considered as examples to use in future watershed management efforts. Included was the Occoquan Watershed in Northern Virginia and New York City's water supply system.

Occoquan Watershed, Northern Virginia

This example was included in the 1997 study because it prominently used science in the course of policy formulation and featured a high degree of interjurisdictional cooperation in dealing with both point and nonpoint source water pollution. Occoquan is also of interest because its reservoir sits on the border between Fairfax County and Prince William County and its watershed occupies parts of four counties and two small cities. Efforts to address periodic water quality problems in the Occoquan water supply have included a nonpoint pollution management program, watershed modeling, and use tracking, water quality monitoring, and stormwater management.

Fairfax and Prince William Counties have both pursued efforts to plan for the future

Best Practices:
The Possibilities of Citizen Reporting and Enforcement

The potential to expand citizen roles in environmental enforcement is a concept that is worth exploring and not without precedent. In 1999, a Neighborhood Volunteer Program was piloted in the Richmond Highway corridor in Fairfax County in response to growing signs of property deterioration and blight. Recognizing the potential for citizens to play a role in code enforcement, County inspectors trained citizen volunteers to visually identify code violations. The volunteers would write a letter to a property owner requesting that the violations be corrected. At a designated time, the volunteers would return to the site to check if violations were corrected. As a result of the program, code violations achieved voluntary compliance over 85% of the time. The remainder of the violations was turned over to County staff for enforcement. In addition to increasing the County's ability to enforce its ordinances, the program also created a heightened sense of awareness that likely prevented violations from occurring in the first place. (Source: Fairfax County)

of the watershed. The Fairfax County Water Authority, as a requirement of the federal Safe Drinking Water Act, completed a Source Water Assessment (SWA) of its Occoquan intake and identified potential sources of contamination within a 64 square mile zone directly tributary to the Reservoir. Potential sources identified include point source discharges, various industrial facilities, and other sites which may provide vehicles for contamination of the reservoir.

Fairfax County also addressed the impact of tree cover on the health of the watershed. After enabling legislation was passed by the state to allow tree canopy requirements in Northern Virginia, Fairfax created a Tree Action Plan and adopted a canopy goal of 45% by 2037 (current tree cover is 41%). The City of Chesapeake is pursuing similar goals in cooperation with the City of Virginia Beach. A report on the state of the City's urban forests was completed in 2007.

City of New York

The City of New York's water supply system (the Catskill/Delaware and Croton water supplies) is notable for its size, the number of people it serves, and the scope of the management programs that are in place to protect it. The surface water sources that serve the system are currently untreated, although a treatment plant is under construction for the Croton, which is the oldest part of the system, due to recurring problems with color, taste, and odor in that part of the system. The watershed management programs in place to protect the New York water supply are numerous and wide-ranging. They include a land acquisition program, an agricultural program, a stream management program, environmental infrastructure programs, waterfowl management, wetlands protection, a forestry program, and public education and outreach.

In January 1997, the Governor and numerous State, local and federal officials, as well as representatives from environmental organizations, signed the historic New York City Watershed Memorandum of Agreement (MOA). This Agreement represented a comprehensive effort to protect and preserve the high-quality water supply produced by the watershed of the City of New York while preserving and enhancing the economic vitality and social character of the communities within the watershed. The MOA includes a wide array of programs to be implemented in watershed areas both East and West of the Hudson River. These programs include acquisition of land and easements, implementation of new regulations affecting activities in the watershed, and more than two dozen watershed protection and partnership programs. NYSEFC (New York State Environmental Facilities Corporation), Technical Advisory Services has responsibility to implement several watershed protection and partnership programs established under the MOA.

The Watershed Protection and Partnership Council was created by the New York City Watershed Memorandum of Agreement to provide a regional forum to aid in the long term protection of New York City's drinking water, and the economic

vitality of the Upstate Watershed communities. The Council serves as the working forum for diverse stakeholders that share an interest in the protection of the New York City Watershed and its communities. It continues to serve as a forum to share information and reports of progress as well as to identify issues of concern. It also provides a resource for dispute resolution.

In July 2007, the Environmental Protection Agency (EPA) released its most recent New York City Filtration Avoidance Determination for the Catskill/Delaware Water Supply. The EPA, in consultation with the New York State Department of Health (DOH), determined that New York City has an adequate long-term watershed protection program for its Catskill/Delaware water supply and that it meets the requirements for unfiltered water supply systems.

Newport News Waterworks

The most complete drinking water protection program in Hampton Roads at the time of the 1997 HRPDC study was instituted by the City of Newport News. Newport News Waterworks draws raw water from the Chickahominy River and uses a series of reservoirs located partially within city boundaries and in surrounding counties. The Chickahominy flows along the border of New Kent and Charles City Counties, and drains two-thirds of the land in New Kent. In 1993, New Kent County entered into an agreement with Newport News to establish protections for the Diascund Creek Reservoir. As a condition of the agreement, land adjacent to the Diascund Creek Reservoir was to be developed for recreational use. The City now provides access for water-based recreational activities at the Reservoir in cooperation with the Virginia Department of Game and Inland Fisheries and James City County. The City has adopted rules and regulations for the use of the land around the Reservoir, which include restrictions on the use of motor vehicles around the reservoir and a prohibition on the disturbance of earth or vegetation without a permit.

Newport News' 2030 Comprehensive Plan states that the viability of existing water sources and reservoirs must be maintained to meet future water supply demands and that reservoir protection is a necessary part of that plan (Newport News Planning Department, 2008). The use of Best Management Practices (BMPs) to protect reservoirs was recommended to Newport News in the Three Phase Reservoir Protection Study produced by Camp, Dresser and McKee, in 1985 and 1986. The study outlined additional watershed protection improvement projects to reduce the input of nutrients and other pollutants entering the reservoir. They included drainage diversion, buffer land acquisition, and wet pond construction.

In 1987, the Newport News City Council adopted a Reservoir Protection Ordinance that controls non-point source pollution from development that drains to the City's water supply reservoirs. A permitting system established by the ordinance, requires that post development runoff create no more contaminants than pre-development runoff. A special fund created by Newport News City Council is used to acquire

additional lands to protect the City's drinking water reservoirs. Funding comes from the sale of surplus Waterworks owned lands that do not drain into the reservoir and other arrangements, including the lease of watershed lands to York County for recreation (Newport News Planning Department, 2008). As part of its watershed protections efforts, Newport News Waterworks preserves more than 12,000 acres of land. River stewardship has also been promoted on the Chickahominy by a coalition of environmentalists, recreational river users, businesses and local governments known as the Chickahominy Watershed Alliance.

MANAGEMENT ALTERNATIVES

Land Use and Development Patterns

The location, density, and design of new development and redevelopment in the Northwest River watershed will be critically important in maintaining the long-term viability of the drinking water supply, the vitality of natural systems, and the quality of life for the citizens of Chesapeake. Intelligent decisions on future development patterns will support both the economic development goals and the watershed protection goals of the City.

The SWAMP program resulted in two key studies of these issues, the Rural Area Preservation Program developed by Siemon and Larson and a critique of development controls employed by the City of Chesapeake by Randall Arendt. Both of these studies emphasize the need to preserve important features of the rural landscape by clustering new development in the areas most suitable for it. Subsequent to this work, the City adopted a cluster ordinance and an update to the comprehensive plan that both echo these themes. In addition, the City adopted a Design Guidelines Manual in May of 2007 that provides extensive guidance on clustering new development in the rural tier of the City (AECOM, EDAW, 2007).

Given all of the focus on the need for nodal development patterns and clustering of new development in these studies, what remains to be done to insure that future development in the watershed meets the goal of watershed protection? Perhaps the most significant gap in the existing development control structure is the lack of a mechanism in the development approval process to protect the Conservation Corridor network surrounding the Northwest River. Much of the network has been protected through fee simple purchase and the establishment of conservation easements, but without specific requirements to address the unprotected areas in the network as new development occurs, many of the potential benefits of this buffer will be lost.

To achieve the desired clustering and nodal development pattern the existing cluster ordinance would need to be modified to provide more flexibility and incentive for its use in exchange for dedication of open space in areas that are in or directly adjacent to the Conservation Corridor system. To protect the rights of property owners and insure that they are not deprived of the fair market value of their land, a TDR program could be established and used in conjunction with the revised cluster ordinance. In addition, similar provisions could be implemented for business and commercial development to create the desired nodal development pattern.

Water Quality and Protection of the Drinking Water Supply

The existing Conservation Corridor network should be expanded to include and buffer all of the Northwest River and its tributary streams. The City of Chesapeake Design Guidelines recommend a setback of 1,000 feet from the shoreline for non-water dependant uses. A contiguous natural buffer along the shoreline is among the best and least expensive preventative measures for nonpoint source pollution.

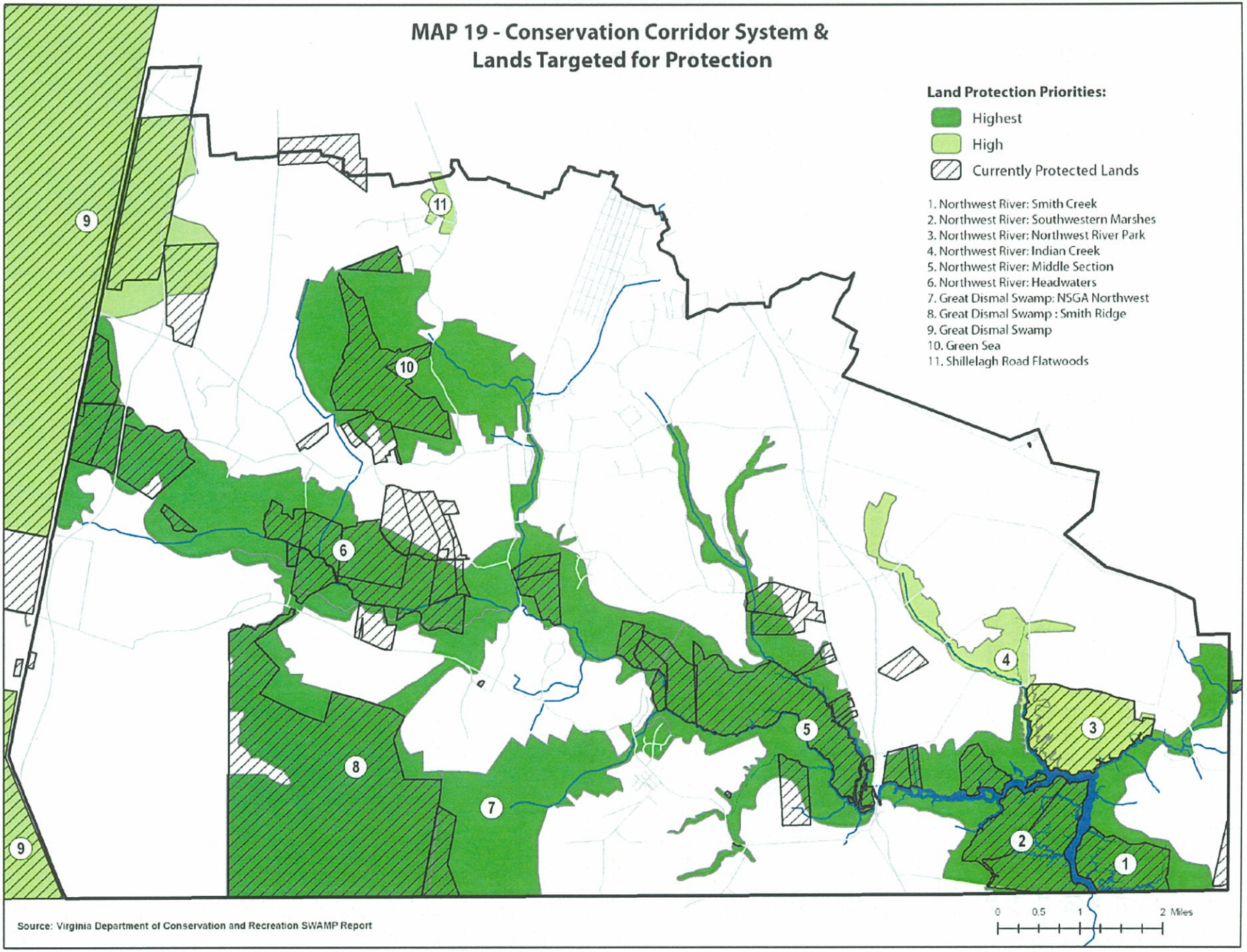
The majority of development in the Northwest River is on septic systems. Failure of these systems is a concern both from the perspective of protecting the drinking water supply and the natural resources in the watershed. A program to assist homeowners with the replacement and upgrade of substandard systems in those cases where financial need is the limiting factor would be of benefit. In addition, an inspection and pump out program could limit the extent of pollution from this source.

Natural Resources and Habitat Protection

Given the continued stress placed on natural systems in the watershed by the combination of development and fragmentation, the best response is to continue efforts to protect those high-value lands within the Conservation Corridor system. Map 19 illustrates target lands for acquisiton and preservation as part of the SWAMP conservation corridor system, through fee simple purchase, a TDR program, or other means. Linking protected lands into a contiguous corridor will maximize the likelihood that these systems will be robust enough to withstand future development in the watershed and stresses from climate change and sea level rise.

Climate Change and Sea Level Rise

Climate change and sea level rise will present a difficult set of watershed management challenges. Given that sea level rise is projected to accelerate and the frequency of intense rainfall events is projected to increase, one of the most effective responses is to limit new development in the floodplain. Over time the location of the floodplain will move inland with rising water levels. Expansion and protection of the Conservation Corridor network is again among the most cost-effective responses. In the case of existing development it may be necessary to elevate structures or, in the case of repeated flood damage, purchase at risk properties. One of the most difficult management issues for the drinking water supply is the eventual conversion of the Currituck Sound to a saltwater system if the barrier island system is breached. Depending on the timing of this change it may be necessary to consider an upgrade to the reverse osmosis facility to deal with the increase in salinity.


MAP 19 - Conservation Corridor System &
Lands Targeted for Protection
Land Protection Priorities:
Highest
High
Currently Protected Lands
1. Northwest River: Smith Creek
2. Northwest River: Southwestern Marshes
3. Northwest River: Northwest River Park
4. Northwest River: Indian Creek
5. Northwest River: Middle Section
6. Northwest River: Headwaters
7. Great Dismal Swamp: NSGA Northwest
8. Great Dismal Swamp : Smith Ridge
9. Great Dismal Swamp
10. Green Sea
11. Shillelagh Road Flatwoods
0 0.5 1 2 Miles
Source: Virginia Department of Conservation and Recreation SWAMP Report

Maintaining the Viability of Military Facilities

The major encroachment concern in the watershed is the area of potential electromagnetic interference surrounding the Northwest Annex. City staff has been working with the Department of Defense to incorporate these concerns in future planning efforts and to include the Conservation Corridor system as a high priority area for purchase of development rights. As previously stated, a nodal development pattern for the watershed that minimizes encroachment on areas that should remain rural is among the most effective strategies.

Threats and Strategies

Table 9 outlines some of threats present in the Northwest River watershed, along with management strategies suggested in previous studies on the watershed or used with success in other regions with similar concerns. Some of the strategies presented, such as a TDR program, will address multiple needs in the Northwest River watershed. Others, such as the MOU with the U.S. Navy, have been put in place and only need to be maintained. Many of these strategies are aimed at the acquisition and protection of vital areas in the watershed, while others include community based programs to involve stakeholdres in the conservation of the watershed. The variety of tools available will provide the City of Chesapeake with options as development pressures appear. The protection of the Northwest River watershed coupled with development options for residents and businesses operating there will benefit all in the future.

TABLE 9, SUMMARY OF CRITICAL AREA THREATS AND RECOMMENDATIONS

CRITICAL AREA	PAGE	THREATS	RECOMMENDATIONS
PROTECTION OF THE DRINKING WATER SUPPLY	43	NON-POINT SOURCE POLLUTION	EXPAND USE OF STORMWATER AND AGRICULTURAL BMP'S
			MAINTAIN SEPTIC SYSTEMS
			RESTORE VEGETATED BUFFERS ALONG RIVER AND TRIBUTARIES
			LIMIT DEVELOPMENT ADJACENT TO RIVER AND TRIBUTARIES
			EXPAND THE CONSERVATION CORRIDOR NETWORK TO BUFFER ALL OF THE NORTHWEST RIVER'S TRIBUTARIES
			ESTABLISH TRANSFER OF DEVELOPMENT RIGHTS PROGRAM
			PROTECT AND EXPAND CONSERVATION CORRIDOR NETWORK
			REQUIRE NORDAL OR CLUSTER DEVELOPMENT IN NEW DEVELOPMENT
		POINT SOURCE POLLUTION	CONTINUE TO MONITOR POINT SOURCES FOR VIOLATIONS
			LIMIT NEW POINT SOURCES
PROTECTION OF NATURAL RESOURCES	51	LAND DEVELOPMENT/ FRAGMENTATION	PROTECT AND BUFFER LAND WITHIN THE CONSERVATION CORRIDOR SYSTEM
			EXPAND THE CONSERVATION CORRIDOR NETWORK TO BUFFER ALL OF THE NORTHWEST RIVER'S TRIBUTARIES
			IMPLEMENT MANAGEMENT RECOMMENDATIONS FROM THE CONSERVATION PLAN FOR THE SOUTHERN WATERSHED AREA

TABLE 9, CONTINUED

CRITICAL AREA	PAGE	THREATS	RECOMMENDATIONS
PRESERVATION OF RURAL CHARACTER	57	LOSS OF OPEN SPACE	REQUIRE NODAL OR CLUSTER DEVELOPMENT IN NEW DEVELOPMENT
			REQUIRE DEDICATION OF OPEN SPACE THAT CONTRIBUTES TO THE CONSERVATION CORRIDOR NETWORK WHEN DEVELOPING ADJACENT LAND
			REVISE ZONING AND CLUSTER ORDINANCES TO PROMOTE NODAL OR CLUSTER DEVELOPMENT
			ESTABLISH TRANSFER OF DEVELOPMENT RIGHTS PROGRAM
		AGRICULTURAL/RESIDENTIAL USE CONFLICTS	ADD RURAL OVERLAY DESIGN SPECIFICATIONS TO THE PUBLIC FACILITY MANUAL
MILITARY FACILITY ENCROACHMENT	63	MILITARY/RESIDENTIAL USE CONFLICT	PARTNER WITH DOD TO PURCHASE LANDS AND EASEMENTS AROUND MILITARY FACILITIES
			USE CLUSTER DEVELOPMENT AND TDR TO LIMIT ENCROACHMENT FROM NEW DEVELOPMENT
CLIMATE CHANGE AND SEA LEVEL RISE	66	DAMAGE TO PRIVATE/PUBLIC PROPERTY	IDENTIFY AREAS VULNERABLE TO SEA LEVEL RISE AND STORM SURGE IN THE WATERSHED
			LIMIT FUTURE DEVELOPMENT IN VULNERABLE AREAS
		LOSS OF ECOLOGICALLY SIGNIFICANT AREAS	REASSESS THE CONSERVATION CORRIDOR NETWORK REGULARLY TO ADJUST FOR SEA LEVEL RISE IMPACTS
		LAND DEVELOPMENT/ FRAGMENTATION	INCREASE CONSERVATION CORRIDOR WIDTH AS NEEDED TO ACCOMMODATE SEA LEVEL RISE

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APPENDIX A – NORTHWEST RIVER TREE CANOPY ANALYSIS

One important component in determining the health of a watershed is the percent of tree canopy coverage. Tree canopy represents the land area covered by a tree as seen from above. Trees provide numerous community benefits including the absorption of nutrients, reduction of peak stormwater flows, improved air quality, habitat enhancement, and energy conservation. The State of the Chesapeake Urban Forest report produced in September 2007 by the Chesapeake City Arborist found that the value of Chesapeake's urban forest in 2005 was $1.479 billion on a one time basis and $100 million on an annual basis (Lestyan, 2008). This value represents the ecological services provided by the urban forest in terms of stormwater management, air pollution stored, and energy conserved. These values were derived from data taken from the American Forest Urban Ecosystem Analysis (American Forests, 2001).

Given these substantial values, the City has started to track the percent of canopy coverage within Chesapeake. For the initial effort at quantifying the percent canopy coverage, the City used 2005 data from the Department of Forestry to establish a baseline. This baseline was compared to US Geological Survey National Land Cover Data from the early 1990s to look at trends over time. This analysis found that the total canopy coverage for the City in 2005 was 36% compared to 38% in the early 1990s (when including the Great Dismal Swamp National Wildlife Refuge the percentages were 51% for the early 1990's and 50% for 2005). Although this indicates a 2% decrease in canopy coverage over a decade, there are limitations in this type of comparison due to the different sources of data and the low resolution (30 meter pixels) of each data set. Referencing this baseline data, the State of the Chesapeake Urban Forest report recommended that the City work to increase Chesapeake's overall tree canopy percentage to 40%.

In September 2006, the City acquired Light Detection and Ranging (LIDAR) elevation data. LIDAR is a technology that can be used to collect topographic data through the transmission of light pulses sent from an airplane. In general, LIDAR collects a data point every 4 feet, which creates a very accurate topographic database for the City. The City's Information Technology Department further processed this dataset to create a tree canopy coverage model. The LIDAR based coverage captures trees with heights greater or equal to 6 feet and delineates the canopy of many individual trees and small clusters of trees in addition to the canopy of wooded areas. The LIDAR coverage is orders of magnitude more accurate than the low resolution data used to create the initial baseline canopy coverage for the City. Consistent with this difference in resolution, Chesapeake's canopy coverage using LIDAR data was 27% (when including the Great Dismal Swamp National Wildlife Refuge the percentage was 36%).

Using the same dataset, the City determined that the Northwest River Watershed in Chesapeake had a canopy coverage of 29%. Appendix A - Map 1 illustrates the

location of the existing tree canopy coverage in the watershed. The analysis was taken a step further by breaking out the canopy coverage by current land use. The Planning Department has recently developed a parcel based current land use dataset that was used for this analysis. Appendix A - Map 2 shows the locations of the land uses in the watershed using this dataset. By overlaying the tree canopy coverage with the land use data, important information starts to emerge that can help with future management decisions in the watershed. Table 1 provides a summary of the relevant statistical information from this analysis.

Table 1: Land Use/Tree Canopy Analysis Results

Land Use Category	Canopy Coverage (acres)	Canopy Coverage (percent)	Total Acres	Percent of Watershed	Percent of Watershed Canopy
AGRICULTURE	2943	12	25360	40	4.59
COMMERCIAL	5	6	84	0	0.01
CONSERVATION	5069	45	11332	18	7.91
GOVERNMENT/ INSTITUTION	1476	41	3593	6	2.30
INDUSTRIAL	23	4	509	1	0.04
MITIGATION BANK	518	40	1295	2	0.81
RECREATION/PARK	760	62	1224	2	1.19
SINGLE FAMILY RESIDENTIAL	2688	31	8680	14	4.19
VACANT LAND	5062	42	12014	19	7.90
Total	**18543**		**64091**		**28.93**

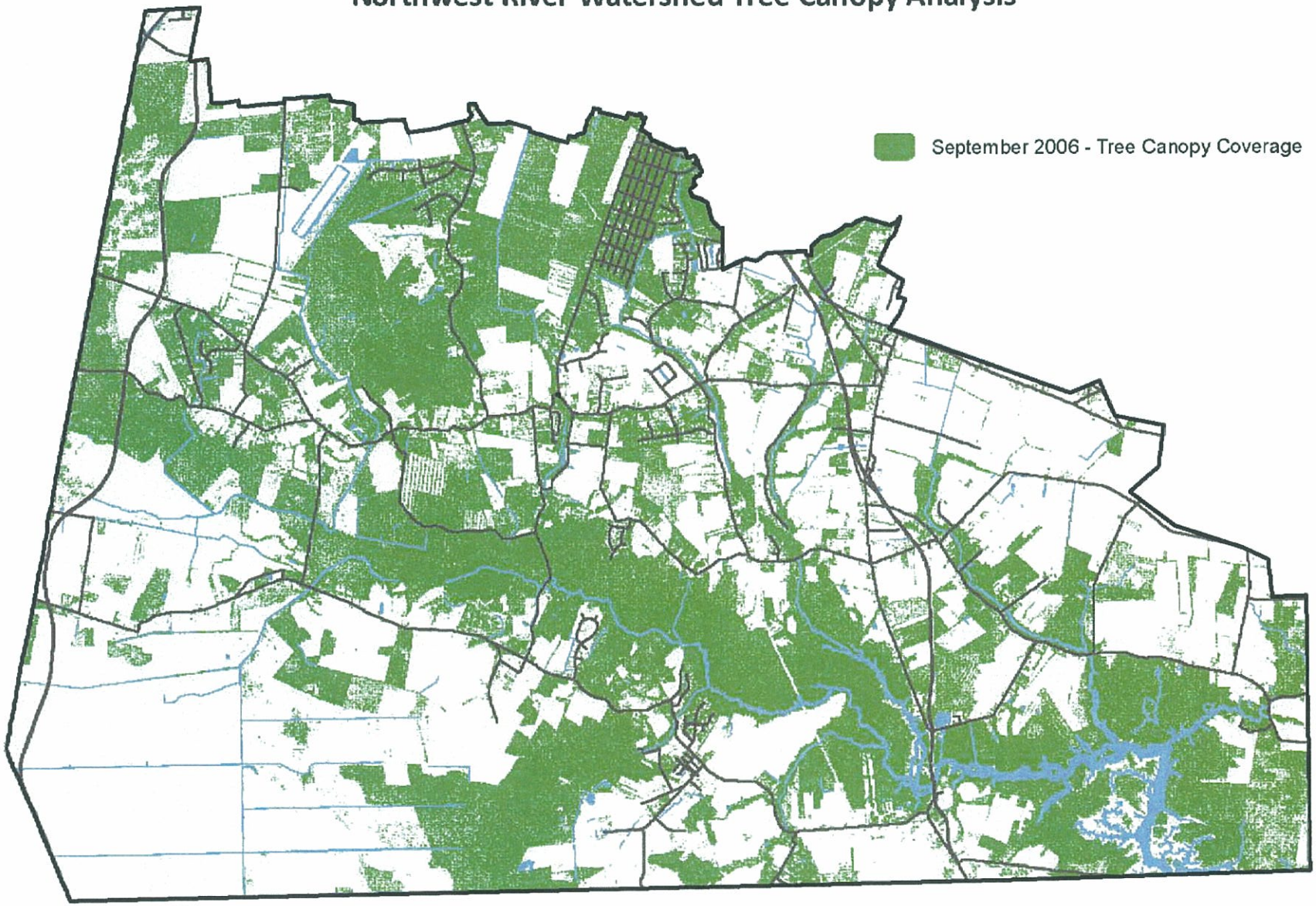
A review of the table indicates that the percent watershed canopy coverage is generally consistent with the major land uses in the watershed. One clear example of this is with the agricultural land use which currently represents 40% of the land area of the watershed. There is an obvious conflict in farming the land and having extensive canopy coverage. If this land use was taken out of the calculation, the watershed would have a canopy coverage of 40% which meets the City's overall canopy goal. Appendix A – Map 3 illustrates the location of land uses without existing canopy coverage. It is easy to see on this map the large areas of farmland without existing canopy. The land uses that characterize protected lands (conservation, mitigation banks, and recreation/parks) all have canopy coverage over 40% and represent 22% of the land area in the watershed. The Government/Institutional land use category, which includes the Naval Support Activity Northwest Annex, also currently has canopy coverage over 40%.

Potential land uses where canopy coverage could be increased are some of the existing developed lands (commercial, industrial, single family). Commercial and Industrial land uses currently only occupy a small percentage of the watershed. It is important to also note that the industrial land use category includes the Chesapeake Municipal Airport which like agriculture has obvious conflicts with extensive canopy coverage. The canopy coverage for single family is important to note for both existing and for new single family. As reported in the main body of the watershed

plan, the main pathway for land conversion in the watershed is for single family to be developed on existing agricultural or vacant land. A significant portion of the existing single family development is comprised of 3 acre lots that were subdivided from farmland. For these existing large lots, the concept of "no-mow zones" outside of established front and back yards could be a potential tool to help increase canopy coverage.

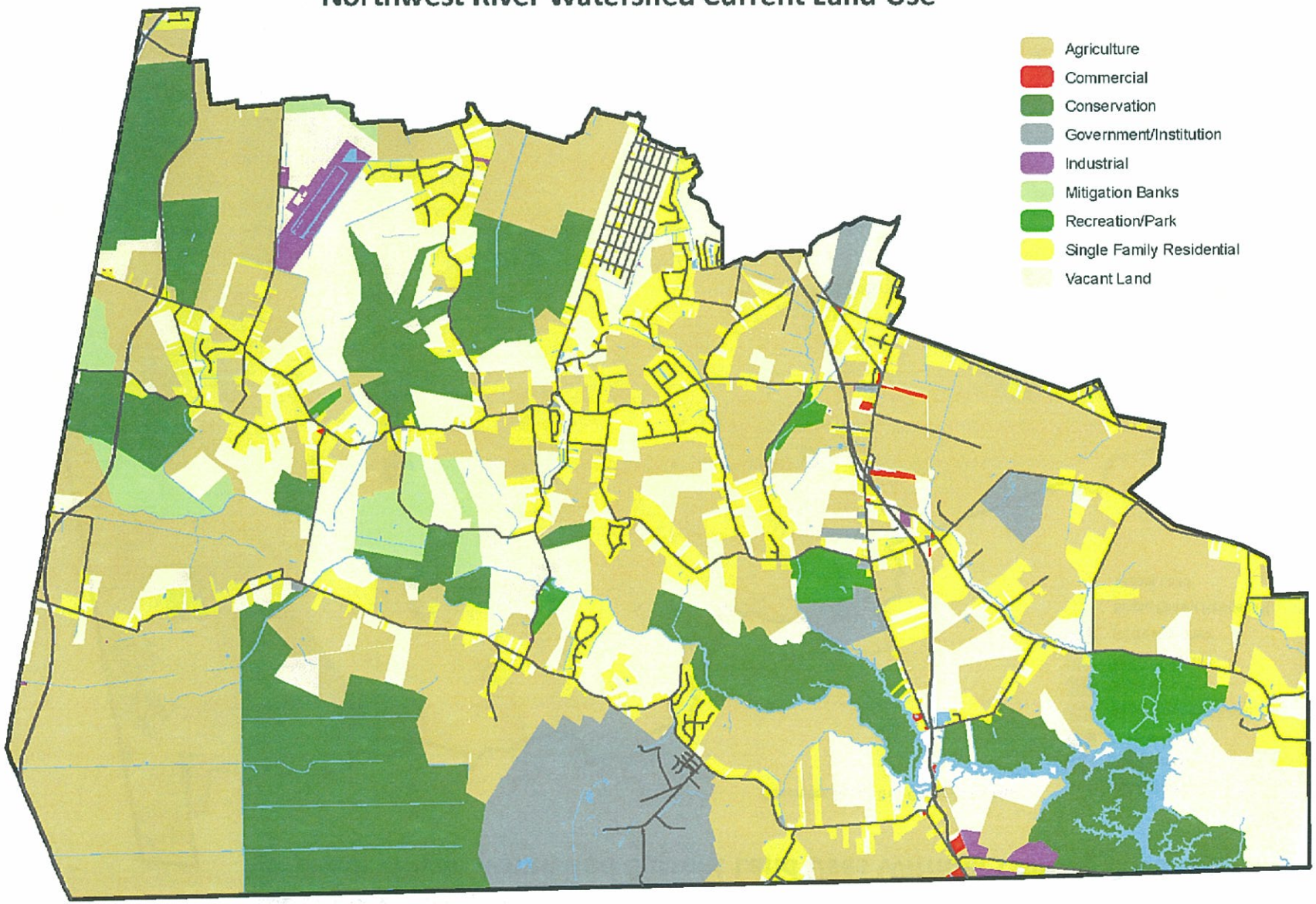
If and when future land conversion occurs, it will be important to consider the existing canopy coverage when developing the property. For agricultural land conversion the City will need to consider policies that promote increasing existing canopy coverage. For vacant land conversion the City will need to consider policies that protect the existing canopy coverage. As discussed in the main body of the plan, one potential tool for use in either scenario is the clustering of new development.

Appendix A - Map 1:
Northwest River Watershed Tree Canopy Analysis



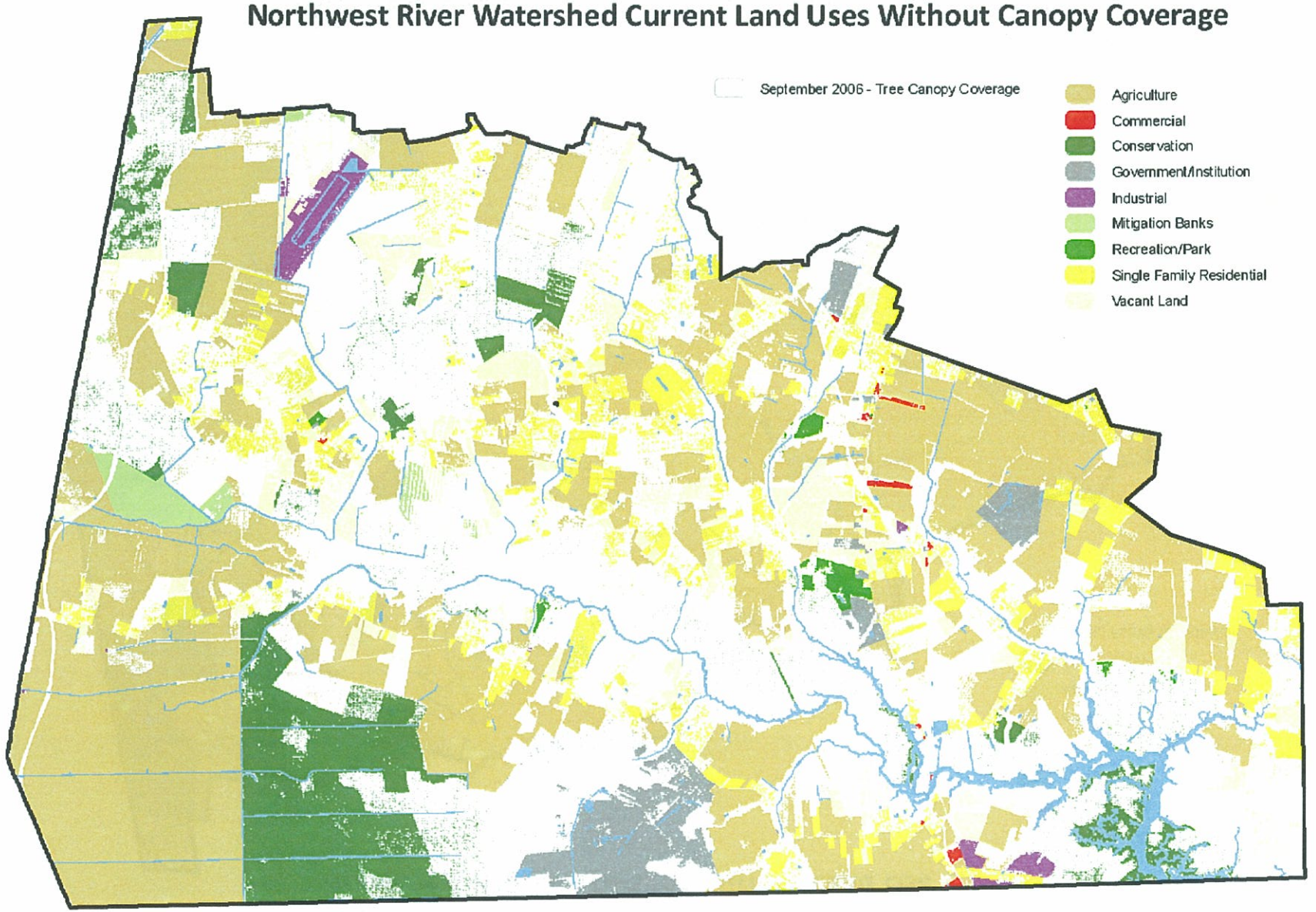
Source: City of Chesapeake Information Technology Department

Appendix A - Map 2:
Northwest River Watershed Current Land Use



Source: City of Chesapeake Planning Department

Appendix A - Map 3:
Northwest River Watershed Current Land Uses Without Canopy Coverage



Source: City of Chesapeake Planning Department