Virginia

By

J.G. Titus,
D.E. Hudgens,
C. Hershner,
J.M. Kassakian,
P.R. Penumalli ,
M. Berman, and
W.H. Nuckols

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The opinions expressed herein are solely those of the authors and do not necessarily represent the official opinion of the Environmental Protection Agency.

To keep the file size reasonably small, the maps in this pdf have relatively poor resolution, and the last two appendices are missing.
For a print-quality version please see http://risingsea.net/ERL/VA.html.
For high resolution maps, please see http://plan.risingsea.net/Virginia.html

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VIRGINIA COASTAL POLICIES AND REGULATIONS

Virginia has not developed an explicit policy to address the consequences of rising sea level. Nevertheless, policies designed to protect wetlands, beaches, and private shorefront property collectively constitute an indirect implicit policy. Overall, the state's policy is to assist local government efforts in nourishing public beaches, preventing new buildings within 100 feet of most tidal shores, preventing most dredging and filling of tidal wetlands, allowing most forms of shore protection structures, and informing property owners of nonstructural options.

Land Use

The Virginia Department of Environmental Quality established the Virginia Coastal Resources Management Program in 1986 as a network of state laws and policies through which the Commonwealth and its coastal localities manage environmentally sensitive coastal lands.[1]

Tidal Wetlands Act[2]

The Tidal Wetlands Act seeks to "…preserve and prevent the despoliation and destruction of wetlands while accommodating necessary economic development in a manner consistent with wetlands preservation".[3] The act provides for a wetlands zoning ordinance that any county, city, or town in Virginia may adopt to regulate the use and development of local wetlands. Under the ordinance, the localities create a wetlands board consisting of five to seven citizen volunteers. The jurisdiction of local boards extends from mean low water (the Virginia Marine Resources Commission has jurisdiction over bottom lands seaward of mean low water) to mean high water where no emergent vegetation exists, and to somewhat above spring high water[4] where marsh is present. The board grants or denies permits for shoreline alterations within their jurisdiction.

The Marine Resources Commission has jurisdiction over the permitting of projects within state-owned subaqueous lands. It also must "… promulgate and periodically update guidelines which scientifically evaluate vegetated and nonvegetated wetlands by type and describe the consequences of use of these wetlands types."[5] VIMS advises the commission. The commission has guidelines for wetlands, subaqueous lands, and coastal primary sand dunes and beaches. The commission has also published a pamphlet of best management practices for shoreline development that might affect wetlands, beaches, and subaqueous lands. The commission also reviews proposed projects in localities that have no local wetlands board by virtue of not having adopted a wetland zoning ordinance.

Coastal Primary Sand Dunes and Beaches Act

Virginia's Dunes and Beaches Act preserves and protects coastal primary sand dunes while accommodating shoreline development. The act identifies eight counties and cities that can adopt a coastal primary sand dune zoning ordinance, somewhat analogous to a Tidal Wetlands ordinance: Accomack, Northampton, Virginia Beach, Norfolk, Hampton, Mathews, Lancaster and Northumberland[6]; all but Hampton and Accomack have done so. The structure of the act is similar to the Tidal Wetlands Ordinances. The act defines beaches as (1) the shoreline zone of unconsolidated sandy material; (2) the land extending from mean low water landward to a

[1]For more specifics about the Virginia Coastal Program and the regulations currently in place, see http://www.deq.state.va.us/coastal/about.html.

[2]This discussion is drawn from Trono, K.L., 2003, *An Analysis of the Current Shoreline Management Framework in Virginia: Focus on the Need for Improved Agency.* As of December 1, 2004, the report was posted as *Virginia Shoreline Management Analysis Report* on the Virginia Coastal Program's publications web page at http://www.deq.state.va.us/coastal/publications/html.

[3]VA Code §28.2-1302

[4]The act grants jurisdiction to an elevation equal to 1.5 times the mean tide range above mean low water.

[5]VA Code § 28.2-1301.

[6]See C.S. Hardaway, L.M. Varnell, D.A. Milligan, G.R. Thomas, and C.H. Hobbs, 2001, *Chesapeake Bay Dune Systems: Evolution and Status,* Virginia Institute of Marine Science.

marked change in material composition or in physiographic form (for example, a dune, marsh or bluff); and (3) if a marked change does not occur, then a line of woody vegetation or the nearest seawall, revetment, bulkhead, or other similar structure.

Chesapeake Bay Preservation Act

The Chesapeake Bay Preservation Act[7] seeks to limit runoff into the Bay by creating a class of land known as Chesapeake Bay Preservation Areas. The act has also created the Chesapeake Bay Local Assistance Board ("the Board") to implement[8] and enforce[9] its provisions. Although the act defers most site-specific development decisions to local governments,[10] it lays out the broad framework for the preservation areas,[11] and provides the Board with rulemaking authority to set overall criteria.[12] The Board has issued regulations[13] defining the programs that local governments must develop to comply with the act.[14]

All localities must create maps that define the locations of the preservation areas, which are subdivided into resource management areas[15] and resource protection areas (RPAs).[16] RPAs include areas flooded by the tides, as well as a 100-ft buffer inland of the tidal shores and wetlands.[17] Very little development is expected in this 100-ft buffer. Within the buffer, development is generally limited to water dependent uses, redevelopment, and some water management facilities. Roads may be allowed if there is no practical alternative. Similarly, for lots subdivided before 2002, new buildings may encroach into the 100-ft buffer if necessary to preserve the owner's right to build; but any building must still be at least 50 feet from the shore.[18] Property owners, however, may still construct shoreline defense structures within the RPA. The type of shoreline defense installed is not regulated (beyond certain engineering considerations). Consequently, hard structures can be installed anywhere along Virginia's shoreline.

For purposes of this study, there is one important difference between Virginia's laws regarding coastal development along Chesapeake Bay and Maryland's Critical Areas Act. The Maryland statute has designated specific Resource Conservation Areas within 1,000 feet of the upper edge of the wetlands, where no more than one home is allowed per 20 acres. Virginia has no such density restriction. As a practical matter, the differences between the statutes do not necessarily imply that more of Virginia's coastal zone will be developed and require shore protection. Economic trends and local land use policies have historically had a greater impact on coastal development than has state regulatory policy. State policies regarding infrastructure such as bridge and tunnel crossings may have an even greater impact.

Although the structures tend to be initially constructed landward of mean high water, neither Virginia nor Maryland[19] requires their removal once the shore erodes to the point where the

[7] Code VA §10.1-2100 *et seq.* As of August 8, 2003, the Act was posted on the Virginia Legislative Information System website as part of the Code of Virginia at: http://leg1.state.va.us/cgi-bin/legp504.exe?000+cod+TOC10010000021000000000000.

[8] Code VA §10.1-2102.

[9] Code VA §10.1-2104.

[10] Code VA §10.1-2109.

[11] Code VA §10.1-2107(B).

[12] Code VA §10.1-2107(A).

[13] Chesapeake Bay Preservation Area Designation and Management Regulations (9 VAC 10-20-10 et. seq.).

[14] 9 Virginia Administrative Code §10-20-50.

[15] The act also provides for Resource Management Areas (RMAs), which are lands that, if improperly used or developed, have the potential to diminish the functional value of RPAs. Finally, areas in which development is concentrated or redevelopment efforts are taking place may be designated as Intensely Developed Areas (IDAs) and become subject to certain performance criteria for redevelopment. Private landowners are free to develop IDA and RMA lands, but must undergo a permitting process as well to prove that these actions will not harm the RPAs.

[16] 9 Virginia Administrative Code §10-20-70.

[17] 9 Virginia Administrative Code §10-20-80 (B).

[18] 9 Virginia Administrative Code §10-20-130 (4).

[19] The Maryland/Virginia border along the Potomac River is the low water mark. Courts have not ruled whether Maryland or Virginia environmental rules would govern a structure in Maryland waters attached to Virginia land. See the section on Northern Virginia, below.

structures are flooded by the tides. Nor has either state prevented construction of new replacement structures within state waters.

Erosion Control Permits

Virginia has a fairly elaborate procedure for issuing permits for erosion control structures. The Virginia Coastal Program's web page recently posted a fairly detailed analysis of this process.[20] The process is designed to avoid destruction of wetlands or other adverse environmental impacts. The focus of the regulations and the review processes, however, is on direct short-term damage to the environment. The long-term impact on the environment from preventing the landward migration of tidal habitats is not considered.

Beach Nourishment

Until 2003, the Board on Conservation and Development of Public Beaches promoted maintenance, access, and development along the public beaches of Virginia. This board was also known as the "Public Beach Board." The largest beach nourishment projects have been along the 13 miles of public beach along the Atlantic Ocean in Virginia Beach. Annual fill projects have added 200,000 to 300,000 cubic yards of land along the shore between 1st and 59th Streets.[21] A $100 million Hurricane Project was completed in 2001, including both a seawall and a major sand replenishment project. During the last 50 years, the State has provided 3 percent of the funding for beach nourishment at Virginia Beach, and the local and federal shares are 67 and 30 percent, respectively.

Virginia has made a greater effort than Maryland to maintain beaches (and public use of beaches) along Chesapeake Bay and its tributaries. Norfolk's four guarded beaches serve 160,000 visitors each summer. Erosion along the shore threatened property, the tourist economy, and local recreation. At a cost of approximately $5 million, the Beach Board helped the city construct a series of breakwaters with beachfill and a terminal groin. Across the James River, the City of Newport News and the Beach Board split the cost of a $1 million beach restoration project at Anderson Park, Huntington Park, and King-Lincoln Beach Park. The City of Hampton's Buckroe Beach along Chesapeake Bay has had a severe erosion problem. Throughout the Beach Board's lifetime, it provided $1.3 million for headland breakwaters and beach nourishment. Immediately to the north, at the Salt Ponds public beach, the Beach Board funded a geotube project with a small amount of sand covering the tubes. More recently, the Beach Board provided $300,000 for a breakwater and beach nourishment project along the public beach of the Town of Cape Charles on the Eastern Shore. Along the Potomac River, the Beach Board supported efforts by the Town of Colonial Beach to maintain its beach with a combination breakwater and beachfill project, contributing $274,000 to this effort. Farther up the river at Aquia Landing in Stafford County, the Board provided $235,000 and technical support for a headland breakwater system and beachfill project. The Board has also supported beach restoration efforts along the York River.

[20] This discussion is drawn from Trono, 2003 (see note 27 for full reference).

[21] Virginia Public Beach Board, 2000, *20 Years of Coastal Management,* Board on Conservation and Development of Public Beaches, Richmond, VA.

STATEWIDE TENDENCIES REGARDING LONG-TERM SHORE PROTECTION

Table 8-5 summarizes the general procedures that this report uses to identify the likelihood that specific parcels of dry land will be protected. Planners tended to agree that the state's general policy favoring shore erosion control provides us with a basis for anticipating responses to sea level rise.[22] This section reviews how we applied our general approach statewide, including typical GIS decision rules used to create maps, given the state policies. The actual assumptions used to create the maps are documented in the sections on the specific planning districts; this section simply provides a general overview. Even within specific planning districts the maps depart from this general approach in many cases for site-specific reasons, which are documented in the region-specific sections of this report.

Areas colored brown in our maps depict places where coastal protection is almost certain. Those areas include highly developed residential (typically with houses within 150 feet of each other), commercial, and industrial areas, as well as locally designated growth areas.[23] In most cases, private or public investment is considerable and expected to continue. Many of these areas are already armored with hard structures. Existing armoring does not necessarily mean that the shore will be protected no matter how much the sea rises, only that the shore will be protected at some point in the future.

In addition to those areas where available data allow one to automatically map the areas likely to be protected using the decision rules, the study followed a number of general procedures based on the input from local planners. The VIMS study obtained initial judgments from planners of Atlantic and Chesapeake Bay localities defining the areas that would be protected from erosion and inundation under any imaginable sea level rise scenario. Some versions[24] of our maps depict those areas in orange, unless stated otherwise.[25] Following that initial meeting, local planners reviewed the general decision rules based on land classifications, and generally accepted those rules. During follow-up meetings, planners often provided modifications, identifying areas where protection is almost certain regardless of the data classification. For example, coastal areas with low-density development often have development concentrated along the Bay, a river, or a creek, and frequently the waterfront homes have extremely high property values even though nonwaterfront lots are inexpensive. The planners generally agreed that these homes will not be abandoned. In many cases we identified these areas based on a roads data layer.

[22] We identify anticipated response guidelines based on discussions with local planners.

[23] We delineate these areas based on information provided by local planners.

[24] The VIMS study is unusual and no similar assessment exists for any other area. For statewide (and nationwide) consistency, we exclude the orange in one set of maps. To provide all the information available, however, we include the orange in another set of maps.

[25] Northampton and Middlesex county planners told us that a few of the VIMS areas were incorrect, and asked us to revise the maps to show those areas as "protection likely" or "protection unlikely." Because the Gloucester zoning data have precise boundaries whereas the VIMS study digitized boundaries at a coarse but unknown scale, we relied on the zoning data wherever they contradicted the polygons provided by VIMS. Northumberland also made a minor refinement to the VIMS assumption during our initial discussions. Maps distributed during the stakeholder review for those counties did not distinguish the orange and brown. Operationally, this study accepted the VIMS study as valid and thus as one source of areas that are almost certain to be protected. We only overrode its designations when there was no logical alternative.

TABLE 8-5. STATEWIDE GENERAL APPROACH FOR IDENTIFYING LIKELIHOOD OF SHORELINE PROTECTION OF DRY LAND [a]

Likelihood of Protection	Land Use Category
Protection almost certain (brown)	Existing developed land (commercial/industrial/residential) within growing and densely populated areas
	Areas currently protected by hard coastal armoring structures
	Undeveloped lands within growth areas[b]
	Valuable waterfront homes in areas where protection would otherwise be classified as "likely"
Protection likely (red)	Existing development[c] outside of growth areas
	Recreational parks in developed areas, especially those along the shore
	Secured federal installations (except for installations within highly urbanized areas)
	Valuable waterfront development in areas where protection would otherwise be classified as "unlikely"
	Projected future development outside of growth areas
	Anticipated growth areas identified based on existence of nearby shore parallel roads or dense network of roads
Protection unlikely (blue)	Undeveloped, privately owned lands with no expectation of significant future development
	Recreational parks and other publicly owned lands where shore protection seems unlikely but would not impair intended use
No protection (light green)	Private lands owned by conservation groups (when data available)[d]
	Publicly owned natural lands such as state parks and national wildlife refuges,[d] where policies imply a preference of natural processes over protecting dry land
	Private lands where government policy precludes shore protection

[a] These general procedures describe the initial assumptions, before site-specific modifications were made to the maps. All site-specific departures from this procedure are discussed in the planning district sections of this report.

[b] Growth areas are identified from local comprehensive plans and conversations with local officials.

[c] Existing development is identified based on the USGS National Land Cover Dataset from 1992 for Virginia, accessed through University of Virginia Library Online at http://fisher.lib.virginia.edu/nlcd/browse_county.html.

[d] Conservation and publicly owned lands are identified from USGS Dataset, US Geographic Data Technology Inc., accessed from 2000 ESRI Data and Maps CD number 3.

Areas depicted in red represent lands that are probably going to be protected from the sea. Although protection is likely for a given locality, at least a few of the areas depicted as likely to be protected will ultimately not be protected. Possible reasons might include that expected development does not occur as planned; that environmental concerns about the need to preserve natural shores lead governments or conservancies to prevent the armoring of this shore through regulation or acquisition; that undeveloped land ultimately becomes parkland as part of the subdivision process; or that the costs of coastal protection prove to be greater than expected.

As a general rule, areas that planners identify as rural development or suburban (typically zoned for plots of less than 2 acres) are considered likely to be protected. In addition, those areas where planners anticipate future development are also identified as likely to be protected. Given that shoreline armoring is relatively inexpensive relative to property values along most of the Virginia shore, most developed areas are likely to be protected. Nevertheless, lands outside of major growth areas are less likely to have sewer and other major infrastructure investments, and less likely to be densely developed. Therefore, if economic or environmental concerns precluded as much shore protection as currently seems likely, growth areas would have a higher priority for shore protection than nongrowth areas. For the most part, planners told us the areas where they expected significant development; in a few cases, they provided digital planning or zoning data[26] or a hard-copy map.[27,28] We supplement their input

[26] Gloucester, Stafford, Prince William, and Fairfax counties.

[27] Suffolk, York, and James City counties.

[28] Planners indicated that in general, residential areas (typically 2-acre lots or smaller) are certain to be protected, whereas the more rural areas (typically between 2- and 5-acre zoning) are likely to be protected. Only Gloucester County, however, provided data to identify these areas by zoning areas.

with an analysis of the road networks in each locality. For our purposes, a highly developed road network and roads parallel to the shore in an undeveloped area that is expected to otherwise remain agricultural would indicate future shorefront development and an increased likelihood of protection.

We also depict secured federal installations in red, unless they are located in areas that are almost certain to be protected or we had evidence that the area is currently protected from erosion and flooding. State and local officials were generally not in a position to make authoritative statements about the fate of such installations, and federal facilities are generally exempt from the coastal land use planning that applies to private lands. Hence this study does not attempt to identify the response to sea level rise by military bases or other secured installations.

The blue areas represent lands whose owners are currently allowed to erect shoreline armoring but are not likely to do so. The most common reason for assuming that an area will not be protected would be a planning policy that explicitly prohibits or discourages development. In many remote areas in Virginia (where zoning typically sets the minimum plot size as 5 acres), development is unlikely for the foreseeable future even if local officials would welcome it. Coastal development is a reasonable possibility even in many remote areas, however, because so many Americans would like to own waterfront property. Nevertheless, Virginia allows property owners to hold back the sea to protect their land, undeveloped or otherwise[29]; and some farmland has been protected with rock revetments. Moreover, development could occur in areas where local officials do not foresee it. Therefore, one might reasonably expect that some of the areas shown in blue may eventually be protected.

Finally, we depict areas that would not be protected given current policies in light green. For the most part, these are publicly owned lands that are managed for conservation.[30] In addition, where information is available, we also depict privately owned lands managed for conservation in light green.[31] Parks and other lands that are important recreational areas, however, are considered likely to be protected and mapped as red whereas government lands used for schools, offices, residential, and industrial uses are typically considered almost certain to be protected. This study considers only shore protection for dry land. Measures may be undertaken to protect wetlands as well, but because such decisions would be made by different people and based on different considerations, we leave those matters for another study. Nevertheless, these maps include wetlands for context. The majority of tidal wetlands are within The Nature Conservancy's barrier island reserves along Virginia's Eastern Shore. The next largest block is the tidal wetlands of the Big Salt Marsh and the Plum Tree Island National Wildlife Refuge in Poquoson. Depending on the wetlands data set used, some lands may be depicted as tidal wetlands (dark green), nontidal wetlands (purple), or dry land such as conservation areas (light green).[32] For example, dunes and other high ground on undeveloped barrier islands are sometimes classified as "wetlands" even though they may be as dry as similarly situated land on developed islands. Recognizing that wetlands data sets may be improved—and that wetlands are migrating inland as sea level rises—we designed this study so that the data we produce can be used to with different wetlands data sets.

[29]Chesapeake Bay Preservation Area Designation and Management Regulations (9 VAC 10-20-10 et seq.).

[30]We map national, state, and local parks and forests based on data available from US Geographic Data Technology Inc., accessed from 2000 ESRI Data and Maps CD number 3.

[31]Maps from The Nature Conservancy also outline major and private lands managed for conservation in the Chesapeake Bay region: The Nature Conservancy–Virginia: available at http://nature.org/wherewework/northamerica/states/virginia/.

[32]Even with a given wetlands data set, whether a particular parcel shows up as wetland or dry land often depends on the particular criteria used for wetland delineation. In addition, newer data sets show recent changes in land use and may have more accurate boundaries.

REGIONAL POLICIES AND SEA LEVEL RISE RESPONSE SCENARIOS

The coastal zone of Virginia includes both rural areas (e.g., Accomack, Northampton, Northumberland, Lancaster, Middlesex, Mathews, and Gloucester) and a highly developed urban core at the mouth of Chesapeake Bay collectively known as Hampton Roads (Poquoson, Hampton, Newport News, Norfolk, and Virginia Beach). The jurisdictions all operate with locally elected governments (city councils or county boards of supervisors). City and County zoning ordinances are the predominant planning and land use regulatory mechanisms. In this section, we provide background information on each locality's[33] potential vulnerability to the impacts of sea level rise, and then describe the anticipated future response. This information begins with the Accomack-Northampton PDC and is then organized from south to north by planning district commission (PDC).

[33]The state of Virginia is subdivided into counties and independent cities. Cities have some governmental powers that counties lack. Although cities generally have higher population densities and less land than counties, some cities have annexed adjacent counties (e.g., Virginia Beach). This report uses the term "locality" to refer to both cities and counties in Virginia. Counties also have incorporated towns; but their participation in this study was minimal.

THE VIRGINIA EASTERN SHORE: ACCOMACK AND NORTHAMPTON COUNTIES

Background

Most of Virginia's lands close to sea level are in the Eastern Shore counties of Accomack and Northampton. These two counties contain 70 percent of the state's tidal wetlands. Accomack also contains 18 percent of the dry land within 2 feet above the tides, as well as three developed islands that are potentially vulnerable: Tangier, Saxis, and Chincoteague.

The rural Eastern Shore of Virginia is approximately 70 miles long and 5 to 10 miles wide, with the Atlantic Ocean to the east and Chesapeake Bay to the west. These shorelines provide a wealth of recreational and tourist opportunities for residents and visitors alike. A number of small towns and villages lie along the shoreline, but the majority of the land area is either undeveloped or used for agricultural purposes. The population of the region grew modestly from approximately 45,000 in 1990 to 51,000 in 2000. Development pressures are not heavy yet.

The need to cross the 17-mile Chesapeake Bay Bridge-Tunnel to reach the Hampton Roads area has made commuting impractical for most people, given the $20 round trip toll and the occasional severe traffic jams when an accident occurs. Recently, however, the bridge portion was expanded to two lanes in each direction, and the one-day roundtrip toll was reduced to $14. As a result, many observers expect development to increase soon in the southern portion of the county, especially along the bayside. Some people commute from northern Accomack County to Salisbury and other towns in southern Maryland, and Chincoteague is a popular resort and gateway to Assateague Island National Seashore. This county seems likely to develop slowly for the foreseeable future. Still, the coming decades may see an increase in development of seasonal homes, tourism, and commercial activity given the natural beauty of the region.

The vulnerabilities of Accomack and Northampton counties are very different: Ecosystems are potentially vulnerable in Northampton, and several communities are vulnerable in Accomack.

Accomack County

Vulnerability to Sea Level Rise

Rising sea level is already converting farmlands to tidal wetlands. Oftentimes one can observe corn and other crops on low land near the Bay or a tributary, and on closer inspection some of the rows of crops will be broken by wetland vegetation. Land that might have been arable a few years ago gradually becomes nonarable because of salt contamination from tidal flooding. (See Photos 8-1 through 8-5.) Given the 14.1 square miles of dry land within 2 feet above the wetlands, a linear interpolation implies that the county has 47 acres within one eighth of an inch (3 millimeters) above the tides. As a result, it may be realistic to assume that 474 acres of wetland are created per year from the gradual inundation of low-lying farms.

The county's land use policies recognize the low-lying character in several ways that will tend to influence the ultimate response to sea level rise.[34] Currently, only Onancock and Tangier have sewage treatment plants. Because of the reliance on septic tanks, soils determine where development goes. Moreover, densities are restricted in the coastal floodplain. Because of these factors, along Chesapeake Bay, development is mostly occurring toward the southern half of the county, where elevations are relatively high. The barrier islands are all owned by the federal government, state government, or The Nature

[34]The County currently requires floor elevations of new homes to be 1 foot above the base flood elevation; Dave Fluhart, Stakeholder Review Meeting.

Conservancy. Along the coastal bays on the Atlantic side, the combination of county policies, environmental factors, and economic trends tends to encourage development in the northern areas near Chincoteague, Wallops Island/NASA, and the Maryland line while discouraging development along the bays opposite The Nature Conservancy's lands. The county continues to grow.[35]

Accomack's three developed islands, Tangier, Saxis, and Chincoteague, have their own town governments with land use authority. Tangier Island is in the middle of Chesapeake Bay, with passenger ferries to Crisfield, Maryland, on the Eastern Shore, Onancock in Accomack County, and Reedville on the Northern Neck of Virginia. Photos 8-6 through 8-9 provide an overview of this Tangier. The town is built on several ridges that once represented the highest ground, but now represent the only dry land. Channels separate each of these ridges now, so that strictly speaking there are several islands. Shore erosion is also severe, necessitating shoreline armoring, particularly on the north side. Approximately 90 percent of the structures are within the 100-year floodplain.[36] USGS topographic maps show the entire island as below the 5-ft contour, except for about half of Canton Ridge. Given the tide range and historical sea level rise, the USGS maps imply that the entire island would be flooded by the tides with a rise in sea level of 2 to 3 feet.

Tangier is as vulnerable as many of the "Small Island States" that researchers and the news media often discuss as potential victims of rising sea level, such as Tuvalu, Marshall Islands, and the Republic of Maldives. Like those atoll republics, here a unique culture is threatened with extinction, only it may be even more immediately vulnerable than those nations. Although one might normally assume that a picturesque island in the United States would have greater resources for holding back the sea, Tangier is a fishing community. The decline of oysters and other shellfish in Chesapeake Bay has reduced incomes, and the fill dirt necessary to enable the island to keep pace with rising sea level is relatively expensive given the island's remote location.[37] Town officials believe that subsidence is exacerbating the effects of sea level rise on some portions of the island.[38]

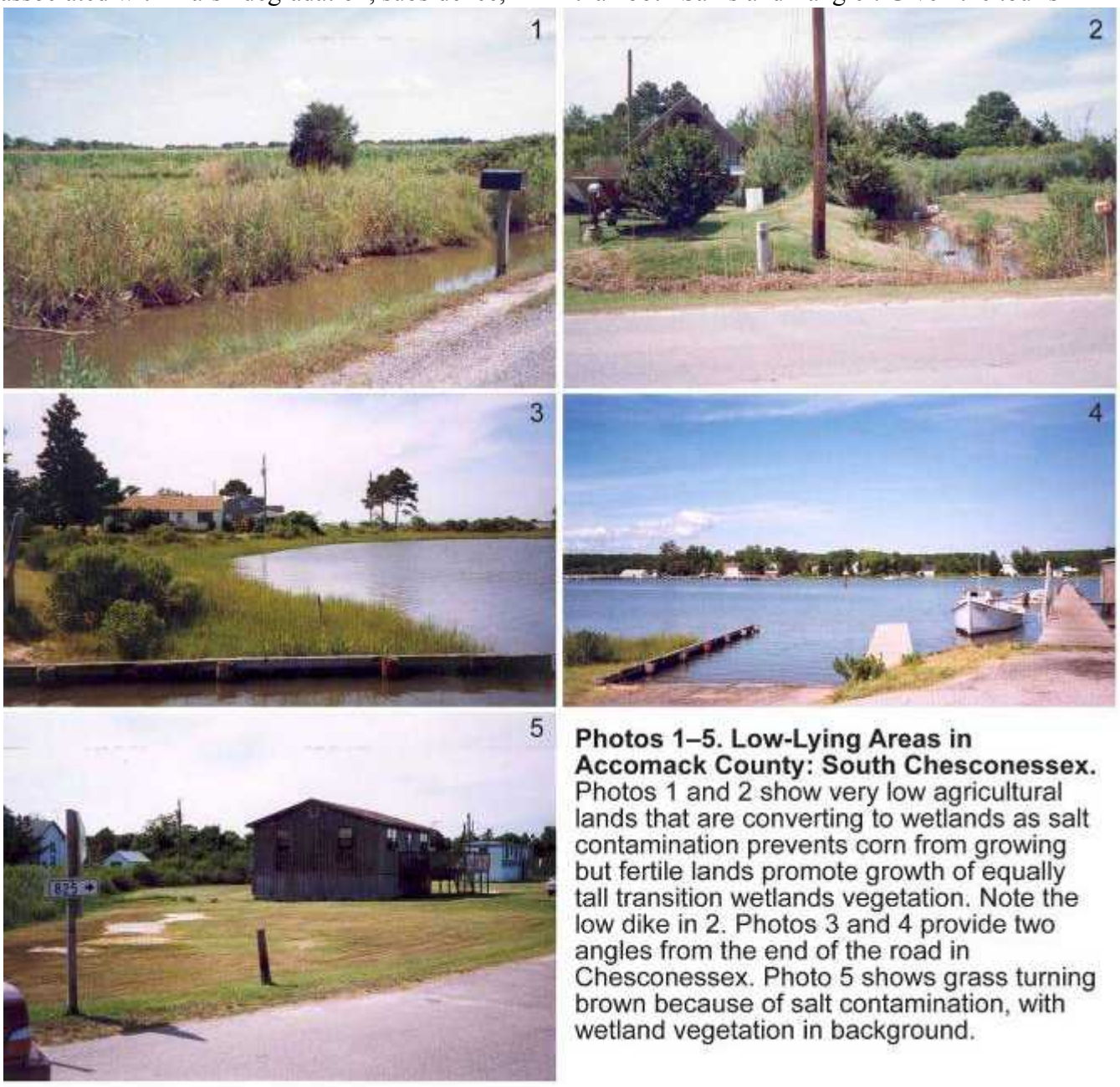
Yet despite its vulnerability, there are reasons to believe that Tangier could survive rising sea level. First, the island has a sewage treatment system, so homes will not be condemned as yards are saturated. It also has a new K–12 school, and a small but viable summer tourism industry. Thus the state has shown a willingness to invest a level of resources that presumed the continued existence of this community. Moreover, the U.S. Army Corps of Engineers has an ongoing project to halt erosion on Tangier Island, based in part on the historical significance of the island.

Saxis is also vulnerable island community. Fortunately, two-thirds of the developed part of the island is above the 5-ft contour, but the northern portion of the island is only about 4 feet above NGVD,[39] that is, approximately 2 feet above the tidal wetlands. The island has a severe erosion problem. The community is actively attempting to secure Corps assistance with its erosion problem.

Moreover, the population is at risk during storms because the nearest high ground is 15 miles away, and the evacuation route along Saxis Road runs through Sanford, which is lower than Saxis; slow drainage there can leave water a foot or so above the water level in the Bay. The causeway through the marsh appears to be compacting, possibly because the fill includes pine logs.[40] Moreover, the marsh through which the road passes is starting to degrade, increasing the threat of waves and washout during storms even today. Although protection of infrastructure is outside the scope of this study, Saxis officials communicated a strong concern that infrastructure planners consider whether the road needs to be redesigned to withstand and possibly mitigate problems

[35]Stakeholder Review Meeting.
[36]The airport and about 25 structures are outside the floodplain; Stakeholder Review Meeting.
[37]One possible source of relatively inexpensive fill would be oyster shells. Historically, oysters harvested by Tangier residents were processed in Crisfield, Maryland.
[38]Stakeholder Review Meeting.
[39]Based on statement made to Jim Titus by an owner of one of the houses in this area, who had paid for a survey, August 1998. USGS 7.5-minute maps depict this area as below the 5-ft NGVD contour.
[40]Stakeholder Review Meeting.

associated with marsh degradation, subsidence, and rising sea level.[41]

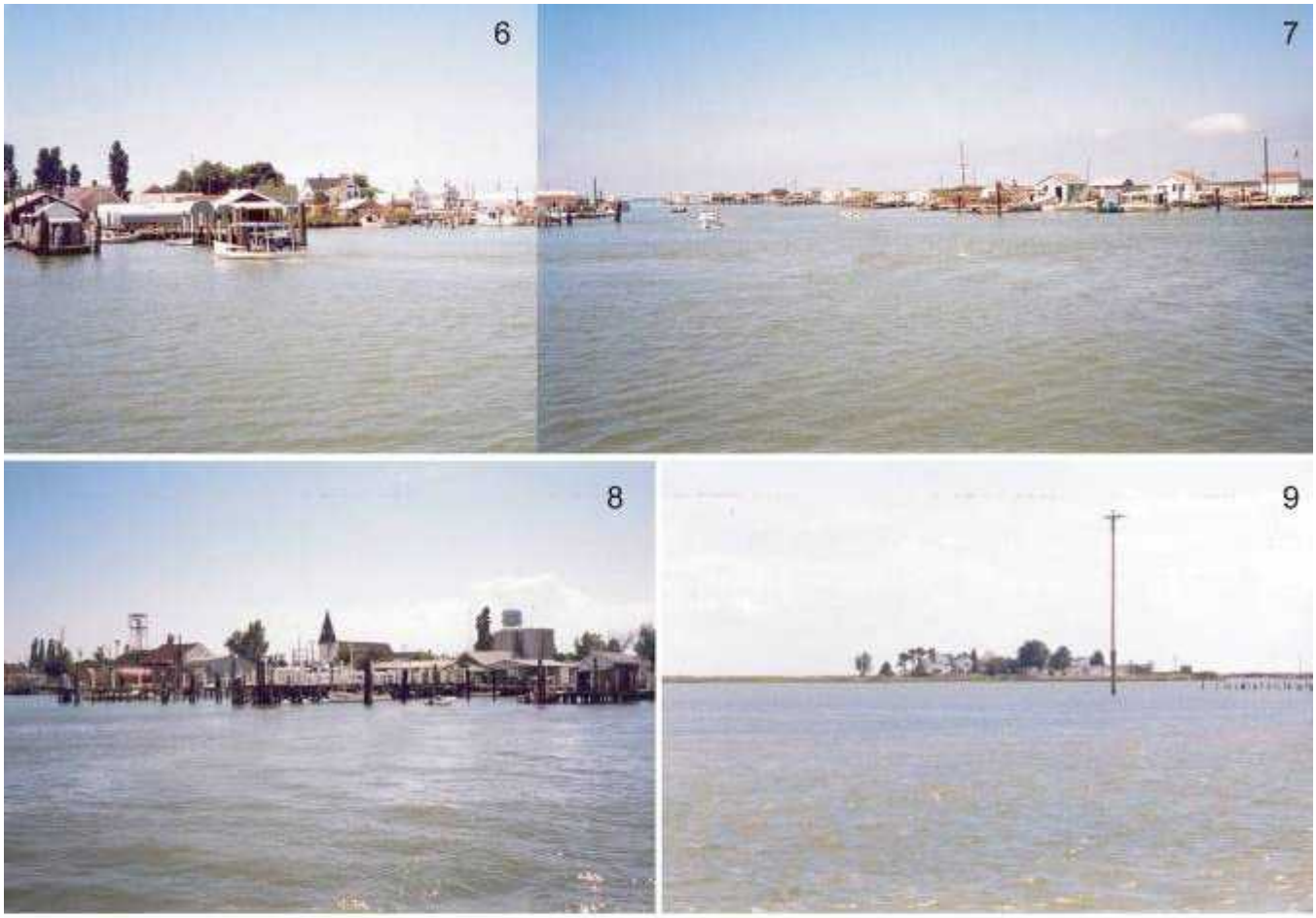


Photos 1–5. Low-Lying Areas in Accomack County: South Chesconessex. Photos 1 and 2 show very low agricultural lands that are converting to wetlands as salt contamination prevents corn from growing but fertile lands promote growth of equally tall transition wetlands vegetation. Note the low dike in 2. Photos 3 and 4 provide two angles from the end of the road in Chesconessex. Photo 5 shows grass turning brown because of salt contamination, with wetland vegetation in background.

Chincoteague is a coastal resort community just inland of the southern portion of Assateague Island, a barrier island that extends into Maryland and is entirely within Assateague Island National Seashore. As the southern gateway to the national seashore, Chincoteague provides overnight accommodations for people making day trips to the barrier island, and many restaurants and shops. The island also has both recreational and commercial fishermen, and it somewhat higher than both Saxis and Tangier. Given the tourism revenues, Chincoteague has the economic ability to maintain itself in the face of rising sea level, and erosion protection costs are less than those for Tangier and Saxis because the wave climate is more benign in Chincoteague Bay than in Chesapeake Bay.

Photos 8-1 and 8-2 show very low agricultural lands that are converting to wetlands as salt contamination prevents corn from growing but fertile lands promote growth of equally tall transition wetlands vegetation. Note the low dike in 8-2. Photos 8-3 and 8-4 provide two angles from the end of the road in Chesconessex. Photo 8-5

[41] Stakeholder Review Meeting.



Photos 6–9. Tangier, Virginia. Photos 6 and 7 show both sides of the navigation channel that now bisects the island. Aside from fishing shanties, the north side is uninhabited. Photo 8 shows the main part of the town, approaching on a ferry from the Eastern Shore. Photo 9 depicts a remote section separated from the rest of the town by marsh.

shows grass turning brown because of salt contamination, with wetland vegetation in background.

Photos 8-6 and 8-7 show both sides of the navigation channel that now bisects the island. Aside from fishing shanties, the north side is uninhabited. Photo 8-8 shows the main part of the town, approaching on a ferry from the Eastern Shore. Photo 8-9 depicts a remote section separated from the rest of the town by marsh.

Anticipated Sea Level Rise Responses

Unless otherwise stated, based on meetings and correspondence with[42]:

Jim McGowan, Accomack-Northampton PDC; David Fluhart and Sandy Manter, Accomack County; Dennis Crockett, Tangier Town Council and principal, Tangier Combined School; Dewey Crockett, mayor of Tangier; Barbara Dawby, Town Council, Saxis; and Charles Tull, mayor of Saxis.

Report and maps revised based on Stakeholder Review Meeting[43] with:

Jim McGowan, Elaine Meil, and John Aigner, Accomack-Northampton PDC; David Fluhart, Accomack County; Bill Reynolds, Town of Tangier; and Charles Tull, mayor of Saxis.

[42]Pratap Penumalli spoke with McGowan in October 2002, Manter on November 7, 2002, and Fluhart on November 26, 2002. Jim Titus met with Sandy Manter and David Fluhart at Accomac in July 1998, with the Tangier officials on Tangier in August 1998, and with Saxis officials (including Mayor Tull) and Dave Fluhart at Saxis in September 1998.

[43]Meeting with Will Nuckols, February 13, 2004, at the Accomack-Northampton Planning District Commission (ANPDC) offices.

Most of the development is being concentrated either along Chesapeake Bay (bayside) in the southern half of the county or along the coastal bays (oceanside) in the northern and southern portions of the county (but not along the central portion). With some exceptions, those are the primary areas that county officials expect to be protected. Map 8-2 shows the three populated islands as almost certain to be protected.

The island towns of Saxis and Tangier are confronting erosion and inundation and are committed to their own continued existence. The county planners are unsure about whether Tangier and Saxis can economically justify holding back the sea if the rate of sea level rise accelerates, and hence were inclined to classify those communities as likely—but not certain—to be protected. Nevertheless, for purposes of these maps, they agreed to defer to the responsible town officials, who have primary land use authority. Although Chincoteague is not currently threatened, the planners all agree that the revenues it generates make it more likely to survive almost any reasonable sea level rise scenario than the other two islands.

Our maps show NASA-owned lands as red because of EPA's general approach of showing secured federal installations as protection uncertain, unless we have additional information showing that another classification is appropriate.[44]

On the mainland oceanside, the planners of Accomack County generally expect the growing communities of Greenbackville and Captains Cove to be protected. Those areas are thus shown as brown. Development there is likely to be extended south to the entrance to NASA, and hence that area is shown as likely to be protected. In the southern portion of the county along the coastal bays, Accomack planners also consider protection to be almost certain for Wachapreague and Quinby, and for Bradford Neck in between those two communities. Along Chesapeake Bay, the historic villages of Harbortown and Onanock are sure to be protected, as well as Broadway Neck and other areas around Onancock.

Protection is likely, but less certain, for a number of more lightly developed areas. Local planners suggested that interior areas in and around Whitesville are in the likely-to-be-protected category, as is Custis Neck on the mainland opposite Cedar Island. They suggested that although these communities are reasonably well developed, they have not demonstrated a commitment to taking measures to hold back the sea and therefore cannot be listed as certain. Sanford is also marginal. The demand to live in this remote, nonwaterfront community is not great, and the costs of maintaining an operating septic system and elevating homes may encourage the abandonment of this community, particularly if a severe hurricane were to destroy it. Still, as long as Saxis survives, the state's commitment to maintaining Saxis Road will provide Sanford with an anchor of dry land. Moreover, rising sea level may eventually convert the miles of marsh between Sanford and Saxis to open water, in which case the value of buildable waterfront lots would be greater than the value of today's marshfront lots.

Most of the farms and forests in this county seem unlikely to be protected. Nevertheless, Accomack County planners identified two areas where agricultural productivity is great enough to justify protection even if they are not developed: the areas southwest of Onancock and west of Wachapreague.

To protect the rural way of life, subdivisions are discouraged in some of the traditionally agricultural areas. Yet development is likely to continue in this coastal county, especially in waterfront areas. Given the areas where growth is generally being directed, the planners agreed that a reasonable way to account for future growth in undeveloped areas would be to assume that those areas south of Onancock with shore-parallel roads will probably be developed over time with waterfront homes, and that those homes will probably be protected. Because of the high ground

[44]Local officials indicated that NASA would continue to fortify the island if faced with rising costs of shore protection at its Wallops Island facility. Our general approach in this study is that federal expectations yield to states, which yield to counties, which yield to incorporated towns, which yield to property owners, because the smallest unit has the best understanding of the situation. In the case of a federal installation, the federal agency is the property owner and hence is best equipped to project the fate of its land as sea level rises.

in that region, protecting waterfront homes from erosion has the effect of protecting the inland areas as well.[45]

The remaining undeveloped areas are unlikely to be protected. Along the oceanside, The Nature Conservancy has a policy of allowing the barrier islands to respond to natural processes, so the barrier islands south of Wallops Island are light green. Because development is directed toward the bayside in southern Accomack, the land along the coastal bays is unlikely to be protected. Similarly, most private farms and forests on the bayside in the northern part of the county will probably continue to gradually convert to wetlands as sea level rises.

Photo 8-10. Cape Charles, Virginia. Dunes along the beach at Cape Charles are just to the left of the photo, with the primary road along the shore to the right.

Table 8-6 summarizes the data used to implement these planning judgments. The planning agencies for Accomack County do not currently have land use or zoning maps in digital format. Therefore, the boundaries of the existing developed communities are based on USGS land use data.

The Stakeholder Review meeting included representatives from the PDC, the county, Saxis, and Tangier. The reviewers provided numerous changes for the text, but suggested only two map changes regarding the land that is likely to be protected.[46]

- ***The southern portion of Tangier Island should not be shown as protected.*** The most accurate depiction would be to show it as wetland, but to the extent that a particular classification scheme might consider the sandy beach to be dry land, it will probably not be protected.
- ***The NASA Wallops Island facility is certain to be protected.*** The planners were aware of the nationwide approach to depicting secured facilities as red pending input from the agencies that manage them, unless it is certain that the land would be protected even if the installation were to close. The planners are quite certain that this facility will not be closed and will be protected. Nevertheless, we leave this area as red, until NASA indicates a preference regarding the most appropriate way to classify the likelihood of shore protection.[47]

Northampton County

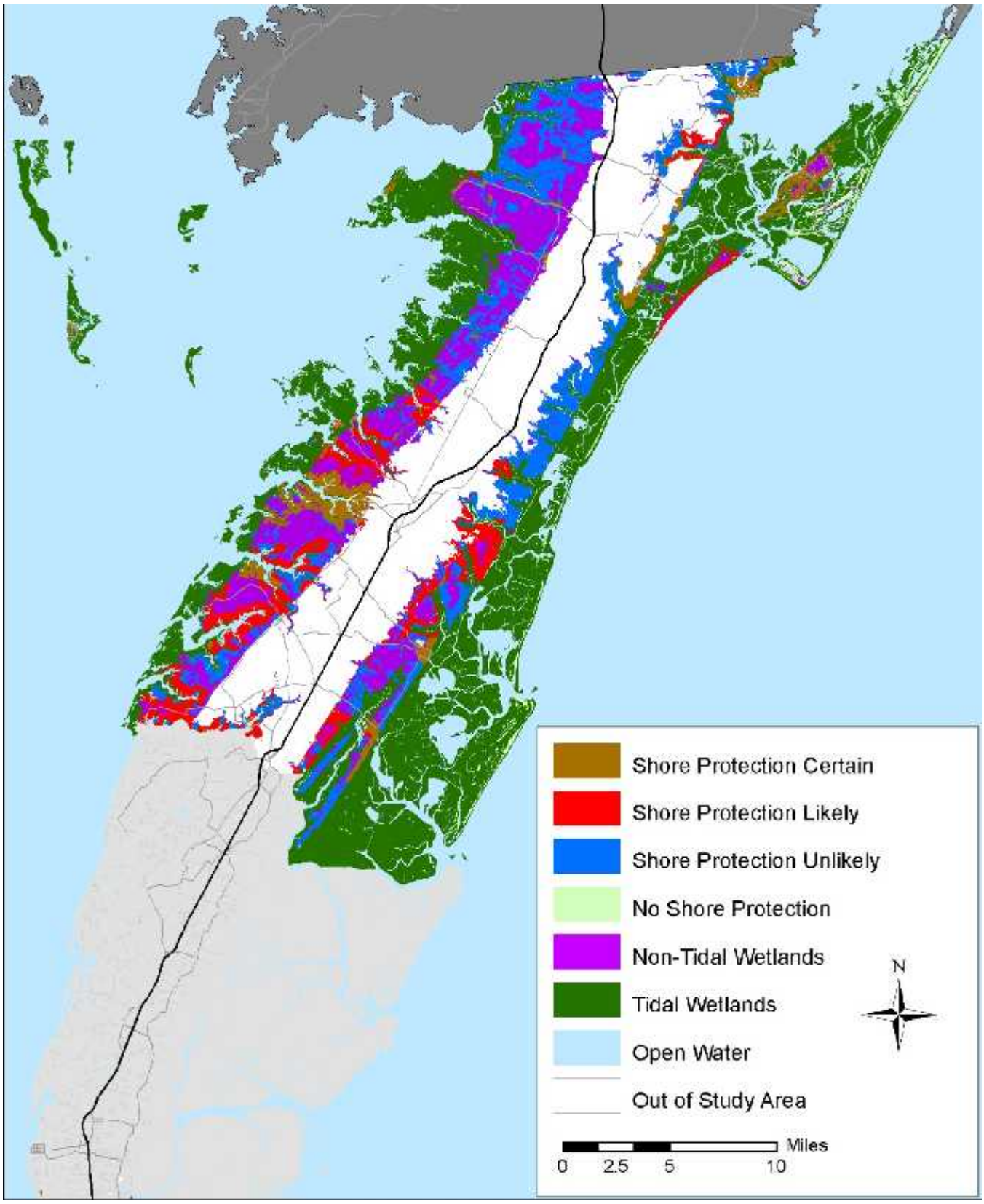
Vulnerability to Sea Level Rise

As the second poorest county in Virginia, Northampton County's median income in 1998 was $19,000, whereas the state median income

[45]This assumption was applied to the entirety of Northampton County's bayside as well.

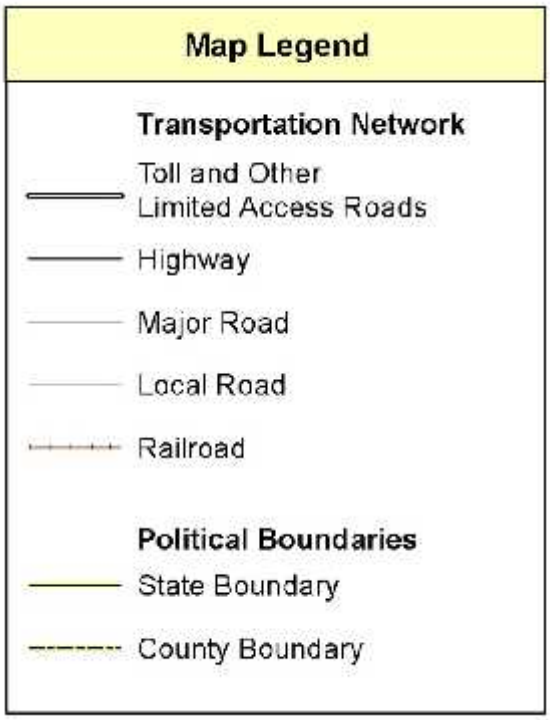
[46]Planners also suggested that the maps should show the road leading to Saxis as protection almost certain. The road is low lying and floods periodically. Planners believe that the road is subsiding because the periodic inundation leads to compaction of the pine log fill. This study, however, shows protection of only land, not infrastructure. Even if the roadway is protected with fill, the roadbed through the marsh is too narrow to show up on the scale of maps depicted in this study.

[47]Our nationwide approach is to code federal secured installations in rural areas as "military" and depict them as red, rather than ask local officials to speculate on the intentions of federal officials.



Map 8-2. Accomack: Likelihood of Shore Protection. The caption and detailed legend for this and the other locality-specific maps is located on the following page.

Map 8-2. Accomack County: Likelihood of Shore Protection. For each shore protection category, the darker shades represent lands that are either less than 20 feet above spring high water. This map is based on data published between 1997 and 2004. Although the map also reflects site-specific changes suggested by planners in 2003 and 2004, the intended use of this map is to convey city and county-wide prospects for shore protection, not to predict the fate of specific neighborhoods. Changes in the policies and trends we considered—or factors that we did not consider—may lead actual shore protection to deviate from the likelihoods depicted in this map.



Map 8-2 (continued). Accomack County: Likelihood of Shore Protection. This legend defines the meaning for the transportation network and political boundary symbols used in the city and county-specific maps.

was $28,000. Less than 3 percent of the county land has residential, commercial, or industrial development today. The county's planners generally view the county's prospects for future development as limited by its lack of drinking water and its relatively remote location. Nevertheless, some people believe that the current perception that Northampton is a long way from the Hampton Roads area will eventually be replaced with the equally valid perception that it is less than 20 miles from that metropolis. Some have speculated that the reduction in tolls from $20.00 to $14.00 per round trip and the increased bridge capacity[48] may fuel development.[49] County planners believe that the recent rush to buy land around the Town of Cape Charles in the past 3 years may be partly due to the decline in toll rates. The Bay Creek Development in Cape Charles continues to grow.[50] Nevertheless, planners expect that Northampton will remain a largely undeveloped region for the foreseeable future.

Northampton, like Accomack, has about one-third of the state's coastal wetlands (see Table 8-3). The county also has about 6 square miles of dry land within 2 feet above the tides, which ranks third behind Accomack and Virginia Beach. Nevertheless, the implications of sea level rise are very different. Northampton's lands along Chesapeake Bay are relatively high, with substantial cliffs near the mouth of the Bay. As Photo 8-10 shows, the Town of Cape Charles has wide sandy beaches along Chesapeake Bay, unlike the narrow beaches and muddy bay shores along Accomack County. Although it is entirely above the 5-ft (NGVD) contour, it is the lowest lying community in the county. Most of the town is below the 10-ft contour, and vulnerable to severe storms; the dunes shown in the photograph provide protection from moderate surges. Northampton's lowest dry[51] land, however, is mostly on the barrier islands, all of which are undeveloped.

The absence of low lands on the mainland implies that aside from the Town of Cape Charles, the primary impact of sea level rise for the foreseeable future will probably be erosion. Because of the relatively high ground, the county has many potential bayfront lots with elevations above the 20-ft contour, compared with Accomack County where tidal marshes and forested wetlands are between the dry land and the Bay.

Anticipated Sea Level Rise Response

Unless otherwise stated, based on meetings and correspondence with:

Jim McGowan, Accomack-Northampton PDC[52]; and Beverly Harper, Northampton County[53]

Report and maps revised based on Stakeholder Review Meeting[54] with:

Jim McGowan, Elaine Meil, and John Aigner, Accomack-Northampton PDC; Samantha Pitts, The Nature Conservancy; Sandra Benson, Northampton County; and Laura Attwood, Town of Cape Charles.

Accomack County officials have developed a thorough perspective on sea level rise, so it was possible to create maps reflecting numerous site-specific considerations. Within Northampton County, local officials have not spent a great deal of time thinking about sea level rise; therefore our mapping approach followed a more data-driven approach, based primarily on an assessment of where development is likely in the future. (See Map 8-3).

The Nature Conservancy owns most of the ocean coast in Northampton County. The planners in

[48]The bridge-tunnel originally consisted of a two-lane bridge over most of the bay, with two-lane tunnels under the shipping lanes. To reduce accidents and accident-related congestion, the Authority constructed parallel bridges, so that there are two lanes in each direction for the bridge portion of the crossing, but not the tunnel crossing.

[49]The Joint Legislative Audit and Review Commission (JLARC) in Virginia, however, concluded that this would not have a significant effect on growth in the Eastern Shore. See Leone, P.A., "The future of the Chesapeake Bay Bridge-Tunnel," p. 27, November 2002. Accessed September 3, 2003 at http://jlarc.state.va.us/Reports/rpt287.pdf. Nevertheless, ANPDC expects that development probably would increase if the toll were to drop. Paradoxically, advocates for keeping the high toll include both those who want to limit development in southern Northampton County and those who want to raise the funds necessary to build a second set of tunnels.

[50]Stakeholder Review Meeting.

[51]Dry is a relative term here, because those islands are occasionally overtopped by storm surges.

[52]Daniel Hudgens spoke with McGowan in October 2002.

[53]Telephone conversations with Pratap Penumalli, October 17 and October 29, 2002.

[54]Meeting with Will Nuckols, February 13, 2004, at the ANPDC offices.

Northampton—as well as TNC itself—agree that The Nature Conservancy has a policy to not hold back the sea with shoreline armoring or beach nourishment. Therefore, the barrier islands are shown in light green. Currently, TNC manages its islands, known as the Virginia Coastal Reserve, primarily for nature preservation, but also allows public visitation.[55] Fisherman's Island is also shown in light green, because it is part of a National Wildlife Refuge.

The few developed areas where protection is certain are defined by the USGS land use and land cover data for developed areas. These represent the location of residential, industrial, commercial, and institutional (e.g., county office building) lands.

The most difficult part of this exercise was identifying those undeveloped areas that will probably be developed eventually and protected. Along Chesapeake Bay, looking several decades into the future, it is realistic to assume that wherever there is a road along the water, someone will eventually build a home. The proximity to Hampton Roads, the high ground, and the spectacular waterfront views all make development inevitable (unless shorefront lands are acquired by the government or conservancies, or dedicated as part of the subdivision). Thus, the bayfront areas will probably be protected. Because this is high ground threatened with erosion but not inundation, protection of the shorefront inherently protects areas immediately inland. On the eastern side of the county, we followed a similar approach. A greater portion of the coastal lands there, however, is along wetlands rather than open water. The maps assume that development (and hence shore protection) is unlikely for areas that currently lack roads and for areas where the roads service farms along wetlands but not open water. The PDC offered one exception to this general approach: All of Willis Wharf is at least likely to be protected.

Development pressures are not nearly as strong today in the Eastern Shore as in many other areas of the Virginia coastal zone, so the planners do not believe that it would be justified to assume that development will certainly occur along these coastal areas, or that landowners will definitely choose to hold back the rising seas. Therefore, as evidenced by the planning maps for the region, red—or likely to be protected—prevails as the decision rule for much of the undeveloped land.[56]

The Stakeholder Review Meeting identified more changes for Northampton County than for Accomack, probably because Northampton had not participated during the original phase of the study. The County asked for the following map changes:

- ***All of the historic portion of Willis Wharf is certain to be protected.*** This historic community has homes that were originally on Hog Island, before that island was abandoned and converted to a wildlife refuge. Our original maps showed only a portion of the area as certain to be protected, based on relatively coarse land cover data.
- ***Show the Village of Red Bank as certain to be protected.*** The original map had shown this important fishing village as unlikely to be protected.
- ***Show the Village of Oyster as certain to be protected.*** Based on the road density, the original map had shown this area as likely to be protected.
- ***Show all of the Town of Cape Charles as certain to be protected.*** The original report showed a mixture of brown, blue, and red, depending on existing development and road densities. Development is continuing and all land within the town borders will be developed soon.
- ***Change Old Town Neck from protection certain to protection likely.*** This lightly developed neck had been shown as protected even in the VIMS worst-case analysis. The planners suggested that this designation had probably resulted from a mapping error.[57]

[55]The Nature Conservancy–Virginia; available at http://nature.org/wherewework/northamerica/states/virginia/.

[56]Given that landowners are allowed to armor their shoreline to protect their property from rising seas and increased erosion, the decision on whether or not to do so will be largely an economic one.

[57]The planners' best guess was that perhaps VIMS had mistakenly digitized this neck, thinking it to be Cape Charles. We examined the VIMS data and found that both Old Town Neck and the downtown portion of Cape Charles were assumed protected in the VIMS study. We made the requested change without investigating further.

- ***Show the state park on Savage Neck as a conservation land.*** The draft had erroneously assumed this polygon to be private land unlikely to be protected.

TABLE 8-6. ASSUMPTIONS FOR SHORE PROTECTION MAP: ACCOMACK-NORTHAMPTON PLANNING DISTRICT[a]

Land Area	Protection Likelihood				Source
	No protection	Unlikely	Likely	Certain	
Military lands			[b]		Military installations
NASA lands, including Wallops Island			[b]		Land use/land cover
Old Town Neck			✓		Stakeholder review comments implemented using initial study data[c]
Major coastal jurisdictions: downtown area of Cape Charles, Accomack, Chincoteague				✓	Planner input from initial study[c]
Nature Conservancy lands	✓				The Nature Conservancy in Virginia
Conservation land at southern end of Savage Neck	✓				Stakeholder review comments implemented using land use/land cover
National and state park lands	✓				Virginia parks
Historic portion of Willis Wharf				✓	Stakeholder review comments implemented using land use/land cover
Other residential developments in Northampton (including Village of Red Bank, Village of Oyster, and Town of Cape Charles)				✓	Stakeholder review comments implemented using land use/land cover
Developed land cover				✓	Land cover[d]
Coastal areas with higher potential for development that have existing shore parallel roads			✓		Implemented using TIGER roads and land use/land cover[e]
Lightly developed areas within Accomack County, including Whitesville, Curtis Neck, and Sanford			✓		Manual edit implemented using land use/land cover
Land with high agricultural productivity southwest of Onancock and west of Wachapreague				✓	Manual edit implemented using land use/land cover
Island towns of Tangier and Saxis				✓	Manual edit implemented using land use/land cover[f]
Developed private and public lands				✓	Land use/land cover[g]
Remaining public and private lands (including agriculture)		✓			Land use/land cover[h]

[a] Where land areas overlap, classifications higher in the table take precedence.

[b] Based on the nationwide approach of this study for secured installations, the maps depict these areas as red. The data we distribute assigns the code “military” rather than “protection likely.”

[c] The initial 2001 VIMS study created polygons representing areas that were certain to be protected in the event of a 20-ft sea level rise. These areas are depicted in orange in some versions of our maps.

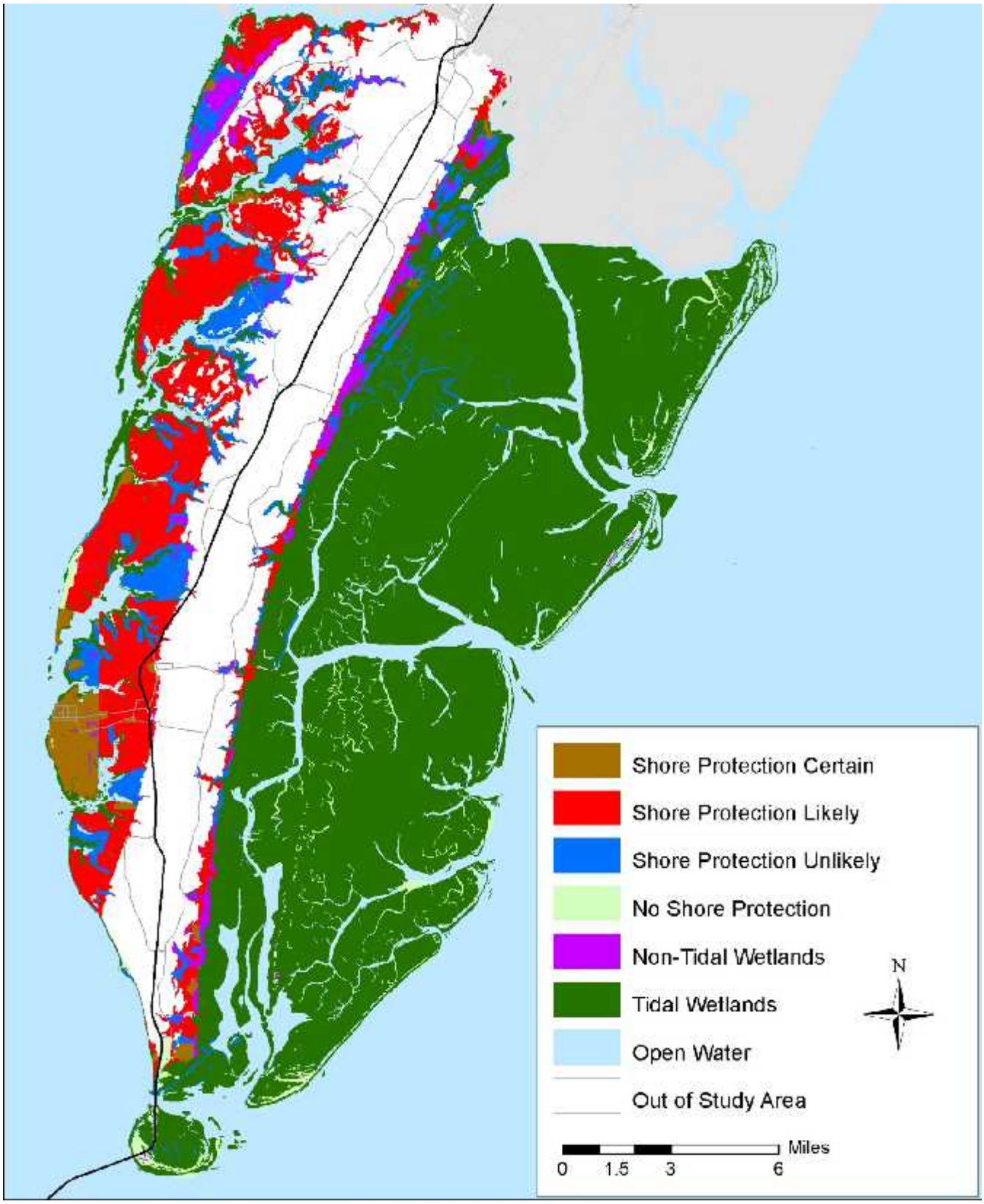
[d] We identify developed land cover, which includes both public and privately owned lands, based on residential, commercial, industrial, and transportation structure land covers in data provided by USGS.

[e] To identify coastal areas with likelihood of further development, we identified polygons from the land use/land cover data that were within 1,000 feet of a shore parallel road (from 2000 TIGER roads layer).

[f] In the fall of 1998, Jim Titus of EPA briefed the mayors and some members of the town councils of these two island towns. Both town governments assured EPA that they have been—and will continue to do—everything within their power to ensure that their communities survive, including shore armoring or elevating land surfaces with fill if necessary.

[g] Developed lands included residential, commercial/services, transportation/communication/utilities, institutional, and other urban/built-up land use/land covers in data provided by USGS.

[h] Undeveloped lands included cropland/pasture, confined feeding operations, other agricultural land, deciduous forest land, evergreen forest land, mixed forest land, nonforested wetland, beaches, sandy area, and strip mine land use/land covers in data provided by the USGS.



Map 8-3. Northampton: Likelihood of Shore Protection. For additional details, see the legend and caption accompanying Map 8-2.

HAMPTON ROADS PLANNING DISTRICT

Background

Hampton Roads is the southernmost coastal planning district in Virginia, extending from the North Carolina border to the York River. The PDC coordinates planning activities among 16 localities whose combined population is more than 1.5 million. Lands vulnerable to sea level rise include beaches along the Atlantic Ocean and Chesapeake Bay, both sides of the lower James River, a barrier spit and back barrier bays near North Carolina's Outer Banks, and parts of the York River.

Because of data limitations, our discussion divides the Hampton Roads Planning District[58] into two groups: localities for which the PDC has recent data on land use and those for which it does not. Figure 8-4 depicts the jurisdictions within each group. The PDC provided land use data for Virginia Beach, Chesapeake, Norfolk, Newport News, Hampton, and Portsmouth. Lacking a better term, we call these six cities the "urban core localities." Virginia Beach and Chesapeake[59] also have rural and transitional developing areas. By "urban core" we mean all the urban core localities except for the rural and transitional areas of Chesapeake and Virginia Beach. The localities for which we lack recent land use data are the independent cities of Suffolk and Poquoson, plus Isle of Wight, Surry, York, and James City counties. Lacking a better term, we call these six localities "outlying jurisdictions." Poquoson and part of York County are along Chesapeake Bay; the remaining localities are along the James and York rivers west of the urban core.

Norfolk is home to the central business district of the Hampton Roads region and consists of more than 90 percent developed land, but both the city's economy and population have been declining for a number of years. According to the U.S. Census Bureau, the city's population dropped from more than 261,000 in 1990 to approximately 234,000 in 2000. Therefore, the local government is taking measures to redevelop and revitalize the urban core. One example is the successful revitalization of the Oceanview area along the northern shore of Norfolk over the past decade. Previously infamous for its high crime rate and undesirable living conditions, Ocean View is now a thriving community with a number of growing single-family-home neighborhoods and a drastically reduced crime rate. A similar effort with a number of civic groups is under way to redevelop the Ward Five area in the south.

Virginia Beach relies heavily on tourism to drive its local economy. The beaches and beachfront commercial and residential property in the north are highly developed, and the south remains pristine and largely undisturbed. Newport News has development similar to Norfolk along its southern shores, with bluffs and less dense residential areas farther north along the coast. The city of Hampton is also highly developed, but overall has a much smaller percentage of commercial and industrial development than Norfolk or Newport News. Norfolk and Newport News are also home to a number of private naval shipyards and coastal military naval establishments. In Norfolk, these shipyards are located on the western shore near the central business district and served as the backbone of the local economy for nearly a hundred years. The Fort Eustis military reservation occupies the majority of the northern third of Newport News.

Outside the urban core, localities are more rural in nature. Although Norfolk is undertaking a number of efforts to draw residents and development back into the city, many localities outside of the urban core are trying to keep development out. These

[58] The VIMS study and our initial meeting for the second phase of this study involved meetings with Virginia Beach, Norfolk, Newport News, Hampton, and Poquoson. Pratap Penumalli met with Surry County, and Jim Titus discussed study assumptions over the telephone with officials from Chesapeake. For the remaining jurisdictions, the maps are based primarily on the data and input from the Hampton Roads PDC staff.

[59] Hampton and Newport News also have undeveloped areas, but within the coastal zone those areas are expected to become developed within the foreseeable future.

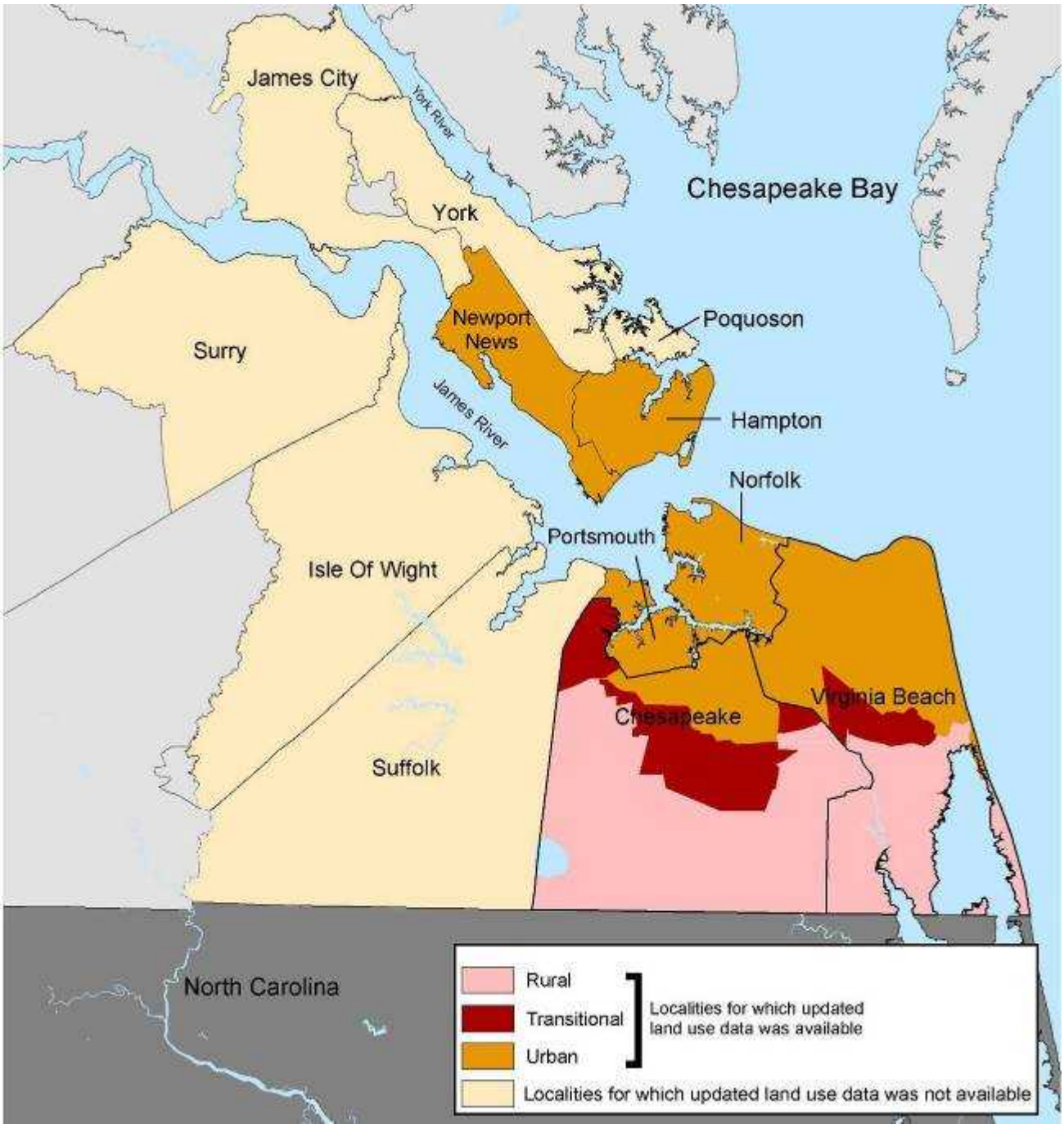


Figure 8-4. The Hampton Roads Planning District. The Planning District Commission was able to provide updated land use data for 6 of its 12 localities. Among those 6 localities, our analysis distinguishes the urban core, the rural area, and the transitional developing area.

localities find themselves facing mounting development pressures, and their comprehensive plans outline how they plan to respond to these pressures. Isle of Wight, Surry, James City, and York counties all face development pressure. Overall, however, the makeup of these outlying localities is a mix of urban and rural development, with historic towns and residential development dotting the landscape. The Town of Poquoson is an exception, being both extensively developed and very vulnerable to sea level rise: The town is approximately 50 percent wetland and is almost entirely below 10 feet in elevation.

Vulnerability to Sea Level Rise

Table 8-7 summarizes the amount of land close to sea level within each of the Hampton Road localities. As shown, most of the vulnerable dry land is located within Virginia Beach and Chesapeake. These low areas are not, however, in the urban portions of those jurisdictions. As the map shows, most of Virginia Beach's very low land above the ebb and flow of the tides is either along the back-barrier bays near the North Carolina border or along the North Landing River. The southern and modestly developed half of this city is mostly within 10 feet above spring high water. Most of Chesapeake's low land is around the Northwest River near the North Carolina border, or the along the Intracoastal Waterway.[60] The Great Dismal Swamp along the border between Suffolk and Chesapeake is mostly between the 10- and 25-ft contours. Hampton and Newport News have substantial areas between the 5- and 10-ft contours, with a few areas that are within 2 feet above the tides.

Poquoson is probably the community that is most vulnerable to rising water levels. (See Photos 8-11 and 8-12.) Virtually the entire community is below the 10-ft contour, with several neighborhoods vulnerable to even minor surges in Chesapeake Bay. In the wake of Hurricane Isabel, dozens of homes were elevated (Photos 8-13 and 8-14).

Shore erosion may confront areas with higher ground. Virginia Beach has sandy shores along both the Atlantic Ocean and the mouth of Chesapeake Bay. Much of the developed ocean shore is protected by a seawall (Photos 8-15 and 8-16), and periodic beach nourishment projects have been necessary. Its bay shore, by contrast, has substantial dunes, with homes set well back from the shore in some areas. The shoreline areas have relatively high ground, although they may be vulnerable to erosion. Norfolk and Suffolk have higher ground, but the dense development there has already led to shoreline armoring along many shores.

[60]The Intracoastal Waterway includes the North Landing River, which flows into Currituck Sound (North Carolina); the southern branch of the Elizabeth River, which flows into Chesapeake Bay; and an east-west canal that connects these two rivers.

The less developed localities are also less vulnerable to sea level rise because they are farther up the James and York rivers. Nevertheless, shore protection may be very important for some areas. Parts of historic Jamestown have, for example, eroded or been inundated. (See Photos 8-19 and 8-20.)

Anticipated Sea Level Rise Responses

Initial maps based on meeting[61] and followup conversations with:

Hugo Valverde, Hampton Roads PDC; Clay Bernick, Virginia Beach[62]; Lee Rosenberg[63] and Barbara McCallum, Norfolk; Keith Cannady, Hampton[64]; Jody Hollingsworth[65], Poquoson; Kathy James-Webb, Newport News[66]; Tyrone Franklin, Surry County; and Amy Ring[67] and Watson Lawrence Chesapeake[68]

We also used the comprehensive plans of Suffolk[69] and York[70], Isle of Wight,[71] and James City[72] counties.

[61]Meeting between Dan Hudgens and Pratap Penumalli of IEc and local officials at the Hampton Roads PDC offices, November 23, 2002, except for representatives from Newport News, Poquoson, and Surry County. Pratap Penumalli met with Surry County the following day at the county offices.
[62]Telephone conversations with Pratap Penumalli, September 24 and October 17, 2002.
[63]Telephone conversations with Pratap Penumalli, October 10, 2002.
[64]Telephone conversations with Pratap Penumalli, October 14, 2002.
[65]Telephone conversations with Pratap Penumalli, October 7 and October 18, 2002.
[66]Telephone conversations with Pratap Penumalli, October 15 and December 16, 2002.
[67]Telephone conversation between Jim Titus and Amy Ring, planner, City of Chesapeake, October 28, 2003.
[68]Telephone conversation between Jim Titus and Chesapeake City's agricultural director, Watson Lawrence, to whom Amy Ring deferred on the question of additional agricultural lands being developed, October 28, 2003.
[69]City of Suffolk Department of Planning, *The Comprehensive Plan for 2018: City of Suffolk, Virginia,* adopted March 25, 1998.
[70]*Charting the Course to 2015: The York County Comprehensive Plan.*
[71]Isle of Wight Planning and Zoning Department, *Isle of Wight Proposed Comprehensive Plan* (as of August 1, 2004, the Planning Department website lists this plan as "to be adopted 2001"); Proposed Land Use Types and Proposed Maps.
[72]James City County. *2003 Comprehensive Plan*. Adopted by the James City County Board of Supervisors on August 12, 2003. Chapters on Land Use and Environment, and *2003 Land Use Map*. Adopted August 12, 2003.

Unless otherwise stated, map revisions are based on Stakeholder Review Briefings[73] and communication with:

Clay Bernick, planner, Virginia Beach[74]; Amy Ring, planner, Chesapeake[75]; Fred Brusso, special projects administrator, Planning and Zoning, Portsmouth[76]; Lee Rosenberg, Department of Environmental Services, Norfolk[77]; Kathy James-Webb, senior district planner, Newport News[78]; Greg Goetz, physical planning coordinator, City of Hampton[79]; Deborah Vest, Planning Department, City of Poquoson[80]; Anna Drake, Department of Environmental and Development Services, York County[81]; Tyrone Franklin, Surry County[82]; Wayland Bass, Development Management, James City County[83]; Jonathan W. Hartley director, Department of Planning and Zoning, Isle of Wight County[84]; and Cynthia Taylor, assistant planning director, City of Suffolk[85];

State law allows property owners to armor or elevate their land.[86] When we asked, officials from each of the participating localities in the Hampton Roads planning district told us that they had no local policies that would prohibit landowners from protecting their land from encroachment caused by sea level rise.[87] Given that landowners are allowed to armor their shoreline to protect their property from rising seas and increased erosion, the primary question for this study is whether a level of development will occur that would lead landowners to choose to invest the resources necessary to do so. Such development is likely or certain for most dry land in the urban core (Norfolk, Portsmouth, Hampton, and Newport News and parts of Virginia Beach and Chesapeake). By contrast, in the rural portions of Virginia Beach, Chesapeake, and the outlying jurisdictions, a significant amount of land may remain undeveloped and thereby afford the opportunity for wetland migration.

The Hampton Roads urban core localities are dominated by urban development. However, both Chesapeake and Virginia Beach also have rural areas between the developed areas and the North Carolina border. Between the urban and rural areas is a developing transition area. Planners indicate that the urban core will almost certainly be protected, with the possible exception of some publicly owned waterfront lands. In many areas, the shoreline is already protected. The PDC provided land use data for identifying commercial, industrial, urban, and suburban residential areas, all of which are certain to be protected. The planners also confirmed that those areas deemed certain to be protected in the VIMS analysis are almost certain to be protected for the more moderate sea level scenarios used by this study.

[73] Jim Titus presented the maps at the Hampton Roads PDC's monthly meeting of the Chesapeake Bay and Stormwater Management Committee, October 7, 2004, at the PDC office in Chesapeake, Virginia. He also met with Deborah Vest, city planner, and Karen Brauer, planning technician of the City of Poquoson, at the city offices on October 6, 2004. See Stakeholder Review section below for additional details.

[74] Marked-up map provided to Jim Titus at Stakeholder Review Briefing, October 7, 2004. Follow-up email from Clay Bernick to Jim Titus on October 15, 2004.

[75] Email from Amy Ring to Jim Titus, September 27, 2004.

[76] See email from Jim Titus to Fred Brusso, October 13, 2004, reporting all of the map changes that Brusso recommended during telephone conversation that afternoon with Titus.

[77] Email to Daniel Hudgens, October 5, 2004.

[78] Marked-up map provided to Jim Titus at Stakeholder Review Briefing, October 7, 2004.

[79] Email from Greg Goetz to Jim Titus, October 15, 2004.

[80] Meeting between Deborah Vest, city planner, Karen Brauer, planning technician, the City of Poquoson Planning Department, and Jim Titus at the city offices, on October 6, 2004.

[81] Telephone conversation with Jim Titus, September 20, 2004.

[82] See email from Jim Titus to Tyrone Franklin, October 5, 2004, repeating the substance of a telephone conversation an hour earlier.

[83] See email from Jim Titus to Wayland Bass, September 27, 2004, quoting entirety of voicemail message left by Bass.

[84] Marked-up map provided to Jim Titus at Stakeholder Review Briefing, October 7, 2004.

[85] Email to Jim Titus, September 21, 2004; email to Daniel Hudgens, October 8, 2004. Private comments at Stakeholder Review Briefing.

[86] See the state section, above.

[87] Meeting between Dan Hudgens and Pratap Penumalli of IEc and local officials at the Hampton Roads PDC offices, November 23, 2002.

TABLE 8-7. AREA OF LAND VULNERABLE TO SEA LEVEL RISE: HAMPTON ROADS PLANNING DISTRICT (square miles)[a]

Jurisdiction[b]	Vulnerable Land[c]	Tidal Wetlands	Elevation[d]					
			0–2 feet		0–4 feet		0–8 feet	
			Dry land	Nontidal Wetlands	Dry land	Nontidal Wetlands	Dry land	Nontidal Wetlands
Virginia Beach	59.8	43.4	11.4	5.0	23.7	9.1	64.9	16.1
Chesapeake	25.1	15.3	4.0	5.8	10.1	11.8	34.5	21.5
Hampton	7.6	5.5	1.9	0.1	6.2	0.1	17.9	0.4
York	8.9	6.6	2.0	0.3	4.7	1.0	10.7	2.6
Newport News	8.2	5.8	2.3	0.1	4.1	0.2	7.1	0.5
Norfolk	3.9	1.8	2.0	0.1	6.0	0.2	17.4	0.4
Poquoson	10.7	9.1	1.5	0.02	3.2	0.1	6.3	0.4
James City	14.2	12.7	1.3	0.3	2.6	0.5	5.0	1.0
Suffolk	12.5	10.2	1.6	0.7	3.0	1.3	6.4	1.9
Portsmouth	5.3	1.4	1.3	2.5	3.4	3.4	8.9	3.7
Surry	[e]	4.4	[e]	[e]	1.0	0.5	1.9	0.9
Isle Of Wight	[e]	11.2	[e]	[e]	2.3	0.8	4.8	1.5
Total[f]	**174.1**	**127.5**	**31.1**	**15.5**	**70.3**	**29.1**	**185.8**	**50.9**

[a] J.G. Titus and J. Wang, 2008, see Table 8-3 for full reference.

[b] Jurisdictions ranked by amount of dry land within 2 feet above the ebb and flow of the tides.

[c] The area of tidal wetlands plus the area of land within 2 feet above spring high water.

[d] Elevations relative to spring high water, that is, the average highest tide during full moons and new moons. Therefore, the land within 2 feet of spring high water is the area that would be tidally flooded if the sea rises 2 feet.

[e] Value omitted because the topographic information Titus and Wang used for this jurisdiction had poor vertical resolution.

[f] Excludes three jurisdictions from the Hampton Roads Planning District: Southampton County and the cities of Franklin and Williamsburg, which this study does not analyze.


Photos 11–12. Tidal Ditches in Poquoson. Photo 11 shows wetland vegetation in a tidal ditch. Photo 12 shows a wooden bulkhead along the shore of a tidal ditch, to prevent a front yard from eroding into the ditch and blocking drainage (October 2002).


Photos 13–14. Elevating Homes in Poquoson One Year after Hurricane Isabel (October 2004).


Photos 15–16. Virginia Beach. Photo 15 shows homes set well back behind the dunes along the north-facing Chesapeake Bay shoreline. Photo 16 shows seawalls along the east-facing Atlantic beaches (October 1998).

Outside of the urban core, however, much of the land is less likely to be developed and protected. Virginia Beach has long had a "Green Line,"[88] south of which the County tries to maintain the rural agricultural way of life. Recognizing that development had occurred and will continue to occur just south of the Green Line, the County has established a "Rural Area Line" that coincides with the Green Line in the eastern part of the county but crosses the west side of the county above 3 miles south of the Green Line. Below the Rural Area Line, the County strongly discourages development and encourages rural legacy and conservation easements. Between the Green and Rural Area lines is the Princess Anne Transition Area, in which the County encourages environmentally sensitive development.

Photo 8-17. Norfolk. Wide beaches and dunes dominate along the Norfolk shore of Oceanview along Chesapeake Bay (from which one can see the ocean) (October 2004).

Table 8-8 summarizes the GIS decision rules we employed to create the maps. Let us examine how the maps treat the urban core, rural, and transition areas within the urban core localities.

Urban Core

We include all the urban core localities within the "urban core" except for southern portions of Virginia Beach and Chesapeake. Within the urban core, planners identify all currently developed private or publicly owned land as certain to be protected. We consider all currently undeveloped lands (e.g., forest, agriculture, recreational lands) surrounded by existing development as certain to be protected. In many cases, these lands will be developed in the foreseeable future and therefore certainly developed. Those areas not developed will receive protection from the surrounding properties. Within Hampton, Newport News, Norfolk, and Portsmouth, we map all undeveloped lands located adjacent to open water and wetlands as likely, but not certain, to be protected.[89] Within Chesapeake and Virginia Beach, we map only vacant lands located adjacent to open water and wetlands as likely to be protected.[90] In many cases the land may be developed or the value of the land used for recreation purposes would be sufficient and the shore would almost certainly be protected. A portion of these properties, however, could be preserved and maintained in their natural states. Because of the uncertainty associated with

[88]"The Green Line has been the city's most formidable defense against sprawl since its inclusion in the first Comprehensive Plan. Designed in 1979 to separate that area of the city where facilities and services could be provided within a reasonable time period (and thus where urban development would be appropriate) from that area where there is no reasonable expectation of providing such services within a reasonable time (and thus where urban growth is not appropriate), the Green Line has been rigidly adhered to by the Council in the formulation and implementation of the city's land use and capital improvement planning." City of Virginia Beach, Comprehensive Plan Policy Document, p. 19.

[89]We identified the undeveloped areas using the Hampton Roads urban land use data. Undeveloped land use categories include agriculture, forests, parks, public/semipublic, recreational, undeveloped, and vacant land classes. We treated these areas as likely to be protected, primarily because the undeveloped status of these lands leaves open the possibility that such land might be set aside for conservation or parkland. During stakeholder review, we asked local reviewers to verify which—if any—of these areas are certain to be protected.

[90]Because Virginia Beach and Chesapeake are focusing development within the urban zone, the maps assume that all recreational, forest, and agriculture are certain to either be developed or have sufficient value to be protected. We have not applied this logic to vacant lands because that category would include lands held for conservation purposes within the urban core; and we had insufficient information to assume that no such lands exist within the urban core of these two cities.

individual properties, we show these lands as likely to be protected.

Virginia Beach is the largest locality within the Hampton Roads PDC and is located along the Atlantic coastline. As shown in Table 8-7, the city has almost 10 square miles of land within 4 feet above the tides, and 20 square miles of land within 4 feet above the tides. Fortunately, most of this land is in the southern part of the city. The northern portion of the city is extensively developed and will be protected to the extent necessary.[91] The city of Virginia Beach is also engaged in an active program of beach nourishment along sections of its 35-mile shoreline. According to Clay Bernick,[92] Virginia Beach will probably continue its beach nourishment policy, even if costs increase as sea level rises; but the city would protect the development even if it had to rely on seawalls or revetments.

The city of Norfolk is also extensively developed, including the shore. Of the city's 167 miles of shoreline, 70 miles have been hardened.[93] Almost none of the shore along Chesapeake Bay is hardened. The bayshore has a wide recreational beach and substantial dunes (Photo 8-17), mostly protected by a series of offshore breakwaters. Local planners indicated that nearly all high- and medium-density residential and commercial lands, regardless of their current value, will also be protected because the prospects for urban revitalization are so strong in the urban core. The aforementioned example of Ocean View serves as evidence of successful revitalization. If these efforts continue to be successful in increasing the desirability and value of the urban core, this would presumably lead to the enhanced possibility of continued protection against the rising seas.

Local officials for Virginia Beach and Norfolk anticipate protecting nearly all city-owned lands such as roads, sewer systems, buildings, and parks.[94] In addition, although the state lacks policies to dictate future responses on state-owned lands, local planners anticipate that state lands will probably be protected, especially where the public lands are surrounded by private development. The land use data, however, do not allow us to distinguish state and local parks.[95] Therefore we had to choose between assuming that parks adjacent to water, wetlands, and undeveloped areas were certain or that they were likely to be protected. We opted to treat these parks as likely to be protected, because it would be easier for reviewers to quickly identify red polygons than brown polygons within a map that is otherwise mostly brown. The maps depict parks that are surrounded by existing development as certain to be protected.

[91]The PDC data included several polygons as undeveloped within the developed portion of Virginia Beach. The PDC staff changed those "infill areas" to likely to be protected.

[92]Meetings between Dan Hudgens and Pratap Penumalli of IEc and local officials at the Hampton Roads PDC offices, November 23, 2002.

[93]Berman, M., H. Berguist, C. Herschner, S. Killeen, T. Rudnicky, D. Schatt, D. Weiss, and H Woods, 2002, City of Norfolk Shoreline Situation Report, Virginia Institute of Marine Science, Gloucester Point, MD.

[94]Based on discussions with Barbara McCallum of Norfolk and Clay Bernick of Virginia Beach, November 23, 2002. As discussed above, based on this information and the relative density of development in the urban core, we assume that all developed city-owned lands are certain to be protected within the urban core. Park lands surrounded by existing development are also certain to be protected.

[95]For several states, we had digital data created by the state or local planning agencies that delineated boundaries of publicly owned recreational parks and open space. For Virginia, however, we had no such data set. For the urban core jurisdictions of Hampton Roads, we relied on the PDC's EMC land use data, which identified parks and some other lands as publicly owned. Outside the urban core localities, we relied on a national dataset of federal, state, and local parks.

Photo 8-18. South Shore of Hampton., The public has access along this shore, which is protected with a stone revetment.

To the north, between the James and York rivers, is the Southern Peninsula, which includes Hampton, Newport News, Poquoson, and York (although Poquoson and York County are densely developed, they are excluded from the PDC's data,[96] so we discuss them in the next section). Representing the primarily residential City of Hampton, planning director Keith Cannady stated that none of its coastal development would be abandoned with a rise in sea level of 3 feet (1 meter) per century.[97] Much of the shore is already armored. (See Photo 8-18.)

In more developed areas where flooding has become too great a problem, localities have taken measures to purchase lands and clear them to restore a natural floodplain. One example is the highly developed southeast area of Newport News, in which the city has implemented a program to purchase homes with severe flooding problems and floor elevations below 4 feet from citizens on a completely voluntary basis. Unfortunately, city planners cannot identify the specific neighborhoods where such a revision might be justified. Therefore, we did not include these potential purchases in our maps.

Although they cannot authoritatively speak to the protection policies for federal lands, local officials expect that federal land managers would continue their present courses of action in terms of protecting certain public lands. For example, most military lands and private naval shipyards are already heavily armored and will continue to be protected. One exception, however, is Fort Eustis in northern Newport News. Kathy James-Webb of Newport News pointed out that because this military base is largely undeveloped, the government may choose to protect only the portions currently developed or slated for future development. Following the nationwide approach[98] for this study, the maps treat secured installations in urban areas as certain to be protected and installations in other areas as uncertain. Because Langley (Hampton) and Fort Eustis are on the outskirts of these urban jurisdictions, those two facilities show up as red on the maps. The others are depicted in brown.

Rural Areas of Virginia Beach and Chesapeake

The rural areas (see Figure 8-3) are defined as the land below the Rural Area Line in the Comprehensive Plan of Virginia Beach and the rural area depicted in the map approved by the City Council of Chesapeake projecting land use for 2050.[99] Within this area, the maps (Map 8-4 for Virginia Beach and Map 8-5 for Chesapeake)

[96] Land use data from EMC Analysis of Stormwater Monitoring Data, provided by Hampton Roads PDC for the cities of Virginia Beach, Norfolk, Chesapeake, Portsmouth, Hampton, and Newport News.

[97] Meeting at Hampton Roads PDC offices, November 23, 2002.

[98] The premise is that only the Department of Defense can authoritatively speak to this issue. Therefore, our study addresses only county perspectives on what would occur *if* the base was closed. In urban areas, the land would be protected even if the base were to close; in less densely developed areas, by contrast, closed military bases sometimes become conservation or park lands.

[99] Hybrid map endorsed by City Council and Planning Commission, available at http://www.chesapeake.va.us/services/depart/planning/maps/PhaseII_8by11.pdf, accessed on August 1, 2004.

depict low-density developed areas as likely to be protected and more developed areas as almost certain to be protected. Undeveloped and vacant land, agriculture, forests, and parks are all unlikely to be protected. The Nature Conservancy owns land along the North Landing River.[100] Because we did not obtain a true conservation layer for Virginia, The Nature Conservancy's lands are depicted in blue; if we had the data needed to delineate their boundaries, the TNC lands would have been depicted as light green (Map 8-8).

Chesapeake does not have specific policies that preclude development. The comprehensive plan indicates that the city is attempting to attract more development. Therefore some rural areas that we depict as unlikely to be protected may in fact be developed and protected. For the most part, mapping the specific areas that are likely to be developed is not yet possible. Chesapeake's comprehensive plan, however, does have a transportation corridor development along VA-168, with development planned on either side within 1 mile. Therefore, city planners thought it would be reasonable for the map to show that land within 1 mile of the highway is certain to be protected.[101] Because of the widespread consensus that more development will occur than is included in the PDC's land use data, the maps also assume that areas within 2 miles of VA-168 will probably be protected.[102] In addition, Chesapeake planners expect development in the area within about 3 miles of the North Carolina border on either side of Rte. 17, extending eastward about 3 miles and westward to the Dismal Swamp Canal.[103]

Farther to the west, flooding has proven to be a major problem for the communities within both Chesapeake and Suffolk that surround the Great Dismal Swamp. As a result, relatively little development is expected in that area.

Transition Areas in Virginia Beach and Chesapeake

The comprehensive plan for Virginia Beach defines the Princess Anne Transition Area as the land between the Green Line and the Rural Area Line. Environmentally sensitive development is encouraged in this area. Therefore shore protection is likely throughout this region. Nevertheless, the land use policies encourage protection of open space through clustering; so wetland migration would be possible in some portion of this area. Because it is currently infeasible to identify the specific areas that might not have to be protected, for any location, it is possible that the area will not be protected. Therefore, any specific location within the undeveloped areas will probably be developed and protected, once it is developed.[104] The maps depict existing development as almost certain to be protected and parks as likely to be protected.

For the City of Chesapeake, we use the suburban areas as defined by the draft 2026 for the city's 2004 comprehensive plan update. Our maps employ the same GIS decision rules for these areas as for the Princess Anne Transition Area. Although the growth policies are different than for Virginia Beach, the implications for our maps are similar: These suburban areas represent lands that the County plans to see developed in the foreseeable future. Therefore, undeveloped areas are likely to be protected.

Stakeholder Review

The staff of the Planning District Commission distributed the maps and report to all the jurisdictions at a regular meeting in September

[100]Hugo Valverde, Hampton Roads PDC, telephone conversation with Jim Titus, October 23, 2003.

[101]Telephone conversation between Jim Titus and Amy Ring, City of Chesapeake, October 28, 2003.

[102]Telephone conversation between Jim Titus and Chesapeake City's agricultural director, Watson Lawrence, to whom Amy Ring deferred on the question of additional agricultural lands being developed, October 28, 2003. Mr. Lawrence indicated that dikes would generally not be built to protect farmland as sea level rises in this region. He is familiar with Tyrill County, and he does not believe that the city has the same level of commitment to protect farmland from the sea that one finds in northeastern North Carolina. He has no doubt that dikes will be built to protect homes, but agriculture is too marginal to justify protection from tidal inundation. He also indicated that more farmers will sell their lands to developers than one would assume based on existing planning maps. The extra 1-mile buffer gives effect to this perception. Moreover, if there is any farm land where protection might be justified, it would be farms along a protected corridor—farmers could provide land for the dike in return for the protection the dike offers, for example; and the incremental cost of protecting farms is mostly the additional pumping of rainwater that falls on the farmland, if a dike of a given length has to be built anyway.

[103]Telephone conversation between Jim Titus and Amy Ring, City of Chesapeake, October 28, 2003.

[104]Once the area is developed, it would be possible to divide such areas into developed (brown) and open space (blue).

2004. Titus and Hudgens followed up by email and phone calls in the following weeks, obtaining some comments. Titus provided a follow-up briefing to 40 local planners at the regular monthly meeting of the PDC's Chesapeake Bay and Stormwater Management committee, obtaining marked-up maps from all the jurisdictions that had not previously commented.

Representatives from Virginia Beach requested the most noteworthy change of this report[105]: Assume that developed areas below the Rural Line are unlikely to be protected, i.e., that all land below the Rural Area Line is unlikely to be protected. This change is consistent with the general preservation philosophy associated with the original creation of the Green Line and subsequent Rural Line. Planning to protect isolated development within this area might tend to encourage development, and much of the rationale for existing development in this area is the need for settlements that support agriculture; so if the farms were to convert to marsh, the support function of the settlements would no longer apply. Nevertheless, this suggested change is a substantial departure from the approach of most state and local governments, which is to assume that no developed land can be abandoned to the sea.

Virginia Beach also requested several changes relating to nontidal wetlands. Within the transition area they identified four areas where all the nontidal wetlands shown in draft maps should be changed to shore protection likely, either because those wetlands have been or because they will probably be developed and protected. These changes make red even more the dominant color in this area. For the most part, the need for this correction reflected the obsolescence of the NWI wetland dataset that we have been using.[106] In one case, however, a nontidal wetland polygon had to be extended over an area that was depicted as certain to be protected.

Finally, Virginia Beach asked us to change the area just west of Stumpy Lake, near (maybe including) Stumpy Lake County Club, along the border with Chesapeake, from brown to blue. This area is above the Green Line. The City explained that "the City has acquired ~1,200 acres in that area for open space/natural resource preservation. We are currently developing a strategy to place a perpetual conservation easement over most of the land. Accordingly, no efforts to protect future infrastructure or development will be necessary or take place in this area."[107]

Chesapeake, by contrast, only sought one change. In response to a previous conversation with Amy Ring, the draft map showed a large area at the southwest corner of the city as likely to be protected, because of a large planned development along the North Carolina border and US-17. The draft map showed this development as extending about a mile north of Ballahack Rd. Ms. Ring indicated via email that the development would be smaller than our previous conversation may have indicated. Accordingly, we changed the areas north of Ballahack Rd. back to protection unlikely (except for a few developed areas that were shown as likely to be protected for other reasons).

Our draft maps showed the dry land of the other urban jurisdictions as all being likely or certain to be protected, and the city planners generally agreed. Nevertheless, they did request some

[105]The specific changes are depicted in both the hard-copy map that Clay Bernick handed Jim Titus at the Stakeholder Review Briefing and the electronic attachment to "Hampton Roads Fixes: VA Beach and Chesapeake," email sent by Jim Titus to Kevin Wright, ICF Incorporated, October 24, 2004.

[106]We remind the reader that this study analyzes only dry land, but that because the wet/dry land is often in doubt, the dataset we created also gives a shore protection designation that would apply if it turns out that the land is dry (or if it is subsequently drained to become dry). The maps that we publish place a wetland dataset on top of the underlying map of shore protection likelihood. When reviewers specifically state that an area is not wetland, we effectively place the shore protection designation on top of the wetland dataset for that area so that an alternative wetland data set would not alter those polygons. The rationale is that, in general, wetland datasets more precisely define dry/wetland boundaries than land use and zoning data, so wetland data usually go "on top." But when stakeholders identify an erroneous wetland designation, their correction is assumed to be more reliable than the wetland dataset.

[107]Clay Bernick, environmental management administrator, City of Virginia Beach, email to Jim Titus, October 15, 2004.

changes between red and brown. Portsmouth had the most extensive comments.[108]

- ***Change the Craney Island Dredge Spoil from purple to red.*** This area is no longer wetland, and there is considerable talk about possibly developing it.
- ***Change the Hoffler Creek Wildlife Preserve from red to light green.***
- ***Change Churchland Park from red to brown.*** This park would be protected as part of any plan to protect surrounding areas.
- ***Change Elizabeth Marion Country Club from red to brown.*** It is too valuable to be given up to the sea.
- ***Change the large area bounded on the southwest side by VA-164 and Lake Kingman, on the east by the Elizabeth River, and on the northwest side by Coast Guard Boulevard from red to brown.*** This former military land was purchased by Mearsk from a private owner, for a planned $80 million development.
- ***Numerous small red polygons are now developed and should be changed to brown.***

The net result was that all the red should be changed to brown except for Hoffler Creek Wildlife Preserve, a few isolated red polygons near Churchland Park, and the following areas that had been correctly mapped as protection likely:

- *The red parcel at the head of Lilly Creek near Kingman, just south of VA-164, should stay red.* The owner is content to maintain it as wooded land and does not intend to sell it to a developer. The city's current plan would be for the parcel to be developed if it is ever transferred to an owner who wants to do so.
- *City Park should stay red.* Protection would be likely if the shore ever erodes. For the foreseeable future, however, erosion is unlikely because sedimentation has converted open water to mudflats in the area.
- *The red polygon bounded by Cedar Lane, Coast Guard Road, and Craney Island Creek is still undeveloped land owned by the Navy.*

Newport News clarified the implications of its buyout program. Homes along the city's small amount of Chesapeake Bay shore near the border with Hampton are being bought out in the wake of storm damage. The planner suggested that land below 4 feet (NAVD '88) should be changed from brown to red, because homes in this area will probably be bought out, with the land becoming part of the existing waterfront park, where protection is likely, but not certain.[109] Aside from that area, she suggested all of our nonmilitary lands depicted in red should be changed to brown except for one polygon. The only nonmilitary land that should be depicted as red is a development along the west side of Deep Creek south of Yoder Pond.

Hampton suggested only one change: an area depicted as nontidal wetlands that is, in fact, being developed into an office park. This parcel has about 470 acres and is bounded by Magruder Blvd. to the east, Semple Farm Rd. to the north, and a golf course to the south.

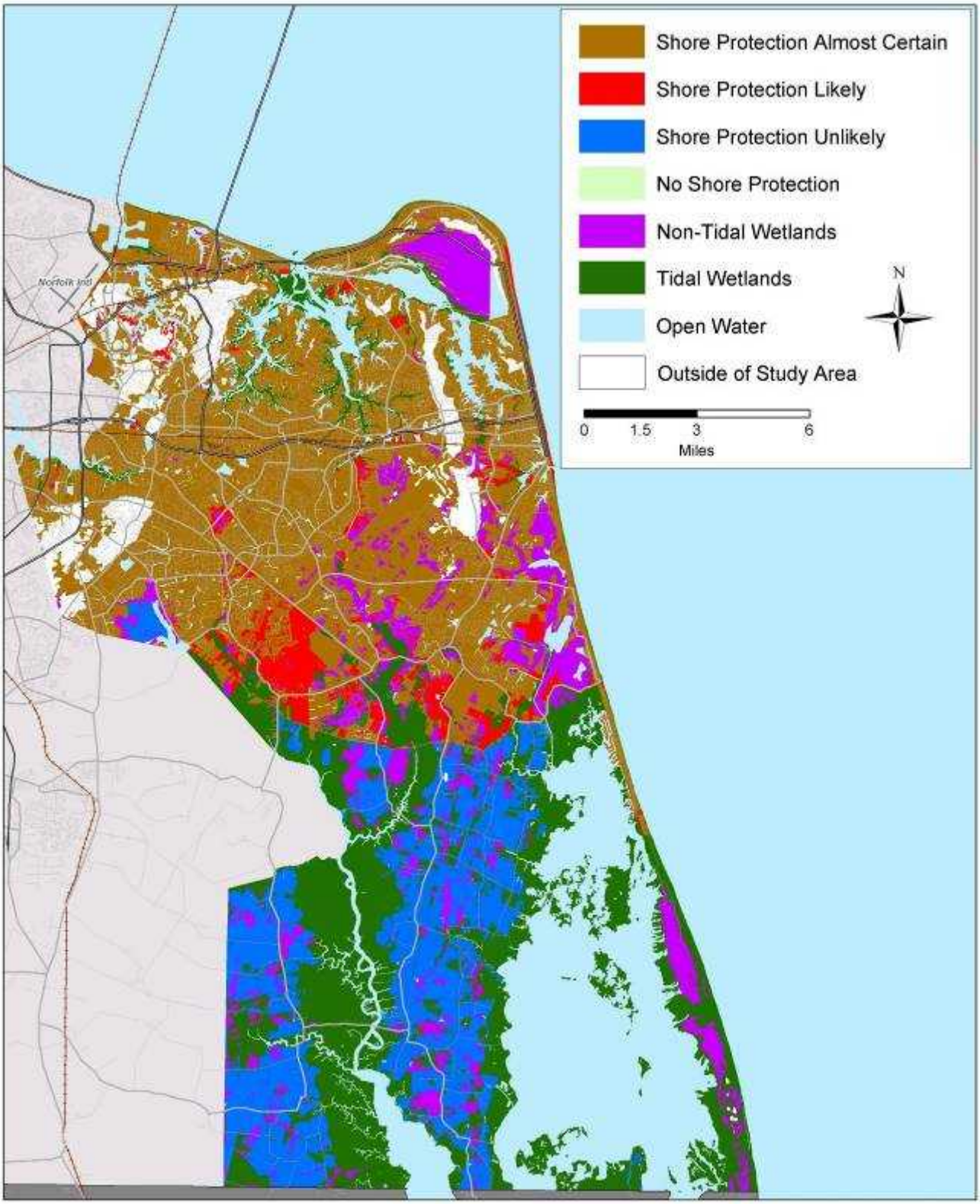
[108] See email from Jim Titus to Fred Brusso, October 13, 2004, reporting all the map changes that Brusso recommended during telephone conversation that afternoon with Titus.

[109] The planner initially offered to provide the location of the 4-ft NAVD contour, but was unable to do so. Therefore, we used the USGS 5-ft NGVD contour from the 1:24,000 map series. At Sewells Point, NAVD is 0.8 feet higher than NGVD (see National Geodetic Survey web site links from the NOAA-NOS Published Benchmark Sheet). Thus the USGS contour could be viewed as a 4.2-ft NAVD contour. The City's data are presumably more precise.

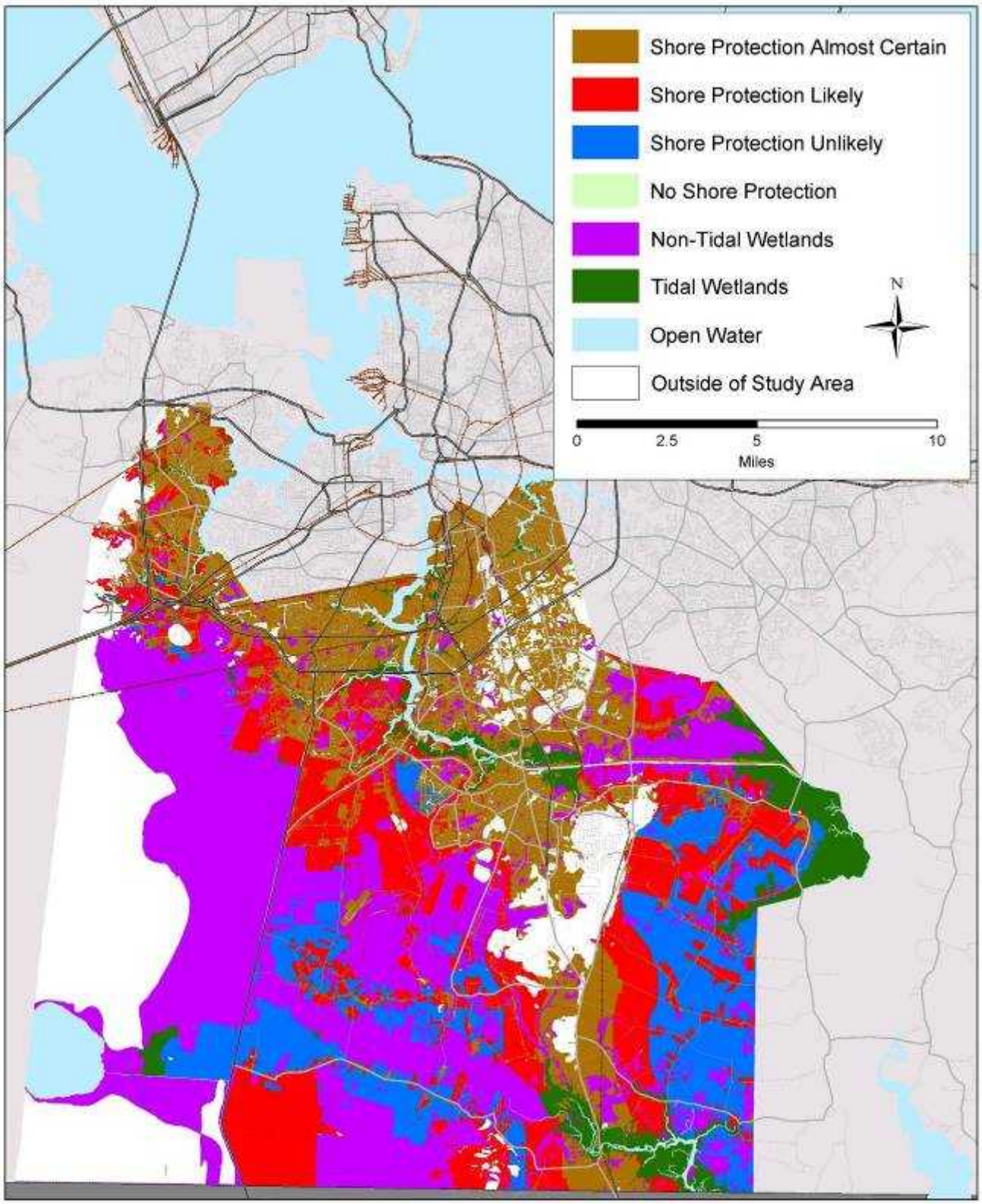
TABLE 8-8. ASSUMPTIONS FOR SHORE PROTECTION MAP: URBAN CORE LOCALITIES, FOR WHICH HAMPTON ROADS PLANNING DISTRICT COMMISSION PROVIDED UPDATED LAND USE DATA (VIRGINIA BEACH, CHESAPEAKE, NORFOLK, PORTSMOUTH, HAMPTON, NEWPORT NEWS)[a]

Land Area	Protection Likelihood				Source
	No protection	Unlikely	Likely	Certain	
Stakeholder review changes	As specified				See text
Virginia Beach: rural areas [b]		✓			Comprehensive plan
Military installations			[c]		Military installations
Central business districts, major coastal communities, and lands slated for future development				✓	Planner input from initial study [c]
Major evacuation routes from protected areas				✓	Planner input implemented using initial study [d]
Hampton Roads bridge-tunnels				✓	Planner input implemented using major roads [d]
Chesapeake: lands within one mile of VA-168				✓	Road buffer delineated using major roads
Undeveloped and vacant lands [e] within urban areas [f] adjacent to open water or wetlands			✓		Hampton Roads urban land use
Developed lands [e]				✓	Hampton Roads urban land use
Urban areas [f]				✓	Projected Chesapeake 2050 land use; VA Beach Comprehensive Plan
Chesapeake: lands within two miles of VA-168, land along Rte. 17 near the North Carolina border extending west three miles and east to the wetlands			✓		Road buffer delineated using major roads
Undeveloped and vacant lands [e] within urban areas [f] adjacent to open water or wetlands			✓		Hampton Roads urban land use
Chesapeake and Virginia Beach: transitional area [g]			✓		Projected Chesapeake 2050 land use; VA Beach Comprehensive Plan
Chesapeake: rural areas [h]		✓[i]			Projected Chesapeake 2050 land use; VA Beach Comprehensive Plan

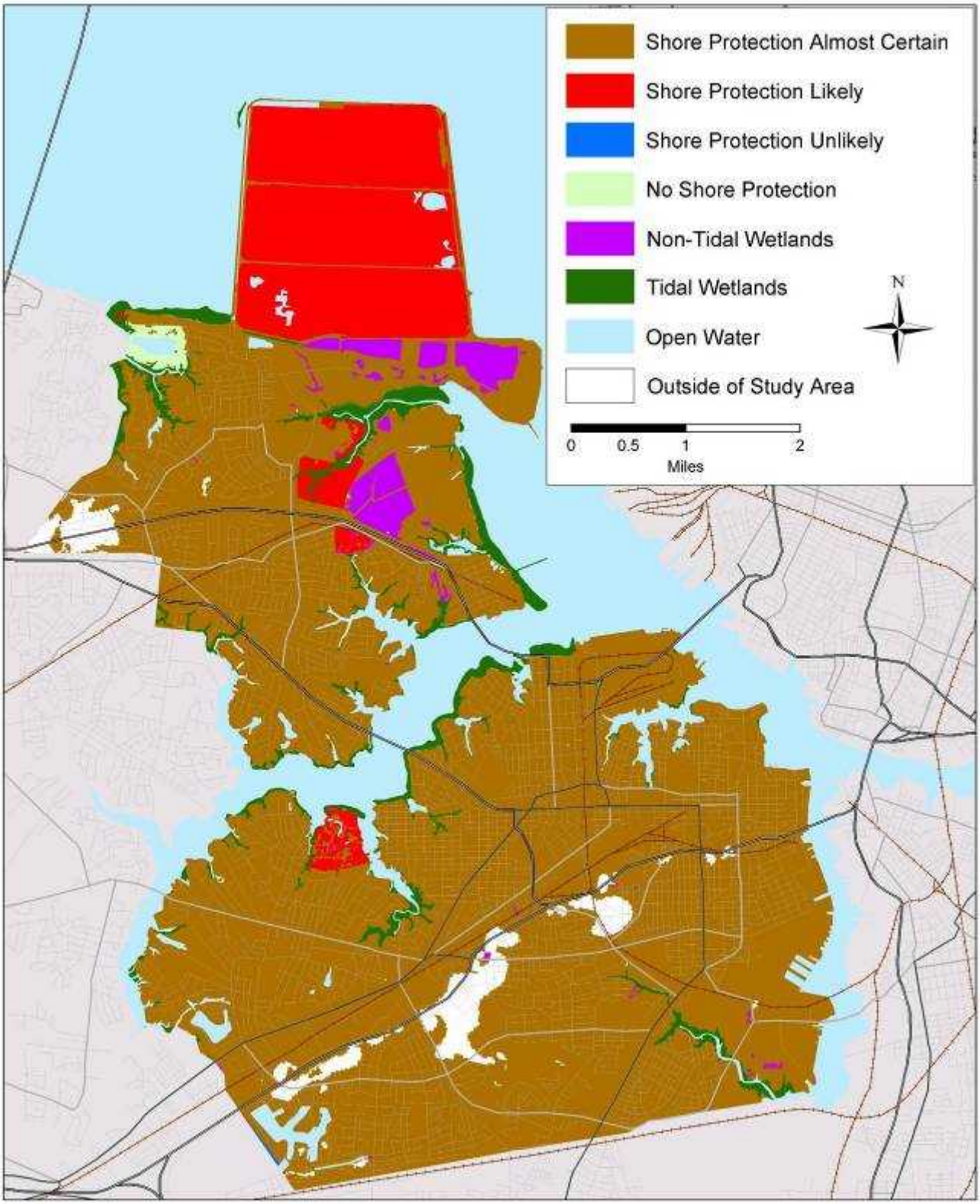
[a] Where land areas overlap, classifications higher in the table take precedence.
[b] Rural area includes southern portions of Chesapeake and Virginia Beach (see Figure 8-3). It consists of all lands not specifically identified as part of the urban or transition areas.
[c] Based on the nationwide approach of this study for secured installations, the maps depict these areas as red. The data we distribute assigns the code “military” rather than “protection likely.”
[d] The initial 2001 VIMS study created polygons representing areas that are certain to be protected in the event of a 20-ft sea level rise. These areas are depicted in orange in some versions of our maps. Within HRPDC, their study area included only the urban core and Poquoson City.
[e] Per planner input from the initial 2001 VIMS study, we identify specific transportation structures as certain to be protected using data provided by ESRI.
[f] The Hampton Roads urban land use data include the following “developed” classifications: urban and suburban residential, industrial, institutional/educational, and commercial areas.
[g] The urban areas include the northern portions of Chesapeake and Virginia Beach and all land within Hampton, Newport News, Norfolk, and Portsmouth (see Figure 8-3).
[h] Transitional area between urban and rural area of Chesapeake and Virginia Beach (see Figure 8-3). The developed lands are certain to be protected; lands shown as “protection likely” are undeveloped, vacant, parks, public, forest, pasture, agriculture, and recreational uses.
[i] The decision rules for the rural area in Chesapeake are parallel to those of the transition area, except that lands not developed are deemed protection unlikely in the rural area and protection likely in the transition area.



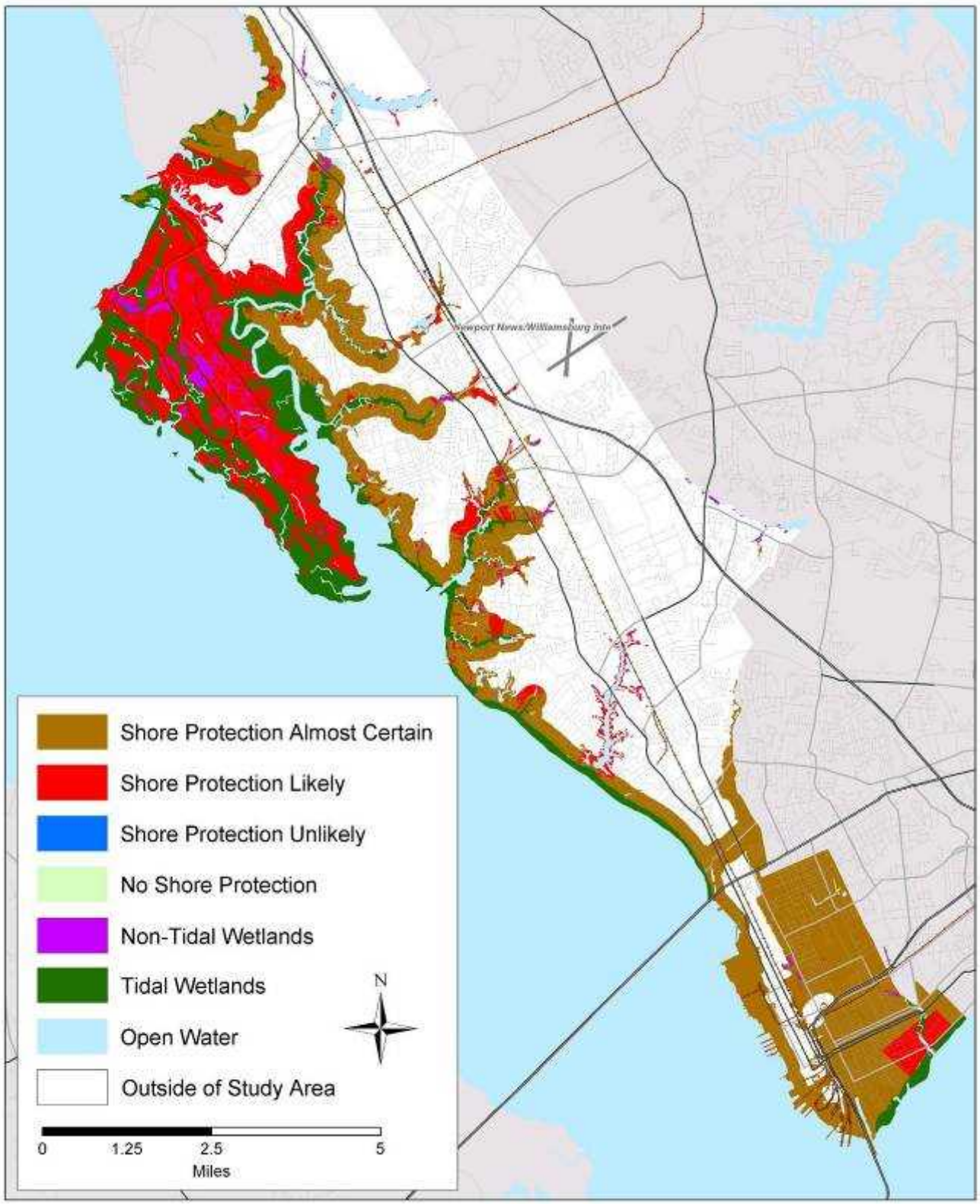
Map 8-4. Virginia Beach: Likelihood of Shore Protection. For additional details, see the legend and caption accompanying Map 8-2.



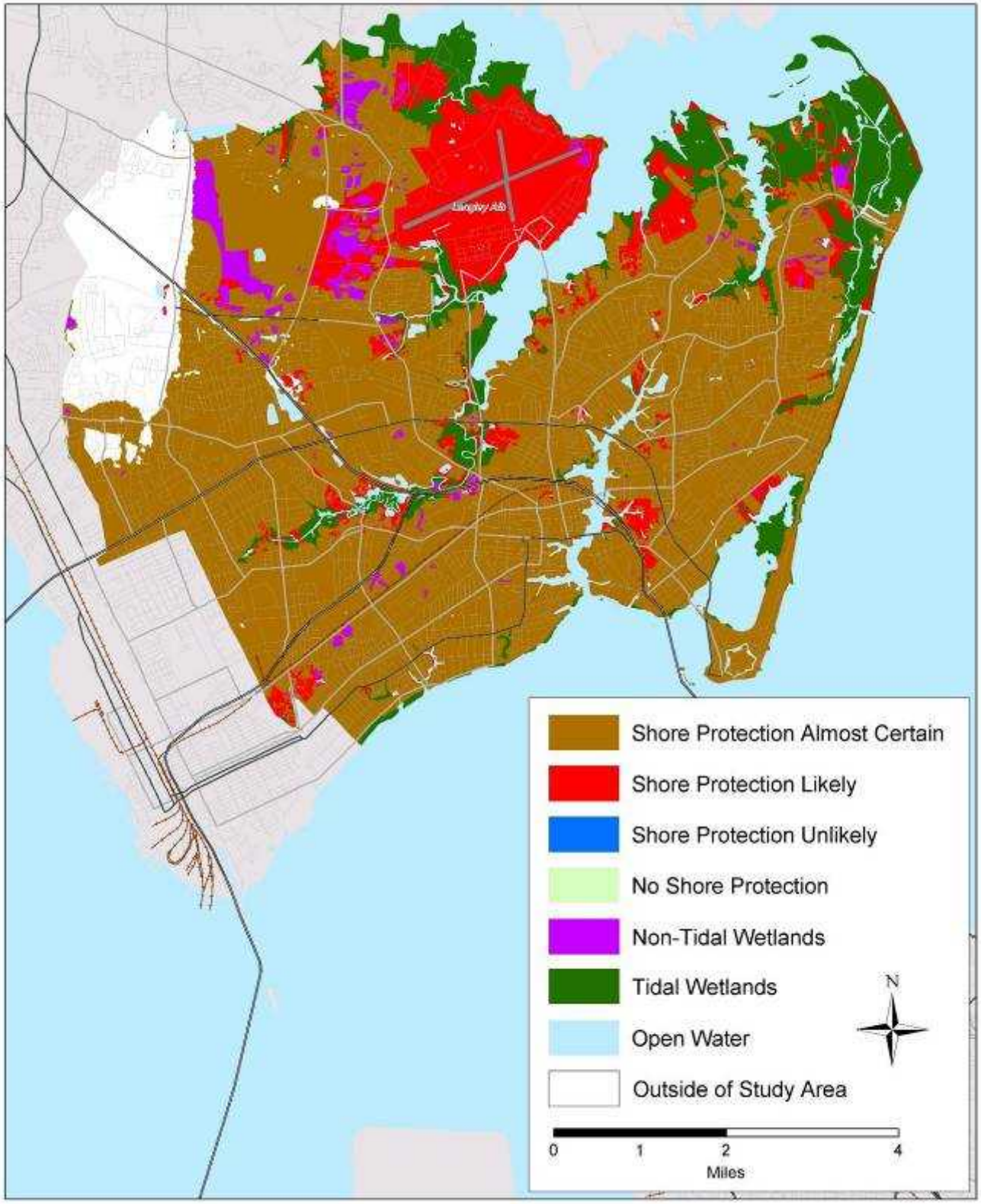
Map 8-5. Chesapeake: Likelihood of Shore Protection. For additional details, see the legend and caption accompanying Map 8-2.



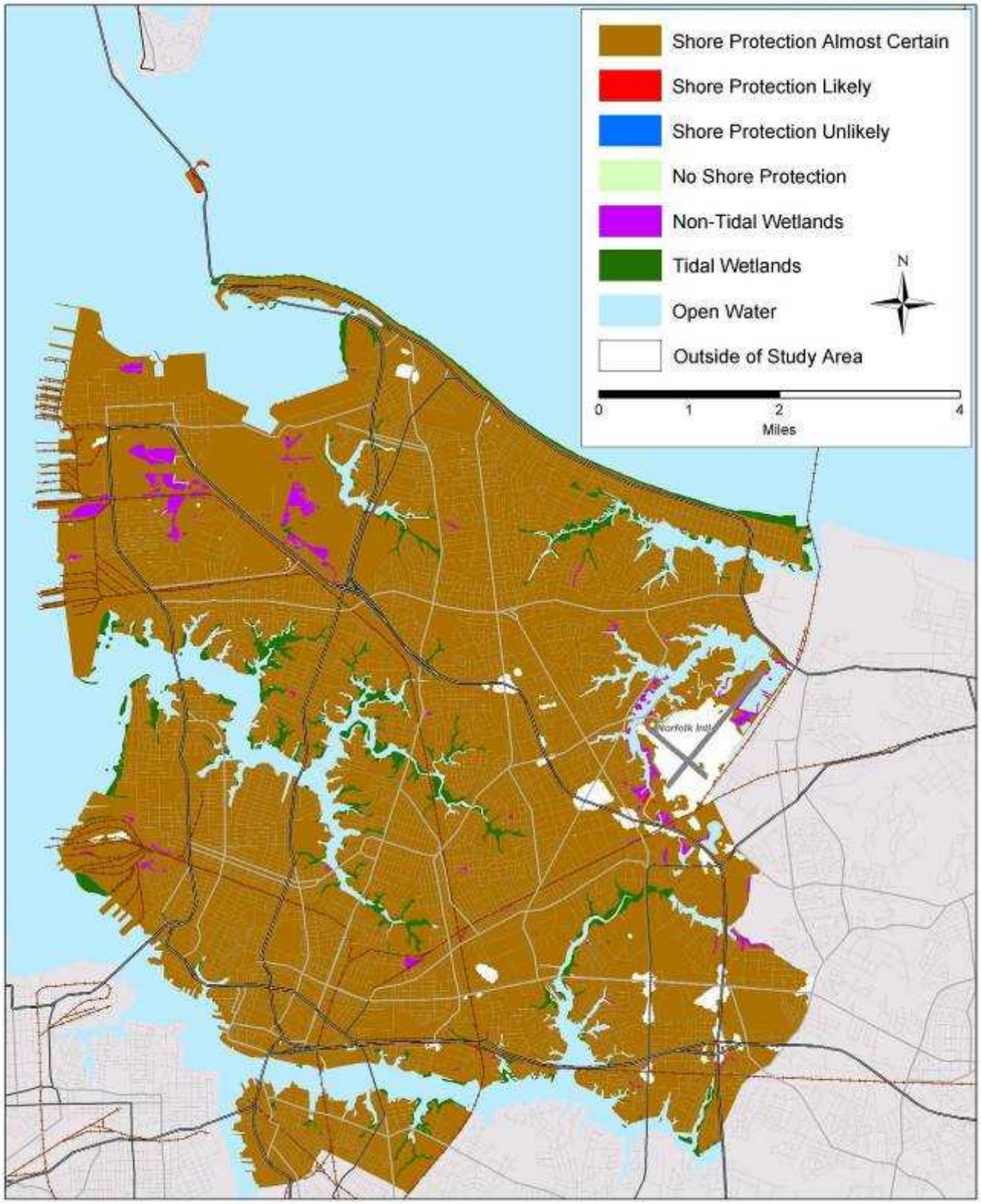
Map 8-6. Portsmouth: Likelihood of Shore Protection. For additional details, see the legend and caption accompanying Map 8-2.



Map 8-7. Newport News: Likelihood of Shore Protection. For additional details, see the legend and caption accompanying Map 8-2.



Map 8-8. Hampton: Likelihood of Shore Protection. For additional details, see the legend and caption accompanying Map 8-2.


Shore Protection Almost Certain
Shore Protection Likely
Shore Protection Unlikely
No Shore Protection
Non-Tidal Wetlands
Tidal Wetlands
Open Water
Outside of Study Area
N
0
1
2
4
Miles
Norfolk Intl

Map 8-9. Norfolk: Likelihood of Shore Protection. The City of Norfolk was entirely brown except for a single red polygon, and the City's representative agreed with that depiction. For additional details, see the legend and caption accompanying Map 8-2.

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