

Natural Resource Assessment

THE JAMESTOWN PROJECT



JAMESTOWN, VIRGINIA



SUBMITTED TO

National Park Service
Colonial National Historical Park, Jamestown Unit

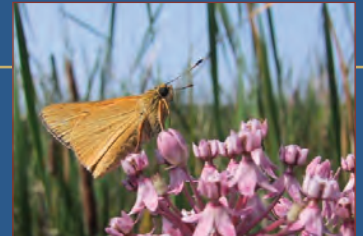


Association for the Preservation of Virginia Antiquities
Jamestown National Historic Site



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Introduction

Jamestown Island is the site of the first permanent English colony in North America. The location marks the time and place of the beginning of the history of this nation. Today, the site is jointly administered by the National Park Service (NPS) and the Association for the Preservation of Virginia Antiquities (APVA) and is commonly referred to as “Historic Jamestowne.” Because the year 2007 marked the 400th anniversary of the founding of the Jamestown Colony, the two landowners worked closely together to improve services and plan for a better overall visitor experience at the site.

The NPS and APVA initiated this planning in 1998 with the Jamestown Project Development Concept Plan/Environmental Impact Statement (DCP/EIS). In 1999, a concentrated effort began to identify and inventory the island’s resources. By mid-2000, the project had progressed to the point where the project team could begin drafting the DCP/EIS. This included developing a purpose and need statement, evaluating alternative actions, defining the project area, assessing the potential impacts of each alternative, and then summarizing the public and agency involvement in the process. The alternatives laid out in the DCP/EIS addressed the antiquated facilities and the quality of the visitor experience at Jamestown, many elements of which had not been modified in nearly 50 years. The alternatives included changes in staffing, interpretive programs, improved access and circulation, and new buildings. The preferred alternative in the DCP/EIS included the replacement of the existing visitor center with a new Visitor Center/Educational Facility in the Island Parking Lot, construction of a joint APVA and NPS Collections and Research Center, Intermodal Transportation facilities, as well as other exhibit venues. Since the signing of the Record of Decision (ROD) in May of 2003 and as of 2008, most of these elements have been implemented.

For both the APVA and the NPS, the purpose and primary significance of Jamestown is to preserve, interpret, and promote the history of the first permanent English colony in North America. However, the natural resources and heritage of the island also are important. As mitigation for proposed impacts to these resources, the NPS and APVA included requirements for a natural resource assessment and long-term monitoring in the ROD for the DCP/EIS. This document is designed to comply with the first of these two requirements. More specifically, the purpose of this Natural Resource Assessment is twofold:

- to update the database of existing conditions with respect to natural resources within the footprint of the Jamestown Project.

- to compare the nature and extent of the developments prescribed within the DCP/EIS versus those actually realized and the implications for natural resources (if any)

Setting

Historic Jamestowne is located on the shores of the James River at the western end of Colonial National Historical Park (NHP), in James City County, Virginia (Figure 1). As an island within the James River, more than half its 1,800 acres is covered by wetlands and open-water habitats, including the Pitch and Tar Swamp, Powhatan Creek, Sandy Bay, Back River, the Thorofare, Kingsmill Creek, and Passmore Creek. The James River forms the island's eastern, southern, and western boundaries. Back River borders the island to the north, separating it from the mainland (Figure 1).

Historic Jamestowne was first secured in 1893 when the APVA purchased 22.5 acres of land on Jamestown Island. The NPS acquired 1,500 acres in 1930 with the establishment of Colonial National Monument. The park was redesignated as Colonial NHP in 1936. The APVA's land is located southwest of the island's main visitor parking lot. It includes the Jamestown Rediscovery™ Center, the Dale House, Glasshouse, and the Old Towne area. The NPS owns the remainder of the island, including the visitor center, the New Towne area, and the relatively undeveloped lands around the Loop Drive (Figure 1). Developments surrounding Historic Jamestowne include the Jamestown Settlement (the Commonwealth of Virginia's living history museum), the Jamestown-Scotland Ferry landing, the Jamestown Marina, private residential developments to the north, and Gospel Spreading Farm. Colonial Williamsburg and Yorktown are located approximately 6 and 15 miles northeast of Jamestown, respectively.

Historic Jamestowne has a temperate climate moderated by its proximity to the Atlantic Ocean. Average winter daytime temperatures peak at 10 °C (50 °F) with nighttime lows of 3 °C (37°F). Summer temperatures range from daytime highs of 30 °C (86°F) down to 20 °C (68°F) at night. The area is generally humid, especially during the summer months. On and offshore breezes are common, as the landmass of the lower peninsula experiences diurnal heating and cooling relative to the ocean. Based on the climatic record for nearby Williamsburg, Historic Jamestowne receives an average of 49.02 inches of precipitation per year (MRCC 2008).



- Colonial National Historical Park Boundary
- Association for the Preservation of Virginia Antiquities Boundary
- Limits of Natural Resource Assessment



Historic Jamestowne

Natural Resource Assessment
Jamestown, Virginia

Figure 1
Jamestown Island
and Environs

History of Jamestown

Archeological evidence indicates that prehistoric American Indians occupied Jamestown Island and the vicinity for at least 10,000 years before the first European colonists arrived in 1607. This evidence shows varying levels of activity on the island through different periods of time and indicates a more established pattern of occupation based on the seasons.

The “Settlement Era” at Jamestown Island began on May 13, 1607 when three shiploads of English colonists landed on Jamestown Island. The settlers established the Colony of Virginia, with Jamestown as the capital. Over the 138 years of the Settlement Era (1607-1745), the colony grew from a small group of settlers living primarily within the confines of a fort to a developed society with houses, government buildings, and successful farming. Farming activities resulted in the removal of many of the remaining trees on the core of the island and the creation of irrigation ditches to transport water to and from cultivated fields. The success of the settlement transitioned the colony into the “Plantation Period.”

The Plantation Period lasted from 1745 until 1892. By this time, the colony had developed beyond the island, and many of the settlers lived on the mainland. Much of Jamestown Island was owned by the Ambler and Travis families, who divided the land into two working plantations. Regular farming on the island continued until the Civil War, leaving the island devoid of many trees and filling in wetlands in place of irrigation ditches. During the American Revolution, the island was initially occupied by the British and later by allied troops. Once it was secured from the British, the island served as an exchange point for prisoners of war and a site where ships were outfitted for combat. After the war, agricultural operations resumed on the island. War returned to the region during the War of 1812 and the Civil War. At the beginning of the Civil War, the Confederates occupied the island in an attempt to control the James River. However, when Union forces, led by Major General George B. McClellan, launched their Peninsula campaign, the Confederates evacuated the region. With Union forces controlling the area, the island became a rendezvous point for escaped slaves. After the Union army withdrew from the area, slaves burned the Ambler Plantation House.

The final period of Jamestown Island’s history is the “Commemorative & Interpretive Period,” running from 1893 to present time. In 1892, the majority of the island was purchased by Edward Barney, a wealthy industrialist. The following year, the Commonwealth of Virginia granted ownership of the Jamestown Church and Cemetery to the APVA and gave them the right to acquire more land on the island. Within months, Barney deeded 22.5 acres of the island to the APVA. Over the next 37 years, the APVA continued to enhance the visitor experience on its land, while Barney continued to develop his land for tourism and agricultural uses. By 1932, the growth in tourism and interest in the history of Jamestown Island and the surrounding region led Congress to authorize the federal government to acquire all of Jamestown Island, except the portion already owned by the APVA. Since then, the APVA and the NPS have worked together to preserve the island’s history. The NPS has also improved neighboring, off-island resources. A number of interpreted structures and building were constructed at Glasshouse Point in 1957 during the Mission 66 period. Maintenance Buildings at Neck of Land were constructed in the same year.

Methods

Formal planning for the Jamestown Project began in 1998. At this time, the project team began conceptual planning and collecting data on the cultural and natural resources at Historic Jamestowne. Data collection included compiling past reports authored by various agencies/organizations, coordinating with local, state, and federal regulatory agencies, and conducting additional surveys, as required. Natural resources that were subjected to further study were the island's wetlands, air and sound quality, and the rare, threatened, and endangered species that inhabit the area.

To address the needs of the NPS and the requirements of the DCP/EIS, wetland scientists reviewed existing data such as the historical park's wetlands Geographic Information System (GIS) database, the National Wetland Inventory (NWI), local soil surveys, and aerial photographs. This information was ground truthed at select locations to confirm the presence and type of wetlands. Additionally, wetlands within the immediate vicinity of some areas identified for construction (e.g., the Townsite, Neck of Land, Glasshouse Point, and the NPS maintenance facility) were subjected to a detailed field delineation and subsequent surveying. The extent of jurisdictional wetlands and streams were confirmed by the U.S. Army Corps of Engineers (COE) on January 24, 2002. This jurisdictional determination was valid for a period of five years, and thus expired on January 24, 2007.

Rare, threatened, and endangered species of the Jamestown Project Area were also investigated. In the spring of 2000, the NPS contracted the Virginia Department of Conservation and Recreation Division of Natural Heritage (DCR-DNH) to conduct an inventory of natural heritage resources within Historic Jamestowne (Chazal and Van Alstine 2001). The inventory was designed to identify rare, threatened, and endangered plant and animal species. Two federally listed species were identified, the sensitive joint-vetch (*Aeschynomene virginica*) and the bald eagle (*Haliaeetus leucocephalus*). The presence of both species resulted in the U.S. Fish and Wildlife Service (FWS) issuing a Biological Opinion. The Biological Opinion provided recommendations for timing construction methods and building footprints. Construction efforts were carefully planned to avoid known areas as well as potential habitat of the sensitive joint-vetch and of nesting eagles. Construction was phased such that exterior activity was limited during periods of eagle nesting and breeding. The information from these surveys, the Biological Opinion, and other reports on natural resources such as groundwater, flood zones, and so on, was compiled in the Jamestown Project DCP/EIS (NPS & APVA 2003).

This natural resource assessment is based on a review of relevant information in the DCP/EIS and related pre-existing documents and studies as well as current information and preliminary data from publications in review or in press. This information was provided in bibliographic format to NPS specialists as well as local, state, and federal regulatory officials to ensure the most up-to-date material was referenced. A meeting was held on April 17, 2007 to solicit input from these individuals and to obtain any additional data sources, the condition of the natural resources on the island, and potential future threats. The results of this meeting and findings from existing literature and ongoing monitoring were used to compile this report.

STUDY AREA

The study area for the natural resource assessment is limited to those areas that have undergone or will undergo improvements as presented in the DCP/EIS. From this point forward, the study area will be referred to as the “natural resource assessment study area,” or “NRA area,” in order to distinguish it from other studies and publications that address resources on an islandwide or parkwide scale (Figures 2 through 4). Furthermore, restricting the study area avoids duplicating the efforts of the Northeast Coastal and Barrier Network’s (NCBN) Vital Signs program. For each natural resource within the NRA area, this report will:

- summarize the existing conditions or most current available information

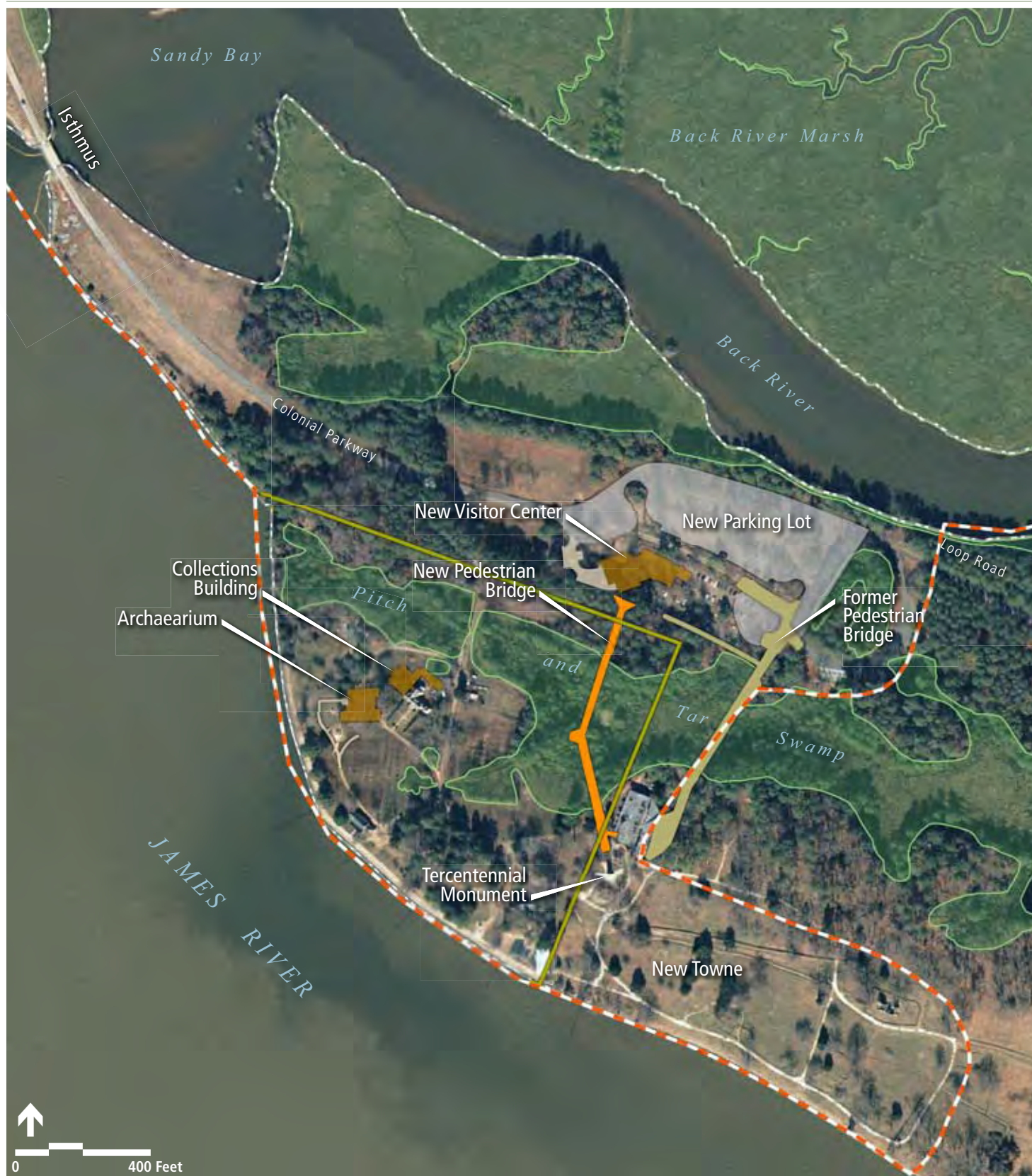
- identify the apparent gaps in knowledge

- discuss the impacts directly resulting from the construction of the Jamestown Project (if any)

- identify potential future impacts from the Jamestown Project (direct and secondary impacts)

Since the signing of the ROD in May 2003, the majority of the originally proposed development has taken place. Table 1 lists the build status of the different elements of the Jamestown Project, indicating those that have been constructed, those that will be constructed in the foreseeable future, and those that may be constructed at a later time. While the DCP/EIS provided a impact analysis based on the size and location of proposed developments as of May 2003, this report describes in greater detail the impacts that have actually occurred at the site since the signing of the ROD.

Table 1: Jamestown Project - Status of The Construction Of Improvements for the Selected Action		
Completed	Foreseeable Future	To Be Constructed at a Later Time
Collections Building	Outdoor Program Area	Observation Building
Neck of Land Intermodal Transportation Terminal		Water Transportation Infrastructure and Hiking/Bicycle paths on the Marsh Boardwalk and Old Road Trace
New Visitor Center		
Archaearium		
Dale House Improvements		
Glasshouse Point Improvements		



- Colonial National Historical Park Boundary
- Association for the Preservation of Virginia Antiquities Boundary
- Limits of Natural Resource Assessment



Historic Jamestowne

Natural Resource Assessment
Jamestown, Virginia

Figure 2
Natural Resource Assessment Area:
Jamestown Island



- Colonial National Historical Park Boundary
- Limits of Natural Resource Assessment



Historic Jamestowne

Natural Resource Assessment
Jamestown, Virginia

Figure 3
Natural Resource Assessment Area:
Glasshouse Point



--- Colonial National Historical Park Boundary
--- Limits of Natural Resource Assessment



Historic Jamestowne

Natural Resource Assessment
Jamestown, Virginia

Figure 4
Natural Resource Assessment Area:
Neck of Land

Natural Resource Assessment

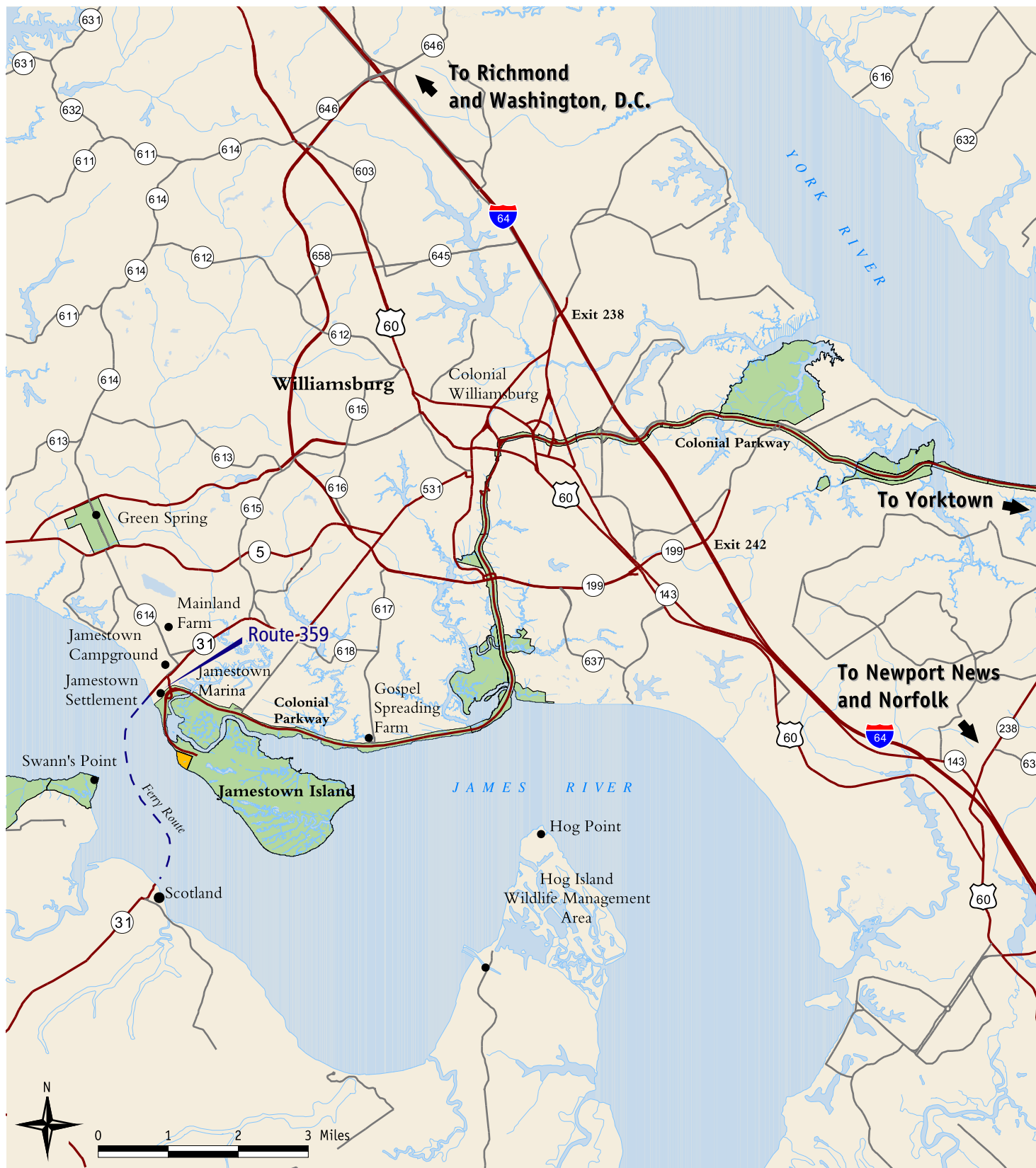
The resource studies, inventories, and documentation completed for the Jamestown Project DCP/EIS represent the most comprehensive collection of up-to-date information on the natural resources at Historic Jamestowne. This information facilitated the completion of the DCP/EIS and signing of the ROD. Because construction began shortly after the signing of the ROD, this information also provides an accurate baseline of natural resource conditions prior to construction. Where more recent information is available, it is presented in this chapter. The list of natural resources discussed herein includes air quality, noise/soundscape, soils, surface water resources and submerged aquatic vegetation, floodplains and floodzones, Chesapeake Bay Protection Areas, groundwater resources, wetlands, vegetation, wildlife, and special status species.

AIR QUALITY

The Colonial NHP Air Quality Management Plan defines air quality related values (AQRVs) as “those values possessed by an area which are or could be affected by changes in air quality. AQRVs include visibility and scenic, cultural, biological, and recreational resources. Resources which may be adversely affected by changes in air quality are visibility, vegetation, wildlife, water quality, soils, historic and archaeological objects and resources, and visitor enjoyment” (NPS 1991).

Air quality studies conducted in 2001 and 2003 evaluated mobile source ozone precursor emissions, including carbon monoxide (CO), nitrogen oxides (NO_x), and volatile organic compounds (VOCs). Vehicular traffic represents the primary source of CO and ozone precursor emissions at Historic Jamestowne (NPS and APVA, 2003). There were two components to these studies: a microscale analysis and a mesoscale analysis. The microscale analysis evaluated the local CO concentrations at four sensitive receptor locations at congested local intersections most affected by project-related traffic, the closest being the entrance to Historic Jamestowne (Colonial Parkway at Route 359, Figure 5). Using the Environmental Protection Agency’s (EPA) CAL3QHC Version 2 program, data were used to predict one-hour and eight-hour CO concentrations at the receptor locations. The mesoscale analysis evaluated the regional ozone precursor emissions of VOCs and NO_x along local roadways during a typical day during the summer.

Subsequent to the publication of the DCP/EIS, the EPA modified the motor vehicle emissions model used in the original 2001 study. The new emissions model, Mobile 6.2, changes the motor vehicle emission’s rate such that it makes it difficult to compare the air quality values that were generated in 2003 against those presented in 2001. Because the 2003 receptor sites include all of the sites covered by the 2001 study, and these results are more current, this report includes only those results from the 2003 air quality analysis. They are reported in Appendix A.



- Primary Route, Class 1
- Secondary Route, Class 2
- - - Ferry Route
- Colonial National Historical Park
- Association for the Preservation of Virginia Anitquities



Historic Jamestowne

Natural Resource Assessment
Jamestown, Virginia

Figure 5
Regional Transportation Network

Most Recent Information

The 1990 Clean Air Act Amendments resulted in states being divided into attainment and nonattainment areas, depending on if they met national air quality standards. Historic Jamestowne is located in James City County, which is an area designated as attainment for both ozone and CO. This means that the air quality of the area meets federal air quality standards designed to protect public health.

The 2003 microscale analysis demonstrated that the one-hour CO concentrations ranged from a minimum of 3.8 parts per million (ppm) at the intersection of the Colonial Parkway and Route 359 at Jamestown Settlement to a maximum of 7.4 ppm at the intersection of Route 31 and Route 199 (Figure 5). The corresponding maximum eight-hour CO concentrations ranged from a minimum of 2.7 ppm to a maximum of 5.2 ppm. All the one-hour and eight-hour concentrations are below the EPA's National Ambient Air Quality Standards (NAAQS) of 35 ppm and 9 ppm, respectively. Furthermore, the minimum and maximum concentrations for both the one and eight-hour periods are lower than those obtained during the 2001 study (Appendix A).

The 2003 mesoscale analysis calculated the VOC and NO_x emissions from major roadways in both the Jamestown and Yorktown study areas. These emissions were estimated to be 1,633.6 kilograms per day (kg/day) of VOCs and 2,277.7 kg/day of NO_x. These emissions establish a baseline to which future emissions and changes in emissions can be compared.

Gaps in Knowledge

The results of the 2003 air quality study demonstrated that conditions at the time did not interfere with the attainment or maintenance of the state and federal air quality standards for CO and ozone in the study area. However, no data are available since the completion of the improvements at Historic Jamestowne in 2007. In addition, the three-mile widening of nearby State Route 199 from two lanes to four lanes between U.S. 60 and State Route 31 has likely resulted in increased traffic on this ring road. Lastly, pine trees are particularly susceptible to ground-level ozone (Mahan 2004) and can suffer foliar damage (Burns et al. 1990). As loblolly pine (*Pinus taeda*) constitutes a significant portion of the tree community at Jamestown Island, further studies may be warranted.

While data for mobile source ozone precursor emissions are relatively recent, information on other parameters such as dry acidic deposition and fine particulate matter are lacking. The nearest station reporting dry acidic deposition to the Clean Air Status and Trends Network (CASTNet) is located in Prince Edward County, or roughly 90 miles due west of Jamestown Island.

Project Related Impacts

Without ongoing air quality monitoring at the project site, it is difficult to elaborate on the impacts that construction activities have had on the resource. However, it is possible that concentrations of fine particulate matter temporarily increased in the vicinity of areas being actively graded or as a by-product of vehicular traffic along temporary, gravel surface construction routes. Minor increases in the concentration of ozone precursor emissions and fine particulate matter also may have occurred as a result of idling construction equipment, the latter pollutant released primarily from heavy duty diesel equipment (EPA 2001). Project

related impacts on air quality were thus temporary and acute. No data were collected to quantify these impacts nor was such monitoring a requirement of any local, state, or federal permit or administrative review.

Potential Future Threats

As mobile sources are the greatest source of CO and other ozone precursor compounds, increases in vehicular traffic, both land and water-based, represent perhaps the greatest threat to air quality at Historic Jamestowne. James City County is currently evaluating the redevelopment of the Jamestown Yacht Basin and the adjacent Jamestown Beach Campground, both of which are in close proximity to Historic Jamestowne. Though currently in the master planning stage, both developments may result in increases in automobile traffic on Jamestown Road and waterborne traffic on the Back River and Powhatan Creek.

Future impacts on local air quality resulting from regional or national-scale sources are difficult to predict. Key contributors include stationary sources of pollution such as coal-fired generating stations, petroleum refineries, steel mills, and so on. Prevailing weather carries pollutants from west to east and through the relatively industrialized midwest. However, future impacts are difficult to forecast given rising interest in alternative energy sources, possible amendments to air pollution legislation, and siting of future point sources.

Even less predictable future threats include events such as the wildfire in the Great Dismal Swamp National Wildlife Refuge, which produced considerable fine particulate pollution as smoke. Initiated by accident on June 9, 2008 and continuing to smoulder into September 2008, this fire at times created visual impairment and respiratory complications for persons living in the Hampton Roads area, including Colonial NHP. The intensity and duration of this fire was compounded by the fact that it occurred during a time of drought in Tidewater Virginia.

NOISE / SOUNDSCAPE

Noise is defined as unwanted or excessive sound. Sound becomes unwanted when it interferes with normal activities such as sleep, work, or recreation. Individual human responses to noise are subject to considerable variability since many emotional and physical factors impact reactions to noise. Natural soundscapes exist in the absence of human-caused sound, and the natural ambient soundscape is the aggregate of all the natural sounds that occur in park units, together with the physical capacity for transmitting natural sounds.

Sound and noise are described in terms of loudness, frequency, and duration. Loudness is the sound pressure level measured on a logarithmic scale in units of decibels (dB). For community noise impact assessments, sound level frequency characteristics are based upon human hearing, using an A-weighted (dBA) frequency filter. The A-weighted filter is used because it best approximates the way humans hear sound. The duration characteristics of sound account for the time varying nature of sound sources.

The most common way to account for the time-varying nature of sound (duration) is through the equivalent sound level measurement, referred to as Leq. The Leq averages the background sound levels with short-term transient sound levels and provides a uniform method for comparing sound levels that vary over time. The time period used for highway noise analysis is

typically one hour. The peak-hour Leq represents the noisiest hour of the day/night and usually occurs during the peak periods of automobile and truck traffic. The Federal Highway Administration (FHWA) guidelines and Noise Abatement Criteria require the use of the one-hour Leq for assessing highway noise impacts on different land uses.

The following general relationships exist between hourly traffic noise levels and human perception. They are expressed in terms of dBAs.

a 1 or 2 dBA increase/decrease is not perceptible to the average person.

a 3 dBA increase/decrease is a doubling/halving of acoustic energy but is just barely perceptible to the human ear.

a 10 dBA increase/decrease is a tenfold increase/decrease in acoustic energy but is perceived as a doubling/halving in loudness to the average person.

Current Conditions

As was the case with air quality, noise monitoring programs were conducted in 2001 and 2003 to establish the existing sound levels in the study area. These sound levels ranged from 51 dBA to 69 dBA. These numbers are typical for residential and recreational areas with moderate automobile and bus traffic. The existing sound levels varied depending upon traffic volumes, number of buses, and the distance from the receptor location to the noise sources. The noise monitoring results provide existing sound levels that can be compared to future predicted sound levels.

The results of the 2001 noise monitoring program demonstrate that the existing sound levels were dominated by roadway traffic. Though no military jets flew over during the monitoring period, they do so occasionally, increasing sound levels temporarily. Sound levels along the Island Loop Drive were measured at 51 Leq, well below the FHWA Type A Noise Abatement criterion of 57 Leq¹. The Island parking area measured 53 Leq. These noise levels were well below most of the surrounding region, which ranged from 51 Leq at the residences at Back River Lane (located just north of the Colonial Parkway where the Back River empties into The Thorofare) to 69 Leq at the Colonial Williamsburg Visitor Center, 4.8 miles to the northeast in the City of Williamsburg. These higher sound levels were due to vehicular traffic along the roadway and in the parking lot. The 2003 study had similar results. Both the Island Loop Drive and the Island parking lot had the same Leq. Regional noise levels continued to reach 69 Leq, primarily due to vehicular traffic.

Natural soundscapes within the NRA area are not present within the NRA area due to the fact that it is surrounded by anthropogenic sources of noise. These include vehicular traffic on the Colonial Parkway, various parking areas, and the Loop Drive, as well as the passage of motorized watercraft within Powhatan Creek and the James and Back Rivers. However, as the FHWA Type A criterion are met within the NRA area, it nevertheless does provide a relatively quiet setting for park visitors.

¹Land use category for Type A noise abatement criteria includes lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.

Gaps in Knowledge

Like air quality, noise studies have not been undertaken since 2003. Without current information, it is difficult to say whether or not sound levels are approaching FHWA criterion. As visitation and activity at the site increase, it will be important for noise levels to be monitored so appropriate mitigation can be implemented as necessary.

Project Related Impacts

As was the case regarding air quality, noise monitoring during construction was neither conducted or mandated. Therefore, no data exist from which to draw any conclusions. However, in accordance with the FWS Biological Opinion on bald eagles (FWS 2003), outdoor construction activities were spatially and temporally restricted to avoid disturbing nesting eagles. Postconstruction noise levels related to newly installed infrastructure are likely very similar to preconstruction conditions. In fact, a side benefit of the installation of a ground source based (i.e., geothermal) climate-control system at the Archaearium is its quieter operation compared with conventional cooling systems that incorporate compressors.

Potential Future Threats

In the future, increasing park visitation may result in increased noise levels. For this reason, a proposed new shuttle bus system was subjected to an impact analysis in 2003. This system includes the Jamestown Shuttle and the Historic Triangle Shuttle that runs along the Colonial Parkway. The analysis compared existing sound levels (dBA) to those expected to exist in 2010. Sound levels for 2010 were established for “no action” as well as the “selected action” (i.e., implementation of the Historic Triangle Shuttle and the Jamestown Area Shuttle) (NPS 2005). No substantial change in sound levels within Historic Jamestowne are expected at any of the receptor locations as a result of implementation of the new shuttle systems. At most, the implementation of the new systems only increases predicted noise levels by one decibel, remaining safely below FHWA criterion.

A draft master plan for the Jamestown Yacht Basin includes improvements to the marina as well as mixed residential and commercial development of the area immediately north of the basin (VHB et al. 2009). Potential impacts to noise and soundscapes associated with this proposed development and attendant boat traffic have not yet been performed.

SOILS

The soils of the NRA area are mapped and described in the *Soil Survey of James City and York Counties and the City of Williamsburg, Virginia* (USDA 1985). Several soil types are present within Historic Jamestowne, the majority of which are sandy loams, silt loams, Bohicket muck, and Levy silt clay. Soil associations are described below. Detail regarding individual soil units and soil mapping are included in the DCP/EIS.

Current Conditions

Soils within the NRA area can be generalized into three categories based on geographic position:

Neck of Land area north of Back River

Jamestown Island area

Glasshouse Point and the Isthmus

Those soils in the Neck of Land area fall into the Levy-Pamunkey-Dogue association, characterized by level or gently sloping and undulating soils. Levy soils are poorly drained silty clays located along tidal creeks and streams. Conversely, Pamunkey soils are well drained sandy loam and lie at higher elevations along river terraces. Dogue inhabits an intermediate elevation and is a moderately well-drained and loamy soil.

Levy soil underlies the tidal Back River Marsh between Jamestown Island and the mainland at Neck of Land. It has medium natural fertility and is very strongly to strongly acidic throughout. The soil is flooded daily by tides and is continuously saturated with water, making the soil unsuitable for farming and development. Vegetation typically consists of water-tolerant grasses and forbs, including arrowleaf (*Trifolium vesiculosum*), cattails (*Typha latifolia*), giant cordgrass (*Spartina cynosuroides*), and lilies (*Lilium* sp.).

Soils in the Jamestown Island portion of the NRA area do not fall into an established association but consist primarily of Newflat, Chickahominy, Tetotum, State and Tomotley soils, with areas of urban land corresponding to the visitor center parking lot and areas around the Memorial Church and Tercentennial Monument. Each of these soil units formed in low-lying riverine terraces having very little relief. Permeability runs the gamut from the poorly drained Chickahominy and Tomotley soils to the somewhat poorly drained Newflat silt loam to the moderately well drained Tetotum silt loam. The erosion hazard for all units is slight.

Glasshouse Point and the Isthmus are underlain almost exclusively by Udorthents loamy soil. This unit formed mostly in loamy fluvial and marine sediments and possesses highly variable texture, having from 0% to 50% quartz pebbles. Correspondingly, it is moderately well drained with permeability ranging from moderately rapid to slow. Slopes commonly range from 2% to 30% but can vary from 0% to 70%.

Hydric Soils

By definition, “a hydric soil is a soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part” (Environmental Laboratory 1987). Hydric soils within the NRA area include Levy silty clay, Chickahominy silt loam, and minor inclusions of the Johnston complex (USDA 2008).

Prime Farmland

Prime farmland soils, as defined by the United States Department of Agriculture (USDA), are soils that are best suited for producing food, feed, fiber, and oilseed crops. Prime farmland soils within the NRA area include Dogue, Emporia, Pamunkey, State, and Tetotum.

Gaps in Knowledge

There are no known gaps in knowledge related to soils. The nature and distribution of soils at Historic Jamestowne is well documented via the local soil survey (USDA 1985). Digital data are available for public consumption via the USDA website. The chief manner by which the survey

could be rendered more accurate would be via the accounting of recently installed infrastructure and associated land disturbance associated with the improvements of the Jamestown Project. However, these would represent minor corrections, the scale of which is typically not resolved by or expected of the local soil survey mapping.

Project Related Impacts

Permanent impacts to soils within the NRA area are generally limited to loss of area extent due to the construction of facilities and impervious surfaces such as the new visitor center parking lot, the collections building, and the archaearium (Figure 2). Temporary impacts include disturbance related to vehicular traffic around these construction sites as well as the staging of equipment and materials. The installation of the geothermal well field just northwest of the archaearium also resulted in temporary impacts to the soil column associated with trenching and pipe placement. However, impacts were minimized by comingling stormwater best management practices with this ground source system. Subsequent to the installation of the well field, a shallow bioretention basin was graded immediately atop it. This basin accepts rooftop runoff from the archaearium and provides an opportunity for infiltration into the soil column rather than point discharge to nearby wetlands. Approximately 400 cubic yards (cy) of soil were disturbed during the initial excavation. The excavated area was then filled with an estimated 170 cy of an organic soil/sand mix layer that was used for the bioretention planting mix material and covered with mulch. The native topsoil was stockpiled on site and used during final landscaping of the site. The same design elements were employed to construct the bioretention basin adjacent to and just north of the collections building.

Over 10,000 linear feet of other utilities were installed as part of the Jamestown Project. The majority of these utilities were installed underground. This involved temporarily disturbing and displacing soils to create new utility trenches. Displaced soils were stockpiled onsite and protected by appropriate erosion and sediment control measures. On average, trenches were cut to be 2 feet in width. The soils removed from the trench could not be returned to their original location but were spread across the site and protected against erosion while they were exposed.

While the creation of new impervious surface represents the chief impact on soils, the demolition of the original visitor center resulted in the removal of such surfaces and the reestablishment of vegetated ground cover over the former building footprint. Benefits of this work included phasing out point sources of stormwater input to the Pitch and Tar Swamp and an increase in the area providing groundwater recharge via infiltration through the soil column. The demolition of the original visitor center and the installation of low impact development (LID) facilities such as the two bioretention basins mitigated for the installation of new impervious surfaces and helped the Jamestown Project comply as closely as possible with NPS policy, which aims for no net gain of impervious surface.

Potential Future Threats

No significant future threats to soils are apparent. Proper installation, maintenance, and inspection of state and locally mandated erosion and sediment control measures will largely avoid serious impact to soil surfaces if and when the Observation Building, water taxi facilities and marsh boardwalk are constructed or should other future development plans arise.

SURFACE WATER RESOURCES & SUBMERGED AQUATIC VEGETATION

This section includes a discussion of surface water resources and how the hydrodynamic setting geographic position of Jamestown Island have implications for water quality, shoreline stability and the presence or absence of submerged aquatic vegetation (SAV).

Current Conditions

Several tidally influenced waterways and their associated wetlands account for most of the area of Historic Jamestowne (Figure 1). The James River borders the island to the west, south, and east. At this point in its course, the James River is a wide and relatively sluggish and brackish estuary, maintaining an average water elevation near sea level. Powhatan Creek flows from the north and empties into the James River via Sandy Bay, Back River, and The Thorofare. These water features isolate Jamestown Island from Neck of Land and Glasshouse Point. In addition, the tidally influenced Pitch and Tar Swamp runs through the NRA area (Figure 2) and is connected to Kingsmill Creek and The Thorofare to the east.

Hydrodynamic Setting

The tides at Jamestown Island are semi-diurnal, consisting of two high tides and two low tides each day. The closest National Oceanic and Atmospheric Administration (NOAA) tidal station having a significant record of data is located roughly 24 miles downstream of Jamestown at Sewell's Point; near the confluence of the James River with the Chesapeake Bay. The mean tidal range at this location is 2.43 feet (NOAA 2008). Historic Jamestowne's proximity to the Atlantic Ocean subjects it to super-elevated tides during storm events. The elevated tides allow wave action to flood significant portions of the island, including the Pitch and Tar Swamp. Wind-driven wave forces, particularly those brought about by hurricanes and nor'easters, can cause moderate to severe shoreline erosion. Recent examples of such storms include Hurricane Gordon in 1994, Hurricanes Bertha and Fran in 1996, two Nor'easters and Hurricane Bonnie in 1998, and Hurricane Isabel in 2003. These storms have eroded the shoreline along the James River in the vicinity of Jamestown Island, though the shoreline within the NRA area is armored and thus relatively static. The Shoreline Management Plan for Jamestown Island (Hardaway et al. 1999), summarized below, contains a detailed description of the wave climate at Jamestown Island.

As a boat passes over the water's surface, part of the energy generated by its propulsion is taken up by the water in the form of surface waves. While the effect of boat wake on shoreline erosion has been little studied, one study (Zabawa et al. 1980) found that wind waves ranked behind storm effects; and in all cases (five sites), boat wakes contributed less energy for erosion than wind waves. Several factors, however, are known to increase the potential for wake-related erosion.

The distance at which boats approach the shore is an important factor in evaluating erosion due to boat wakes. For instance, if boats pass too close to the shore, wake energy does not dissipate before reaching land. Boat speed and the depth of the water also affect boat wake energy. In small creeks, the largest wakes can be expected from boats traveling slightly faster than 6 knots at a water depth of about 6 feet (about 8 knots at a water depth of 12 feet). These large wakes produce more energy, thereby increasing the potential for erosion along the shore. However, the greatest potential for boating to increase erosion rates above natural levels can be expected

when high frequencies of boat passes occur within a few hundred feet of the shore (Zabawa et al. 1980).

Powhatan Creek and Back River are relatively narrow, averaging 100 feet and 200 feet wide, respectively. The shorelines here are therefore fetch-limited (i.e., they are not wide enough for winds to play a major part in wave action and erosion), but tidal currents and boat wakes can exacerbate shoreline erosion (Hardaway et al. 1999). However, all of the areas that have historically experienced shoreline erosion have been armored by bulkheads or riprap.

Shoreline

In 1999, the Virginia Institute of Marine Science (VIMS) prepared for Colonial NHP a Shoreline Management Plan for Jamestown Island, including the shores of Powhatan Creek, Sandy Bay, Back River, The Thorofare, and the James River. The management plan addresses the desire of federal and state agencies to “develop cooperative projects to improve water quality and enhance wetland habitat in the Chesapeake Bay region, while preventing the loss of significant resources, particularly those archeological sites near the water’s edge” (Hardaway et al. 1999).

In undertaking development of the property according to the Shoreline Management Plan, all shorelines and nearshore characteristics surrounding NPS and APVA properties on and around Jamestown Island were analyzed for historic erosion trends, wave climate, and adjacent land use. The total length of shoreline included in the VIMS study is about 14.6 miles. Generally, there are four important bank/shore types around Jamestown Island and along the Colonial Parkway: beaches/spits, upland banks, marsh fringe, and protected shorelines. Protected or armored shorelines constitute the entire length of the James River shoreline within the NRA area as well as at the Isthmus, whereas marsh fringe is the dominant shore type for the remainder of the area in Back River. Additional details on the status of the shoreline around Historic Jamestowne can be found in the DCP/EIS (NPS & APVA 2003).

Water Quality

The Lower James River is classified as a Category I Watershed, meaning that it does not meet, or faces imminent threat of not meeting, clean water goals (DCR 1998). The James River watershed is stressed by a combination of pollutants, including nutrients, toxics, bacteria, and sediments. The James receives the highest combined point and nonpoint nutrient inputs of any of the major Virginia Chesapeake Bay tributaries (NPS and APVA, 2003). Nitrogen and phosphorus loading are considerably higher in the more populated areas below the fall line (near Richmond) than in the rural areas above it (ODU 2005). Likewise, the percentage of impaired stream segments generally increases progressing from west to east (downstream) in the James River watershed. Because of Jamestown Island’s location near the confluence of the James with the Bay, water quality at the NRA area is an complex agglomeration of multiple inputs and is thus generally more compromised than locations further upstream in the river continuum.

Surface water quality at Jamestown Island is also affected by conditions within the Powhatan Creek watershed, as this water course makes confluence with the James River between the island and Neck of Land and thus flows through the NRA area. The Powhatan Creek watershed is located primarily in James City County and covers 22 square miles. It is designated by the Virginia DCR-DNH as one of the most significant natural areas remaining on the Lower Peninsula. Approximately 35% of the total watershed has been designated by the CWP as

priority conservation areas (CWP 2001, Sturm 2001). Because the watershed is technically adjacent to and does not intersect the Jamestown Project site, no conservation areas have been identified within the project area; however, the conservation area closest to Historic Jamestowne is located north of the Jamestown Yacht Basin (Figure 1). It is a contiguous forest tract approximately 60 acres in size. Where Powhatan Creek flows into the James River, the watershed is tidally influenced. This tidal portion extends from the northern border of the Jamestown Project site to the crossing at Route 5 and covers 2.5 square miles. Development within the watershed has notably increased over the past 30 years. In 1970, impervious cover within the watershed was approximately 3%. By 1998, the percentage of impervious cover had reached approximately 8%. Just two years later, the figure had reached an estimated 9.8%.

The Center for Watershed Protection (CWP) conducted an assessment of the watershed of Powhatan Creek and presented its findings in the Baseline Watershed Assessment for Powhatan Creek Final Report (CWP 2001). Ten subwatersheds, the mainstem of Powhatan Creek, and the tidal portion of Powhatan Creek, in which the Jamestown Project site is located, were assessed for hydrologic, geomorphic, biological, and water quality impacts.

The areas were then classified as sensitive, impacted, or nonsupporting, which are defined as follows:

Sensitive streams typically have a watershed impervious cover of 0-10%; are high quality; and are typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of fish and aquatic insects. Sensitive streams do not experience frequent flooding due to the low impervious cover.

Impacted streams typically have a watershed impervious cover ranging 11-25% and show clear signs of degradation due to watershed urbanization. Greater storm flows alter stream geometry, erosion is evident, stream banks are unstable, and physical habitat in the stream declines noticeably. Stream water quality is in the fair/good category.

Nonsupporting streams are ones in which impervious cover exceeds 25%. At this point, the stream channel becomes highly unstable, water quality is rated fair to poor, and contact recreation, such as swimming, is no longer possible because of high bacterial levels. The biological quality of nonsupporting streams is generally considered poor and is dominated by pollution-tolerant insects and fish.

The tidal segment of Powhatan Creek, to which the Jamestown Project site belongs, was classified as sensitive and has the potential to be classified as impacted in the near future. As of 2001, approximately 13.6% of the area consists of impervious or impacted cover (CWP 2001), and heavy stormwater pollutant loads from upstream are likely to increase fecal coliform problems. The area is currently listed as a 303 (d) water body, as defined by Section 303 (d) of the Clean Water Act. Waters designated by Section 303(d) are impaired for one or more pollutants and therefore do not meet one or more water quality standards. Section 305(b) of the Clean Water Act provides further analysis of water quality, identifying which designated uses the given body of water is able to support (i.e., aquatic life, drinking water, fishing, shellfishing, primary contact recreation, secondary contact recreation, agriculture).

As part of their requirements under the Clean Water Act, each state must develop Total Maximum Daily Loads (TMDLs) for its waters. TMDLs provide a measurement of the total amount of pollutants that a given body of water can absorb without affecting its 303(d) or 305(b) designation. The Department of Environmental Quality's (DEQ) latest 303(d) report (DEQ 2006) lists several impairments to water quality in the James River or Powhatan Creek at or near Jamestown Island, including:

the Shallow-Water Submerged Aquatic Vegetation Use is impaired based on failure to meet SAV acreage criteria.

the Open-Water Aquatic Life Use is impaired based on failure to meet the dissolved oxygen criteria for open water – summer.

the Recreation Use is impaired due to exceedance of the instantaneous criteria for *Enterococcus* bacteria.

These impairments are related to point source (industrial and municipal discharges) and nonpoint source pollutants (agricultural runoff and wet weather discharges).

Submerged Aquatic Vegetation

The predominant form of SAV in the more saline portions of tidal tributaries of the Chesapeake Bay is eel grass (*Zostera marina*), which grows in dense patches on the benthos in the depth zone where light penetration is good. Historically, the James River had a large SAV population. Evidence suggests that in the 1930s, there was over 1,600 hectares of SAV in the river. However, beginning in the 1940s, the upper James River began to experience a loss of SAV. By the 1960s, the lower river was also experiencing a reduction in overall numbers (Orth et al. 1998).

VIMS conducts annual surveys of SAV in the Chesapeake Bay and its tributaries, including the James River. Since the baywide survey began in 1978, and until 1995, only one bed had been mapped in the mainstem of the James, at the mouth of Hampton River. This bed persisted and increased to four beds by 1996; and a fifth bed was mapped east of the Hampton Bridge in 1997. The Upper and Middle James River had no SAV mapped in 1997 (Orth et al. 1998). In 1998, a fringing bed was discovered at the mouth of Mill Creek on the north side of The Thorofare near Jamestown Island; however, no SAV was observed in 2000 in the vicinity of Jamestown Island (Orth et al. 2000). In fact, the area of SAV in the Upper and Middle James decreased by 25% and 36%, respectively, between 1998 and 2000. Between 2000 and 2006, SAV populations continued to fluctuate throughout the James. In Back River, the only occurrence of SAVs was noted in 2004 (Orth et al. 2007). The overall lack of SAV in this reach is likely related to high concentrations of suspended sediments in the water transported from the developing Powhatan Creek watershed, which prevents light penetration sufficient to sustain SAV (Orth et al. 2007).

Gaps in Knowledge

Despite the depth of knowledge presented on water resources, there are still some notable gaps in knowledge. One of the three principal recommendations arising from the workshop is the collection of more up-to-date data on shoreline position and condition. This is particularly important before the commencement of the proposed water taxi service from Neck of Land in order to establish a baseline condition against which future shoreline transgression (or

regression) can be compared. Such a baseline survey would also be a critical component in any evaluation of shoreline change and loss of land due to sea-level rise. Shoreline erosion can add to the already highly turbid waters that surround the island (G. Speiran, pers comm. April 2007), which may in turn limit habitat for SAVs. The NPS currently possesses a 1997 shoreline survey in vector format as well as light detection and ranging (LIDAR) surveys from 2005 and 2007 (D. Geyer, pers comm. November 2008). The 2007 data may provide an adequate baseline for future studies of wake-related shoreline loss, but its suitability will depend on when the taxi service initiates.

Similarly, before the initiation of the water-taxi service across Back River, a water quality baseline would be appropriate. As expressed above, monitoring turbidity may be especially important. However, experimental design must take into account other factors that affect local turbidity, including off-site sources, wind/wave speed and direction, degree of boating activity, and so on.

Between the fall of 1995 and spring 1996, the FWS conducted a baseline water quality study in the vicinity of Historic Jamestowne, specifically within Black Duck Gut and the near-shore areas of the James River in the Swann's Point area. The results of the survey indicate that water quality is well suited to provide quality nursing habitat for numerous fishes of ecological, commercial, and recreational importance for the area. However, the FWS also concluded that the baseline water quality and fisheries resources should be resurveyed on a 10-year basis with a recommendation for more frequent surveying in areas prone to or that have the potential for overfishing or degradation (Odom and Swihart 1998). As recent data from the DEQ suggest that waters around Jamestown Island may be impaired with respect to dissolved oxygen, an update of the 1995-96 baseline survey may be warranted.

Project Related Impacts

The Jamestown stormwater management observation program (VHB 2008) gathered both qualitative and quantitative information to chronicle surface water quality before, during, and after the construction of new facilities within the NRA area. Qualitative observations identified obvious potential threats to the receiving waters of the Pitch and Tar Swamp and Back River. These included failed silt fencing, inadequate filtration at drop and curb inlets, exhausted or offline filter bags at pump outfalls, and poor stabilization of disturbed or recently graded ground surfaces. Site visits determined that the failure of standard erosion and sediment control measures represented the most potent threat to water quality and also the easiest to remedy. Quantitative records of measured water quality parameters helped identify a less obvious source of contamination: the flushing of high pH wash water associated with the installation of exposed aggregate surfaces.

After the completion of site construction and the stabilization of disturbed ground surfaces via reseeded, the water quality of runoff at all sampling stations returned to pre-construction conditions (where adequate baseline data were available). In areas where baseline data were not available, all post-construction water quality metrics exhibited a pronounced improvement over construction conditions and remained within state guidelines. This indicates the overall stormwater system was installed and is functioning per design. The installation of low-impact development facilities, such as the two bioretention basins, provides a water quality benefit previously absent at Historic Jamestowne. When these basins are empty or at low stage, runoff from minor storm events can be retained completely, infiltrating slowly into the basin substrate

rather than being discharged directly to wetlands of the Pitch and Tar Swamp. This new stormwater management strategy, coupled with the removal of the septic tank at the collections building, has resulted in an overall decrease in pollutant loading to adjacent wetlands.

Potential Future Threats

Projections calculated by the CWP suggest that impervious cover will occupy over 15.5% of the Powhatan Creek watershed in the future (CWP 2001). Though James City County is developing watershed-specific ordinance to help diminish non point source pollution of Powhatan Creek, this degree of development may create water quality concerns in downstream Sandy Bay, Back River, and The Thorofare.

As previously mentioned, James City County is currently evaluating options to improve the recreational facilities at the Jamestown Yacht Basin, located just upstream of the Colonial Parkway on Powhatan Creek, and at the nearby Jamestown Beach Campground. Though master planning is just beginning, it is conceivable that improvements to these amenities may result in increased recreational boat traffic around Jamestown Island, with attendant threats of wake-induced shoreline erosion and accidental spillage of boat fuel. The same threats could arise as a result of the planned water taxi, boats docks and marsh boardwalk, along with potential temporary threats posed by their construction.

Sea-level rise presents a significant threat to the shoreline and marshland habitats at Jamestown Island. Habitat and foraging areas for migratory waterfowl may be lost if the rate of rise exceeds the ability for marshes to migrate landward or if the potential area for migration is topographically limited (USGS 2008). The latter is more the case within the NRA area, as the expansive Back River Marsh abuts relatively high ground along Neck of Land.

NOAA is currently monitoring sea levels at multiple locations on the lower James River and in the Chesapeake Bay. These data will facilitate the identification of trends in sea level fluctuations over the coming years. The nearest NOAA gauging stations on the James River is located roughly 9 miles upstream at Tettington, Virginia, established in October 2007. The nearest station with a significant recorded history is located approximately 30 miles downstream at Sewell's Point, Virginia, established in 1927.

FLOODPLAINS AND FLOOD ZONES

Current Conditions

At the location of Jamestown Island, the James River more closely resembles a bay and estuary system than a true floodplain. This is because the river maintains an average water elevation near sea level. For this reason, the river can be viewed as having an infinite flood storage capacity. It can safely be assumed, therefore, that the Jamestown Island area is not at risk of flooding as a result of water from upstream influxes. Similarly, the downstream limit of the Powhatan Creek floodplain that is subject to flooding from upstream water sources occurs approximately 3 miles upstream from Jamestown Island (FEMA 1991).

On the other hand, flooding as a result of a tidal storm surge is a recognized threat. The old visitor center was located at an elevation below the 100-year floodplain, also known as the 1%

annual chance flood. At the time of Hurricane Isabel in 2003, the historical park's collection was permanently stored in the basement of the visitor center. The storm surge breached the sandbag dikes and entered the building, damaging the collection and resulting in the condemnation of the facility. While Isabel was the most powerful storm to hit the region in recent years, it was not the first time Historic Jamestowne was flooded. Anecdotal evidence suggests that the area has been flooded at least two to three times over the last 10 years. These floods were related to nor'easters and resulted in 2-3 inches of water in portions of the old visitor center.

Areas having a high risk of flooding from tidal storm surges have been identified by the Federal Emergency Management Agency (FEMA) based on a particular elevation. FEMA has recently revised the Flood Insurance Rate Map (FIRM) for the area around Jamestown Island and has determined the 100-year flood zone elevation (or 1% annual chance flood) to be 7.5 ft North American Vertical Datum (NAVD) 1988 (FEMA 2007). This value differs from the previous value of 8.5 ft National Geodetic Vertical Datum (NGVD) 1929, or approximately 7.2 NAVD 1988, thus the new value is thus just slightly less inclusive. The areas falling into the 500-year flood zone (or 0.2% annual chance flood) no longer have a determined elevation. The former map put this zone at 9.8 ft NGVD 1929. The overwhelming percentage of the NRA area falls within the 100-year flood zone. The exceptions are the upland portions of the Neck of Land area, the Isthmus and associated roadway, the location of the new visitor center, and the vicinity of the Tercentennial Monument and portions of New Towne.

Gaps in Knowledge

As the FEMA FIRM was updated in September 2007, floodplain designation within the NRA area is current. Therefore, there are no known gaps in knowledge of floodplains and flood zones at the site.

Project Related Impacts

Several newly constructed buildings lie within the 100-year flood zone, yet were constructed at an elevation above 7.5 ft NAVD88, and indeed, above the 9.8 ft NGVD29 elevation of the 500-year floodplain. These include the collections building, archaearium, and the new visitor center. As explained above, the addition of such features to the "floodplain" of the James River has virtually no impact on flood storage potential due to the estuarine-like setting at Jamestown Island. In addition, if floodwaters were to reach the collections building, pumps installed in the building's crawlspace would keep the collections dry.

Potential Future Threats

Proposed future developments in recognized FEMA flood zones include the marsh boardwalk and docks for the water taxi as well as the Observation Building. For the reasons mentioned in "Project Related Impacts" above, these features will have little or no effect on flood attenuation potential in the lower James River.

CHESAPEAKE BAY PROTECTION AREAS

Historic Jamestowne and other parts of Colonial NHP are located within the Chesapeake Bay watershed. Adopted by the Virginia General Assembly in 1988, the Chesapeake Bay

Preservation Act designates areas within the watershed as Resource Protection Areas (RPAs) and Resource Management Areas (RMAs), both of which serve to prohibit water quality degradation by limiting development in natural buffer areas. RPAs include tidal wetlands, tidal shores, nontidal wetlands connected by surface flow and contiguous to tidal wetlands or tributary streams, and an adjacent 100-foot buffer area. RMAs include floodplains, highly erodible soils, steep slopes, highly permeable soils, nontidal wetlands not included in the RPA, and other areas deemed critical in the protection of the state's water quality.

The James City County Chesapeake Bay Preservation Ordinance (Ord. No.183, 8-6-90) designates all of James City County as a Chesapeake Bay Preservation Area. RPAs are established based on the criteria in the Chesapeake Bay Preservation Act, while all other areas within the county have been designated RMA status. The ordinance provides guidelines for development within either of these areas and strives to control and regulate runoff to minimize pollution and sediment deposition in wetlands, streams, and lakes.

Current Conditions

The actual RPA boundaries within the NRA area were determined using the general RPA/RMA map provided by James City County combined with the known delineated wetlands at the site. Within the NRA area, RPAs are primarily limited to 100 feet landward of the shoreline of the James and Back Rivers and the tidal wetlands of the Pitch and Tar Swamp, as well as those nontidal wetlands that are contiguous with these features. Further detail on the vegetative communities located within the RPAs on Jamestown Island can be found in the DCP/EIS (NPS & APVA 2003). It should be noted that while recent guidance released by the Virginia DCR Division of Chesapeake Bay Local Assistance and adopted by James City County has generally resulted in the expansion of RPA-worthy wetlands and associated buffers in other parts of the county, the extent of the RPA depicted in the DCP/EIS is consistent with this new guidance and thus remains accurate (DCR 2007).

Gaps in Knowledge

By definition, the extent of RPAs and RMAs within the NRA area are well understood. Therefore, there are no known gaps in knowledge of Chesapeake Bay Protection Areas at the site.

Project Related Impacts

The footprint of the collections building does intersect the RPA related to the Pitch and Tar Swamp. Though such infrastructure is typically not authorized for construction in the RPA, the implementation of low-impact development features such as porous pavers and bioretention basins, coupled with the phasing out of an active septic field system, was accepted by James City County as worthy mitigation for the encroachment. Similarly, the well field for the geothermal climate control system serving the archaearium was installed entirely within the RPA. However, as a largely subterranean feature that poses no threat to surface water resources, the installation was authorized. Another bioretention basin resides atop the geothermal well field, treating runoff from the roof of the archaearium. Thus, available RPA encroachment was minimized by shared land use.

Potential Future Threats

Though infrastructure related to the future water taxi service would infringe upon RPAs, the recreational and water-dependent nature of the prescribed activity would render it permissible. Furthermore, the limited size and nature of the structures (e.g., docks, walkways) pose little threat to surface water resources.

GROUNDWATER RESOURCES

Current Conditions

Historic Jamestowne is located within the Coastal Plain Province of Virginia, which consists of a thick sequence of nonmarine deposits overlain by a thinner sequence of marine deposits. According to the Geologic Map of Virginia (DMME 1993), the majority of the Jamestown area is classified as Quaternary and Tertiary deposits, undifferentiated. These deposits consist of the Tabb Formation, Poquoson Member, Lynnhaven Member, Sedgefield Member, Shirley Formation, Chuckatuck Formation, Charles City Formation, Windsor Formation, and alluvial/tidal prism deposits. The remaining area (a small portion of Neck of Land and the Colonial Parkway east of Powhatan Creek) consists of the Sedgefield Member.

VIMS compiled and analyzed groundwater quality data from the Jamestown Project site as part of another project (MacIntyre et al. 1998). Among its findings, the project noted sources of groundwater contamination from nitrate and ammonia at several sites within Historic Jamestowne. Additional information on water quality data collected at several monitoring wells located near Jamestown Island can be found in the DCP/EIS (NPS & APVA 2003). While the history of settlement at Historic Jamestowne was tied closely to the settlers' ability to access clean groundwater, reliance on potable groundwater is no longer an issue. The increased development in the surrounding region has allowed the APVA and NPS to connect to county water supplies that are piped to the site.

Gaps in Knowledge

As groundwater is no longer used as a source of potable water and no rare or threatened vegetative communities have been identified within the NRA area that are sustained by or require groundwater discharge, groundwater studies are arguably less critical than those of surface water resources. Nevertheless, the Colonial NHP Water Resource Management Plan (VIMS 1994) did indicate that

... to to achieve its management objectives, Colonial NHP needs to know considerably more than is currently available about the structure and function of its hydrologic systems and water dependent environments. This will require a commitment to basic descriptive studies to define the extent and behavior of shallow groundwater systems in the park...

While such groundwater studies may provide some useful insight, it is worthwhile noting that no new vectors for groundwater contamination have been introduced within the NRA area by the implementation of the Jamestown Project. The principal threat to groundwater continues to be accidental petrochemical spillage from vehicular traffic, the risk of which increases correspondingly with traffic volume. However, at the visitor center parking lot, the network of stormwater pipes would route such spills to surface water drainages at Back River and the Pitch

and Tar Swamp though a grass-lined stormwater basin. The basin, located at the collections building parking lot just east of the visitor center, may present an avenue for the percolation of contaminants to the groundwater table. This is true of the collections building bioretention basin as well, which accepts some overland flow from the adjacent road and parking surfaces.

Each of the wells in the geothermal well field installed near the archaearium intersects the groundwater table. The circulating fluid used in the wells is typically a non-toxic, water-based antifreeze, though the fluid employed in this case has not been determined. All wells and connections were hydrologically isolated from groundwater by bentonite grout, thereby protecting the aquifer in the event of system leakage.

Project Related Impacts

Impacts on groundwater arising from the construction of new buildings and parking areas is limited chiefly to diminished recharge. However, due to the lowland, coastal setting, the groundwater table is relatively shallow. The timing and amount of flow of nearby, on island streams are driven as much or more by tidal fluctuations as by groundwater discharge. Thus, minor increases in impervious surface area (occurring principally at the visitor center and associated parking lot) likely have no consequence for groundwater recharge or stream baseflow. This is especially true at the location of the collections building and archaearium, given the use of bioretention (i.e., infiltration) basins to treat stormwater runoff from their rooftops and environs.

Potential Future Threats

No potential future threats to groundwater have been identified at this time.

WETLANDS

The EPA and the COE define wetlands as “areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (Environmental Laboratory 1987). Determination of a jurisdictional wetland requires the the presence of three parameters: hydric soil, a dominance of hydrophytic vegetation, and wetland hydrology.

Current Conditions

Approximately 1,055 acres of estuarine tidal deepwater habitats and wetlands, nontidal wetlands, and palustrine open water habitats exist within Historic Jamestowne. The tidal wetlands surrounding Jamestown Island and Neck of Land lie very close to the upper range of the estuarine environment and the lower range of the freshwater environment. Cowardin et al. (1979) distinguish the boundary between estuarine and palustrine (freshwater) systems to be the point where salinity reaches 0.5 parts per thousand (ppt) during low flow periods. The FWS wetland inventory mapping identifies the wetlands surrounding the island as palustrine. However, the agency performed a fisheries and water quality study in 1991 in the vicinity of Jamestown Island (Swihart et al. 1991), which indicates that salinity levels for the main rivers and marsh creeks were 0.0 ppt during the spring of that year, and rose to between 4.0 to 8.0 ppt during the month of October (period of low flow). Assuming the data represents a normal year,

the designation of the area's tidally influenced marshes and adjacent wetland forests may more appropriately be called estuarine. All other wetlands are classified as palustrine.

Within the NRA area, two chief wetland systems are present other than the open water of the James and Back Rivers:

tidal marshes characterized by herbaceous vegetation and related to Powhatan Creek, Sandy Bay, and Back River

the Pitch and Tar Swamp complex of forested and scrub-shrub wetlands, marsh, and open water

The boundary between freshwater and oligohaline marshes in the Back River is roughly coincident with the location of Pyping Point (Patterson 2008). The location of Pyping Point is presented in Figure 1. The oligohaline marshes (E2EM1R) consist primarily of rice cut grass (*Leersia oryzoides*), giant bulrush (*Scirpus validus*), and big cordgrass (*Spartina cynosuroides*). The boundary between the freshwater and oligohaline marsh is indistinct, although plants such as arrow arum (*Peltandra virginica*), duck potato (*Sagittaria latifolia*), and cattails (*Typha latifolia*) indicate the change in salinity to a freshwater system (PEM2R). These species are dominant along Powhatan Creek, north of the Colonial Parkway. The Pitch and Tar Swamp is similarly an oligohaline wetland, though plant diversity seems to increase with diminishing halinity in a westerly (upgradient) direction. Black needlerush (*Juncus roemerianus*), narrow-leaved cattail (*Typha angustifolia*), and spikerush (*Eleocharis* spp.) are common emergent plants in the Pitch and Tar Swamp, while wax myrtle (*Myrica cerifera*) and loblolly pine (*Pinus taeda*) are common along its scrub-shrub fringes.

Estuarine deepwater habitats occur in the NRA area in the form of tidal creeks (E1UB3R) within the marshes of Neck of Land (Figure 4). These channels function as flow ways important to the distribution of tidal waters throughout the large marsh systems. They also serve as habitat to the area fisheries for spawning, cover for fingerlings, and foraging for adults. In addition, waterfowl and wading birds seek these narrow creeks for protection from harsh weather and foraging. A wetland functional values assessment was completed for the entire Jamestown Project area. Additional information regarding this assessment can be found within the DCP/EIS.

Gaps in Knowledge

The distribution and classification of wetlands within the NRA area are well understood. This is particularly true given the June 2008 release of the latest vegetative classification and mapping technical report (Patterson 2008). However, it should be noted that the COE-confirmed wetland delineation for the Jamestown Project expired in January of 2007. Therefore, any planned future impacts to jurisdictional wetlands or streams would require an updated or reconfirmed delineation. One example of such a project would be the proposed marsh boardwalk linking Jamestown Island to the Intermodal Transportation Terminal at Neck of Land (Figure 4).

Project Related Impacts

Impacts to jurisdictional wetlands associated with the Jamestown Project were limited to the installation of the new pedestrian bridge. However, by employing top-down construction

methods, mechanical damage to the wetland substrate was limited to the location of the support pilings alone. Furthermore, the height of the bridge provides for light penetration to underlying plants, resulting in minimal impact to vegetation. Lastly, the planned decommissioning of the former pedestrian bridge will result in the restoration of those similarly impacted wetlands. Thus, this aspect of the Jamestown Project can be deemed to be essentially self mitigating.

One small, non-jurisdictional wetland was impacted in order to install the bioretention basin just north of the collections building. At just 1,485 square feet in size, this isolated feature was found to provide no special functions or values. Removal of this feature and the sanitary drain field underlying it required no mitigation as it fell below the NPS threshold of one-tenth of an acre.

Potential Future Threats

Potential future threats to wetlands are those previously discussed under the section “Surface Water Resources and Submerged Aquatic Vegetation.” These include construction of the proposed water taxi docks and marsh boardwalk. Increased activity in the Back River – both from the proposed future water taxi and possible improvements at Jamestown Marina and attendant traffic – may result in shoreline erosion caused by boat wakes. This would have the dual impact of decreasing wetland area via bank substrate failure and diminishing water quality via turbidity and suspended sediment. Potential impacts unrelated to the Jamestown Project include a degradation in water quality caused by developments in the James River and Powhatan Creek watersheds, shoreline erosion by storm activity, and sea-level rise.

VEGETATION

The following section describes the vegetative communities and nonnative invasive species found within the NRA area. Ecologically sensitive areas and state and federally protected species are discussed under the special status species section of this document.

Current Conditions

Communities and Species

Jamestown Island offers an excellent assortment of mature, undisturbed habitat types typical of the Virginia Coastal Plain, many of which closely resemble habitats the European settlers probably experienced when they first arrived. These habitat types offer significant diversity and productivity as they relate to hydrology and topography of the landscape. Habitats range from tidal riverine waters, tidal freshwater marshes, forested swamps, and upland pine/hardwood forests.

Vegetative cover types in the NRA area have been classified on various occasions in the past using unique systems. In 2002, Vanasse Hangen Brustlin, Inc. (VHB) performed one such classification using the Natural Communities of Virginia Classification of Ecological Community Types (Fleming et al. 2001) and cross-referenced to the “formation” level using the Standardized National Vegetation Classification System (TNC and ESRI 1994). Seven cover types were identified based on orthophotos, 200-foot-scale glossy color photographs, NWI maps, and field reconnaissance.

The DCR-DNH also performed an ecological communities inventory of the Jamestown project area for the NPS (Weber and Coulling 2002). They examined 19 sample plots across the entire project area, 10 of which were in the estuarine tidal marsh, 7 in the upland forest, and 2 in the palustrine wetland forest communities. Data included a listing of the vascular plants within each plot, the slope of the landscape, soil surface substrate, and mineral soil composition in the A-horizon. The results yielded six distinct vegetative groups, which were classified to the species alliance level using the Standardized National Vegetation Classification System.

In June of 2008, the NPS released Technical Report NPS/NER/NRTR – 2008/129, entitled “Vegetation Classification and Mapping at Colonial National Historical Park, Virginia.” This report utilizes the United States National Vegetation Classification Standard (NVCS) in accordance with jointly established standards of the U.S. Geological Survey (USGS) and NPS. Vegetation map classes were determined via extensive field data collection from 2003 to 2005. Map classes include existing NVCS associations, nonstandard (park-specific) vegetation classes, and Anderson Level II land-use categories. Additional details on methods can be found within the published report. The results for the NRA area are summarized below. Mapping for each of these associations can be found within the DCP/EIS.

Forests

Coastal Plain Loblolly Pine – Oak Forest (NVCS: CEG004766): This map unit constitutes the bulk of the forest upland within the NRA area, both at Neck of Land and on the island itself. The dominant oak species are white, southern red, and post oak (*Quercus alba*, *Q. falcata*, and *Q. stellata*).

This area was previously classified as Mesic Mixed Hardwood Forest, though the presence of loblolly pine was acknowledged. Braun (1950) describes the area as being within the oak/pine region of the Coastal Plain physiographic province. In addition to loblolly pine and oaks, common species include sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), American beech (*Fagus grandifolia*), American holly (*Ilex opaca*), persimmon (*Diospyros virginiana*), flowering dogwood (*Cornus florida*), and yellow poplar (*Liriodendron tulipifera*). Dominant understory species include wax myrtle (*Myrica cerifera*), red bay (*Persea palustris*), grape (*Vitis rotundifolia*), honeysuckle (*Lonicera japonica*), greenbrier (*Smilax rotundifolia*), poison ivy (*Toxicodendron radicans*), and chasmanthium (*Chasmanthium sessiliflorum*).

Tidal Bald Cypress Forest / Woodland (NVCS: CEG004654): This map unit is limited to a very small area immediately south of the Glasshouse on the west side of the Colonial Parkway’s approach to the Isthmus. This association is comprised of bald cypress (*Taxodium distichum*) and shoreline sedge (*Carex hyalinolepis*) and was previously mapped as Non-Riverine Swamp Forest. Observed understory species include wax myrtle (*Myrica cerifera*) and red bay (*Persea palustris*).

Successional Tuliptree – Loblolly Pine Forest (NVCS: CEG007521): This map unit is restricted to the north and west side of the Colonial Parkway, starting just east of the entrance to the Jamestown Settlement and extending south to the Glasshouse parking lot. This area was previously mapped as Mesic Mixed Hardwood Forest.

Grasslands

Cultural Meadow (NVCS: CEG006107): These areas include mowed roadsides measuring greater than 0.5 ha (1.2 ac) and are dominated by herbaceous species such as orchardgrass (*Dactylis glomerata*), timothy-grass (*Phleum pratense*), fescue (*Festuca* spp.) and goldenrod (*Solidago* spp.). Cultural meadows are mapped abutting the Colonial Parkway at Neck of Land and along the Isthmus.

Wetlands

Tidal Freshwater Marsh (NVCS: CEG004706): The entire limit of the Back River Marsh within the NRA area is classified as a Tidal Freshwater Marsh, characterized by green arrow arum (*Peltandra virginica*), annual wildrice (*Zizania aquatic var. aquatica*) and pickerelweed (*Pontederia cordata*). The transition to Tidal Oligohaline Marsh is mapped just east of the NRA area, at roughly the same longitude as the NPS Maintenance Facility.

The placement of this mapping unit represents the only significant departure from the previous vegetative classification contained within the DCP/EIS, which mapped the same area as Tidal Oligohaline Marsh. This decision was based in large part on water samples tested for halinity. Results were generally near the lower threshold for oligohaline conditions (0.5 ppt) though some samples from Back River Marsh did indeed exceed this value. The area is generally considered to be freshwater, though it is understood that the density front is transient in accordance with prevailing conditions.

Tidal Oligohaline Marsh (NVCS: varies): The Pitch and Tar Swamp is classified as a Tidal Oligohaline Marsh within the NRA area.

Other Map Units

In addition to the deviations noted above, other differences were observed between the latest NPS vegetation inventory and that performed by VHB for the DCP/EIS. VHB's work, while focusing much effort on the wetland inventory, resulted in several small forested and scrub-shrub wetland communities that were apparently undetected by the 2008 report. These are provided hereafter for informational purposes, and should not be considered as surrogate for the more current report.

Estuarine Fringe Pine Forests: This community type occurs along the upper fringes of the tidally influenced marshes and creeks. Loblolly pine is the dominant tree, with wax myrtle and greenbrier as the most common understory species. A small patch of this community type occurs on the south flank of the Pitch and Tar Swamp just east of the new pedestrian bridge, and another in the depression between the bus stop turnaround and the visitor center parking lot.

Tidal Shrub Swamp: The tidal shrub swamp community comprises wetland scrub/shrub habitats typically found immediately upstream from the freshwater and oligohaline marshes. This small occurrence is found just west of the new pedestrian bridge where seasonally high tides affect the functioning capacity of these systems. The dominant shrub species is almost

exclusively wax myrtle, with patches of soft rush, switchgrass, and cattails. Stressed saplings of loblolly pine, red maple, black gum, elm, and cypress were also observed.

Tidal Hardwood Swamp: The upper reaches of the Pitch and Tar Swamp is dominated by hardwood trees. This location is just north of the archaearium, just west (upstream) of the tidal shrub swamp described above, and east of the James River seawall. The dominant trees include loblolly pine, cypress, black gum, red maple, and sweetgum. Wax myrtle, soft rush, greenbrier, sedges, and chain ferns tend to be the dominant understory plants.

Invasive Nonnative Species:

Invasive nonnative plant species are typically found along roadsides or in areas that have been disturbed in some fashion or another. In some instances, these species have been found to penetrate natural communities because of their rapid growth and maturity, rampant vegetative spread, prolific seed production and dispersal, and aggressive ability to outcompete native species. This is most commonly seen in natural areas adjacent to or fragmented by a disturbed site so the integrity of the native community is threatened.

The NPS conducted an invasive nonnative flora inventory of Colonial NHP beginning in April 1999. The results of the inventory were reported in Final Report: Inventory of Invasive Exotic Plants of Colonial NHP (Gounaris and Grubbs 2000). The inventory included the following areas within Jamestown and the Colonial Parkway corridor: all forested areas and forested wetlands, all fields (Colonial Parkway only), and all nonforested wetlands. Mowed lawns of Jamestown Island (including the Townsite) were excluded from the inventory due to the difficulty of identifying species within those areas. During fieldwork conducted for the latest NPS vegetation classification and mapping report (Patterson 2008), 38 nonnative plant species were identified.

For the NRA area, nonnative plant infestation is concentrated primarily along the Colonial Parkway at Neck of Land with minor instances identified within the Back River marshes. Overall, Nepalese browntop (*Microstegium vimineum*) and Japanese honeysuckle (*Lonicera japonica*) are widespread throughout Jamestown and the rest of Colonial NHP. Parkwide, other species having a high percent ground cover include orchard grass (*Dactylis glomerata*), Bermuda grass (*Cynodon dactylon*), and tall fescue (*Festuca elatior*). However, if the large percentage of invasive coverage found on roadsides, trailsides, and fields is removed, Chinese privet (*Ligustrum sinense*) is the most abundant species, followed by common chickweed (*Stellaria media*), common reed (*Phragmites australis*), and tree of heaven (*Ailanthus altissima*).

The following additional invasive species were identified at Jamestown, including the Neck of Land area: aneilima (*Murdannia keisak*), beefsteak plant (*Perilla frutescens*), Canada bluegrass (*Poa compressa*), Chinese lespedeza (*Lespedeza cuneata*), English ivy (*Hedera helix*), gill over the ground (*Glechoma hederacea*), golden bamboo (*Phyllostachys aurea*), Japanese barberry (*Berberis thunbergii*), Johnson grass (*Sorghum halepense*), mimosa (*Albizia julibrissin*), multiflora rose (*Rosa multiflora*), princess tree (*Paulonia tomentosa*), red sorrel (*Rumex acetosella*), velvet grass (*Holcus lanatus*), and wineberry (*Rubus phoenicolasius*).

The plants listed above also were identified in the Colonial Parkway corridor, except Japanese barberry. In addition to those, the following species were observed: autumn olive (*Elaeagnus umbellata*), Chinese wisteria (*Wisteria sinensis*), common dayflower (*Commelina communis*), crown

vetch (*Coronilla varia*), kudzu (*Pueraria lobata*), moneywort (*Lysimachia nummularia*), morning glory (*Ipomoea purpurea*, *I. coccinea*, and *I. hederacea*), oriental bittersweet (*Celastrus orbiculatus*), sweet-clover (*Melilotus alba* and *M. officinalis*), thorny Elaeagnus (*Elaeagnus pungens*), white mulberry (*Morus alba*), and white poplar (*Populus alba*). It should be noted that reported results for the Colonial Parkway include the entire length of this road and not just the portion at Jamestown.

In the summer of 2007, VHB scientists performed field reconnaissance of that part of the Pitch and Tar Swamp within the NRA area with particular emphasis on the areas around and between the old and new pedestrian bridges (Figure 2). Common reed and cattails are commonly found at this location and are important in that they may be recognizable to some park visitors as occurrences of invasive species.

Gaps in Knowledge

With the release of the 2008 report, vegetation classification and mapping are thoroughly up to date. However, additional work may be worthwhile with regards to mapping the extent of invasive, nonnative plant species. While the general locations of invasive plant infestations are known, actual baseline survey data for those occurrences beyond the roadways has not been performed. This is a critical step in invasive species management and allows for prioritizing resource allocation, evaluating the efficacy of those eradication programs currently in place, and to plan for additional action as warranted.

Project Related Impacts

Construction of the archaearium and collections building necessitated the removal of minor amounts of woody and herbaceous vegetation. Grassed areas around these two facilities were temporarily impacted by construction vehicle traffic and by staged equipment and materials, as well as the stockpiling of soils. However, both of these developments also introduced new vegetation. Both buildings have dedicated stormwater BMPs which include both native and nonnative vegetation.

Reconfiguration of the Glasshouse Point parking lot and the construction of the Neck of Land Intermodal Transportation Terminal and associated parking lot also resulted in the removal and permanent loss of woody vegetation. At Neck of Land, a select mature trees were preserved in a strip of land between the parking lot and the Colonial Parkway, augmented by the installation of additional native specimen trees.

The removal of the old visitor center provided the opportunity to reestablish vegetation on previously impervious surfaces. The area was replanted with native grasses and landscaped to provide a favorable view of the Tercentennial Monument when approached from the original pedestrian bridge.

Potential Future Threats

Like many of the other resources within the project area, future impacts to vegetation are tied primarily to potential development within the project area. However, installation of the marsh boardwalk, boat docks and Observation Building would result in relatively minor impacts to

vegetation. The design elevation of the boardwalk is such that plant loss to shading effects will be negligible.

Other impacts to vegetation may come from increased browsing by deer. Overbrowsing can lead to loss of habitat and increased invasive species populations. As discussed in the forthcoming "Wildlife" section, undeveloped areas like Historic Jamestowne provide refuge from increasing development in the areas surrounding the island. As a general note, disturbances to native soil and vegetation can create conditions that favor invasive, nonnative species. The establishment of monotypic stands of common reed may threaten habitat for the rare skipper (*Problema bulenta*), a state species of concern.

WILDLIFE

In general, the wildlife population densities depend on many factors, including habitat availability, habitat quality for cover and nutritional food supplies, predator/prey relationships, climate, and human disturbance/interaction. Censuses and studies of terrestrial or arboreal wildlife census studies and measures of habitat quality for the Jamestown area are increasing, with very recent publications released by the NPS or forthcoming. These include inventories of amphibians and reptiles (Mitchell 2004) and surveys of lepidoptera (moths and butterflies), odonata (dragonflies and damselflies) (Chazal 2006), and endangered and threatened species within the project area (Chazal and Van Alstine 2001). Though taken from the introduction to the lepidoptera and odonata survey, the following quote applies to all such inventories that have been or will be performed at Colonial NHP:

The practical goal of these inventories [is] to advance the knowledge of the natural resources in [Colonial NHP] and to aid park personnel in decisions concerning land use, maintenance activities, public access, site placement for facilities, and management of areas containing any rare, threatened, or endangered species found...

The following section presents information regarding the existing populations of mammals, reptiles/amphibians, birds, insects and fish, as well as the status of the benthic community. Special status species are discussed in the subsequent subchapter.

Current Conditions

Mammals

Eighty species of terrestrial mammals are known to exist in the Carolinas and Virginia (Webster et al. 1985), which comprises approximately two-thirds of the number of species estimated to occur in the region 10,000 years ago (McDonald et al. 1998). Webster et al. (1985) lists five extirpated species of mammals present before and during colonial times. These include the gray wolf, red wolf, porcupine, elk, and bison. Webster et al. (1985) believe the mountain lion (eastern cougar) still exists in western Virginia, although Linzey (1998) lists the mountain lion as an extirpated species.

The NRA area offers a diversity of wetland and terrestrial habitat types for a variety of mammals. Of the 80 known species of mammals that occur in Virginia, the Virginia Department of Game and Inland Fisheries (DGIF) has identified 42 species as potential residents of the Jamestown Island area (DGIF 2000) based on confirmed sightings, habitat preference, and

known species ranges (Appendix B). All but one of the species listed in Appendix B have a global rarity rank of G5 (abundant). The northern long-eared myotis (*Myotis septentrionalis septentrionalis*) has global rarity rank of G4. The most recent inventory of mammals at Colonial NHP is listed by the NCBN as “complete,” however the results have not been made available to the public pending internal review.

The mixture of wetland systems within the NRA area is an important source of habitat for several common mammals on the Island such as the raccoon, beaver, muskrat, and mink. Bats often frequent open water and field environments as hunting territories for insect prey. White-tailed deer, flying squirrels, gray squirrels, opossums, shrews, voles, cottontails, foxes, and rats are terrestrial species that potentially occupy the mowed fields and pine/hardwood upland forests. Raccoons, white-tailed deer, gray squirrels, mice, and Norway rats are species that have adapted to human-altered environments and may encroach upon yards, buildings, and storage areas in the study area (Snyder 1981).

Reptiles/Amphibians

Mitchell (1994) records the presence of 62 species of reptiles in Virginia, of which 48 species are known to occur in the Coastal Plain. Forty-three reptilian species and 34 amphibian species were cited by the DGIF (2000) as potential residents of the Jamestown study area. Many species of frogs and salamanders are likely occupants of the hardwood swamps, marshes, and artificial drainage ways in the NRA area, in addition to a variety of snakes and turtles such as the northern water snake (*Nerodia sipedon*), eastern mud snake (*Farancia abacura abacura*), northern black racer (*Coluber constrictor constrictor*), black rat snake (*Elaphe obsoleta obsoleta*), eastern mud turtle (*Kinosternon subrubrum subrubrum*), eastern painted turtle (*Chrysemys picta picta*), eastern snapping turtle (*Chelydra serpentina serpentina*), striped mud turtle (*Kinosternon baurii*), and northern red-bellied cooter (*Pseudemys rubriventris rubriventris*). The tidal creeks also offer excellent habitat for these species. In addition, many turtles and frogs frequent the Pitch and Tar Swamp and can be viewed from the pedestrian footbridge south of the visitor center.

A site-specific herpetological survey was performed by Dr. Joseph Mitchell from the Department of Biology at the University of Richmond (Mitchell 2002). Using a variety of observation and trapping techniques, the results of his study confirmed the presence of 36 species of reptiles and amphibians in the Jamestown Island area. These include a variety of toads, treefrogs, salamanders, skinks, snakes, and turtles. No listed species were observed.

Some of the more common species observed in Dr. Mitchell’s recent study include the green treefrog (*Hyla cinerea*), northern green frog (*Rana clamitans melanota*), southern leopard frog (*Rana sphenoccephala*), marbled salamander (*Ambystoma opacum*), red-backed salamander (*Plethodon cinereus*), red-spotted newt (*Notophthalmus viridescens viridescens*), common snapping turtle, eastern painted turtle, eastern box turtle (*Terrapene carolina carolina*), eastern mud turtle, five-lined skink (*Eumeces fasciatus*), worm snake (*Carphophis amoenus amoenus*), and northern water snake.

Dr. Mitchell’s inventory of reptiles and amphibians revealed very little usage of what he classified as “bottomland hardwood” habitat. This is primarily due to the very small amount of this particular habitat type. The most commonly used habitat types were the ponds and vernal pools and upland pine forests. The island tended to harbor a higher number of species than

Neck of Land due to the higher quality habitat and more frequent presence of wetlands with open water.

Preferred habitats for most frogs include the ponds and vernal forested depressions on the island, whereas most salamanders were observed in the deciduous and pine forests. Water-loving turtles such as the common snapping turtle, Eastern painted turtle, spotted turtle, and Eastern mud turtle were observed occupying the ponds and vernal depressions on the island. The Eastern box turtle was the most common species observed in the forested uplands, and the Northern diamond-backed terrapin was the only species of turtle to be found exclusively in the tidal marsh. Most all snakes and lizards were observed in the forested upland habitats, with the exception of the Northern watersnake, which was commonly observed in areas of open water and was the only species of snake observed in the tidal marsh.

From 2001 to 2003, the NPS again contracted Dr. Mitchell to conduct an inventory to document 90% of the amphibians and reptiles of Colonial NHP, including the Jamestown study area (Mitchell 2004). Success criteria for this survey was based on distribution patterns indicated in previous literature (beyond that cited above), which documented the presence of 66 different species of frogs, salamanders, turtles, lizards, and snakes in the area. Fifty-one species were actually observed for Colonial National Historical Park as a whole, representing a success percentage of 83% of amphibians and 72% of reptiles as compared to the expectancy based on the literature. These were considered reasonable levels based on the drought conditions that plagued the first two years of the study. Of these 51 species, 23 were surveyed in the Jamestown Island area.

Nine habitat types were defined by the study, all of which were observed to support multiple species. The hardwood forests of Jamestown Island were distinguished by the study as supporting a unique assemblage of species. Only one state-listed threatened amphibian species, the Mabee's Salamander (*Amylostoma mabeei*), was encountered during this survey.

Appendix C provides a list of all the potential reptile and amphibian species that may inhabit the project area. All but two of the species listed in Appendix C have a global rarity rank of G5 (abundant). The northern diamond-backed terrapin (*Malaclemys terrapin terrapin*) and Mabee's salamander are listed as G4.

Birds

The Jamestown Project area contains important habitat for regional and migratory avifauna. The wetland, riverine, open field, and forested oak/pine complexes provide the diversity necessary to host a variety of passerines, buteos, accipiters, waterfowl, wading birds, woodpeckers, and shorebirds. As part of the Atlantic flyway, the Island is particularly important for wintering and breeding migratory species that use the habitats during all seasons. For example, the area marshes and surrounding waters provide wintering habitat for waterfowl; upland forests and wetland scrub areas offer breeding and foraging habitat for neotropical species during the spring/summer; and all habitats are used by year-round residents such as crows, jays, wading birds, cardinals, and owls.

The NRA area's marshes, rivers, and tidal creeks offer the most significant habitat for migratory and resident birds. The richness of this habitat provides excellent nesting, brooding, foraging, and roosting areas, particularly for the bald eagle. The NRA area is currently host to but one

bald eagle nest site, described in greater detail in the forthcoming “Special Status Species” section of this document.

The NPS has hosted annual neotropical bird counts on Jamestown Island each June, the results of which have consistently yielded 66-68 species observed. However, these surveys are performed when wintering migrants would not be detected. The DGIF has prepared a more comprehensive list of 189 species of birds that potentially use the Island at various times of the year. In addition to the DGIF list, Dr. Bryan Watts reviewed the potential avifauna at Jamestown, and the results of his study yielded 48 additional species of birds that may potentially use the project site (Appendix D). Of the total list, 88 are winter migrants, 75 are year-round residents, and 74 are migrant breeders.

Great Blue Heron

The great blue heron (*Ardea herodias*) is a large, grayish, wading bird with a yellowish bill. It is common throughout the Southeast and Midwest United States where it can be found around lakes, ponds, rivers, and coastal marshes. It is a colonial, tree-nesting species, often nesting in association with other wading birds within rookeries. Its preferred food source includes amphibians and fish generally found in shallow water. In the NRA area, the marshes of the Back River provide foraging habitat for the great blue heron.

Three great blue heron rookeries, all near one another, were discovered in 1984 on the southeast side of Jamestown Island between Passmore Creek and the James River. Nests occupy large loblolly pines that overlook the Passmore Creek marsh. These rookeries have been routinely monitored over the years, and the breeding pairs have seen considerable fluctuation in their numbers (Smith 2006). Between 1984 and 1988, the number of nesting pairs ranged from 13 to 25. Observations in 1993 indicated a dramatic upswing in the population to 110 nesting pairs, culminating with a peak of 225 in 2003. The most recent report issued by the Center for Conservation Biology (CCB) notes that while colonies have been observed on four different ridges on the southern end of Jamestown Island, just one ridge was occupied in 2006 (Smith 2006). The number of nesting pairs has decreased substantially from the 2003 peak to 110 in 2005 and just 21 in 2006. This decline is thought to be a reflection of the recent tendency for great blue herons to nest in smaller and more isolated colonies, though hurricane damage to and subsequent fall of mature canopy trees may also be a factor.

The Jamestown Island heronry lies directly across the James River from a similar colony in on Swanns Point, and the two colonies appear to share foraging areas and perhaps birds. Between 2005 and 2006, the number of nesting pairs in the Swanns Point heronry remained virtually unchanged at 55 and 56 pairs, respectively. However, like the colony at Jamestown Island, a notable decline did occur after 2003, which represented the peak year for nesting pairs at 135.

Insects

The DCR-DNH was contracted by the NPS to conduct surveys in 2003 and 2004 for Lepidoptera (i.e., butterflies and skippers) and Odonata (i.e., dragonflies and damselflies) in Colonial NHP, including areas within and surrounding the NRA area (Chazal 2006). Six habitat types were investigated, including developed areas, fields, forested uplands, forested wetlands, marshes, and water, all of which exist within the NRA area. A total of 57 species of Lepidoptera and 42 species of Odonata were documented over the 18 cumulative days of field survey. Of the six

habitat types, the field habitat (i.e., areas of herbaceous vegetation) yielded the highest species diversity and total numbers of adults for Lepidoptera species. Fields also supported the highest species diversity for Odonata and second highest total number for observed Odonata adults. The forested wetland habitat yielded the highest total numbers for Odonata species. Five watchlisted species were observed: Aaron's Skipper (*Poanes aaroni*), Comet Darner (*Anax longipes*), Blue-faced Meadowhawk (*Sympetrum ambiguum*), Furtive Forktail (*Ischnura prognata*), and Duckweed Firetail (*Telebasis byersi*).

Rare Skipper: A principal objective of the DCR-DNH study was to conduct a survey specifically targeting the Rare Skipper (*Problema bulenta*), a globally rare species (G2G3) that had been previously documented in Colonial NHP. The Rare Skipper was reconfirmed at a previously known location in a fringe marsh along The Thorofare, but no further documentation of this species was found in the remainder of the inventories. Individuals of this species were observed primarily in association with swamp milkweed (*Asclepias incarnata*).

Fisheries

The NRA area's location offers multiple habitat types for fisheries resources. This unique quality results from its position near the upper reaches of tidal waters associated with the mouth of the James River and Chesapeake Bay. At Jamestown Island, freshwaters from the upper James River and Powhatan Creek begin to meet brackish tidal waters to create several distinct ecological variants. As a result, this region supplies habitat for anadromous, estuarine, and freshwater species important to commercial and recreational fisheries.

The VDGIF (1999) and the FWS (Swihart et al. 1991) have performed surveys in the vicinity of Jamestown Island to monitor fluctuations in fisheries populations. Sampling was conducted in Sandy Bay, Back River, The Thorofare, Kingsmill Creek, several small creeks throughout the Island (Swihart et al. 1991), and in the James River near Swann's Point (Odum and Swihart 1998). The combined results of these studies yielded a total of 53 species collected in the James River, Powhatan Creek, and Back River (Appendix E). The composition of sampled species varied between the spring and fall sampling periods because of seasonal fluctuations in salinity levels. Populations of fish preferring freshwater were highest during the spring, when seasonally high rainfall routinely increases freshwater flow from upstream rivers, lowering the salinity in the region. Conversely, seasonal periods of lower rainfall have been shown to result in salinity levels rising to create oligohaline conditions preferable to perch (*Perca* spp.), striped bass (*Morone saxatilis*), and mullet (*Mugilidae* spp.).

Anadromous Fish:

Anadromous species spend their adult lives in marine or brackish waters and travel to fresher waters in inland drainages and rivers to spawn. Five species worthy of mentioning within this category include shad (*Alosa sapidissima*), herring (*Clupea* spp.), striped bass, white perch (*Morone americana*), and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*).

American Shad: Shad has historically been an important commercial fish, reaching its peak in the late 1800s. Population declines over the years have been attributed to multiple issues such as damming of rivers, pollution, sedimentation, and overharvesting (Klauda et al. 1991a) to such an extent that a moratorium on recreational fishing has been in place since the 1980s. DGIF has begun a restoration program for the American shad in hopes of reversing this decline.

According to agency officials, this program has shown early promise, especially with regards to dam removal projects (A. Weaver pers comm. 2008). Furthermore, recent studies conducted by VIMS are showing increases in American gizzard (*Dorosoma cepedianum*) and threadfin shad (*Dorosoma petenense*) populations (Onley 2001).

Herring: Herring has also been an important commercial fish. However, as with the shad populations, the herring populations have seen a decline since the 1970s, even more dramatically than all the other anadromous fish (Klauda et al. 1991b). The decline began as a result of several causes, which include overharvesting, the decline in stock abundance, and the gradual loss of upstream spawning habitat. Alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*), two species sampled in the Jamestown Island area, are viewed similarly as “river herring” in the commercial fisheries industry (USDOT 1984). These fish occur in all Atlantic coast states except Georgia (Klauda et al. 1991a).

Striped Bass: Striped bass are semi-anadromous fish in that they migrate to tidal freshwater areas just above the salt wedge to spawn (USDOT 1984). As the Chesapeake Bay region is considered the most primary spawning area, they are considered one of the most highly sought-after commercial and recreational fish in Virginia. Population levels have fluctuated over the years, even to the extent that fishing was closed to striped bass during the 1980s. However, fishing has since been reopened with size restrictions and creel limits.

Atlantic Sturgeon: The Atlantic sturgeon was once very populous in the Chesapeake region. It is found in the Chesapeake Bay and spawns in the tidal freshwaters of the connecting rivers during April and May. The population has experienced a drastic decline most likely due to overharvesting (Burkhead and Jenkins 1991), but other factors such as pollution, sedimentation, and construction of dams also may have been contributors. The Atlantic sturgeon is not a federally listed species and carries no legal federal status. It is a species of special concern, and harvesting of sturgeon is currently prohibited. Recent studies by the Virginia Sturgeon Research Team (COE 2008) indicated Atlantic sturgeon are particularly prevalent in the waters southeast of Jamestown and upriver of Hog Island, where a number of juveniles and adults were observed in 2007 during a catch and release program. Fish are being tagged with tracking devices in order to better study their life cycle and determine the location of spawning areas so that future management plans can provide guidance on avoiding these sensitive areas (FLMNH 2008).

Estuarine Fish

Estuarine fish are species that prefer brackish waters. This would include killifish (various families), silversides (Order *Atheriniformes*), the Bay anchovy (*Anchoa mitchilli*), and various species of minnows (Subfamily *Leuciscinae*) that were sampled near Jamestown Island. While most of these species are not commercially or recreationally important, they are significant in the food web as prey.

Freshwater Fish

During the spring, data seem to support an increase in freshwater fish at Jamestown Island, particularly in Back Bay and Powhatan Creek. The most common of these include largemouth bass (*Micropterus salmoides*), pumpkinseed (*Lepomis gibbosus*), channel catfish (*Ictalurus*

punctatus), bluegill (*Lepomis macrochirus*), and sunfish (Family *Centrarchidae*). These species are most notably important to the recreational and sport fisheries industry.

Commercial and Recreational Fisheries

A number of important commercial and recreational fishes were captured in sampling of the James River near Swann's Point (Odum and Swihart 1998). These included American eel (*Anguilla rostrata*), American shad, Atlantic menhaden (*Brevoortia tyrannus*), blue catfish (*Ictalurus furcatus*), channel catfish, white perch, striped bass, bluegill, largemouth bass, black crappie (*Pomoxis nigromaculatus*), yellow perch (*Perca flavescens*), weakfish (*Cynoscion regalis*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), and southern flounder (*Paralichthys lethostigma*). This diverse mixture of fish is typical of the upper estuarine habitat.

In addition to the fish captured, the commercially and recreationally important blue crab (*Callinectes sapidus*) was encountered at all sites sampled. White shrimp (*Penaeus setiferus*) was also observed and captured in sizeable numbers at several sites.

Benthic Community

Benthic refers to aquatic organisms that are found near on or in the bottom sediments. Numerous benthic surveys have been conducted in the Hampton Roads area, including the James River and vicinity (Boesch 1971, 1973; Diaz 1989). Generally, there are no significant marine resources, such as oysters or clams, in the nearshore environment at Historic Jamestowne because anthropogenic impacts, both locally and upstream, have been significant. These impacts include the construction of the Jamestown Isthmus and Colonial Parkway, dredging and disposal of sediment, and building of shoreline defense structures upriver from Jamestown Island, which restrict the natural sediment supply.

The substrate in this area is generally high in numbers of individual organisms but low in community diversity. Micro- and macro-organisms include diatoms, dinoflagellates, foraminifera, skeleton shrimp, jellyfish, stinging nettles, and larval forms of fish, crustaceans, and other organisms. Animal benthos known to inhabit the Jamestown Island area include the barnacle (*Balanus* sp.), spider crab (*Libinia* sp.), hermit crab (*Pagurus* sp.), blue crab (*Callinectes sapidus*), starfish (*Asterias* sp.), slipper shell (*Crepidula* sp.), mud snail (*Nassarius* sp.), and oyster drill (*Urosalpinx* sp.). There are no public or privately leased oyster grounds in the vicinity of Jamestown Island. In fact, the waters around Historic Jamestowne were condemned for shellfish harvesting by the Virginia Department of Health (VDH) effective December 2006 (VDH 2008). The closest active oyster grounds are located downriver, approximately 14 miles.

Gaps in Knowledge

The latest publications and forthcoming documents have largely addressed gaps in the knowledge database with regards to wildlife at Jamestown Island. However, no recent and comprehensive information regarding fish populations could be found. The NCBN has established protocols for saltmarsh nekton sampling, though has not confirmed a schedule for performing the work at Jamestown Island (D. Geyer pers comm. November 2008).

The latest amphibian and reptile survey for Colonial NHP recommends that the mature hardwood stands of Jamestown Island and their accompanying ephemeral wetlands be

subjected to continued monitoring (Mitchell 2004). The same publication cites a need for a natural habitat management plan to conserve reptiles and amphibians. It cites the discovery of six species using logs and snags marked for removal as an example of the potential for unintended habitat destruction.

The findings of the Lepidoptera and Odonata surveys suggest that frequent mowing during the breeding season can have adverse impacts on these species, either directly via take or indirectly through depletion of nectar or host plant availability. Accumulation curves based on this survey indicate that additional surveys for these species may increase the known fauna of Colonial NHP. In other words, the potential species numbers based on previous studies in the area are higher than the yields from this survey, meaning that some species were potentially missed. Further survey data collected for this area would therefore likely include some of these additional species based on those curves.

Very little is known about the population size, dynamics, movements, and survivorship of the Mabee's salamander in Colonial NHP. Additional studies and monitoring are recommended by the latest study (Mitchell 2004), along with the development of a conservation management plan. The park is making efforts at monitoring the Mabee's salamander and the Virginia Herpetological Society performed a survey in May 2008. No individuals or eggs were observed, perhaps as a result of persistent drought conditions at the time (D. Geyer pers comm. November 2008).

Project Related Impacts

Due to the high level of coordination and planning involved in the Jamestown Project DCP/EIS, impacts to wildlife within the project area were limited. The most immediate impact likely came from the increased noise associated with the construction process. Noise may have scared animals away from their usual feeding or nesting spots but only for relatively short periods. Time of year restrictions were implemented to protect special status species, as discussed in the section below. Once complete, the new construction did not notably extend the developed footprint on the site. Wildlife continues to move freely across the site with no increased threats or disturbances.

Removal of woody vegetation and habitat for the construction of the Neck of Land Intermodal Transportation Terminal

Potential Future Threats

Any future development at Historic Jamestowne could pose additional threats to wildlife populations, as described in the previous chapter. Expanding the developed portion of the project area would deprive wildlife species of existing habitat for feeding, breeding, and/or nesting. It would also push the populations into a smaller space, creating increased competition for food and space.

This could also become a problem without increased development in the project area. Southeast Virginia is experiencing rapid levels of land development. As development increases, wildlife across the region will be pushed out of existing habitats. Areas where development is limited, like Historic Jamestowne, will become safe havens for displaced wildlife. As displaced

populations move in to the area, the existing populations in Historic Jamestowne may experience increased competition for food and shelter.

Both boat traffic and vehicular traffic along the Colonial Parkway were listed in the latest amphibian and reptile survey report (Mitchell 2004) as potential threats, both directly and indirectly. Boat and roadway traffic could increase in response to the construction of the marsh boardwalk and water taxi docks. Predatory species populations have been shown to increase in areas of high human use. Additionally, disease introduction from the release of captive-raised or captive-bred reptiles and amphibians is another concern raised by the amphibian and reptile survey.

A fish survey is recommended in order to establish baseline conditions before the onset of the water taxi service and the construction of the boardwalk across the Back River from Neck of Land.

RARE, THREATENED AND ENDANGERED SPECIES AND SPECIES OF CONCERN

The FWS and NOAA are responsible for administration of the Endangered Species Act. The Act protects plant and animal species that are listed as threatened or endangered. The DCR-DNH maintains a similar listing for rare species of the Commonwealth of Virginia. The following sections describe what state and federal listed species have been confirmed to be present within the NRA area.

Current Conditions

According to surveys by the DCR-DNH, Colonial NHP hosts the second-highest number of rare, threatened, and endangered species of all the NPS units in Virginia (Colonial NHP 1999). Communications with DCR-DNH, DGIF, and the FWS, indicate that several federal- and state-listed species, as well as species of special concern, have been documented within and adjacent to the Jamestown Project site (Table 2).

To document the presence of rare, threatened, and/or endangered species, as well as the natural vegetation communities within the Jamestown Project site, DCR-DNH performed surveys for known listed plant and animal species. Observations confirmed the following species: bald eagle (*Haliaeetus leucocephalus*), sensitive joint-vetch (*Aeschynomene virginica*), gaping panic grass (*Steinchisma hians*), and the rare skipper (*Problema bulenta*) (Chazal and Van Alstine 2001). Extensive searches for the small-whorled pogonia (*Isotria medeoloides*) failed to locate any existing populations or appropriate habitat within the Jamestown Project site (Chazal and Van Alstine 2001). In addition, a search for Parker's pipewort (*Eriocaulon parkeri*) within the mudflats along Back River also found nothing (DCR-DNH 2001).

Conservation Sites

Conservation sites, designated by DCR-DNH, represent key areas of the landscape worthy of protection and stewardship action because of the natural heritage resources and habitat they support. Conservation sites are polygons designed around one or more occurrences of rare

Table 2: Special Status Species Confirmed at Historic Jamestowne

Status	Common Name	Scientific Name
FS / SS	Atlantic sturgeon	<i>Acipenser oxyrinchus</i>
ST	Bald eagle	<i>Haliaeetus leucocephalus</i>
SS	Barn owl	<i>Tyto alba pratincola</i>
SS	Bridle shiner	<i>Notropis bifrenatus</i>
SS	Caspian tern	<i>Sterna caspia</i>
SS	Forsters tern	<i>Sterna forsteri</i>
SS	Golden-crowned kinglet	<i>Regulus starapa</i>
SS	Great egret	<i>Ardea alba egretta</i>
SS	Hermit thrush	<i>Catharus guttatus</i>
SS	Least tern	<i>Sterna antillarum</i>
ST	Loggerhead shrike	<i>Lanius ludovicianus</i>
ST	Mabee's salamander	<i>Ambystoma mabeei</i>
SS	Northern harrier	<i>Circus cyaneus</i>
ST	Peregrine falcon	<i>Falco peregrinus</i>
SS	Purple finch	<i>Carpodacus purpureus</i>
SS	Red-breasted nuthatch	<i>Sitta canadensis</i>
FT / ST	Sensitive joint-vetch	<i>Aeschynomene virginica</i>
SS	Winter wren	<i>Troglodytes troglodytes</i>

Source: Roble 2006, Townsend 2006

FE = Federal Endangered, FT = Federal Threatened, FS = Federal Species of Concern (not legal status),

ST = State Threatened, SS = State Special Concern (not legal status)

plant, animal, or natural communities. They include the natural heritage resources and, where possible, associated habitat buffer or other adjacent land thought necessary for the resource's conservation. Conservation sites are given a biodiversity significance ranking based on the rarity, quality, and number of natural heritage resources they contain. One conservation site is located within the NRA area. The Jamestown Island conservation site was created by the merger of three elements: the Back River marshes, upper Jamestown Island fields (Chazal and Van Alstine 2001), and Jamestown Island marshes (Clark and Rafkind 1998).

The Jamestown Island conservation site has a biodiversity rank of B3 (as per the DCR Natural Heritage Program) because it has a high significance for biodiversity. It contains a small population of the state and federal listed plant sensitive joint-vetch, as well as seven nesting sites for the state threatened bald eagle, an increase of four since the publication of the DCP/EIS in 2003 (Watts and Byrd 2008). The Island also supports a great blue heron rookery. While these birds are not federally listed, they are protected under other federal laws such as the Migratory Bird Treaty Act of 1918 and local regulations that protect colonial waterbirds.

At the western end of the Island, periodically wet areas support a population of at least 120 individuals of the state rare plant gaping panic grass. Watchlist species in this area also included big carpet grass (*Axonopus furcatus*), Florida paspalum (*Paspalum floridanum*), pasture flatsedge (*Kyllinga gracillima*), panic grass (*Panicum anceps*), a flatsedge (*Cyperus flavicomus*),

grass leaved rush (*Juncus biflorus*), forked rush (*Juncus dichotomus*), fall witchgrass (*Panicum dichotomiflorum*), and Virginia buttonweed (*Diodia virginiana*). This site represents the only recently documented occurrence of gaping panic grass in Virginia. Other historical records for gaping panic grass in Virginia are from the late 1930s and early 1940s (Chazal and Van Alstine 2001).

Threatened Species

Sensitive Joint-Vetch

Sensitive joint-vetch (*Aeschynomene virginica*) is a tall annual plant in the Legume family (Fabaceae) bearing pinnately compound leaves and small, yellow flowers with light red venation. The legume (pod) is produced in late summer to early autumn and breaks apart into one-seeded segments that are dispersed by floatation. The species is native to the Mid-Atlantic states and is known from a very restricted range in Virginia. Suitable habitat includes slightly brackish, high diversity tidal marshes along rivers and creeks (Ware 1991). Upon dropping, the seeds float until subtle high points or encumbrances in the marsh are encountered. Such features are typically found along natural levees, bars, and wrack lines at the marsh fringe. The seeds are also likely to germinate in areas recently denuded of vegetation, such as muskrat “eat-outs” and sediment depositional areas.

By virtue of its FWS designation as a “threatened” plant in 1992, sensitive joint-vetch is afforded protection under the federal Endangered Species Act (FWS 1995). As recently as 2007, an extant population of this species has been documented at Colonial NHP along the fringe of an abandoned roadway crossing Back River marsh just west of Sandy Bay (pers. obs., Figure 6). The recent historical record of this location dates back to 2000, but the first documented account of sensitive joint-vetch in the park was in the late 1930s. Bailey et al. (2006) summarize the historical record of this species at Colonial NHP as follows:

Aeschynomene virginica has been known to occur at the Colonial National Historical Park (COLO) site since at least 1938 (Fernald, 1939), and specimens were collected from this location in 1938 and 1939 by Fernald & Long [11052 (US)]. In 2000, the Virginia Department of Conservation and Recreation discovered an *Ae. virginica* population of 13 plants within the COLO management area in Back River marsh, in a location historically known to support this species (Chazal & Van Alstine, 2001; Erdle & Heffernan, 2002). As this population was documented during a wet growing season (2000), Chazal and Van Alstine (2001) hypothesized that *Ae. virginica* may respond positively to wetter summer precipitation patterns.

Since that 2000 discovery, return visits by various researchers have shown the annual demography of this population to be highly variable. Table 3 provides statistics on population size and climate trends that were taken from Bailey et al. (2006), with additional data provided by VHB.

The hypothesized correlation between summer precipitation and population size has been discussed in relation to soil chemistry (Bailey et al. 2006). Though no specific experiments have tested this hypothesis, it is presumed to be the case that wetter summer conditions lead to the



- Colonial National Historical Park Boundary
- Association for the Preservation of Virginia Antiquities Boundary
- Limits of Natural Resource Assessment
- Sensitive Joint-Vetch Colony (Surveyed Sept. 2007)
- Bald Eagle Nests (Observed Spring 2008)



Historic Jamestowne

Natural Resource Assessment
Jamestown, Virginia

Figure 6
Confirmed Locations of
Sensitive Joint-Vetch
and Bald Eagle Nests

Table 3. Summary of Sensitive Joint-Vetch Surveys: Back River Marsh

Year	Number of Plants In Back River Marsh	Spring [Mar-May] Precipitation (cm)*	Summer [Jun-Aug] Precipitation (cm)*
2000	13	25.8 (-1.1)	61.4 (+23.6)
2001	0	23.1 (+3.8)	39.4 (+1.6)
2003	0	35.5 (+8.6)	45.9 (+8.1)
2004	>458	24.3 (-2.6)	68.2 (+30.4)
2005	6	22.0 (-4.9)	40.2 (+2.4)
2007	2	23.1 (-3.8)	32.7 (-5.1)

Source: D. DeBerry pers comm. 2009

*Departure from average shown in parentheses, with (+) indicating wetter conditions and (-) indicating drier conditions.

dilution of brackish soil water with freshwater from rainfall and river subsidies. If true, then the lower salinity conditions would render the soil more conducive to seed germination for sensitive joint-vetch, the seed of which has very low tolerance for salt content (Baskin et al. 1998, 2005). As Bailey et al. (2006) note, the two most abundant population years were 2000 and 2004, which happened to coincide with the 4th and 3rd wettest summers on record, respectively.

What this means is that sensitive joint-vetch seeds may require a combination of exposed substrate (i.e., open or partially open soil), elevation (i.e., slightly higher than other areas in the surrounding marsh), and an abundance of fresh water (not brackish) in the marsh. This last item is based mostly on speculation from observations of weather data and population trends, along with the seed studies of other researchers (e.g. Baskin et al. 1998, 2005); however, it is clearly the case that the extreme population spike in 2004 coincided with a very wet summer.

The presence (or absence) of exposed soil in any given year may be related to storm events in the previous year. For example, Hurricane Isabel, which created extreme storm surge conditions in the lower James River estuary, occurred in September of 2003, approximately one year prior to the 2004 survey which documented over 450 sensitive joint-vetch plants. It is possible that tidal forcing associated with Isabel created localized disturbances around the sensitive joint-vetch colony, removing competitive species that had begun to encroach on the site (such as big cordgrass (*Spartina cynosuroides*)). On a slightly elevated area such as the abandoned road on which sensitive joint-vetch grows, it is not difficult to envision a high-energy tidal pulse pushing flotsam and river debris across the low berm of the road – and taking some of the colonizing vegetation along with it. If this happened during Isabel, then the resulting exposed soil, coupled with the fresher water in a very rainy summer, might have been the coalescence of conditions that allowed this annual plant to proliferate in the summer of 2004.

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) has made a significant comeback in North America after regulations were adopted to protect the bird from hunting and Dichloro-Diphenyl-Trichloroethane (DDT) was banned. This is especially true for the Chesapeake Bay area. The most recent data obtained from CCB show that the number of nesting bald eagles in Virginia has increased dramatically since 1977, from 31 to 557 active nests (Watts and Byrd 2008).

Furthermore, a total of 864 chicks were observed in 2008, the highest number in the 32-year record of CCB surveying. In 2008, the majority of Virginia's nesting eagles were associated with the Chesapeake Bay and the bay's tributary rivers (Potomac, Rappahannock, York, and James). The success of the eagles' population expansion since the early 1970s resulted in its removal from the federal list of endangered and threatened wildlife, though they continue to be protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. The Commonwealth of Virginia continues to list the bald eagle as threatened (Roble 2006).

The bald eagle in the eastern United States comprises several population cells that tend to migrate and intermingle seasonally throughout the East Coast. A breeding population exists in the northeast United States and Canada that tends to migrate south to the Chesapeake Bay region after the nesting season. At the same time, the breeding population in Florida, the largest of the eastern breeding populations, migrates north during the summer to the Chesapeake Bay or Great Lakes region or Canada.

In addition, Virginia hosts a population of nonmigratory resident bald eagles. It is during the summer that the largest numbers of eagles congregate in Virginia. The odd migratory and residential behavioral patterns of the eastern eagle populations all point to the Chesapeake Bay region as being one of the most important habitats for the species in eastern North America. The banks of the James River, in particular, has been one of the more productive locations in terms of the number of active nests (121 nests in 2008) and fecundity rates (average of 1.5 chicks per active nest over last two years).

Eagles have specific habitat requirements based on their desire for fish as their main food source. These consist of nest sites, perching areas, and foraging areas in close proximity to open water (Andrew and Mosher 1982). Preferred nest trees typically consist of tall pines along shorelines that offer open flyways for ease of egress and ingress (McEwan and Hirth 1979). When nest sites are not particularly available along the shoreline, sites have been used several miles away from open water. Some eagles have also shown an ability to habituate to some routine human activities (Stalmaster and Newman 1978). Nest sites have been documented near home sites, boat ramps/marinas, bridges, and golf courses.

Preferred perching habitat consists of tall trees and snags of almost any tree species immediately adjacent to the shoreline of lakes, rivers, bays, and estuaries. Perching areas tend to coincide with foraging areas of shallow water, such as coves, where the birds can overlook the open water for fish. The same perch sites tend to be frequently used for hunting and for overnight roosting. Perch sites also provide resting sites for migratory birds moving through the Chesapeake Bay region.

As part of the James River habitat corridor, the Jamestown Island project area provides acres of relatively undisturbed, high quality habitat for nesting eagles. Since the inception of the CCB flyover studies, seven nests have been documented on Jamestown Island (Figure 6). One of these nests is located in the NRA area, at the northwest edge of the Island near the visitor center parking lot. It appears that the birds using this nest have habituated to automobile traffic in and around the parking lot as well as existing boat traffic in Back River. A brief survey conducted from April to June 2002 showed that eagles had virtually no reaction to passing boats. The shallow waters of Sandy Bay and nearby James River provide excellent foraging habitat for this pair. This nest (assigned name JC-01-01 by the CCB) produced one chick in 2008. Of the

remaining six nests on the Island, two were active in 2008: one produced two chicks and the other none.

Birds of Special Concern

The following birds are listed as species of special concern or as watch-list species by the state of Virginia: great egret (*Ardea alba*), northern harrier (*Circus cyaneus*), Caspian tern (*Hydroprogne caspia*) and the least tern (*Sternula antillarum*).

Least Bittern: The least bittern is a small, cryptic heron with conspicuous buff wing patches. It prefers freshwater marshes with reeds along the edges of open water, where it forages primarily on aquatic invertebrates. Within North America, the bittern ranges from southern Canada to southern Texas, and winters from the Gulf Coast southward.

The marshes at Neck of Land provide adequate habitat for the least bittern. However, no data regarding population numbers are available.

Great Egret: The great egret is a large, white heron with a yellow bill and black legs. Habitat preferences include freshwater and saltwater marshes, ponds, lakes, and tidal flats. It ranges as far north as New England during the summer months, with the dominant winter range extending from South Carolina southward and along the Gulf Coast. Preferred food sources include fish, amphibians, small reptiles, and crustaceans.

Habitat in the NRA area includes the marshes of Neck of Land. However, the only observed nest occurs in the area of the existing great blue heron rookery on the southern tip of the island (Smith 2006). Management recommendations to protect potential habitat for the great egret include protection of the marshes and tidal creeks and ensuring the water quality of the rivers and ponds is maintained to provide excellent foraging habitat.

Northern Harrier: The northern harrier is a medium sized hawk that is recognized by its white rump patch and low, gliding flight pattern over its preferred habitat of marshes, open fields, and farms. This is the only hawk that hunts from the wing rather than from the perch. Prey includes small mammals, birds, and reptiles. The northern harrier's breeding range extends from north-central United States and Canada, while the wintering habitat includes the East Coast states, south-central United States, and Gulf states.

Habitat for the harrier in the NRA area includes the open marshes of the Back River and the Pitch and Tar Swamp. Upland mowed fields provide some limited habitat.

Caspian Tern: The Caspian tern is a mostly white, gull-sized bird with a black cap and pale gray back and wings. Its bill is very bright red. The Caspian tern's habitat includes sandy shores of lakes, ponds, large rivers, and the sea coast where it can be found from the Great Lakes region and the Newfoundland area of Canada southward to wintering grounds in the Carolinas and Gulf Coast. Breeding habitat often corresponds with other colonial nesting shorebirds.

Habitat for the Caspian tern within the NRA area is limited to the feeding areas associated with open water, such as the Back River and Sandy Bay. No habitat for nesting is suitable for the Caspian tern.

Least Tern: The least tern is the smallest of the terns, about the size of a sparrow. It is noted by its yellow bill with black cap. It is a colonial nester and prefers open beaches, sand dunes, and large river sandbars for nesting. This bird occurs along most North American coastlines and large rivers. Concern for the species has been raised due to the increased use of shoreline and waterfront for development, which has reduced nesting habitat.

The NRA area does not provide any colonial, ground nesting sites that would include the least tern. Use of the area by least terns is limited to feeding areas within the rivers and open water.

Gaps in Knowledge

Sensitive Joint-Vetch

Additional studies are needed to further evaluate the response of sensitive joint-vetch seed germination to climate variation. However, such studies are problematic in the field due to the synergistic effects of other population variables such as competition, tidal forcing, marsh morphometry, and stochastic events (e.g., storm surges) which cannot be field-controlled in an experimental manner. One approach that has been used successfully in the past is conducting experiments in mesocosms (i.e., small habitat replicas in greenhouses or other experimentally controlled locations), as demonstrated by the experiments of Baskin et al. (1998, 2005).

In addition, one obvious commonality among most extant populations is the recurrence of open conditions such as muskrat “eat-outs” or otherwise denuded substrate (Ware 1991). These open substrate conditions usually occur near the marsh fringe where exposure to energy (wave, tide, storm surge, etc.) is high. As such, there is some suggestion that disturbance is a factor in establishing viable populations of this species. If true, then the presumed correlation between high precipitation summers and local population rise could be related to a higher occurrence of substrate-disturbing events such as storm surges (e.g., tidal forcing, destructive flotsam, sedimentation, etc.). Additional research on storm-related substrate disturbance and sensitive joint-vetch demographic data is needed to better understand this relationship.

Bald Eagle

Routine monitoring of the eagle nests on Jamestown Island and the vicinity have resulted a thorough record of the activity of the breeding pairs of bald eagles within the NRA area. Coupled with data from ongoing annual flyovers, there are no significant gaps in knowledge with respect to the Jamestown Island eagle population.

Project Related Impacts

As noted in the previous section, time of year restrictions were imposed on the construction process to protect special status species within the project area, specifically the bald eagle. The FWS’s Biological Assessment created time of year restrictions that prevented construction activities from interrupting the bald eagle breeding season. The DCP/EIS also included plans to protect the sensitive joint-vetch and other conservation areas within the site.

During the construction process, monitoring was conducted to ensure that these protective measures were abided by and successful. Reports authored by the CCB indicate that the bald

eagle population has suffered no adverse effects from the development and has quickly adapted to new structures and distractions.

Potential Future Threats

The continued existence of the Back River marsh sensitive joint-vetch colony is uncertain. However, given that the colony wasn't detected in 2001 and 2003 and given its dramatic resurgence in 2004, erratic fluctuations in population numbers appear to be normal for the species at this location. This is, in fact, a typical life history strategy for an annual plant – rapid growth when conditions are favorable – and should probably be considered a normal population process for sensitive joint-vetch. Given the nearly annual data collected on this colony since 2000, continued sensitive joint-vetch monitoring of the Back River marsh is recommended to maintain this database, which has proven valuable in the study of this rare species.

Future threats to special status species are similar to those faced by other wildlife populations. However, because of the sensitive nature of these species, their tolerance for competition is much less than others. These species are afforded additional protection through their federal and state listings, but these protections may not address all potential threats. If competition for food and space increases or disturbances augment, these species will face greater challenges. Future habitat disturbances may arise subsequent to construction of the marsh boardwalk and boat docks, as visitor frequency and watercraft traffic may increase. The potential realization of improvements to Jamestown Yacht Basin may also result in additional boat traffic in Back River.

In July 2007, the bald eagle was removed from the federal list of endangered and threatened wildlife. However, it remains federally protected by both the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act and is protected under state law and DGIF regulations. As such, the active nests at Jamestown Island are not threatened by the delisting. As discussed above, ongoing monitoring has proven that the eagles within Historic Jamestowne have adapted very well to the changing environment and have not had their breeding, feeding, or nesting patterns disrupted. This is particularly evident in the increase in active nesting since 2003.

Conclusion

The birthplace of modern American society and an active and vital historical resource, Jamestown Island's estuarine setting also offers inherent riches in terms of natural resources. Expansive tidal marshes occurring at the fresh/brackish water transition are particularly productive. Active bald eagle nests are steadily growing in number on Jamestown Island, taking advantage of these protected marshlands for foraging. Back River Marsh also houses at least one colony of the federal and state-listed sensitive joint-vetch, which has a very restricted range in Virginia. Ridge and swale topography provides for a diverse assemblage of plants and animals. The island's complex amalgam of landforms and elevations; its mosaic of forested, scrub-shrub, and emergent wetlands is reflected in its ranking as high significance for biodiversity (B3). The rare skipper, a globally rare butterfly, has recently been reconfirmed at Colonial NHP (Chazal 2006) and has been previously observed occupying the tidal marshes of the Back River. This occurrence marks just one of two known populations in the state of Virginia.

Recent publications released by the NPS have largely resolved outstanding gaps in knowledge, particularly with respect to wildlife. However, during a workshop attended by representatives of the FWS, DCR-DNH, USGS, and NPS, four key natural resource issues were identified as being most pressing to address:

Shorelines: Conduct baseline survey of shoreline condition and associated vegetative fringe. This survey is of critical importance to identify areas of erosion and associated habitat loss. Suspended sediment from eroding shorelines is also a recognized inhibitor for SAV colonization. The area around Jamestown Island remains impaired with respect to SAV acreage criteria (DEQ 2006). Effects of erosion on local fish habitat are unknown. A shoreline survey will also identify areas of armored shoreline that may be in need of repair. This recommendation is consistent with the Geological Resources Management Issues Scoping Summary prepared by Colorado State University (Thornberry-Ehrlich 2005).

Invasive species: Reassessing the strategic plan for managing invasive species (Åkerson et al 2000) and taking stock of the efficacy of the management program to date was suggested from both an ecological and aesthetic perspective. Invasive species can out compete desirable native plants, establishing relatively unproductive monocultures. Common reed is well established in some areas of Jamestown Island, and along with cattails, are present and can be readily observed by visitors from the pedestrian bridge crossing the Pitch and Tar Swamp. Monotypic stands of common reed may threaten habitat for the state-listed rare skipper as well as other wildlife.

Threatened and endangered species: Workshop participants encouraged continued monitoring of bald eagle nests at Jamestown, particularly nest JC-01-01 located within the NRA area. The CCB continues to perform annual flyovers of bald eagle nests at Jamestown and will continue to do so for the foreseeable future. An exhaustive baseline survey for sensitive joint-vetch in the Back River marsh has never been undertaken.

Though the location of the colony mentioned in this report has been relatively well studied, questions remain regarding population dynamics, whether or not suitable conditions exist elsewhere in the marsh for other such colonies, and if shoreline erosion may threaten such colonies.

Water quality: Developing monitoring plans for water quality was also recommended, though workshop attendees recognized the difficulty in interpreting results and identifying potential sources of pollution because of the location of Jamestown Island at the lower end of the James River and near its confluence with both the Chickahominy River and Powhatan Creek. Nevertheless, collecting baseline water quality data – particularly in Back River and Sandy Bay – was deemed useful. This is especially important before the onset of the water taxi service and/or improvements to the nearby Jamestown Yacht Basin.

Appendixes

APPENDIX A. AIR QUALITY DATA: 2003

Table A-1. Predicted Maximum One-Hour CO Concentrations*	
Receptor Location	2003 Existing**
State Route 31 (Jamestown Road) and State Route 359	
1. West side of Route 31	4.4
2. Jamestown Settlement parking lot (west side)	4.4
3. Jamestown Settlement Visitor's Center (west side)	4.7
Colonial Parkway and State Route 359	
1. East side of Colonial Parkway	3.8
2. Jamestown Settlement Parking lot (east side)	4.0
3. Jamestown Settlement Visitor's Center (east side)	3.8
State Route 31 (Jamestown Road) and State Route 199	
1. Prudential reality office	7.4
2. CVS convenience store and pharmacy	6.9
3. SunTrust Bank and office park	7.3
4. 7-Eleven convenience store	6.9
Colonial Parkway and State Route 199	
1. Open space northeast quadrant	5.6
2. Open space southeast quadrant	3.1
3. Open space southwest quadrant	6.5
4. Open space northwest quadrant	5.3

Source: NPS and APVA, 2003

* = The concentrations are expressed in ppm and include a one-hour background concentration of 3.0 ppm

** = The one-hour NAAQS for CO is 35 ppm

Table A2. Predicted Maximum Eight-Hour CO Concentrations*	
Receptor Location	2003 Existing**
State Route 31 (Jamestown Road) and State Route 359	
1. West side of Route 31	3.1
2. Jamestown Settlement parking lot (west side)	3.1
3. Jamestown Settlement Visitor's Center (west side)	3.3
Colonial Parkway and State Route 359	
1. East side of Colonial Parkway	2.7
2. Jamestown Settlement Parking lot (east side)	2.8
3. Jamestown Settlement Visitor's Center (east side)	2.7
State Route 31 (Jamestown Road) and State Route 199	
1. Prudential reality office	5.2
2. CVS convenience store and pharmacy	4.8
3. SunTrust Bank and office park	5.1
4. 7-Eleven convenience store	4.8
Colonial Parkway and State Route 199	
1. Open space northeast quadrant	3.9
2. Open space southeast quadrant	4.3
3. Open space southwest quadrant	4.6
4. Open space northwest quadrant	3.7

Source: NPS and APVA, 2003

*= The concentrations are expressed in ppm. The eight-hour concentrations were calculated using a persistence factor of 0.7.

**= The eight-hour NAAQS for CO is 9 ppm.

Appendixes

APPENDIX B. POTENTIAL MAMMALIAN WILDLIFE INHABITANTS

Table B-1. Potential Mammalian Wildlife Inhabitants of Jamestown Project Area		
Scientific Name	Common Name	Habitat Preference
<i>Blarina brevicauda kirtlandi</i>	Kirtland's short-tailed shrew	Mostly terrestrial environments including salt marshes, fields, and forests.
<i>Castor canadensis</i>	Beaver	Wooded streams, ponds, lakes, and marshes.
<i>Cryptotis parva parva</i>	Least shrew	Relatively open areas dominated by herbaceous vegetation, such as grassy fields and salt marshes.
<i>Didelphis virginiana virginiana</i>	Virginia opossum	Wooded bottomlands near streams, ponds, swamps and other sources of water.
<i>Eptesicus fuscus fuscus</i>	Big brown bat	Abandoned buildings, attics, behind window shutters and under eaves. Hollow trees and crevices in rocks and under loose bark are also used to a lesser extent.
<i>Glaucomys volans volans</i>	Southern flying squirrel	Mature hardwood and mixed conifer hardwood forests, especially where there is an abundance of old trees with natural cavities or woodpecker holes suitable for nest-building.
<i>Lasionycteris noctivagans</i>	Silver-haired bat	Near permanent water in clumps of leaves, abandoned woodpecker holes, and protected crevices under loose bark in trees. Rock crevices and relatively open buildings sometimes serve as daytime roosts.
<i>Lasiurus borealis borealis</i>	Eastern red bat	Favored roost sites are trees and shrubs, often near permanent water or open fields.
<i>Lasiurus cinereus cinerius</i>	Hoary bat	Coniferous forests that border cleared areas and permanent water.
<i>Lynx rufus rufus</i>	Bobcat	A wide variety of habitats to include both coastal swamps and upland forests. Prefers forests where there are extensive areas of dense thickets associated land-clearing.
<i>Marmota monax monax</i>	Woodchuck	Prefers to dig a burrow on the edge of forests that border open land, along brushy fence rows or stream banks; also under building and the edge of utility easements.
<i>Mephitis mephitis nigra</i>	Striped skunk	Variety of habitats ranging from high mountain forests to old fields, cultivated lands, and suburban neighborhoods.
<i>Microtus pennsylvanicus pennsylvanicus</i>	Meadow vole	Damp meadows; also in coastal brackish and salt marshes, grassy upland fields, and orchards with a dense layer of herbaceous vegetation covering the ground.
<i>Microtus pinetorum pinetorum</i>	Common pine vole	A variety of woodland and old-field habitats, especially those with well-drained soil and either a deep layer of leaf litter or dense vegetation on the ground.
<i>Microtus pinetorum scalapsoides</i>	Pine vole	Deciduous woods, grasslands, meadows, orchards.
<i>Mus musculus musculus</i>	House mouse	Houses, fields, farms.
<i>Mustela frenata noveboracensis</i>	Long-tailed weasel	Woodlands, brushy areas, and borders between woodlands and fields.
<i>Mustela vison mink</i>	Common mink	Semiaquatic; associated with most types of wetlands.
<i>Myotis lucifugus lucifugus</i>	Little brown bat	Attics of houses and buildings; under shingles and shutters; close proximity to permanent bodies of water.
<i>Myotis septentrionalis septentrionalis</i>	Northern long-eared myotis	Forested areas; hibernates in caves, mines, and tunnels.
<i>Nycticeius humeralis humeralis</i>	Evening bat	Hollow trees or in crevices under bark.

Table B-1. Potential Mammalian Wildlife Inhabitants of Jamestown Project Area		
Scientific Name	Common Name	Habitat Preference
<i>Ochrotomys nuttalli nutalli</i>	Common golden mouse	A variety of habitats, from moist woodlands and boulder-strewn slopes and ridges of the mountains to low thickets, swampy woodlands and canebrakes at lower elevations.
<i>Odocoileus virginianus</i>	White-tailed deer	Broken areas of mixed young forests, old fields, and croplands typical of much of the rural portions of the region.
<i>Ondatra zibethicus macrodon</i>	Large-toothed muskrat	Brackish marshes dominated by bulrushes or cattails, but is likely present in most well-vegetated fresh or brackish marshes.
<i>Oryzomys palustris palustris</i>	Marsh rice rat	Fresh, brackish, and salt marshes and marsh edges.
<i>Peromyscus gossypinus gossypinus</i>	Cotton mouse	Lowland deciduous forests, cane and cypress swamps, thickets, and river floodplains.
<i>Peromyscus leucopus leucopus</i>	Common white-footed mouse	Hardwood forests preferred; field margins, myrtle thickets, marshes, canebrakes, and brushy fencerows are also inhabited.
<i>Pipistrellus subflavus subflavus</i>	Eastern pipistrelle	Spanish moss and clumps of leaves are used as daytime roosts; caves, rock crevices, and mines serve as hibernacula.
<i>Procyon lotor lotor</i>	Raccoon	Wetland habitats such as marshes, swamps, and streams but also occur in moist upland habitats and even in suburban neighborhoods.
<i>Rattus norvegicus norvegicus</i>	Norway rat	Lives in close proximity to humans; ground floor of buildings, tunnels, sewers, wharves, garbage dumps, and storage bins or elevators.
<i>Reithrodontomys humulis virginianus</i>	Eastern harvest mouse	Old fields, marshes, and meadows.
<i>Scalopus aquaticus aquaticus</i>	Eastern mole	Old field habitats. Likely to be found in broomsedge fields, but also in cultivated grain fields.
<i>Sciurus carolinensis carolinensis</i>	Gray squirrel	Extensive tracts of mature forests of oaks, hickories, and beeches mixed with other hardwoods and various species of conifers.
<i>Sciurus niger niger</i>	Southeastern fox squirrel	Longleaf pine-oak forests and along the edges of adjacent swamps in the Carolinas; Virginia sub-species may inhabit loblolly pine-hardwood forests with minimal undergrowth.
<i>Sigmodon hispidus virginianus</i>	Hispid cotton rat	Thick pastures, grassy roadsides, and abandoned agricultural fields dominated by broomsedge; also field edges with tangle of honeysuckle and other vines.
<i>Sorex hoyi winnemana</i>	Pygmy shrew	Ridges and slopes in deciduous forests with scattered rocks, fallen logs, and leaf litter covering the forest floor.
<i>Sorex longirostris longirostris</i>	Southeastern shrew	Damp fields, canebrakes, thickets, and lowland forests, particularly under the tangles of honeysuckle, poison ivy, and other vines.
<i>Sylvilagus floridanus mallurus</i>	Eastern cottontail	Old fields, brushy edges, and other habitats characterized by mixtures of herbaceous and shrubby plants.
<i>Tamias striatus fisheri</i>	Fisher's eastern chipmunk	Deciduous woodlands, the edges of forests, or open and brushy forests where there are abundant crevices for refuge.
<i>Urocyon cinereoargenteus cinereoargenteus</i>	Eastern gray fox	Strong preference for woodlands, especially those in the early stages of forest succession.
<i>Vulpes vulpes fulva</i>	Red fox	Open habitats, seldom found in dense woodlands; interspersed croplands, woodlots, and old fields.

Table B-1. Potential Mammalian Wildlife Inhabitants of Jamestown Project Area

Scientific Name	Common Name	Habitat Preference
<i>Zapus hudsonius americanus</i>	Meadow jumping mouse	Moist weedy or grassy fields and in thick vegetation near marshes, streams, or ponds.

Source: NPS and APVA, 2003

Appendixes

APPENDIX C. POTENTIAL AMPHIBIAN AND REPTILIAN INHABITANTS

Table C-1. Potential Amphibian and Reptilian Inhabitants of Jamestown Project Area		
Scientific Name	Common Name	Preferred Habitat
<i>Acris crepitans crepitans</i>	Eastern cricket frog	Upland areas in the Northern U.S.
<i>Acris gryllus gryllus</i>	Coastal plain cricket frog	Lowlands, Coastal Plain bogs and ponds and river-bottom swamps.
<i>Agkistrodon contortrix mokasen</i> ³	Northern copperhead	Rocky, wooded hillsides and mountainous areas; abandoned and rotting slab or sawdust piles.
<i>Agkistrodon piscivorus piscivorus</i>	Eastern cottonmouth	Swamps, lakes, and rivers, of rice fields and ditches.
<i>Ambystoma mabeei</i> ³	Mabee's salamander	Bottomland forests and floodplains, but may also be found in upland forests with suitable breeding sites (semi-permanent pools about 1 m deep). Fossorial during the nonbreeding season and migrate to ponds, streams, or pools to breed.
<i>Ambystoma maculatum</i> ^{1,3}	Spotted salamander	Beneath stones or boards in moist environments; breeds in woodland ponds.
<i>Ambystoma opacum</i> ^{1,3}	Marbled salamander	Moist sandy areas to dry hillsides.
<i>Amphiuma means</i> ^{1,3}	Two-toed amphiuma	Ditches, sloughs, ponds, rice fields, swamps, streams.
<i>Bufo americanus</i> ^{1,3}	American toad	Shallow bodies of water in which to breed, hiding places where there is some moisture, and an abundant supply of insects and other invertebrates for food.
<i>Bufo fowleri</i> ^{1,3}	Fowler's toad	Chiefly in sandy areas, around shores of lakes, or in river valleys.
<i>Bufo terrestris</i>	Southern toad	Particularly abundant in sandy areas.
<i>Carphophis amoenus amoenus</i> ^{1,3}	Eastern worm snake	Usually discovered under stones or boards, in rotting logs, during digging operations.
<i>Cemophora coccinea copei</i>	Northern scarlet snake	In or near soil suitable for burrowing (sandy, loamy, etc.), in logs, beneath bark, etc.
<i>Chelydra serpentina serpentina</i> ^{1,3}	Eastern snapping turtle	Any permanent body of fresh water.
<i>Chrysemys picta picta</i> ^{1,3}	Eastern painted turtle	Shallow water with profuse aquatic vegetation and the bottom soft and muddy.
<i>Clemmys guttata</i> ^{1,3}	Spotted turtle	Marshy meadows, bogs, swamps, small ponds, ditches, or other shallow bodies of water.
<i>Cnemidophorus sexlineatus sexlineatus</i>	Six-lined racerunner	Open, well-drained areas are preferred -- those covered with sand or loose soil; fields, open woods, thicket margins, rocky outcrops, river floodplains.
<i>Coluber constrictor constrictor</i> ^{1,3}	Northern black racer	Wet or dry woods, farms, fields, swamps.
<i>Desmognathus auriculatus</i>	Southern dusky salamander	Mucky and acidic cypress ponds, stagnant to slightly stagnant pools in river floodplains and coastal swamps.
<i>Desmognathus fuscus</i> ³	Northern dusky salamander	Brooks, streams and seepage areas.
<i>Diadophis punctatus edwardsii</i>	Northern ringneck snake	Cutover areas that include an abundance of hiding places in the form of stones, logs, bark slabs, or other rotting wood.
<i>Diadophis punctatus punctatus</i> ^{1,3}	Southern ringneck snake	Although not aquatic, ringnecks are most often found where there are evidences of moisture---near swamps, springs, on damp wooded hillsides, in flat, poorly-drained pine woods, etc.
<i>Elaphe guttata</i> ³	Corn snake	Terrestrial habitats----in pine barrens or wood lots, on rocky hillsides; spends a lot of time underground.

Table C-1. Potential Amphibian and Reptilian Inhabitants of Jamestown Project Area

Scientific Name	Common Name	Preferred Habitat
<i>Elaphe obsoleta obsoleta</i> ^{1,3}	Black rat snake	Habitats range from rocky, timbered hillsides to flat farmlands or the Coastal Plain. May establish residence in tree cavities.
<i>Eumeces fasciatus</i> ^{1,3}	Five-lined skink	A great variety of habitats but able to tolerate drier conditions. Thrives mainly on small seashore islands in the southeast that have no fresh water and little vegetation.
<i>Eumeces inexpectus</i> ³	Southeastern five-lined skink	Found in a great variety of habitats but able to tolerate drier conditions. Thrives mainly on small seashore islands in the southeast that have no fresh water and little vegetation.
<i>Eumeces laticeps</i> ^{1,3}	Broadhead skink	Habitats vary from swamp forests to empty urban lots strewn with debris.
<i>Eurycea cirrigera</i> ³	Southern two-lined salamander	Beneath masses of wet leaves in creek or river swamps.
<i>Eurycea guttolineata</i> ³	Three-lined salamander	River-bottom swamps, wet ditches, seepage areas at springs and streamsides.
<i>Farancia abacura abacura</i>	Eastern mud snake	Southern swamps and lowlands.
<i>Farancia erythrogramma erythrogramma</i>	Rainbow snake	Found in or near water; streams passing through cypress swamps.
<i>Gastrophryne carolinensis</i> ^{1,3}	Eastern narrow-mouthed toad	A wide variety of habitats with shelter and moisture.
<i>Hemidactylum scutatum</i> ^{1,3}	Four-toed salamander	Usually associated with sphagnum as well as boggy woodland ponds.
<i>Heterodon platirhinos</i>	Eastern hognose snake	Sandy areas.
<i>Hyla chrysoscelis</i> ^{1,3}	Cope's gray treefrog	Chiefly in relatively small trees or shrubs that are near or actually standing in shallow bodies of water.
<i>Hyla cinerea</i> ^{1,3}	Green treefrog	Swamps, borders of lakes and streams, floating vegetation, or almost any place well supplied with water or dampness.
<i>Hyla femoralis</i>	Pine woods treefrog	Climbs high in the trees, commonly found in pine flatwoods and in or near cypress swamps.
<i>Hyla squirrela</i> ^{1,3}	Squirrel treefrog	Found in gardens, weed or brush tangles, woods, trees, vines-anywhere close to moisture.
<i>Kinosternon bauri</i> ³	Striped mud turtle	Deep drainage canals, sloughs, ponds, and "lettuce" lakes in cypress swamps to wet meadows, ditches, and other small, shallow bodies of water.
<i>Kinosternon subrubrum subrubrum</i> ^{1,3}	Eastern mud turtle	Shallow water areas such as ditches, wet meadows, small ponds, marshes, etc.
<i>Lampropeltis triangulum triangulum</i>	Eastern milk snake	Fields, woodlands, rocky hillsides, river bottoms, etc.
<i>Lampropeltis calligaster rhombomaculata</i>	Mole kingsnake	Thickets, woodlots, cultivated fields, and even back yards in some suburban areas.
<i>Lampropeltis getula getula</i> ³	Eastern kingsnake	Chiefly terrestrial, but shows a distinct liking for streambanks and borders of swamps.
<i>Malaclemys terrapin terrapin</i> ^{2,3}	Northern Diamond-backed terrapin	Coastal marshes, tidal flats; prefers estuaries and lagoons behind barrier beaches.
<i>Nerodia erythrogaster erythrogaster</i> ³	Red-bellied water snake	River swamps and numerous other aquatic habitats of the Southeast.

Table C-1. Potential Amphibian and Reptilian Inhabitants of Jamestown Project Area

Scientific Name	Common Name	Preferred Habitat
<i>Nerodia sipedon sipedon</i> ^{1,3}	Northern water snake	Resident of virtually every swamp, marsh, or bog, of every stream, pond, or lake border within its range.
<i>Nerodia taxipilota</i>	Brown water snake	Clear, quiet waters; resident of great rivers and swamps of the south.
<i>Notophthalmus viridescens viridescens</i> ^{1,3}	Red-spotted newt	Ponds, small lakes, marshes, ditches, quiet portions of streams, or other permanent or semi-permanent bodies of unpolluted water.
<i>Opheodrys aestivus aestivus</i> ¹	Rough green snake	Frequent habitat includes brushy areas overhanging a stream or lake border.
<i>Ophisaurus attenuatus longicaudus</i>	Eastern slender glass lizard	Dry grasslands or dry, open woods.
<i>Plethodon chlorobryonis</i> ^{1,3}	Atlantic coast slimy salamander	Moist woodland ravines or hillsides.
<i>Plethodon cinereus</i> ^{1,3}	Northern red-backed salamander	Terrestrial, more or less wooded areas beneath logs, stones, bark, etc.
<i>Pseudacris brimleyi</i>	Brimley's chorus frog	Marshes, swamps, ditches, and wet open woods of the Coastal Plain.
<i>Pseudacris crucifer crucifer</i> ^{1,3}	Northern spring peeper	Especially abundant in second growth brushy areas or cutover woodlots, if these are small temporary or semi-permanent ponds or swamps.
<i>Pseudacris feriarum</i> ³	Southeastern chorus frog	Grassy swales, moist woodlands, river-bottom swamps, and environs of ponds, bogs, and marshes. Upland in North, Lowland in South.
<i>Pseudacris ocularis</i>	Little grass frog	Grassy environs of ponds and cypress bays.
<i>Pseudemys rubriventris rubriventris</i> ^{1,3}	Northern red-bellied cooter	Ponds, rivers, and, in general, relatively large bodies of fresh water.
<i>Pseudotriton montanus montanus</i>	Eastern mud salamander	Muddy environs of springs, muddy seeps along small streams.
<i>Pseudotriton ruber ruber</i>	Northern red salamander	Under moss, stones near springs or rills, provided that the water is not stagnant. Streams that flow through open fields, woods (sand, gravel, or rock bottom).
<i>Rana catesbeiana</i> ^{1,3}	Bullfrog	Lakes, ponds, bogs, sluggish portions of streams, cattle tanks.
<i>Rana clamitans melanota</i> ¹	Southern green frog	Abundant wherever there is shallow fresh water-- springs, rills, creeks, and ditches. Also common in brooks and small streams.
<i>Rana palustris</i> ³	Pickerel frog	Typically a species of cool, clear water in the North—sphagnum bogs, rocky ravines, and meadow streams.
<i>Rana sphenoccephala utricularius</i> ^{1,3}	Southern leopard frog	All types of freshwater habitats, and even entering slightly brackish marshes along coasts.
<i>Regina rigida rigida</i>	Glossy crayfish snake	Aquatic, habitat similar to that of the Swamp Snakes.
<i>Scaphiopus holbrookii</i> ^{1,3}	Eastern spadefoot	Areas characterized by sandy or other loose soil.
<i>Sceloporus undulatus hyacinthinus</i>	Northern fence lizard	Often seen on rail fences or on rotting logs or stumps.
<i>Scincella lateralis</i> ^{1,3}	Little brown skink	On the woodland floor. Likely to appear anywhere in the deep south, even in towns and gardens.
<i>Siren lacertina</i>	Greater siren	Ditches, weed-choked or muddy ponds, rice fields, streams with clear or turbid water, lakes.
<i>Stereochilus marginatus</i>	Many-lined salamander	Pools and sluggish streams in swampy woodlands.

Table C-1. Potential Amphibian and Reptilian Inhabitants of Jamestown Project Area

Scientific Name	Common Name	Preferred Habitat
<i>Stemotherus odoratus</i> ³	Eastern musk turtle	Shallow, clear-water lakes, ponds and rivers.
<i>Storeria dekayi dekayi</i> ^{1,3}	Northern brown snake	Environs of bogs, swamps, freshwater marshes, moist woods, hillsides, etc.
<i>Storeria occipitomaculata occipitomaculata</i>	Northern red-bellied snake	Abundant in many mountainous or upland parts of the northeast. Often found in or near open woods, but also occurring in sphagnum bogs from sea level to high in the mountains.
<i>Terrapene carolina carolina</i> ³	Eastern box turtle	Terrestrial species that is found under logs or rotting vegetation.
<i>Thamnophis sauritus sauritus</i>	Eastern ribbon snake	Streams, ponds, bogs, or swamps.
<i>Thamnophis sirtalis sirtalis</i> ^{1,3}	Eastern garter snake	Meadows, marshes, woodlands, hillsides, along streams and drainage ditches, and sometimes even in city lots, parks, and cemeteries if pollution is not too severe.
<i>Trachemys scripta elegans</i>	Red-eared slider	Quiet water with a muddy bottom and a profusion of vegetation.
<i>Trachemys scripta scripta</i> ³	Yellowbellied slider	Rivers, ditches, sloughs, lakes, and ponds.
<i>Virginia striatula</i>	Rough earth snake	Seldom appears above ground.
<i>Virginia valeriae valeriae</i> ³	Eastern smooth earth snake	Abandoned fields and environs of trails and back roads, especially those in or near deciduous forests.

Source: Mitchell, 2002, 2005 and NPS and APVA, 2003

Notes: 1-Species cited by VDGIF database and observed by Mitchell (2002).

2-Species observed by Mitchell (2002) and not cited by VDGIF database as a potential resident.

3-Species observed by Mitchell (2005).

Appendixes

APPENDIX D. POTENTIAL AVIFAUNAL INHABITANTS

Table D-1 Potential Avifaunal Inhabitants of Jamestown Project Area		
Scientific Name	Common Name	Preferred Habitat
<i>Accipiter cooperii</i>	Cooper's hawk	Deciduous and coniferous forests near clearings.
<i>Accipiter striatus velox</i>	Sharp-shinned hawk	Coniferous forests, less often in deciduous forests.
<i>Actitis macularia</i>	Spotted sandpiper	Wooded and open areas near water.
<i>Agelaius phoeniceus</i>	Red-winged blackbird	Marshes
<i>Aix sponsa</i>	Wood duck	Marshes, forested swamps, lakes, ponds.
<i>Ammodramus caudacutus</i>	Sharp-tailed sparrow	Edges of salt water and freshwater marshes
<i>Ammodramus maritimus</i>	Seaside sparrow	Exclusively salt marshes with pockets of open water
<i>Ammodramus savannarum pratensis</i>	Grasshopper sparrow	Open fields, meadows
<i>Anas acuta acuta</i>	Northern pintail	Marshes, open water
<i>Anas americana</i>	American widgeon	Marshes, open water
<i>Anas clypeata</i>	Northern shoveler	Marshes, open water
<i>Anas crecca carolinensis</i>	Green-winged teal	Marshes, open water, ponds, lakes
<i>Anas discors</i>	Blue-winged teal	Marshes, open water, ponds, lakes
<i>Anas penelope</i>	Eurasian widgeon	Marshes, open water, ponds, lakes
<i>Anas platyrhynchos</i>	Mallard	Lakes, ponds, swamps, marshes
<i>Anas rubripes</i>	American black duck	Lakes, ponds, swamps, marshes
<i>Anas strepera</i>	Gadwall	Lakes, ponds, swamps, marshes
<i>Anser albifrons flavirostris</i>	Greater white-fronted goose	Lakes, ponds, marshes, open fields
<i>Anthus rubescens</i>	American pipit	Beaches, barren lands, agricultural fields, and golf courses
<i>Archilochus colubris</i>	Ruby-throated hummingbird	Gardens, parks, woodlands
<i>Ardea alba</i>	Great egret	Marshes, ponds, lakes, ditches
<i>Ardea herodias herodias</i>	Great blue heron	Marshes, ponds, lakes, ditches
<i>Asio flammeus</i>	Short-eared owl	Marshes, grasslands, prairies
<i>Aythya affinis</i>	Lesser scaup	Marshes, open water, ponds, lakes
<i>Aythya americana</i>	Redhead	Marshes, open water, ponds, lakes
<i>Aythya affinis</i>	Lesser scaup	Marshes, open water, ponds, lakes
<i>Aythya americana</i>	Redhead	Marshes, open water, ponds, lakes
<i>Aythya collaris</i>	Ring-necked duck	Marshes, open water, ponds, lakes
<i>Aythya marila</i>	Greater scaup	Marshes, open water, ponds, lakes
<i>Aythya valisineria</i>	Canvasback	Marshes, open water, ponds, lakes
<i>Baeolophus bicolor</i>	Tufted titmouse	Swamp or moist woodlands, shade trees in cities and parks
<i>Bartramia longicauda</i>	Upland sandpiper	Open grasslands, meadows, fields

Table D-1 Potential Avifaunal Inhabitants of Jamestown Project Area		
Scientific Name	Common Name	Preferred Habitat
<i>Bombycilla cedrorum</i>	Cedar waxwing	Open woodlands, orchards
<i>Botaurus lentiginosus</i>	American bittern	Marshes, lake shores
<i>Branta canadensis</i>	Canada goose	Open water, lakes, marshes, fields, meadows
<i>Bubo virginianus</i>	Great-horned owl	Deciduous and coniferous forests, swamps, city parks
<i>Bubo virginianus</i>	Great horned owl	Open forests, swamps, urban parks
<i>Bubulcus abis</i>	Cattle egret	Open fields near open water
<i>Bucephala albeola</i>	Bufflehead	Lakes, ponds, marshes
<i>Bucephala clangula americana</i>	Common goldeneye	Marshes, bays, inlets
<i>Buteo jamaicensis</i>	Red-tailed hawk	Deciduous forests and open fields
<i>Buteo lagopus johannis</i>	Rough-legged hawk	Marshes, open fields,, farms
<i>Buteo lineatus lineatus</i>	Red-shouldered hawk	Deciduous forests, especially with standing water
<i>Buteo platypterus</i>	Broad-winged hawk	Deciduous woodlands
<i>Butorides virescens</i>	Green heron	Lake margins, streams, ponds, marshes
<i>Calidris alba</i>	Sanderling	Beaches, sandbars, mudflats, inland lakes
<i>Calidris alpina hudsonia</i>	Dunlin	Beaches, sandbars, mudflats, inland lakes
<i>Calidris himantopus</i>	Stilt sandpiper	Grassy pools, pond shores
<i>Calidris melanotos</i>	Pectoral sandpiper	Wet, short-grass areas; grassy pools; golf courses and airports after heavy rains; and salt creeks and meadows.
<i>Calidris pusilla</i>	Semipalmated sandpiper	Coastal beaches, lake and river shores, flats, and pools in salt marshes
<i>Calidris minutilla</i>	Least sandpiper	Grassy pools, bogs, flooded fields
<i>Caprimulgus carolinensis</i>	Chuck-will's widow	Open woodlands, clearings, farms
<i>Caprimulgus vociferus</i>	Whip-poor-will	Open woodlands, clearings, farms
<i>Cardinalis cardinalis</i>	Northern cardinal	Woodlands, thickets, brushy swamps
<i>Carduelis flammea</i>	Common redpoll	Brushy pastures, weedy fields as winter habitat
<i>Carduelis pinus</i>	Pine siskin	Mixed and coniferous woods, brushy pastures
<i>Carduelis tristis</i>	American goldfinch	Brushy thickets, grasslands
<i>Carpodacus mexicanus</i>	House finch	Cities and residential areas
<i>Carpodacus purpureus</i>	Purple finch	Mixed and coniferous woodlands; ornamental conifers in gardens
<i>Cathartes aura</i>	Turkey vulture	Deciduous forests and woodlands, farm fields
<i>Catharus fuscescens</i>	Veery	Moist deciduous woodlands; willow thickets along streams and thickets in winter
<i>Catharus guttatus</i>	Hermit thrush	Coniferous and mixed forests; deciduous woodlands and thickets in winter.
<i>Catharus minimus</i>	Gray-cheeked thrush	Nests in coniferous forests and willow thickets
<i>Catharus ustulatus</i>	Swainson's thrush	Coniferous forests and willow thickets

Table D-1 Potential Avifaunal Inhabitants of Jamestown Project Area

Scientific Name	Common Name	Preferred Habitat
<i>Certhia familiaris</i>	Brown creeper	Deciduous and mixed woodlands
<i>Ceryle alcyon</i>	Belted kingfisher	Rivers, lakes, and saltwater estuaries
<i>Chaetura pelagica</i>	Chimney swift	Breeds and roosts in chimneys
<i>Charadrius semipalmatus</i>	Semipalmated plover	Beaches and tidal flats, shallow pools in salt marshes; lakeshores in the interior during migration
<i>Charadrius vociferus</i>	Killdeer	Open country generally; plowed fields, golf courses, and short-grass prairies
<i>Chen caerulescens caerulescens</i>	Lesser snow goose	Breeds on the tundra and winters in salt marshes and marshy coastal bays
<i>Chen caerulescens atlanticus</i>	Snow goose	Breeds on the tundra and winters in salt marshes and marshy coastal bays
<i>Chordeiles minor</i>	Common nighthawk	Aerial, but open country generally; also cities and towns
<i>Circus cyaneus</i>	Northern harrier (Marsh hawk)	Marshes and open grasslands
<i>Cistothorus palustris</i>	Marsh wren	Fresh and brackish marshes with cattails, reeds, bulrushes, or sedges
<i>Cistothorus platensis</i> ¹	Sedge wren (short-billed marsh wren)	Grassy freshwater marshes and sedges; also brackish marshes and wet meadows in winter
<i>Clangula hyemalis</i>	Oldsquaw	Tundra; in winter on open bays and inshore waters
<i>Coccothraustes vespertinus</i>	Evening grosbeak	Nests in coniferous forests; visits deciduous woodlands and suburban areas in winter
<i>Coccyzus americanus</i>	Yellow-billed cuckoo	Moist thickets, willows, overgrown pastures, and orchards
<i>Coccyzus erythrophthalmus</i>	Black-billed cuckoo	Moist thickets in low, overgrown pastures and orchards, but occurs in thicker undergrowth and in sparse woodland
<i>Colaptes auratus</i>	Northern flicker	Open country with trees; parks and rural estates
<i>Colinus virginianus</i>	Northern bobwhite	Pastures, grassy roadsides, and farmlands
<i>Columba livia</i>	Rock dove	City parks, suburban gardens, and farmland
<i>Contopus virens</i>	Eastern wood pewee	Forest, open woodland, orchards, and shade trees in parks and along roadsides
<i>Coragyps atratus</i>	Black vulture	Open country wherever carrion is present
<i>Corvus brachyrhynchos</i>	American crow	Woodlands, farmland, and suburban areas
<i>Corvus ossifragus</i>	Fish crow	Low coastal country, near tidewater in the north; in the south also lakes, rivers, and swamps far inland
<i>Cyanocitta cristata</i>	Blue jay	Chiefly oak forest, but now also city parks and suburban yards, especially where oak trees predominate
<i>Cygnus columbianus columbianus</i>	Tundra swan	Lakes, ponds, freshwater and brackish marshes with open water
<i>Cygnus olor</i>	Mute swan	Ponds, rivers, coastal lagoons, and bays
<i>Dendrocygna bicolor</i>	Fulvous whistling-duck	Ponds, coastal marshes, bays
<i>Dendroica caerulescens</i> ¹	Black-throated blue warbler	Mixed deciduous and evergreen
<i>Dendroica castanea</i> ¹	Bay-breasted warbler	Breeds in open spruce forests. During migration frequents deciduous trees as well.
<i>Dendroica cerulea</i> ¹	Cerulean warbler	Open woodland, often near streams and rivers
<i>Dendroica coronata cornata</i>	Yellow-rumped warbler	Coniferous and mixed forests; widespread during migration and winter

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Scientific Name	Common Name	Preferred Habitat
<i>Dendroica discolor</i>	Prairie warbler	Open scrub in the south
<i>Dendroica dominica</i>	Yellow-throated warbler	Forests of pine, cypress, sycamore, and oak, in both swampy places and dry uplands
<i>Dendroica fusca</i> ¹	Blackburnian warbler	Most numerous in mixed forests of hemlock, spruce, and various hardwoods, usually ranging high in the trees
<i>Dendroica magnolia</i> ¹	Magnolia warbler	Breeds in open stands of young spruce and fir. In migration is found almost any place where shrubbery or trees occur.
<i>Dendroica palmarum</i>	Palm warbler	Open places, especially weedy fields and borders of marshes
<i>Dendroica pensylvanica</i> ¹	Chestnut-sided warbler	Young, open, second-growth woodland and scrub.
<i>Dendroica petechia</i>	Yellow warbler	Moist thickets, especially along streams and in swampy areas; gardens
<i>Dendroica pinus</i>	Pine warbler	Pine forests
<i>Dendroica striata</i>	Blackpoll warbler	Breeds in coniferous forests. During migration is found chiefly in tall trees
<i>Dendroica tigrina</i> ¹	Cape May warbler	Open spruce forests; in migration, in evergreen or deciduous woodlands and often in parks, estates, or suburban yards
<i>Dendroica virens</i> ¹	Black-throated green warbler	Open stands of hemlock or pine; in migration in a variety of habitats.
<i>Dolichonyx oryzivorus</i> ¹	Bobolink	Prairies and meadows; marshes during migration.
<i>Dryocopus pileatus</i>	Pileated woodpecker	Dense forest and borders
<i>Dumetella carolinensis</i>	Gray catbird	Thickets and brush, residential areas and gardens
<i>Egretta caerulea</i> ¹	Little blue heron	Freshwater swamps and lagoons in the South; coastal thickets on islands in the North.
<i>Egretta thula</i>	Snowy egret	Salt marshes, ponds, rice fields, and shallow coastal bays
<i>Egretta tricolor</i>	Tricolored heron	Marshes, ponds, mudflats, swamps, and lagoons
<i>Empidonax flaviventris</i> ¹	Yellow-bellied flycatcher	Thickets of alder and willow in northern coniferous forests; on migration in second-growth woodlands.
<i>Empidonax traillii</i> ²	Willow flycatcher	Swampy thickets, upland pastures, and old abandoned orchards
<i>Empidonax virescens</i>	Acadian flycatcher	Beech-maple or hemlock forest, usually under the canopy but also in clearings; often in wooded ravines
<i>Eremopila alpestris</i>	Horned lark	Plains, fields, airports, and beaches
<i>Eudocimus albus</i>	White ibis	Marshy sloughs, mud flats, lagoons, and swamp forests
<i>Euphagus carolinus</i>	Rusty blackbird	Wooded swamps and damp woods with pools during migration; boreal bogs in the breeding season
<i>Falco columbarius</i>	Merlin	Coniferous forests; more widespread in winter
<i>Falco peregrinus</i> ¹	Peregrine falcon	Open country, especially along rivers, also near lakes, and the coast. Migrates chiefly along the coast.
<i>Falco sparverius sparverius</i>	American kestrel	Towns and cities, parks, farmlands, and open country
<i>Fulica americana</i>	American coot	Open ponds and marshes; in winter, also in saltwater bays and inlets
<i>Gallinula chloropus</i>	Common moorhen	Freshwater marshes and ponds with cattails and other aquatic vegetation
<i>Gallinago gallinago</i>	Common snipe	Freshwater marshes, ponds, flooded meadows, and fields; more rarely in salt marshes
<i>Gavia immer</i>	Common loon	Forested lakes and rivers; oceans and bays in winter

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Scientific Name	Common Name	Preferred Habitat
<i>Gavia stellata</i> ²	Red-throated loon	Salt bays and tundra ponds during the summer; bays and estuaries and ocean in winter
<i>Geothlypis trichas brachidactylus</i>	Common yellowthroat	Moist thickets and grassy marshes
<i>Guiraca caerulea caerulea</i>	Blue grosbeak	Brushy, moist pastures and roadside thickets
<i>Haliaeetus leucocephalus</i>	Bald eagle	Tall pines and open woods adjacent to open water.
<i>Helmitheros vermivorus</i>	Worm-eating warbler	Dry wooded hillsides
<i>Hirundo rustica</i>	Barn swallow	Agricultural land, suburban areas, marshes, lake shores
<i>Hylocichla mustelina</i>	Wood thrush	Moist deciduous woodlands with a thick understory; also well-planted parks and gardens
<i>Icteria virens virens</i>	Yellow-breasted chat	Dense thickets and brush, often with thorns; streamside tangles and dry hillsides
<i>Icterus galbula</i>	Baltimore oriole	Deciduous woodland and shade trees. American elm was traditionally a preferred nesting site before their decline
<i>Icterus spurius</i>	Orchard oriole	Orchard, shade trees in parks and gardens, and scattered trees along lakes and streams
<i>Ixobrychus exilis exilis</i>	Least bittern	Freshwater marshes where cattails and reeds predominate
<i>Junco hyemalis</i>	Dark-eyed junco	Coniferous or mixed forests; winters in fields, gardens, city parks, and roadside thickets
<i>Larus argentatus</i>	Herring gull	Lakes, rivers, estuaries, and beaches; common in all aquatic habitats
<i>Larus atricilla</i>	Laughing gull	Salt marshes, bays, and estuaries; very rare inland
<i>Larus delawarensis</i>	Ring-billed gull	Lakes and rivers; many move to salt water in the winter
<i>Larus fuscus</i>	Lesser black-back gull	Nearly all types of open country—coasts, islands, fields, lakes, airports, refuse dumps, etc.
<i>Larus marinus</i>	Great black-backed gull	Coastal beaches, estuaries, and lagoons; also at refuse dumps. Less commonly on inland lakes and rivers
<i>Larus philadelphia</i>	Bonaparte's gull	Forested lakes and rivers; winters along the coast, in estuaries, and at the mouth of large rivers
<i>Laterallus jamaicensis</i>	Black rail	Coastal salt marshes, rarely inland in freshwater marshes
<i>Limnodromus griseus</i>	Short-billed dowitcher	Mud flats, creeks, salt marshes, and tidal estuaries
<i>Limnothlypis swainsonii</i> ⁱ	Swainson's warbler	Wooded swamps and southern canebrakes; also rhododendron thickets in the mountains.
<i>Lophodytes cucullatus</i>	Hooded merganser	Wooded ponds, lakes, and rivers; sometimes in tidal channels in winter
<i>Loxia curvirostra</i> ¹	Red crossbill	Coniferous forests; visits ornamental evergreens in winter.
<i>Loxia leucoptera</i>	White-winged crossbill	Coniferous forests; more widespread in winter
<i>Melanerpes carolinus</i>	Red-bellied woodpecker	Open and swamp woodland; comes into parks during migration and to feeders in winter
<i>Melanerpes erythrocephalus</i>	Red-headed woodpecker	Open country, farms, rural roads, open park-like woodland, and golf courses
<i>Meleagris gallopavo</i>	Wild turkey	Open woodlands and forests with scattered natural or man-made clearings
<i>Melospiza georgiana</i>	Swamp sparrow	Freshwater marshes and open wooded swamps; in migration with other sparrows in weedy fields, parks, and brush piles

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Scientific Name	Common Name	Preferred Habitat
<i>Melospiza lincolni</i> ¹	Lincoln's sparrow	Brushy bogs, willow, or alder thickets; winter in woodlad thickets and brushy pastures.
<i>Melospiza melodia</i>	Song sparrow	Thickets, pastures, undergrowth in gardens, and city parks
<i>Mergus merganser americanus</i>	Common merganser	Wooded rivers and ponds; in winter, also on salt bays
<i>Mergus serrator serrator</i>	Red-breasted merganser	Northern lakes and tundra ponds; in winter, principally on the ocean and in salt bays
<i>Mimus polyglottos</i>	Northern mockingbird	Residential areas, city parks, farmlands, open country with thickets, and desert brushland
<i>Mniotilta varia</i>	Black-and-white warbler	Primary and secondary forest, chiefly deciduous. In migration in parks, gardens, and lawn areas with trees and shrubs
<i>Molothrus ater</i>	Brown-headed cowbird	Agricultural land, fields, woodland edges, and suburban areas
<i>Myiarchus crinitus</i>	Great-crested flycatcher	Open forest, orchards, and large trees in farm country
<i>Nyctanassa violacea</i>	Yellow-crowned night heron	Wooded swamps and coastal thickets
<i>Nycticorax nycticorax hoactii</i>	Black-crowned night heron	Marshes, swamps, and wooded streams
<i>Oporornis agilis</i>	Connecticut warbler	Open larch-spruce bogs; in migration in low wet woods and damp thickets
<i>Oporornis formosus</i>	Kentucky warbler	Low, moist, rich woodland with luxuriant undergrowth; often in ravines
<i>Oporornis philadelphia</i> ¹	Mourning warbler	Dense thickets of blackberries and briars in forest clearings; also in wet woods with thick undergrowth.
<i>Otus asio</i>	Eastern screech owl	Open deciduous woods, wood lots, suburban areas, lakeshores, old orchards
<i>Oxyura jamaicensis</i>	Ruddy duck	Freshwater marshes, marshy lakes and ponds; sometimes shallow salt bays and rivers in winter
<i>Pandion haliaetus carolinensis</i>	Osprey	Lakes, rivers, and sea coasts
<i>Parula americana</i>	Northern parula	Breeds in wet, chiefly coniferous woods, swamps, and along lakes and ponds; more widespread on migration
<i>Passer domesticus</i>	House sparrow	Cities, towns, agricultural areas
<i>Passerculus sandwichensis</i>	Savannah sparrow	Fields, prairies, salt marshes, and grassy dunes
<i>Passerella iliaca</i>	Fox sparrow	Coniferous forest undergrowth in summer; dense woodland thickets, weedy pastures, and brushy roadsides in winter
<i>Passerina cyanea</i>	Indigo bunting	Brushy slopes, abandoned farmland, old pastures and fields grown up to scrub, woodland clearings, and forest edge adjacent to fields
<i>Pelecanus erythrorhynchos</i>	American white pelican	Marshy lakes and along the pacific and Texas coasts. Winters chiefly in coastal lagoons
<i>Phalacrocorax auritus</i>	Double-crested cormorant	Lakes, rivers, swamps, and coasts
<i>Phalacrocorax carbo</i>	Great cormorant	Cliffs, rocks, and trees of coastal inlands
<i>Phalaropus tricolor</i>	Wilson's phalarope	Prairie pools and marshes, lake and pond shorelines, marshy areas along the coast
<i>Phasianus colchicus</i>	Ring-necked pheasant	Farmlands, pastures, and grassy woodland edges
<i>Pheucticus ludovicianus</i> ¹	Rose-breasted grosbeak	Moist woodland adjacent to open fields with tall shrubs; also old and overgrown orchards.
<i>Phoenicoperus ruber</i>	Greater flamingo	Shallow coastal lagoons and mudflats

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Scientific Name	Common Name	Preferred Habitat
<i>Picoides pubescens medianus</i>	Downy woodpecker	Wood lots, parks, and gardens; suet feeders in winter
<i>Picoides villosus</i>	Hairy woodpecker	Deciduous forest; more widespread in winter and migration
<i>Pipilo erythrophthalmus</i>	Eastern towhee	Thickets, and brushy woodland edges
<i>Piranga olivacea</i>	Scarlet tanager	Chiefly mature woodland, especially oak and pine
<i>Piranga rubra</i>	Summer tanager	Open woodland and shade trees
<i>Plectrophenax nivalis nivalis</i>	Snow bunting	Arctic tundra Winters on windswept grasslands and beaches
<i>Plegadis falcinellus</i> ¹	Glossy ibis	Marshes, swamps, flooded fields, coastal bays, and estuaries.
<i>Podilymbus podiceps</i>	Pied-billed grebe	Marshes, ponds; salt water in winter if freshwater habitats freeze
<i>Podiceps auritus</i>	Horned grebe	Marshes and lakes in summer; in winter, mainly on salt water but also on the great lakes
<i>Poecile carolinensis</i>	Carolina chickadee	Deciduous woodlands and residential area
<i>Poliophtila caerulea</i>	Blue-gray gnatcatcher	Open, moist woodlands and brushy streamside thickets
<i>Poocetes gramineus</i>	Vesper sparrow	Fields, pastures, and roadsides in farming country
<i>Porzana carolina</i>	Sora	Chiefly freshwater marshes and marshy ponds; rice fields and salt marshes in winter
<i>Progne subis</i>	Purple martin	Open woodland , residential areas, and agricultural land
<i>Protonotaria citrea</i>	Prothonotary warbler	Wooded swamps, flooded bottomland forest, and streams with dead trees
<i>Quiscalus quiscula</i>	Common grackle	Lawns, parks, fields, open woodland
<i>Rallus elegans</i>	King rail	Freshwater marshes and roadside ditches; wanders to salt marshes in fall and winter
<i>Rallus limicola</i>	Virginia rail	Freshwater and brackish marshes. May visit salt marshes in winter
<i>Rallus longirostris crepitans</i>	Clapper rail	Salt marshes, bays, and estuaries; very rare inland
<i>Regulus calendula</i>	Ruby-crowned kinglet	Coniferous forests in summer; also deciduous forests and thickets in winter
<i>Regulus satrapa</i> ¹	Golden-crowned kinglet	Dense, old conifer stands; also in deciduous forests and thickets in winter.
<i>Riparia riparia</i> ¹	Bank swallow	Rivers and streams, especially near sandbanks; more widespread during migration.
<i>Rychops niger</i> ¹	Black skimmer	Breeds chiefly on sandbars and beaches; feeds in shallow bays, inlets, and estuaries.
<i>Sayornis phoebe</i>	Eastern phoebe	Open woodland near streams; cliffs, bridges, and buildings with ledges
<i>Scolopax minor</i>	American woodcock	Moist woodland and thickets near open fields
<i>Seiurus aurocapillus</i>	Ovenbird	Mature dry forest with little undergrowth
<i>Seiurus motacilla</i>	Louisiana waterthrush	Prefers swift moving brooks on hillsides and, where the northern waterthrush is absent, occurs in river swamps and along sluggish streams
<i>Seiurus noveboracensis</i> ¹	Northern waterthrush	Cool bogs, wooded swamps, and lake shores in the breeding season; almost any wooded habitat in migration.
<i>Setophaga ruticulla</i>	American redstart	Second-growth woodlands; thickets with saplings
<i>Sialia sialis</i>	Eastern bluebird	Open farmlands with scattered fields
<i>Sitta canadensis</i> ¹	Red-breasted nuthatch	Coniferous forests; more widespread in migration and winter.
<i>Sitta carolinensis</i>	White-breasted nuthatch	Deciduous and mixed forest
<i>Sitta pusilla</i>	Brown-headed nuthatch	Coniferous and mixed forests

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Scientific Name	Common Name	Preferred Habitat
<i>Sphyrapicus varius</i>	Yellow-bellied sapsucker	Young, open deciduous or mixed forest with clearings; in migration, in parks, yards, gardens
<i>Spiza americana</i>	Dickcissel	Open grain and hay fields
<i>Spizella arborea</i>	American tree sparrow	Arctic willow and birch thickets, fields, weedy woodland edges, and roadside thickets in winter
<i>Spizella passerina</i>	Chipping sparrow	Grassy woodland edges, gardens, city parks, brushy pastures, and lawns
<i>Spizella pusilla</i>	Field sparrow	Abandoned fields and pastures grown up to weeds, scattered bushes, and small saplings
<i>Stelgidopteryx serripennis</i>	Northern rough-winged swallow	Streams and rivers, especially in the vicinity of steep banks and man-made structures providing nest sites
<i>Sterna albibrons</i>	Least tern	Sandy and pebbly beaches along the coast; sandbars in large rivers. Often on land fills.
<i>Sterna caspia</i> ¹	Caspian tern	Sandy or pebbly shores of lakes and large rivers, and along seacoasts.
<i>Sterna forsteri</i> ¹	Forster's tern	Salt marshes in the East; freshwater marshes in the West.
<i>Sterna hirundo</i>	Common tern	Lakes, ponds, rivers, coastal beaches, and islands
<i>Sterna maxima maximus</i>	Royal tern	Sandy beaches
<i>Strix varia</i>	Barred owl	Low, wet woods and swamp forest
<i>Sturnella magna</i>	Eastern meadowlark	Meadows, pastures, and prairies; in migration, in open country generally
<i>Sturnus vulgaris</i>	European starling	Cities, suburban areas, farmlands, and ranches
<i>Tachycineta bicolor</i>	Tree swallow	Lake shores, flooded meadows, marshes, and streams
<i>Thryothorus ludovicianus</i>	Carolina wren	Woodland thickets, ravines, and rocky slopes covered with brush
<i>Toxostoma rutum</i>	Brown thrasher	Thickets, fields with scrub, and woodland borders
<i>Tringa flavipes</i>	Lesser yellowlegs	Marshy ponds, lake and river shores, mud flats; in the breeding season, boreal bogs
<i>Tringa melanoleuca</i>	Greater yellowlegs	Prefers pools, lakeshores, and tidal mud flats on migration, but open wet tundra and marshy ground in the breeding season
<i>Tringa solitaria</i> ¹	Solitary sandpiper	Inland ponds and bogs, wet swampy places, and woodland streams.
<i>Troglodytes aedon</i>	House wren	Residential areas, city parks, farmlands, and woodland edges
<i>Troglodytes troglodytes</i> ¹	Winter wren	Dense tangles and thickets in coniferous and mixed forests.
<i>Turdus migratorius</i>	American robin	Towns, gardens, open woodland, and agricultural land
<i>Tyrannus tyrannus</i>	Eastern kingbird	Open country; farms, orchards, roadsides, and lake and river shores
<i>Tyto alba</i> ¹	Barn owl	Open country, forest edge and clearings, cultivated areas, and cities.
<i>Vermivora celata</i>	Orange-crowned warbler	Thickets and brushy woodlands
<i>Vermivora peregrina</i> ¹	Tennessee warbler	Open mixed woodlands in the breeding season; in trees and bushes during migration.
<i>Vermivora pinus</i>	Blue-winged warbler	Abandoned fields and pastures grown up to saplings; forest clearings and edges with clumps of catbrier, blackberry, and various bushes and young trees.
<i>Vermivora ruficapilla</i> ¹	Nashville warbler	Woodland edges; thickets in open mixed forest or brushy borders of swamps.
<i>Vireo flavifrons</i>	Yellow-throated vireo	Tall deciduous trees at the edge of forests, along streams, roadsides, orchards, parks, and estates

Table D-1 Potential Avifaunal Inhabitants of Jamestown Project Area

Scientific Name	Common Name	Preferred Habitat
<i>Vireo gilvus gilvus</i> ²	Warbling vireo	Deciduous woodland, especially near streams; in isolated groves and shade trees
<i>Vireo griseus</i>	White-eyed vireo	Dense swampy thickets and hillsides with blackberry and briar tangles
<i>Vireo olivaceus</i>	Red-eyed vireo	Deciduous forest, and shade trees in residential areas
<i>Vireo solitarius</i>	Blue-headed vireo	Coniferous and mixed forests
<i>Wilsonia canadensis</i> ¹	Canada warbler	Cool, moist woodland that is nearly mature and has much undergrowth.
<i>Wilsonia citrina</i>	Hooded warbler	Mature, moist forest with luxuriant undergrowth, especially in ravines; also in wooded swamps
<i>Wilsonia pusilla</i> ¹	Wilson's warbler	Moist thickets in woodland and along streams; alder and willow thickets and bogs.
<i>Zenaida macroura carolinensis</i>	Mourning dove	Open fields, parks, and lawns with many trees and shrubs
<i>Zonotrichia albicollis</i>	White-throated sparrow	Brushy undergrowth in coniferous woodland. Winters in brush woodland, pastures, and suburban areas
<i>Zonotrichia leucophrys</i>	White-crowned sparrow	Nests in dense brush, especially where near open grassland; winters in open woods and gardens

Source: NPS and APVA, 2003

Notes: 1-Species referenced only by Dr. Bryan Watts

2-Species referenced only by the Virginia Department of Game and Inland Fisheries

Appendixes

APPENDIX E. FISH SPECIES COLLECTED IN JAMES RIVER, POWHATAN CREEK, AND BACK RIVER

Table E-1. Fish Species Collected in James River, Powhatan Creek, and Back River						
Scientific Name	Common Name	Lifestyle		Scientific Name	Common Name	Lifestyle
<i>Alosa aestivalis</i>	Blueback herring	Semi-anadromous		<i>Leiostomos xanthurus</i>	Spot	Marine
<i>Alosa pseudoharengus</i>	Alewife	Estuarine		<i>Lepomis auritus</i>	Redbreast sunfish	Freshwater
<i>Ameiurus catus</i>	White catfish	Freshwater		<i>Lepomis gibbosus</i>	Pumpkinseed	Freshwater
<i>Ameiurus natalis</i>	Yellow bullhead	Freshwater		<i>Lepomis gulosus</i>	Warmouth	Freshwater
<i>Ameiurus nebulosus</i>	Brown bullhead	Freshwater		<i>Lepomis macrochirus</i>	Bluegill	Freshwater
<i>Amia calva</i>	Bowfin	Freshwater		<i>Lepomis microlophus</i>	Redear sunfish	Freshwater
<i>Anguilla rostrata</i>	American eel	Catadromous		<i>Membras martinica</i>	Rough silverside	Marine
<i>Aphredoderus sayanus</i>	Pirate perch	Freshwater		<i>Menidia beryllina</i>	Inland silverside	Estuarine
<i>Brevoortia tyrannus</i>	Atlantic menhaden	Marine, estuarine		<i>Menidia menidia</i>	Atlantic silverside	Estuarine
<i>Clinostomus funduloides</i>	Royside Dace	Freshwater		<i>Menidia peninsulae</i>	Tidewater silverside	Estuarine
<i>Cyprinella analostana</i>	Satinfin shiner	Freshwater		<i>Micropogonias salmoides</i>	Largemouth bass	Freshwater
<i>Cyprinus carpio carpio</i>	Common carp	Freshwater		<i>Micropogonias undulatus</i>	Atlantic croaker	Marine
<i>Dorosoma cepedianum</i>	Gizzard shad	Anadromous		<i>Morone americana</i>	White perch	Semi-anadromous
<i>Dorosoma petenense</i>	Threadfin shad	Anadromous		<i>Morone saxatilis</i>	Striped bass	Semi-anadromous
<i>Engraulis mordax</i>	Bay anchovy	Estuarine		<i>Mugil cephalus</i>	Striped mullet	Estuarine
<i>Enneacanthus gloriosus</i>	Bluespotted sunfish	Freshwater		<i>Mugil curema</i>	White mullet	Estuarine
<i>Erimyzon oblongus</i>	Creek chubsucker	Freshwater		<i>Notemigonus crysoleucas</i>	Golden shiner	Freshwater
<i>Esox niger</i>	Chain pickerel	Freshwater		<i>Notropis hudsonius</i>	Spottail shiner	Freshwater
<i>Etheostoma olmstedii</i>	Tessellated darter	Freshwater		<i>Noturus gyrinus</i>	Tadpole madtom	Freshwater
<i>Fundulus diaphanus diaphanus</i>	Banded killifish	Freshwater		<i>Noturus insignis</i>	Margined madtom	Freshwater
<i>Fundulus heteroclitus heteroclitus</i>	Mummichog	Estuarine		<i>Paralichthys dentatus</i>	Summer flounder	Estuarine
<i>Gambusia holbrooki</i>	Eastern mosquitofish	Freshwater		<i>Perca flavescens</i>	Yellow perch	Freshwater
<i>Gobiosoma boscii</i>	Naked goby	Estuarine		<i>Pomoxis nigromaculatus</i>	Black crappie	Freshwater
<i>Hybognathus regius</i>	Eastern silvery minnow	Freshwater		<i>Syngnathus sp.</i>	Pipefish	Estuarine
<i>Ictalurus furcatus</i>	Blue catfish	Freshwater		<i>Trinectes maculatus</i>	Hog choker	Estuarine to freshwater
<i>Ictalurus punctatus</i>	Channel catfish	Freshwater		<i>Umbra pygmaea</i>	Eastern mudminnow	Freshwater

Source: Swihart et al. 1991, DGIF, 1999

References

ACRONYMS AND ABBREVIATIONS

APVA – Association for the Preservation of Virginia Antiquities
AQRVs – air quality related values
CASTNet – Clean Air Status and Trends Network
CCB – Center for Conservation Biology
CO – carbon monoxide
COE – United States Army Corps of Engineers
CWP – Center for Watershed Protection
cy – cubic yard(s)
dB – decibels
dBA – decibels on A-weighted scale
DEQ – Virginia Department of Environmental Quality
DCP – Development Concept Plan
DCR – Virginia Department of Conservation and Recreation
DGIF – Virginia Department of Game and Inland Fisheries
DMME – Virginia Department of Mines, Minerals, and Energy
DNH – Division of Natural Heritage
EIS – Environmental Impact Statement
EPA – Environmental Protection Agency
FEMA – Federal Emergency Management Agency
FHWA – Federal Highway Administration
FWS – United States Fish and Wildlife Service
FIRM – Flood Insurance Rate Map
GIS – Geographic Information System
kg/day – kilograms per day
Leq – equivalent continuous noise level measured in dBA
LID – low-impact development
LIDAR – light detection and ranging
MRCC – Midwestern Regional Climate Center
NAAQS – National Ambient Air Quality Standards
NAVD – North American Vertical Datum
NCBN – Northeast Coastal and Barrier Network
NGVD – National Geodetic Vertical Datum
NHP – National Historical Park
NOAA – National Oceanic and Atmospheric Administration
NO_x – nitrogen oxides
NPS – National Park Service
NRA – Natural Resource Assessment
NVCS – National Vegetation Classification Standard
NWI – National Wetland Inventory
ppm – parts per million

ppt – parts per thousand
ROD – Record of Decision
RMA – Resource Management Area
RPA – Resource Protection Area
SAV – submerged aquatic vegetation
TMDL – Total Maximum Daily Load
USDA – United States Department of Agriculture
USGS – United States Geological Survey
VDH – Virginia Department of Health
VHB – Vanasse Hangen Brustlin, Inc
VIMS – Virginia Institute of Marine Science
VOCs – volatile organic compounds

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Founded in 1889, The Association for the Preservation of Virginia Antiquities (APVA) is the oldest statewide preservation organization in the nation. Today, thanks to the continuing support of members and generous donors, the APVA is sharing the rich heritage of Virginia through a portfolio of properties that span the centuries from early seventeenth through mid-nineteenth centuries. The APVA's Revolving Fund adds a dimension to the organization's ability to preserve Virginia's historic part by partnering with individuals and organizations interested in preserving sites across the state. A nonprofit, charitable, and educational organization, the APVA is preserving, interpreting and sharing significant landmarks across the Commonwealth of Virginia to benefit visitors today and future generations.

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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