3 AFFECTED ENVIRONMENT

This chapter describes the environment of the area that may be affected by the Proposed Action, as required by the Council on Environmental Quality's (CEQ's) regulations implementing NEPA (40 CFR Part 1500). Depending on the resource considered, the potentially affected environment for this EIS includes:

1. NSF Dahlgren.
2. The Potomac River from the UDZ to the river's mouth at the Chesapeake Bay, which marks the limits of the PRTR.
3. The five counties surrounding the PRTR:
   - King George County, Virginia
   - Westmoreland County, Virginia
   - Northumberland County, Virginia
   - St. Mary's County, Maryland
   - Charles County, Maryland
4. The larger region, including the:
   - The Tri-County Council for Southern Maryland, which is the regional planning agency for Charles, St. Mary's, and Calvert counties.
   - Virginia's Northern Neck Planning District, which includes Westmoreland, Northumberland, Richmond, and Lancaster counties.
   - Virginia's RADCO Planning District, which includes Caroline, King George, Stafford, and Spotsylvania counties and the City of Fredericksburg.

For any given resource, the extent of the potentially affected area may be NSF Dahlgren, the PRTR, the surrounding counties, the larger region, or some combination thereof. For some resources (such as terrestrial wildlife), the affected environment mostly consists of NSF Dahlgren; for others (such as fish), it is the PRTR; for still others (such as socioeconomics and air quality), it is broader and encompasses the installation, the PRTR, the surrounding counties, and the larger region.

The impacts of implementing the alternatives are addressed in Chapter 4.

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3.1 Land Use, Plans, and Coastal Zone Management

3.1.1 NSF Dahlgren

This section characterizes existing land use at NSF Dahlgren, current land use plans and goals, and major projects presently under development.

3.1.1.1 Existing Land Use

NSF Dahlgren occupies approximately 4,320 acres (ac) in King George County, Virginia. The facility is home to several tenant agencies, the largest of which is NSWCDD. Other tenants include the Joint Warfare Analysis Center; the Aegis Training and Readiness Center; the Center for Surface Combat Systems; the AEGIS Ballistic Missile Defense Field Activity; the Navy Air and Missile Defense Command; and 20th Space Control Squadron Detachment One.

NSF Dahlgren consists of two discrete areas separated by Upper Machodoc Creek: the 2,680-ac Mainside to the north of the creek and the 1,640-ac EEA on Pumpkin Neck, to the south. Physical connection between the two areas is through off-base public roads and a barge across the creek.

The EEA complex, which contains the Harris and Churchill Ranges, is one of two range complexes at NSF Dahlgren. Development there is very limited and consists mostly of small support buildings, test facilities, and magazines. The other range complex is the PRTR Complex, which extends mostly over water but also has a land component along the eastern edge of Mainside that comprises five ranges. From north to south, these are the Missile Test Range, Terminal Range, Main Range, Anti-Aircraft (AA) Fuze Range, and Machine Gun Range. A detailed description of both range complexes and their components is provided in Chapter 1 of this EIS.

Almost all existing development at NSF Dahlgren is found on Mainside. Existing land use on Mainside is shown in Figure 3.1-1 (Land Use – Mainside). The land use designations depicted come from Naval District Washington's Regionally Integrated Master Program and are based on the prevailing land use. The land uses include:

- *Ordnance/RDT&E*, which is the primary land use on NSF Dahlgren. Operations within this land use may include the use of explosive ordnance, and explosive ordnance is stored there. All of the PRTR land ranges and some of the Mission Area are encompassed within the *Ordnance/RDT&E* land use. Existing development within these ranges is mostly industrial in character.
- *RDT&E* land use encompasses laboratory-based RDT&E; no explosives are used in this area. Part of the Mission Area is within this area. The type of development is mostly that typical of suburban office parks, with large administrative and research facilities surrounded by parking lots and landscape features.
- *Open Space* encompasses the northwestern part of the installation, where natural special interest areas (SIAs), such as Gambo Creek, are located (see Section 3.13).

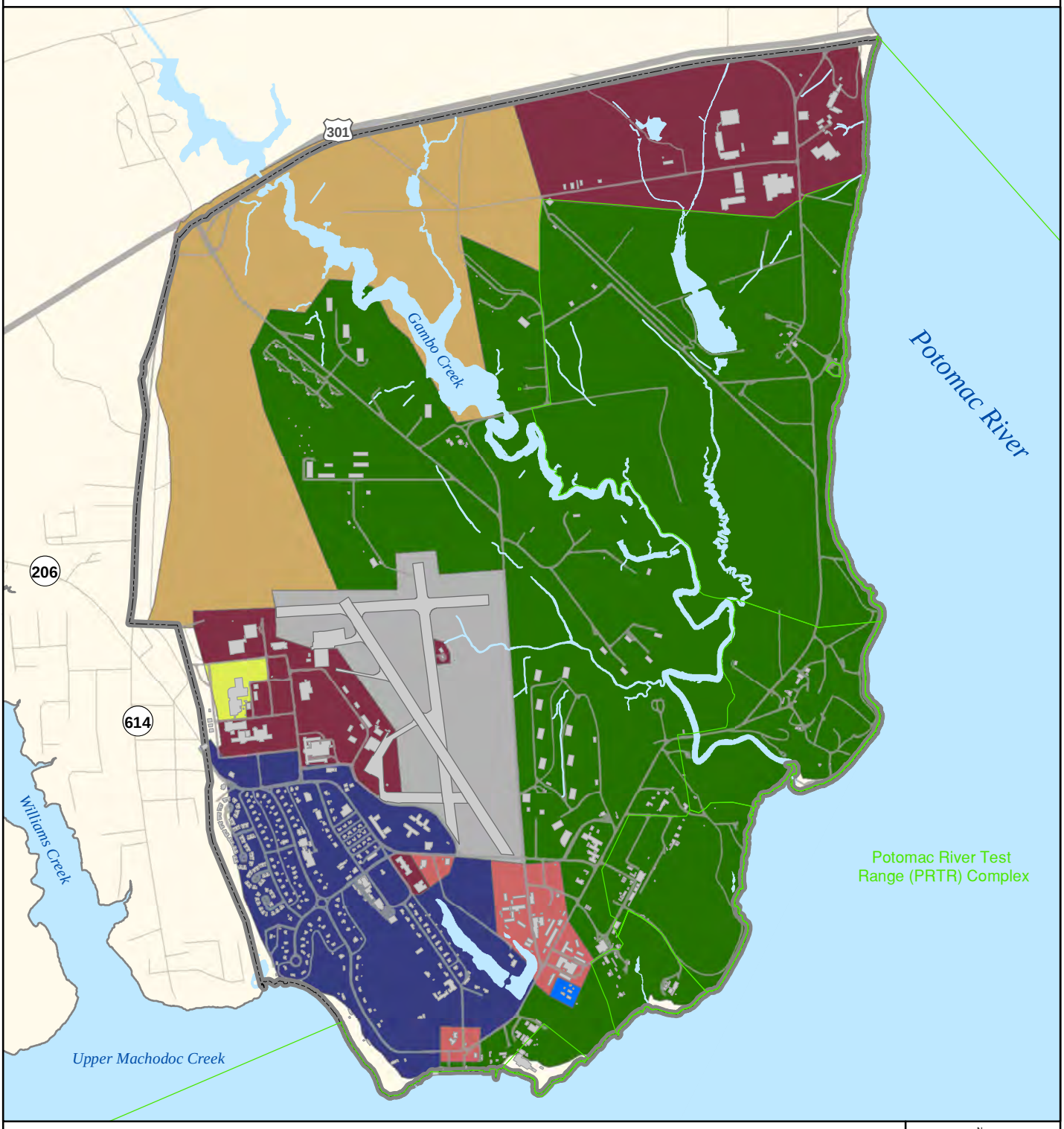
- *Airfield Operations* land use includes existing runways and taxiways, hard stand areas, and the designated Clear Zone to the northwest. This land use is part of the Mission Area. Of the airfield's three existing runways, one (16/34) is restricted to daytime visual-flight-rules helicopter use only; the other two are inactive. Landing strips have been built near the Potomac River's shore on the EEA's Churchill Range and on Mainside's Terminal Range (see Figure 1-11) to accommodate unmanned aerial vehicle (UAV) operations because the existing runways are outside the installation's special use airspace (SUA, see Section 3.1.3), and military UAVs can only operate within controlled SUA.
- *Sailor and Family Support* land use includes facilities that support military personnel and their dependents: family housing and unaccompanied housing, as well as an elementary school, health clinic, fitness center, and Morale, Welfare, and Recreation facilities.
- *Base Support* land use includes administrative facilities.
- *Training Support* land use includes facilities used to train Navy personnel.
- *Utilities* land use includes installation utility support facilities.

3.1.1.2 Planning Documents: 2001 Area Development Plans

Naval Surface Warfare Center Dahlgren Site Area Development Plans: Warfare Systems Complex, Weapons Development Complex, and Advanced Concepts Complex (NSWCDD, 2001) was prepared in 2001 for NSWCDD. This document provides a comprehensive vision for facilities that would support current and future mission requirements and allow NSF Dahlgren to make optimal use of its existing assets and development opportunities. The plan is not a comprehensive installation master plan but rather focuses on the three complexes listed in the title, for which it offers broad development concepts based on an analysis of present and future requirements, constraints, and opportunities. These concepts realize the plan's overall goals and objectives, which are to:

1. Improve quality of work-life and quality of service to attract and maintain highly-qualified personnel by creating a campus-like environment with amenities through:
    - Developing open-space areas that provide recreational opportunities while providing aesthetic value to the installation.
    - Enhancing views of prominent facilities and installation functions.
    - Screening undesirable views.
    - Enhancing pedestrian access and circulation within and between complexes.
    - Enhancing the visual quality of the installation by developing streetscape standards.
2. Project a strong, positive image and create a sense of orderly and rational facility development through:
    - Consolidating interrelated activities and functions to reduce the number of facilities and achieve greater efficiency and convenience.
    - Optimizing the physical siting of new core facilities.
    - Evaluating long-range requirements and determining adequate area for development.

Land Use - Mainside



Source: NSWCDD GIS (2008 - 2011)

Figure 3.1-1

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3. Reduce the impact of operational constraints through:
    - Avoiding, where possible, intrusion into existing operations.
    - Evaluating/analyzing existing operational constraints, identifying opportunities to reduce, eliminate, consolidate, or relocate functions that create constraints.
    - Identifying areas that are free of operational constraints.
    - Reducing ordnance magazine/operation/testing exclusion zones when possible.
4. Reduce impact of natural and man-made constraints through:
    - Identifying constraints and evaluating the impact of future development scenarios.
    - Identifying areas of development that are free of constraints.

3.1.1.3 Planning Documents: 2005 NDW Regional Shore Infrastructure Plan

Naval District Washington (NDW) is the regional provider of common operating support to naval installations within a 100-mile (mi) radius of the Pentagon. Services provided include public affairs; public works; public safety; community support; human resources; information technology; supply; air and port operations; ceremonial support; environmental and safety; and morale, welfare, and recreation. NDW encompasses more than 4,000 square miles (sq mi), including the District of Columbia; the Maryland counties of Anne Arundel, Calvert, Charles, Frederick, Montgomery, Prince George's, and St. Mary's; and the Virginia counties of Loudoun, Fauquier, Fairfax, Prince William, Stafford, King George, Westmoreland, and Arlington, as well as the incorporated cities within their boundaries (NDW, 2011). NSF Dahlgren is one of 17 Navy installations in the District that are covered by the *NDW Regional Shore Infrastructure Plan* (RSIP), completed in 2005 (NDW, 2005)

The RSIP was prepared in accordance with a directive from the Chief of Naval Operations (CNO) to establish a comprehensive approach to managing the Navy's resources, facilities, and infrastructure. The policy objectives of the RSIP are to: reduce footprints and costs; increase existing capabilities and sustainability; and maximize mission efficiencies.

Among the various recommendations included in the RSIP, two are particularly relevant to NSF Dahlgren and this EIS:

- Recognize NDW as an RTD&E center: "The high concentration of RDT&E missions and facilities in the region is a unique occurrence in the Navy and provides an opportunity for NDW to stand out among other regions." RDT&E is "a priority for the Navy because of the continuing requirement to test and evaluate many weapons and platforms that are procured."
- Maximize existing facilities for highest and best use: under this recommendation, the Dahlgren Airfield is called out as an under-utilized facility with potential for better use: "The UAV testing program is rapidly expanding and will reach limits within Naval Air Station Patuxent River and Webster Field air spaces. The Air Operations Program Director must evaluate the necessary resources and facilities to support UAV testing or another air operations mission at Dahlgren."

3.1.2 Dahlgren Area and Potomac River Shoreline

This section broadly describes existing land use around NSF Dahlgren and along the shoreline of the stretch of the Potomac River overlain by the PRTR. Three Virginia counties – King George, Westmoreland, and Northumberland – one incorporated town – Colonial Beach, Virginia – and two Maryland counties – Charles and St. Mary's – have land within this area. The current comprehensive plans and, where applicable, other planning documents designed to guide land use decisions in each of the five counties and in Colonial Beach are briefly characterized. Existing water-access points and county planning pertaining to water access are addressed in a separate subsection, as are the known large-scale projects currently being planned or implemented within the area under consideration and the several military installations present in or adjacent to the area.

3.1.2.1 Existing Land Use

All five counties within the area under consideration are predominantly rural in character, with agricultural and forested land comprising approximately 72 percent of the land in Charles County in 2009 (Charles County, 2012) and 77 percent of the land in St. Mary's County in 2002 (St. Mary's County, 2010). In King George County in 2007, about 31 percent of the land was in agricultural use and, in 2010, about 63 percent of the land was forested (King George County, 2012). In 2004, approximately 59 percent of the land area of Westmoreland County was forested; in 2007, about 42 percent of the county's land was agricultural (Westmoreland County, 2010). Finally, in Northumberland County in 2005, about 83 percent of the land was either in agricultural use or forested (Northumberland County, 2006).

In all five counties, however, the trend over the last decades has been toward a loss of farm and forest land to development – particularly residential, single-family home development – to accommodate a growing population. For instance, between 1997 and 2009, the amount of developed land in Charles County increased by almost 57 percent, from 46,878 ac to 73,419 ac; the amount of residential development increased by more than 67 percent, from 37,280 ac to 62,328 ac (Charles County, 2012). In St. Mary's County, the amount of developed land increased by 30 percent between 1997 and 2002 (St. Mary's County, 2010). As a further illustration of this trend, Table 3.1-1 shows the increase in the number of housing units for each of the five counties between 2000 and 2010.

Table 3.1-1
Housing Units – 2000 & 2010

County	Housing Units in 2000	Housing Units in 2010	Increase
Charles	43,903	54,963	25%
St. Mary's	34,081	41,282	21%
King George	6,820	9,477	39%
Westmoreland	9,286	10,618	14%
Northumberland	8,057	8,995	12%

Source: US Census Bureau, 2011a, Census 2000, QT-H4 Physical Housing Characteristics 2000; 2011b, Census 2010, QT-H1 General Housing Characteristics 2010.

In all five counties, development, especially residential development, is low-density and widely spread out. However, each county features clusters of relatively denser residential and commercial uses, generally located along the main highways or around employment centers.

These denser areas are more suburban in character and contrast with areas characterized by more diffuse, more obviously rural patterns of development. Both types are found along the shores of the Potomac River and adjacent bays and estuaries, which are particularly popular with retirees and second-home owners. There, forested land, fields, and parkland alternate with loosely-woven communities and denser villages or subdivisions. Colonial Beach is the only substantial town within the area. Throughout, shoreline development is primarily residential, with commercial uses mostly being water-dependent businesses, such as charter boat operations, marinas, or seafood eateries. However, there are a few exceptions, as noted below.

The following paragraphs provide a summary description of existing shoreline land uses within each county, down from Charles along the Maryland side and up from Northumberland along the Virginia side. Places and features mentioned in the text are shown on Figures 3.1-2a (Study Area Points of Interest – Upper and Middle Danger Zones) or 3.1-2b (Study Area Points of Interest – Lower Danger Zone).

Charles County

In Charles County, which is the most populated county of the five under consideration, areas of denser development are found mostly to the north and northwest, away from the waterfront. The major population centers are La Plata, Waldorf, and St. Charles. The presence of NSF Indian Head and the relative proximity to Washington, DC largely account for this distribution pattern. By contrast, the south and southeast of Charles County, including the shorelines of the Potomac River and its tributaries, are predominantly rural and undeveloped, particularly between Indian Head and the US Route 301 bridge (the Governor Harry W. Nice Memorial Bridge, henceforth the Harry Nice Bridge), where land use maps and aerial photography show widely spread-out areas of low-density waterside residential development. Many of the houses fronting the water have piers for recreational boating or fishing, a feature found throughout the study area.

Several recreational/natural and cultural resource areas are located along the western shore of the Nanjemoy peninsula, fronting the Potomac River: the Mallows Bay Natural Resources Management Area, the US Bureau of Land Management's Douglas Point property, the Douglas Point State Natural Resources Management Area, and Purse State Park comprise together about 1,900 ac of contiguous protected public land offering hunting, bird-watching, fishing, and fossil-hunting opportunities (Maryland Department of Natural Resources, 2011). On the eastern side of the peninsula, near the head of the estuary formed by Nanjemoy Creek, Friendship Farm Park occupies about 380 ac; the park features ball fields, a boat ramp, and allows for pier and shoreline fishing. Fronting the Port Tobacco River due north of NSF Dahlgren, lies Chapel Point State Park (approximately 820 ac in area) (Charles County, 2012).

Finally, two military installations front the Potomac River: NSF Indian Head, where Naval Surface Warfare Center Indian Head is based (about 20 mi to the northwest of NSF Dahlgren), and the Army's Blossom Point Field Test facility, which is approximately 7 mi north of NSF Dahlgren, at the tip of the small peninsula formed by Nanjemoy Creek and the Port Tobacco River (see Section 3.1.2.4 for brief descriptions of these facilities).

Farther south, the Charles County side of the Harry Nice Bridge is dominated by the smokestacks of the Morgantown generating station – the only heavy industrial land use within the area under consideration – and clusters of residential and commercial development to the north (Newburg) and south (Morgantown). The shoreline south of the bridge down to the county

line is again characterized by very low-density, spread-out residential uses with a few areas of greater concentration, including Morgantown, Issue, the Swan Point Yacht and Country Club, and Cobb Island, separated by fields and forest. Here too, most riverside houses feature piers for recreational boating or fishing. Southern Park, featuring a playground, picnic area, ball fields, tennis courts, and a fishing pier, is located on about 40 ac between Issue and Cobb Island (Charles County, 2012).

St. Mary's County

Existing land use along the southern shoreline of St. Mary's County shows a similar pattern of very-low-density residential development interspersed with fields and forest, with a few denser waterside communities, such as Mill Point, Longview Beach, River Springs, Coltons Point, and Piney Point/St. George Island. Leonardtown, the county seat, lies at the head of Breton Bay, one of several deep bays and estuaries along the southern coastline of the county. A concentration of residential developments is also found on the northern shore of Breton Bay (Society Hill) and on the eastern shore of the adjacent St. Clements Bay (St. Clements Shores).

Two state parks are located along the southern shore of St. Mary's County: St. Clements Island State Park (the site of arrival of the first English settlers in the state), which is accessible by boat only; and Point Lookout State Park (about 1,000 ac), which offers swimming, fishing, boating, and camping opportunities.

NAS Patuxent River Webster Field Annex is located on the eastern shore of the St. Mary's River estuary into the Potomac, to the northwest of Point Lookout Park, about 35 mi to the southeast of NSF Dahlgren. NAS Patuxent River lies approximately 34 mi east of NSF Dahlgren, at the confluence of the Patuxent River and the Chesapeake Bay (see Section 3.1.2.4 for a brief description of these facilities).

Northumberland County

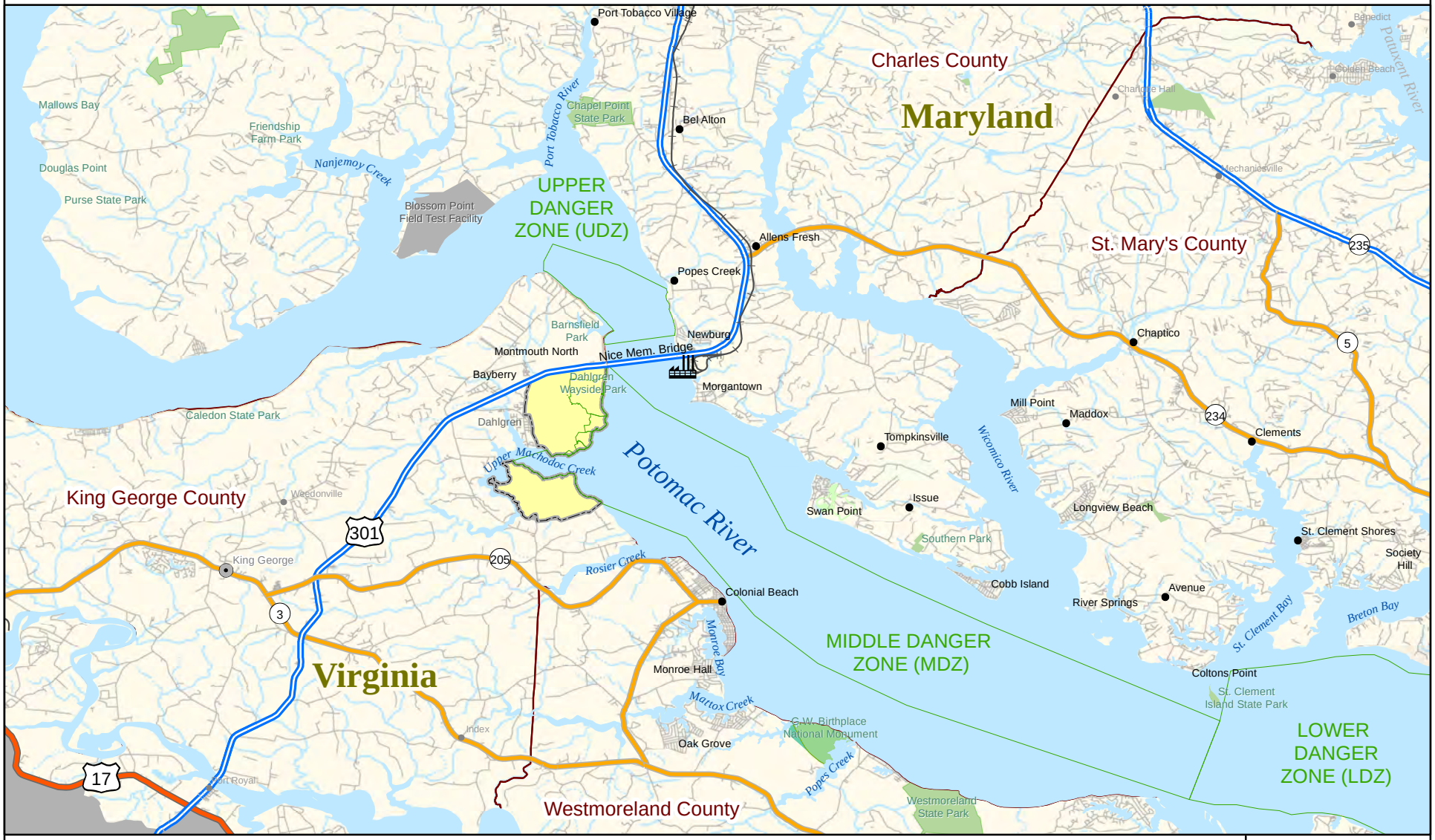
Across the river, in Northumberland County, development is typically concentrated along the main roadways (both residential and commercial development) and the waterfront (primarily residential). As elsewhere in the study area, along the shore low-density housing alternates with fields and forested parcels. Approximately 45 percent of the county shoreline is forested and 34 percent is in residential use, with other development accounting for a little over two percent of the shoreline. Moving westward from Smith Point along the river, the main residential clusters include Ophelia, Lake, and Lewisetta. Two major waterside subdivisions identified in the county's comprehensive plan are White Sand Harbour and Bay Quarter Shores (Northumberland County, 2006).

Westmoreland County and Colonial Beach

A similar pattern of development characterizes the shoreline in Westmoreland County, although waterside residential uses there appear less evenly distributed and more clustered than in Northumberland County, while longer continuous stretches of coast are completely undeveloped.

This is due, largely, to the presence of two large riverside park areas: Westmoreland State Park and the George Washington Birthplace National Monument, located east and west of Popes Creek, respectively. Westmoreland State Park, a 1,311-ac facility extending about 1.5 mi along

Study Area Points of Interest - Upper and Middle Danger Zones



Source: NSWCDD GIS (2008 - 2011)

Figure 3.1-2a

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Study Area Points of Interest - Lower Danger Zone

Source: NSWCDD GIS (2008 - 2011)

Figure 3.1-2b

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the river, offers opportunities for hiking, camping, fishing, boating, and swimming (Virginia Department of Conservation and Recreation, 2012). The 622-ac George Washington Birthplace National Monument, managed by the National Park Service, has approximately 1 mi of waterfront. Areas of waterside residential concentration include the Yeocomico estuary (Kinsale), Coles Point and Glebe Harbor on Lower Machodoc Creek, the Currioman Bay area, and the area around Mattox Creek and Monroe Bay, surrounding Colonial Beach (Monroe Hall, Oak Grove).

Colonial Beach is one of two incorporated towns in Westmoreland County and the only substantial town in the study area along the river. Founded as a waterside resort in the 19th century, Colonial Beach experienced a marked decline in the 1960s and 1970s. In more recent decades, it has regained popularity as a waterfront community and beach resort; its year-round population of about 3,250 swells to 10,000 in the summer (Colonial Beach, 2007). Colonial Beach extends along a four-mile stretch of the Potomac River, on a small peninsula separating the river from Monroe Bay. For this reason, potential future growth is mostly confined to the northwest. In 2008, approximately 70 percent of the town was developed and 30 percent was vacant. The predominant land use is single-family residential on small lots (0.25 ac or less), although more recent residences tend to be built on larger lots. The proportion of year-round residences relative to vacation homes has been rising. Commercial uses occur mainly in three locations: the downtown/beachfront area, Colonial Avenue, and Route 205. Community uses (e.g., schools, churches) are mostly found within the Central Area (just south of Colonial Avenue) (Colonial Beach, 2010).

King George County

Rosier Creek, north of Colonial Beach, separates Westmoreland County from King George County. Between the creek and the Harry Nice Bridge, most of the shoreline is occupied by NSF Dahlgren, with a few residential lots between the southern boundary of the installation and the county line. A designated Primary Settlement Area, the area immediately around NSF Dahlgren is the most intensely developed part of King George County, with 12 percent of the county's population and approximately 1,100 housing units. It includes the Dahlgren community, wedged between Williams Creek and NSF Dahlgren, which consists of a commercial core along Route 206 (Dahlgren Road) and Route 614 (Potomac Drive) surrounded by residential uses. Outside of the Dahlgren community, the area contains two large residential subdivisions – Bayberry and Monmouth North. It also has the largest office park in the county (the Dahlgren Technology Center) and the largest concentration of commercial development (including a strip shopping center, several fast food and other restaurants, and the majority of the county's gas stations) (King George County, 2012).

The county's shoreline north of NSF Dahlgren is characterized by widely spread-out residential lots, most with piers into the river, as is the case throughout the study area for waterfront properties. Barnesfield Park, a 154-ac facility, lies just north of the Harry Nice Bridge landing (King George County, 2012). It is King George County's primary active recreational resource (King George County Planning Commission, 2006) and features nature trails, picnic areas, a playground, and beach fishing. The adjacent 10-ac Dahlgren Wayside Park, at the foot of the bridge, is the location of the Potomac Gateway Welcome Center, which provides touring information to visitors who have just entered Virginia via the bridge. Farther along the shore, near the bottom of the bend the Potomac makes at this location, is Caledon State Park, which

extends over 2,579 ac and is a designated National Natural Landmark. Among other recreational options, it offers visitors the opportunity to view bald eagles, which are very numerous in this area. Preservation of eagle habitat is an important focus of the park as a natural resources area.

3.1.2.2 County and Town Plans

All five counties in the study area and the Town of Colonial Beach have current comprehensive plans. A comprehensive plan is a document that provides a framework for land use management policies and decisions based on a set of goals that express the planning jurisdiction's growth-management philosophy and vision for the future.

In Maryland, county comprehensive plans are prepared pursuant to the legislation and requirements contained in Article 66-B of the Annotated Code of Maryland, as amended by the Economic Growth, Resource Protection and Planning Act, which establishes seven land use visions for Maryland's future, complemented by an eighth vision added in 2000. Under the act, the land use visions must be implemented when a local comprehensive plan is prepared. The eight visions are as follows:

1. Development is concentrated in suitable areas.
2. Sensitive areas are protected.
3. In rural areas, growth is directed to existing population centers and resource areas are protected.
4. Stewardship of the Chesapeake Bay and the land is a universal ethic.
5. Conservation of resources, including a reduction in resource consumption, is practiced.
6. To assure the achievement of the above, economic growth is encouraged and regulatory mechanisms are streamlined.
7. Adequate public facilities and infrastructure under control of the county or municipal corporation are available or planned in areas where growth is to occur.
8. Funding mechanisms are addressed to achieve these visions.

Additionally, Maryland counties are required to prepare and submit to the state land preservation, parks, and recreation plans (LPPRPs) that are to be updated every six years as of 2005. LPPRPs support Maryland's planning visions and qualify local governments for State Program Open Space funds and other programs related to the plan's objectives for three land resource elements: recreation and parks, agricultural land preservation, and natural resource conservation. Upon final adoption by the county board, the LPPRP becomes an amendment to the county's comprehensive plan.

In Virginia, county and city comprehensive plans are prepared pursuant to § 15.2-2223 through § 15.2-2232 of the Code of Virginia. As stated in the Code of Virginia,

> In the preparation of a comprehensive plan the commission shall make careful and comprehensive surveys and studies of the existing conditions and trends of growth, and of the probable future requirements of its territory and inhabitants. The comprehensive plan shall be made with the purpose of guiding and accomplishing a coordinated, adjusted and harmonious development of the territory which will, in accordance with present and probable future needs and

resources, best promote the health, safety, morals, order, convenience, prosperity and general welfare of the inhabitants.

Both Maryland and Virginia have regional planning agencies whose role is to coordinate local planning efforts to promote effective social and economic growth in their respective areas of jurisdiction. In Maryland, the Tri-County Council for Southern Maryland is the regional planning agency for Charles, St. Mary's, and Calvert counties as well as for the incorporated towns of Chesapeake Beach and North Beach (Calvert County); Indian Head, La Plata, and Village of Port Tobacco (Charles County); and Leonardtown (St. Mary's County). In Virginia, the Northern Neck Planning District Commission coordinates regional planning for Lancaster, Richmond, Northumberland, and Westmoreland counties. King George County is within the purview of the George Washington Regional Commission, along with the counties of Caroline, Spotsylvania, and Stafford, and the City of Fredericksburg. However, the primary focus of these regional planning agencies is on coordinating regional economic development and transportation. Specific land use planning and decision-making rest with local jurisdictions.

Current planning documents applying within the study area are the following:

- Charles County's *Comprehensive Plan* (2006a)
- Charles County's *Land Preservation, Parks, and Recreation Plan* (2006b)
- St. Mary's County's *Comprehensive Plan: Quality of Life in St. Mary's County – A Strategy for the 21st Century* (2010)
- St. Mary's County's *Land Preservation, Parks, and Recreation Plan* (2005)
- Northumberland County's *Comprehensive Plan* (2006)
- Westmoreland County's *Comprehensive Plan: Vision 2030* (2010)
- The Town of Colonial Beach's *Comprehensive Plan, 2009-2029* (2010)
- King George County's *Comprehensive Plan* (2006)

Though each plan is different in its details and emphases, they all share a few common characteristics, as can be expected, given the many common features of the areas under consideration:

- All five counties and Colonial Beach have experienced substantial growth in the past decades and all expect substantial growth to continue over the next two decades.
- All five counties strive to accommodate the expected growth while preserving their rural character and quality of life. Similarly, Colonial Beach aims to accommodate growth while preserving its character as a small town and an attractive waterfront resort.
- All five counties aim to focus a majority of the expected future development in specific areas already developed and served by county services (growth areas) and to discourage sprawl and the unstructured development of rural areas in favor of rural villages. (The area around NSF Dahlgren is a designated growth area for King George County.)
- All six jurisdictions consider the Potomac River and its shoreline a major natural and recreational asset essential to the quality of life of their residents. All emphasize the importance of providing, enhancing, and maintaining public access to the river for

recreational and economic purposes while preserving the natural shoreline environment and water quality.

More detailed summaries of the goals and objectives of each plan, as they pertain to land use and the scope of this EIS, are provided in Appendix B.

3.1.2.3 Public Water Access

The Potomac River and the several tributaries that empty into it through the many bays and estuaries that characterize the study area offer opportunities for a wide range of water-based activities. As noted above, every jurisdiction recognizes the role of the river in enhancing quality of life in, and drawing new residents to, the area; therefore, all jurisdictions strive to promote better access to the water for recreational and economic purposes.

There are numerous boat ramps, car-top boat launches, marinas, mooring and fishing piers, and swimming or fishing beaches throughout the study area. The following paragraphs focus on existing and planned public boat ramps or launches and public beaches as described in the aforementioned LPPRPs (for Maryland) and comprehensive plans (for Virginia). Locations within the study area that are mentioned in the text are shown in Figure 3.1-3 (Public Access to Water).

According to its draft LPPRP (Charles County, 2012), Charles County has a total of 19 boat ramps that are available to the public, 6 of which are at Smallwood State Park, just south of Indian Head. Other public boat ramp locations within the study area for this EIS include Mattingly Park, Mallows Bay Park, Friendship Farm Park, and Hatton Creek. The public beaches in the county are maintained by the state at Smallwood State Park, adjacent to NSF Indian Head, Douglas Point State Natural Resource Management Area and Purse State Park, north of Maryland Point, and Chapel Point State Park, along the Port Tobacco River. Based on an analysis of existing and future demand, the county's draft LPPRP estimates that Charles County had a deficit of three boat ramps in 2010 and would have a deficit of nine ramps by 2022. Actions to remedy this deficit outlined in the draft plan include the construction of new boat ramps at Friendship Farm Park and Chapel Point State Park (Charles County, 2012). Noting similar deficits, the LPPRP adopted in 2006 likewise prescribed the construction of new boat ramps, although at Friendship Farm Park and Mallows Bay (Charles County, 2006b).

St. Mary's County's LPPRP identifies 22 state- and county-owned water-access points, 13 with boat ramps. Compared to estimated demand, this represents a deficit of four for 2005 and five by 2020. Water-access points within the study area include the Wicomico Shores Landing, Chaptico Wharf, Bushwood Wharf, Paul Ellis Landing, River Springs Landing, Leonardtown Landing, Camp Calvert, Abell's Wharf, Tall Timbers Landing, Piney Point Landing, Piney Point Lighthouse, St. George Island Landing, St. Inigoes Landing, Fox Harbor Landing, and Point Lookout State Park. Among the plan's stated priorities is the acquisition of 20 to 50 ac in the central part of the county's southern shoreline for construction of a Potomac waterfront park sometime between 2015 and 2020. There are also four public beaches in St. Mary's County, only one of which is within the study area for this EIS: Point Lookout State Park Beach (St. Mary's County, 2005).

Public Access to Water

Source: NSWCDD GIS (2008 - 2011)

Figure 3.1-3

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According to Northumberland County's comprehensive plan, public water access in the county is limited, though numerous private facilities are available. There are 14 public powerboat ramps, but few places for launching canoes or bank fishing. Ramps on the Potomac side of the county are found at the head of the Coan River estuary (Rowes Landing, Forest Landing) and the Yeocomico River (Lodge Landing). VirMar Beach is one of only two public beaches in the county (the other one, Hughlett Point, is outside the study area). Improving water access is one of the county's major goals, as stated in the comprehensive plan. Implementation of this goal will involve developing additional public boat ramps and fishing piers, identifying new public beach areas and improving existing ones, establishing waterfront parks, and creating a network of canoe/kayak landings allowing for one-way traveling on county waters. Specific projects delineated in the plan include improvements at Rowes Landing (such as the addition of a floating canoe/kayak launch platform) and reactivation of an abandoned public water-access site at Hampton Hall Creek near the border with Westmoreland County as a canoe/kayak launch site (Northumberland County, 2006).

Westmoreland County's comprehensive plan lists a total of 32 public and private waterfront access areas, including public boat ramps at Bonum Creek, Branson Cove, Currioman Bay, Monroe Creek, and Westmoreland State Park. The county also has three public beaches in Colonial Beach and one at Westmoreland State Park. The plan notes that additional public access locations could be considered, including the provision of water access at Virginia Department of Transportation bridge repair or replacement project sites (Westmoreland County, 2010).

Even more than for the other jurisdictions considered here, the waterfront, which stretches along two miles of river, is an essential element of Colonial Beach's identity and appeal. As noted in the 2010 comprehensive plan, residents and local leaders value the town's beach front as of prime importance to the economic vitality of the area. To make optimum use of this asset, the plan recommends that the town work with the US Army Corps of Engineers and the State Beach Board on replenishment projects and structural erosion control. The town is also pursuing the redevelopment of the entire boardwalk area. Another significant feature is the 200-ft municipal pier in the center of the main beach area, which creates a focal point for water-related activities. The town also has a public boat ramp near Castlewood Park in the Point area (south end of the peninsula), which is recommended for improvement (Colonial Beach, 2010).

Potomac River access in King George County is inherently limited because much of the shoreline is occupied by limited-access facilities, including NSF Dahlgren but also the Caledon Natural Area (due to sensitive bald eagle habitat). Access to the Potomac is available from three private marinas and one public site at Wayside Park. There also is a river-access point on Dahlgren, reserved for use by Navy personnel. Two of the county's goals for community services and facilities, as stated in its current (adopted) and draft comprehensive plans (King George County Planning Commission, 2006; King George County, 2012), are to provide and encourage adequate recreational access to state waters while ensuring continued protection of the natural environment, and to create public-access opportunities that offer varied waterfront experiences and can enhance economic opportunities. The plans recommend that the county seek to control or acquire a select few places for recreational water access, but due to the presence of bald eagle habitat, such access points must remain limited in size and number, with sensitive siting, access, and design, especially along the Potomac River.

3.1.2.4 Nearby Military Installations

In addition to NSF Dahlgren, there are several major military installations within and near the study area for this EIS. These installations are considered here because impacts from their activities may overlap or combine with the impacts of NSWCDD. The following paragraphs provide short descriptions of each installation and briefly characterize the activities at each. Figure 3.1-4 (Nearby Military Installations) shows where each installation is located in relation to NSF Dahlgren.

NSF Indian Head

NSF Indian Head (Indian Head), home to Naval Surface Warfare Center Indian Head, a sister organization to NSWCDD, occupies 3,500 ac on the eastern shore of the Potomac River in Charles County, approximately 20 mi northwest of NSF Dahlgren. The installation consists of two parcels: Cornwallis Neck on the peninsula formed by Mattawoman Creek and the Potomac River, and Stump Neck across the creek's mouth.

The land use on Cornwallis Neck includes an operational area and a restricted area in the southern part of the peninsula, where munitions explosive testing is performed. Stump Neck is the primary location for the Naval Explosive Ordnance Disposal Technology Division and Range 3, where the division performs open air detonations of foreign ordnance.

Marine Corps Base Quantico

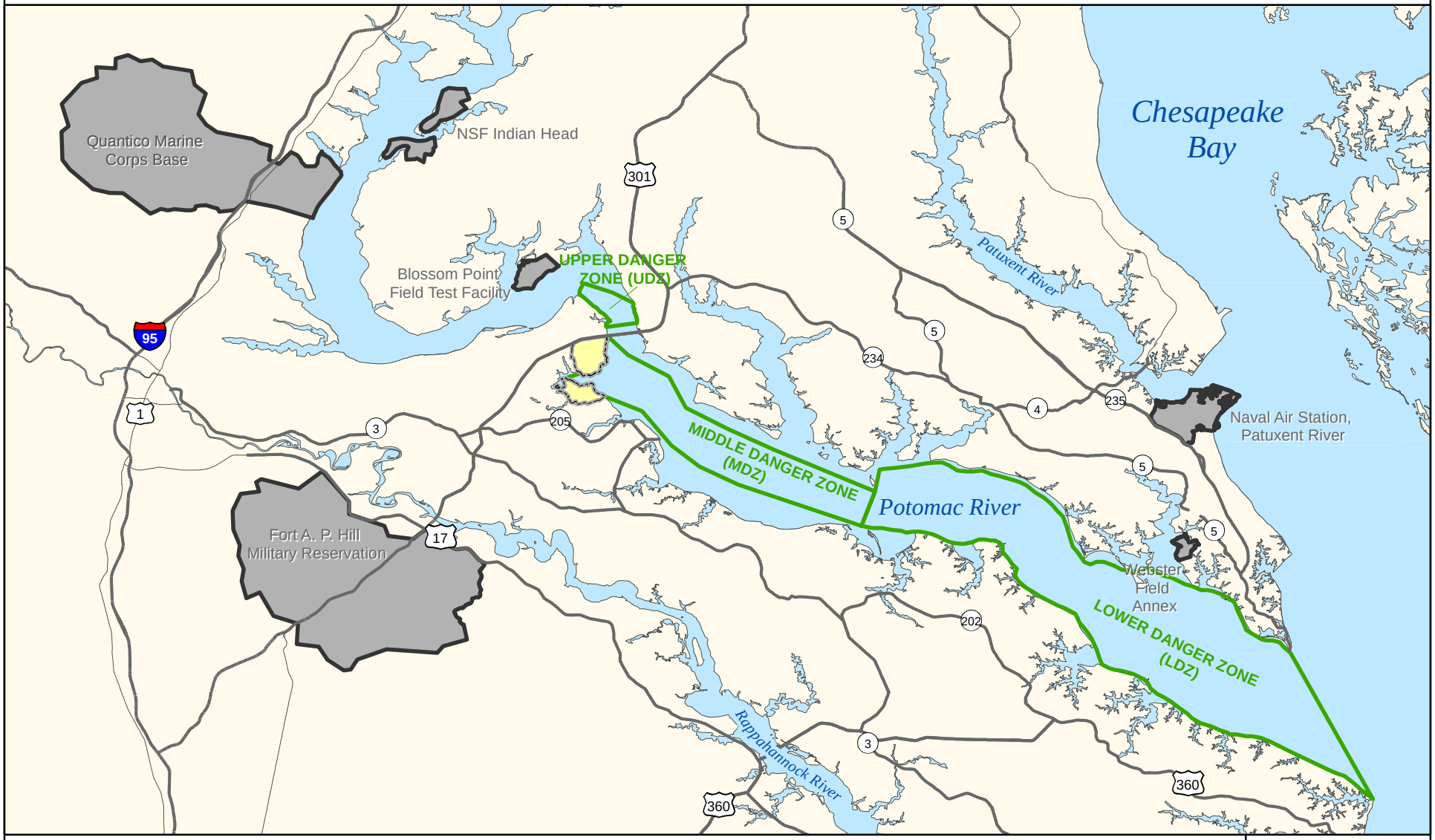
Just south of Indian Head, across the Potomac River, Marine Corps Base Quantico, known as the "Crossroads of the Marine Corps" is a major Marine Corps training base occupying about 59,000 ac in Prince William, Stafford, and Fauquier counties, Virginia, approximately 20 mi northwest of NSF Dahlgren. The base consists of two major areas on either side of Interstate 95: Mainside, east of the interstate, and Westside, west of it. Mainside is home to numerous administrative support functions, some training functions, and Marine Corps Air Facility Quantico. Westside is used primarily for military training. Largely undeveloped, it consists mostly of training areas and ranges used for a wide array of training activities, including small arms and artillery training, demolition training, and air-to-ground training.

Blossom Point Field Test Facility

The US Army's Blossom Point Field Test facility is a 1,600-ac installation located in Charles County about 7 mi northwest of NSF Dahlgren, on the peninsula formed by Nanjemoy Creek and the Potomac River. The site is an active testing range of the US Army Research Laboratory, Adelphi, Maryland. The Army Research Laboratory is the Army's corporate basic and applied research laboratory. The primary land use on the installation is research and development, with significantly smaller land uses comprising administration, storage and supply, and maintenance (US Army Garrison Adelphi Laboratory Center, 2009).

Under a permit from the Army, the Naval Research Laboratory (NRL) manages satellites through its Blossom Point Tracking Facility, which, at this location, enjoys horizon-to-horizon look angles and an interference-free, low-noise environment. Potential interference with the sensitive satellite antenna radio receivers is minimized by a 2,000-foot (ft) - radius buffer zone around the NRL site.

Nearby Military Installations



Source: NSWCDD GIS (2008 - 2011)

Figure 3.1-4

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Fort A.P. Hill

Fort A.P. Hill is a US Army training facility located in Caroline County, Virginia, just north of the town of Bowling Green, approximately 20 mi southwest of NSF Dahlgren. The installation encompasses 75,794 contiguous ac and leases an additional 111 ac for specialized training along the Rappahannock River. The range complex is primarily for small arms, direct-fire weapons, anti-tank missiles, artillery, and aerial gunnery. In addition, ample tactical landing zones, parking areas, and refueling facilities for rotary-wing aircraft are available. The Fort A.P. Hill Airfield is located on the southeast side of US Route 301 and is used by rotary-wing aircraft. In addition, C-130 aircraft originating at other airfields train two or three times a year at the assault airstrip in the installation's drop zone (US Army, 2004).

Naval Air Station Patuxent River and Webster Field Annex

The 6,500-ac Patuxent River Naval Air Station Complex stretches across 25 mi of shoreline on the Patuxent River, near where the river enters the Chesapeake Bay, approximately 34 mi from NSF Dahlgren. The complex supports naval aviation operations by researching, developing, testing, and evaluating aircraft, aircraft components, and related products. Naval Air Warfare Center Patuxent River serves as the Navy's principal research, development, test, evaluation, engineering, and fleet support activity for naval aircraft, engines, avionics, aircraft support systems, and ship/shore/air operations. Webster Field Annex is an 850-ac dependence located on the eastern shore of the St. Mary's River (approximately 35 mi southeast of NSF Dahlgren) used primarily for UAV operations (GlobalSecurity, 2011).

3.1.2.5 Projects under Development

At any given time, in an area as large as the study area for this EIS, a number of private and public development and other projects of varying scale and scope are being planned, designed, or implemented. These projects can affect, or be affected by, the alternatives evaluated in this EIS. Therefore, this section briefly describes the most significant of these projects, based on publicly-available information.

Governor Harry W. Nice Bridge Replacement Project

The two-lane Harry Nice Bridge, which carries US Route 301 across the Potomac River and lands just north of NSF Dahlgren, is the only bridge across the Potomac south of the Woodrow Wilson Bridge, which carries the Washington, DC Beltway across the river. The Maryland Transportation Authority (MdTA) initiated planning for the Nice Memorial Bridge Improvement Project in 2006 to address the transportation conditions and capacity limitations at the bridge (MdTA, 2008). The purpose of the project includes providing sufficient capacity for future growth, improving traffic safety, and maintaining the traffic flow during adverse conditions.

In 2009, the MdTA released an Environmental Assessment (EA) (MdTA, 2009) that evaluated a total of seven alternatives: Alternate 1 is the no-build alternative and would include extensive rehabilitation of the existing bridge; Alternates 2 and 4 would rehabilitate the existing two-lane bridge and build a new two-lane span adjacent to it; Alternates 3 and 5 would replace the existing two-lane bridge and build a new two-lane span adjacent to it; and Alternates 6 and 7 would build a new four-lane bridge and take the existing structure out of service. The build

alternatives – Alternates 2 through 7 – provide reasonable tie-in points with the existing and planned highway network, capacity for 2030 traffic demand, the ability to maintain two-way traffic flow, improved safety on approach roadways and bridge, and the ability to comply with navigational channel guidelines. The build alternatives would require an alignment shift of the US Route 301 approach roadways to connect to the new bridge, and each includes a barrier-separated bicycle-pedestrian path (MdTA, 2009).

The EA did not identify a preferred alternative. However, in May 2010, the MdTA issued for review a draft Preferred Alternate/Conceptual Mitigation document (MdTA, 2010) that recommends Modified Alternate 7 – i.e., Alternate 7 with a modified bicycle/pedestrian option – as the preferred alternative. Modified Alternate 7 comprises the installation of a new four-lane bridge to the north of the existing bridge, with a single, barrier-separated, two-way bicycle/pedestrian path on the south side of the new bridge. The existing bridge would be removed under Modified Alternate 7.

The MdTA study team coordinated with regulatory agencies to develop the final environmental document, which was approved by the Federal Highway Administration on November 27, 2012. The Nice Memorial Bridge Improvement Project final environmental document comprises two components: a Finding of No Significant Impact (MdTA, 2012) and a Final Section 4(f) Evaluation (Federal Highway Administration and MdTA, 2012).

Dahlgren Wayside Park, at the foot of the existing Harry Nice Bridge, includes a sand beach along the Potomac River, boat access for small watercraft, and picnic tables, and provides the public opportunities for recreational activities including fishing and canoeing/kayaking. The Final Section 4(f) Evaluation (Federal Highway Administration and MdTA, 2012) found that Modified Alternate 7 would require approximately 2.2 acres of land from the park, including a portion of the park entrance road, a parking area, a portion of the picnic area, and a portion of the beach area. However, mitigation measures were incorporated into Modified Alternate 7 for Section 4(f) uses that cannot be avoided or further minimized and were documented in a memorandum of agreement, executed in September 2011. (Section 4(f) use is the use of land from any publicly-owned public park, recreation area, wildlife or waterfowl refuge, or any significant historic site as part of a federally funded or approved transportation project.) The memorandum of agreement specifies that the Dahlgren Wayside Park entrance and parking lot will be relocated, and that hardscape features such as picnic tables, barbeque grills, and a replacement boat landing will be installed.

Morgantown Generating Station Coal Barge Facility, Flue Gas Desulfurization System, Coal Blending and Gypsum Loadout Facilities, and Fly Ash Beneficiation Facility Projects

The Morgantown power generating station is located just south of the Harry Nice Bridge landing in Charles County, across from NSF Dahlgren. The owner of the plant, Mirant Corporation, has a number of projects that have recently been completed or that are under development. One of the recently completed projects is the new offloading facility that allows the power plant to import coal from overseas suppliers on large open barges that travel up the Potomac River and unload at this facility (Allen, pers. comm., February 19, 2009). Previously, the only option to transport coal to the plant was by train. In March 2007, Mirant began construction of the facility (Rucker, 2007). The new facility extends approximately 836 ft into the Potomac (Maryland Power Plant Research Program, 2007).

Another recent project at the Morgantown generating station was the installation of a flue gas desulfurization system and other associated facilities. The Mirant Corporation declared the desulfurization system operational on December 20, 2009 (Allen, pers. comm., June 3, 2010). The primary purpose of installing a flue gas desulfurization (FGD) system was to reduce sulfur dioxide (SO_2) emissions from the existing coal-fired steam-generating units in keeping with Maryland's Healthy Air Act (Mirant Mid-Atlantic, LLC, 2006).

Coal blending and gypsum loadout facilities were also recently completed at the Morgantown generating station. The coal blending facilities use different types of coals to match the specifications of the boilers and air quality control equipment of the station's coal-fired steam-generating units. The facilities enable optimizing fuel flexibility while meeting Mirant Corporation's system-wide SO_2 emission reduction compliance plan, designed to meet the requirements of state-mandated emission reductions. The gypsum loadout facility supports the beneficial use and efficient transportation of synthetic gypsum, a byproduct formed during the desulfurization process.

The Mirant Corporation is also proposing to modify its Morgantown generating station to install a coal fly ash beneficiation facility and associated truck loading and offloading equipment (Mirant Mid-Atlantic, LLC, 2010). The beneficiation facility would use staged turbulent air reactor thermal process technology to convert high-carbon fly ash that is otherwise unsuitable for commercial use into low-carbon mineral admixture material suitable for use as a Portland cement substitute, which avoids landfilling this fly ash. The proposed beneficiation facility and associated equipment would be constructed on previously-disturbed areas within the existing generating station property (Mirant Mid-Atlantic, LLC, 2010).

Villages at Swan Point Project

This project of US Steel Corporation and Brookfield Homes LLC, approximately 7 miles southeast of NSF Dahlgren along the river in Charles County, is the second phase of a development project initiated in the 1980s. The first phase built the existing Swan Point Yacht and Country Club community, which consists of 322 homes, a golf course, and a marina. The second phase would add 1,500 homes to the site, along with a hotel on the Weir Peninsula, a private beach, retail shops and restaurants along the Potomac shoreline, and a 150-slip marina on the Potomac River at Weir Creek (Degregorio, 2006; McConaty, 2007).

In 2006, Charles County approved a master plan and general development plan for the Villages at Swan Point (Dailey, pers. comm., June 3, 2010). Initiation of construction of all components of the development has been delayed because of the state of the economy and the housing market. Brookfield Homes anticipates that construction will begin in 2012 (Lannin, pers. comm., July 27, 2010).

Residential Development Projects in Colonial Beach

Over the last few years, the town of Colonial Beach has experienced substantial growth and several major residential development projects have been initiated, including: the construction at Monroe Point of about 330 units on 51 ac and a 12-ac commercial site; the construction of 751 homes along Route 205 west of the creek separating Colonial Beach from the unincorporated parts of the county (Northern Neck Subdivision); and, nearby, Potomac Crossing, with 913 residential units, 182,000 square feet of commercial space, a golf course, and a community recreation center (Colonial Beach Virginia Attractions, 2011; Delano, 2006 and 2007). However,

in October 2007, the developer of Potomac Crossing announced that the project was being put on hold due to unfavorable market conditions (Ficklin, 2007) and has remained on hold due to the economy (Colonial Beach Virginia Attractions, 2011).

3.1.3 Special-Use Airspace (SUA)

As explained in Sections 1.4.4 and 1.6.2, SUA areas have been established by the FAA to prevent hazards to aircraft from NSWCDD's RDT&E operations (see Figure 1-6 for the location of these areas). Over the PRTR, the maximum altitudes are 40,000 ft for R-6611A and R-6613A, and 60,000 ft for R-6611B and R-6613B. Over the EEA, the SUA (R-6612) extends up to 7,000 ft. R-6612, R-6611A, and R-6613A (surface to 7,000 or 40,000 ft) are automatically in effect (i.e., restricted to air traffic) from 8 am to 5 pm daily, excluding weekends and holidays. When NSWCDD does not plan to use the SUA during these hours, it turns it back to the FAA. Conversely, NSWCDD may need to use the airspace outside the normal hours (i.e., at night or on weekends), in which case a Notice to Airmen (NOTAM) is issued by the FAA 48 hours in advance. The same procedure is used for R-6611B and R-6613B (40,000 to 60,000 ft), which are not automatically in effect. When they are needed, the FAA, at the request of NSWCDD, issues a NOTAM 48 hours in advance. These higher altitude zones are used only on rare occasions.

Although the SUA around NSF Dahlgren is potentially accessible to civilian aircraft when it is not in effect, commercial and general aviation operators seldom take advantage of this accessibility for practical reasons. Commercial airlines prepare and file their flight plans well before any notice of the airspace status can be issued (Saulsberry, pers. comm., July 15, 2008) and would not benefit from last minute changes. Airliners flying in and out of Ronald Reagan-Washington National Airport, about 35 mi north of the installation, follow established arrival and departure routes that do not traverse the SUA. Only an emergency could prompt them to deviate from these routes, in which case protocols are in place to request and grant access to the restricted airspace if needed.

General aviation pilots have the option of verifying the status of the SUA when planning their flights by looking up NOTAMs or communicating with traffic control at NAS Patuxent River if they want to fly into the SUA. However, based on information provided by Maryland's Director of the Office of Regional Aviation assistance, they very rarely do so, being trained to assume as a matter of course that military restricted air space is off-limits at all times (Solanki, pers. comm., January 7, 2010).

3.1.4 Coastal Zone Management

The Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. § 1451, et seq., as amended) encourages states, in cooperation with federal and local agencies, to develop land and water use programs in coastal zones. The CZMA excludes from the coastal zone "…lands the use of which is by law subject solely to the discretion of … the Federal Government, its officers or agents" (16 U.S.C. § 1453 (1)). By this statutory definition, NSF Dahlgren is not within Virginia's coastal zone. However, if a proposed federal activity affects coastal resources or uses beyond the boundaries of the federal property – i.e., has spillover effects – Section 307 of CZMA applies. Section 307 stipulates that federal projects that affect land uses, water uses, or other coastal

resources of a state's coastal zone must be consistent to the maximum extent practicable with the enforceable policies of that state's federally-approved coastal management plan. Federal consistency with a state's coastal zone management program (CZMP) is demonstrated by means of a coastal consistency determination that is submitted to the state agency responsible for review and comments. Applying for and complying with state permits when required by federal law also achieves consistency.

King George, Westmoreland, and Northumberland counties are within Virginia's designated coastal zone. Virginia has developed and implemented a federally-approved coastal resources management program (CRMP) describing current coastal legislation and enforceable policies. The Virginia CRMP has nine enforceable policies: fisheries management, subaqueous lands management, wetlands management, dune management, non-point source pollution control, point source pollution control, shoreline sanitation, air pollution control, and coastal lands management (Chesapeake Bay Preservation Act). Federal consistency determinations in Virginia are reviewed by the Virginia Department of Environmental Quality (VDEQ), which coordinates reviews with other state agencies as well as county and regional planning agencies.

Charles and St. Mary's counties are within the designated coastal zone of Maryland. Maryland has developed and implemented a federally-approved CZMP based on existing state laws and regulations, particularly the Maryland Tidal Wetlands Law (Wetlands and Riparian Rights) and the Maryland Critical Areas Program. Federal consistency determinations in Maryland are reviewed by the Wetlands and Waterways Program of the Maryland Department of the Environment (MDE).

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3.2 Socioeconomics

For the purposes of this section, the study area consists of King George, Westmoreland, and Northumberland counties in Virginia; and Charles and St. Mary's counties in Maryland. Data for smaller (e.g., census tracts) or larger (i.e., the states of Virginia and Maryland) areas will also be provided for comparison, as appropriate.

The following paragraphs describe the population of the study area and its general demographic characteristics, including age and ethnicity; its economic characteristics, including income and employment; and housing conditions.

3.2.1 Demographic Profile

This demographic analysis characterizes the population of the study area and its evolution based on US Census Bureau data from the 1990 Census, the 2000 Census, and the 2010 Census, and Maryland Department of Planning and Virginia Employment Commission population projections.

3.2.1.1 General Demographic Trends

As shown in Table 3.2-1, between 1990 and 2010 the total population of the five-county study area went from 216,659 to 305,070, an increase of 88,411 or 40.8 percent. The combined growth rate of the five counties exceeded that of both Maryland and Virginia both between 1990 and 2000 and between 2000 and 2010.

Table 3.2-1
Population 1990-2010

Geography	Population			Change			
	1990	2000	2010	1990-2000	Percent	2000-2010	Percent
King George Co.	13,527	16,803	23,584	3,276	24.2	6,781	40.4
Northumberland Co.	10,524	12,259	12,330	1,735	16.5	71	0.6
Westmoreland Co.	15,480	16,718	17,454	1,238	8.0	736	4.4
Charles Co.	101,154	120,546	146,551	19,392	19.2	26,005	21.6
St. Mary's Co.	75,974	86,211	105,151	10,237	13.5	18,940	22.0
Study Area	216,659	252,537	305,070	35,878	16.6	52,533	20.8
Maryland	4,781,468	5,296,486	5,773,552	515,018	10.8	477,066	9.0
Virginia	6,187,358	7,078,515	8,001,024	891,157	14.4	922,509	13.0

Sources: US Census Bureau, 2011a, Census 1990, DP-1 General Population and Housing Characteristics 1990; 2011b, Census 2000, DP-1 Profile of General Demographic Characteristics 2000; 2011c, Census 2010, DP-1 Profile of General Population and Housing Characteristics 2010.

Among the five counties, King George County experienced the highest rate of growth: 40.4 percent (or 6,781 new residents) between 2000 and 2010, following a 24.2 percent increase between 1990 and 2000. However, its population remained relatively small compared to that of

Charles and St. Mary's counties, which are closer to Washington, DC and its suburban growth. These two counties together accounted for about 82 percent of the study area's population both in 2000 and 2010. St. Mary's County had the second highest growth rate between 2000 and 2010 (22.0 percent) and Charles County had the third highest growth rate (21.6 percent). Because of Charles County's large base population – it is the most populous county in the study area – Charles accounted for 51.3 percent of all the population growth in the area over the period 1990-2010. Charles and St. Mary's are the counties that gained the most residents during this period.

Table 3.2-2 shows available population projections to 2020 for each of the five counties and the states of Maryland and Virginia. As might be expected, the two Maryland counties account for the lion's share (85.3 percent) of the projected growth in the study area. In Virginia, King George is projected to experience the most growth, at a rate higher than that of the Maryland counties, but this projected growth rate is mostly because its base population is relatively small. In absolute terms, projected growth in all three Virginia counties remains substantially less than in the Maryland counties. Because of their proximity to Washington, DC, the Maryland counties will continue to account for a large majority of the population of the study area.

Table 3.2-2
Population Projections for 2020

Geography	Change			
	2000	2020	2000-2020	Percent
King George Co.	16,803	30,126	13,323	79.3
Northumberland Co.	12,259	14,587	2,328	19.0
Westmoreland Co.	16,718	18,336	1,618	9.7
Charles Co.	120,546	177,200	56,654	47.0
St. Mary's Co.	86,211	130,100	43,889	50.9
Study Area	252,537	370,349	117,812	46.7
Maryland	5,296,486	6,339,290	1,042,804	19.7
Virginia	7,078,515	8,917,396	1,838,881	26.0

Sources: US Census Bureau, 2011b, Census 2000, DP-1 Profile of General Demographic Characteristics 2000; Virginia Employment Commission, 2011; Maryland Department of Planning, 2008.

3.2.1.2 Age Distribution

Table 3.2-3 shows the age structure of the study area's population as of 2010. While the age distribution in the study area as a whole is similar to that of Virginia and Maryland, the proportion of persons 65 years and over in Northumberland and Westmoreland counties is noticeably higher than in King George, Charles and St. Mary's counties. Both Northumberland and Westmoreland counties have fewer members of their populations in the workforce years or younger. This reflects these counties' greater distance from the Washington, DC area and other major employment centers and possibly their attractiveness to retirees.

Median age data from the 2010 Census confirm Westmoreland and Northumberland counties' distinct age patterns: the median age is 37.4 in Charles County, 36.0 in St. Mary's, 36.6 in King George (all three comparable to Maryland – 38.0 – and Virginia – 37.5) but 53.6 in Northumberland County and 46.6 in Westmoreland.

Table 3.2-3
Age Distribution (2010)

Geography	Total 2010 Population	Percent			
		Under 5 years	5-19 years	20-64 years	65 and over
King George Co.	23,584	7.6	22.3	59.9	10.2
Northumberland Co.	12,330	4.3	14.1	51.5	30.1
Westmoreland Co.	17,454	5.3	16.9	57.0	20.9
Charles Co.	146,551	6.4	22.8	61.3	9.5
St. Mary's Co.	105,151	7.2	22.1	60.5	10.3
Study Area	305,070	6.6	21.8	60.2	11.3
Maryland	5,773,552	6.3	20.0	61.5	12.3
Virginia	8,001,024	6.4	19.7	61.7	12.2
Source: US Census Bureau, 2011c, Census 2010, DP-1 Profile of General Population and Housing Characteristics 2010.					

3.2.1.3 Households

Table 3.2-4 provides information on the number and type of households in the study area, based on Census 2010 data.

Table 3.2-4
Households (2010)

Geography	Households	Persons per Household
King George Co.	8,376	2.78
Northumberland Co.	5,540	2.23
Westmoreland Co.	7,310	2.38
Charles Co.	51,214	2.83
St. Mary's Co.	37,604	2.72
Study Area	110,044	2.73
Maryland	2,156,411	2.61
Virginia	3,056,058	2.54
Source: US Census Bureau, 2011c, Census 2010, DP-1 Profile of General Population and Housing Characteristics 2010.		

As shown in Table 3.2-4, household size varies across the area, with Charles County's higher number (2.83 persons per household) tilting the five counties' average (2.73). As might be expected based on age patterns, household size is smaller in Westmoreland and Northumberland counties than it is elsewhere in the study area and than in Maryland and Virginia statewide.

3.2.1.4 Race and Ethnicity

Table 3.2-5 shows the racial and ethnic composition of the study area's population based on 2010 Census Bureau estimates. White Alone is the largest racial category; the only other major

category is Black or African American Alone. Charles County has the largest proportion of African Americans (41.0 percent), followed by Westmoreland County (28.0 percent). Both counties have substantially more Black residents (as a percentage of the total population) than their respective states, as does Northumberland County. The opposite is true for St. Mary's County, which has less than half the proportion of African Americans than does the state of Maryland.

Table 3.2-5
Race and Ethnicity 2010

Geography	Percent							
	White Alone	Black or African American Alone	American Indian and Alaska Native Alone	Asian Alone	Native Hawaiian and Other Pacific Islander Alone	Two or more Races	Hispanic*	All Minorities Combined
King George Co.	76.7	17.9	0.5	1.2	0.1	2.9	3.3	25.4
Northumberland Co.	71.4	25.3	0.2	0.3	0.0	1.2	3.1	29.9
Westmoreland Co.	65.9	28.0	0.4	0.6	0.0	2.2	5.7	36.5
Charles Co.	50.3	41.0	0.7	3.0	0.1	3.7	4.3	51.6
St. Mary's Co.	78.6	14.3	0.4	2.5	0.1	3.2	3.8	23.5
Study Area	63.8	28.6	0.5	2.4	0.1	3.3	4.1	38.2
Maryland	58.2	29.4	0.4	5.5	0.1	2.9	8.2	45.3
Virginia	68.6	19.4	0.4	5.5	0.1	2.9	7.9	35.2

Note: * Hispanic or Latino ethnicity may be of any race and their percentages are already included among other racial categories.

Source: US Census, 2011c, Census 2010, DP-1 Profile of General Population and Housing Characteristics 2010.

Asians and Hispanics in the study area have smaller proportions than in the two states. Within the study area, the county with the largest proportion of Hispanics is Westmoreland County (5.7 percent), followed by Charles County (4.3 percent).

3.2.2 Economic Profile

3.2.2.1 NSWCDD

A limited set of economic data is available to characterize NSWCDD. Data provided by NSWCDD for fiscal year 2009 indicate that civilian employment at the agency was 3,055, with an additional 13 military, for total employment of 3,068. These numbers do not include approximately 2,700 NSWCDD contractors who work at the installation each day; including them brings the total number of NSWCDD employees to approximately 5,800 (NSWCDD, Public Affairs Office, 2009).

The annual payroll for the regular NSWCDD employees in fiscal year 2009 was $296.3 million; thus, with 3,068 employees, the average salary was $96,577. In addition, contractors working at NSF Dahlgren accounted for $399 million in expenditures. The total direct economic impact of

NSWCDD employment, therefore, was on the order of $695.3 million in fiscal year 2009 (NSWCDD, Public Affairs Office, 2009).

Approximately half of the employees of NSWCDD reside in the study area. Table 3.2-6 shows the residential distribution of the employees in fiscal year 2009. Approximately one-third reside in the greater Fredericksburg area (Fredericksburg plus Stafford and Spotsylvania counties), which is the nearest metropolitan center to NSF Dahlgren but is not included in the study area.

Table 3.2-6
NSWCDD Civilian Employment and Place of Residence (2009)

Residence Location	NSWCDD Civilian Employment	Percent
King George	1,079	35.3
Fredericksburg	163	5.3
Spotsylvania	588	19.2
Stafford	383	12.5
Caroline	74	2.4
Westmoreland	169	5.5
Other VA Counties	285	7.8
Maryland	236	9.3
Other States	78	2.5
Totals	3,055	100.0
Source: NSWCDD, Public Affairs Office, 2009.		

The workforce at NSWCDD is particularly well educated, with 3 percent (91 employees) holding doctoral degrees, 20 percent (611 employees) holding masters' degrees, and 59 percent (1,803 employees) holding bachelors' degrees. The distribution of the workforce by occupation is shown in Figure 3.2-1, NSWCDD Occupations (NSWCDD, Public Affairs Office, 2009). Computer scientists and a variety of other scientists and engineers dominate the occupation categories.

3.2.2.2 Income and Poverty

The 2000 Census provides data on income based on 1999 incomes; the 2006-2010 American Community Survey provides five-year income and poverty estimates. These data are shown in Table 3.2-7.

In 2006-2010, among the study-area counties, the highest median household income – $88,825 – was recorded in Charles County, the county closest to Washington, DC and its jobs. Median incomes in St. Mary's and King George counties were lower, but comparable. By contrast, Westmoreland and Northumberland counties had substantially lower median incomes.

Of particular interest is how increases in median household income between 1999 and 2006-2010 were highest in King George County, with a growth of 52.8 percent, higher than the rates in the other counties and much higher than the rates in the states. Other income data for families and per capita income in 2006-2010 generally follow the same distribution pattern for households in 2006-2010.

Table 3.2-7 also shows the distribution of persons below poverty in 1999, with Westmoreland County experiencing the highest proportion (14.7 percent) and with the next highest in Northumberland County (12.3 percent), both substantially higher than the other counties or among the two states. The 2006-2010 Census Bureau estimates show that King George County and the states increased the proportion of their population below the poverty level since 1999, whereas the other counties decreased the proportion of their population below the poverty level.

Figure 3.2-1
NSWCDD Occupations

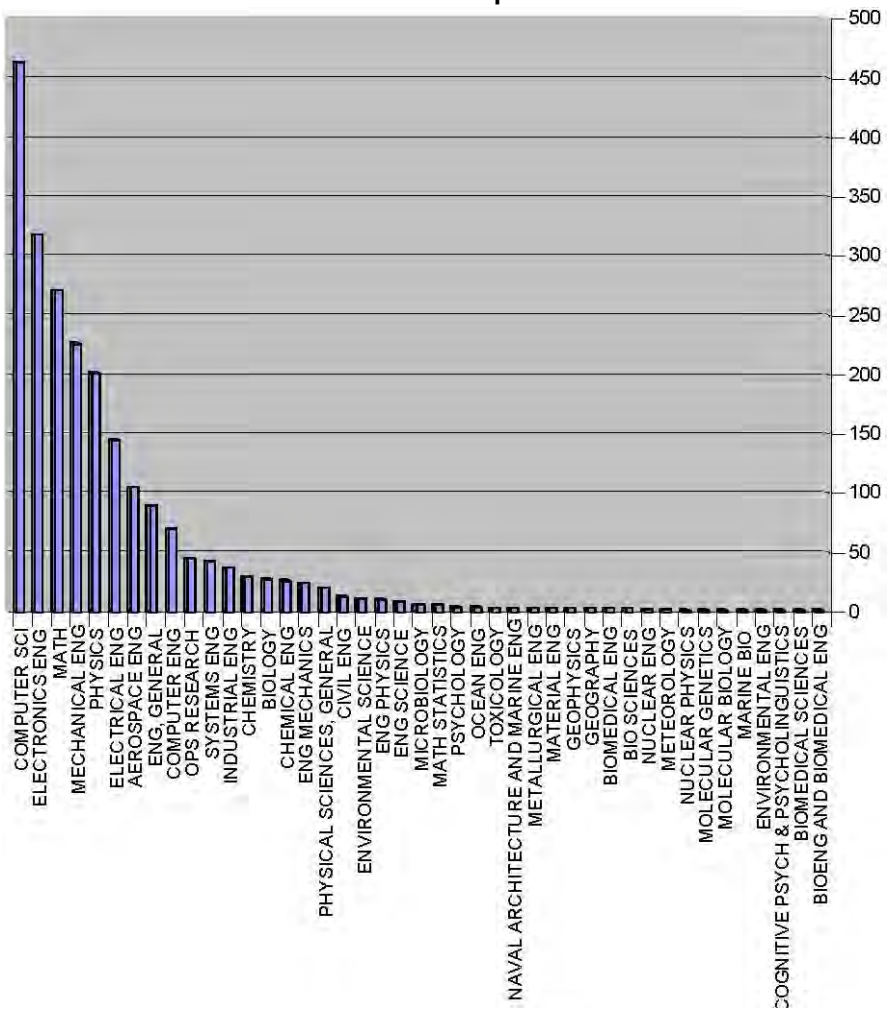


Table 3.2-7
Income and Poverty ($)

Geography	Median Household Income			Median Family Income 2006-2010	Per Capita Income 2006-2010	Percent Below Poverty	
	In 1999	2006-2010	Percent Change			In 1999	2006-2010
King George Co.	49,882	76,241	52.8	87,155	32,630	5.6	7.1
Northumberland Co.	38,129	51,944	36.2	60,872	28,646	12.3	10.9
Westmoreland Co.	35,797	52,990	48.0	59,613	27,501	14.7	9.7
Charles Co.	62,199	88,825	42.8	98,560	35,780	5.5	5.2
St. Mary's Co.	54,706	80,053	46.3	89,385	34,000	7.2	7.1
Study Area	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Maryland	52,868	70,647	33.6	85,098	34,849	8.5	8.6
Virginia	46,677	61,406	31.6	73,514	32,145	9.6	10.3

Note: 2006-2010 incomes are in 2010 inflation-adjusted dollars.
Sources: US Census Bureau, 2011b, Census 2000, DP-3 Profile of Selected Economic Characteristics 2000; 2012a, 2006-2010 American Community Survey 5-year estimates, DP03 Selected Economic Characteristics.

3.2.2.3 Employment

General

Data to profile the employment characteristics of the study area are compiled from several sources. Table 3.2-8 shows data from the US Bureau of Economic Analysis (USBEA) on employment trends between 2005 and 2009. During this period, employment in the study area grew by 4.7 percent, with the greater growth occurring in St. Mary's County, Maryland, and Westmoreland County, Virginia. With the exception of Northumberland County, Virginia, all five counties experienced growth rates that were higher than those of the two states.

Table 3.2-8
Employment 2005 and 2009

Geography	2005 Total Full- and Part-Time Employment	2009 Total Full- and Part-Time Employment	Percent Change 2005-2009
King George Co.	15,166	15,385	1.4
Northumberland Co.	4,710	4,655	-1.2
Westmoreland Co.	5,788	6,097	5.3
Charles Co.	58,160	59,184	1.8
St. Mary's Co.	56,786	61,870	9.0
Study Area	140,610	147,191	4.7
Maryland	3,308,776	3,356,112	1.4
Virginia	4,693,310	4,741,530	1.0

Source: USBEA, Regional Economic Accounts, 2011, CA25N.

Table 3.2-9 shows the most recent unemployment rates available from the US Bureau of Labor Statistics. Generally, unemployment in the study area is low, although the three Virginia counties have rates, equal to, or higher than their state's, whereas the two Maryland counties have rates lower than their state's.

Table 3.2-9
Unemployment Rates (August 2011)

Geography	Unemployment (percent)
King George Co.	7.5
Northumberland Co.	7.7
Westmoreland Co.	7.2
Charles Co.	6.5
St. Mary's Co.	6.5
Study Area	n/a
Maryland	7.4
Virginia	6.5
Source: US Bureau of Labor Statistics, Local Area Unemployment Statistics, 2011.	

USBEA provides information on the industries employing study area residents, as shown in Table 3.2-10. Data for the entire study area are not compiled because data suppression for confidentiality purposes among some industries would distort study-area totals. The USBEA suppresses certain industries' data because the numbers are either too small or would identify a specific employer; however, these data are included in totals for counties and states. Despite these limitations, useful employment information is discernable at the county level.

First, it may be noted that the five counties have higher rates of *proprietors employment* than do the two states; these are mostly *nonfarm proprietors*. King George and St. Mary's counties are distinct in having much higher rates of employment in *professional and technical* services (respectively 19.3 percent and 17.2 percent), and in *government* (respectively 33.7 percent and 24.1 percent), than do the other counties or the two states. For King George, in particular, this is largely attributable to employment at NSF Dahlgren. For St. Mary's, this is largely attributable to employment at NAS Patuxent River.

In King George County, *federal civilian* and *military* together account for 27.6 percent of employment (or 4,246 jobs); this is by far the largest proportion among counties in the study area and much higher than in Virginia as a whole, indicating the economic significance of NSF Dahlgren to the county. On the other hand, the county is underrepresented in traditional employment sectors such as manufacturing (1.0 percent, as opposed to 5.2 percent for Virginia) as well as in many trade and service sectors.

Table 3.2-10
Resident Employment by Industry (2009) (In Percentages, Except for Total Employment)

Industry	King George	Northumberland	Westmoreland	Charles	St. Mary's	Maryland	Virginia
Total employment	**15,385**	**4,655**	**6,097**	**59,184**	**61,870**	**3,356,112**	**4,741,530**
Wage and salary employment	70.0	62.8	65.1	74.5	73.5	78.7	81.9
Proprietors employment	30.0	37.2	34.9	25.5	26.5	21.3	18.1
Farm proprietors employment	1.0	2.1	2.1	0.6	0.9	0.3	0.9
Nonfarm proprietors	29.1	35.1	32.7	24.8	25.6	20.9	17.3
Farm employment	1.1	2.5	5.7	0.7	1.0	0.5	1.1
Nonfarm employment	98.9	97.5	94.3	99.3	99.0	99.5	98.9
Private employment	65.2	85.9	79.2	81.9	74.9	82.9	80.5
Forestry, fishing, related activities	0.7	(D)	3.1	(D)	0.5	0.2	0.3
Mining	0.6	(D)	0.2	(D)	0.1	0.1	0.3
Utilities	(D)	(L)	0.3	(D)	(D)	0.3	0.3
Construction	5.4	13.3	8.6	9.2	5.3	6.4	6.0
Manufacturing	1.0	11.7	11.3	1.7	1.1	3.7	5.2
Wholesale trade	(D)	2.6	1.3	(D)	(D)	2.9	2.6
Retail trade	5.2	9.9	9.5	16.4	9.1	9.9	10.0
Transport and warehousing	1.4	2.0	2.2	2.8	4.0	2.7	2.8
Information	2.1	0.8	0.3	1.1	0.9	1.8	2.0
Finance and insurance	2.6	3.6	3.4	3.3	2.3	4.8	4.0
Real estate & rental/leasing	5.7	7.3	6.3	5.5	5.7	5.0	4.3
Professional & tech services	19.3	6.4	(D)	6.3	17.2	9.9	10.6
Management of companies & enterprises	(D)	(D)	(D)	0.2	(D)	0.6	1.6
Administration and waste services	(D)	(D)	5.3	4.8	(D)	5.9	5.5
Educational services	(D)	(L)	(D)	1.1	1.9	2.7	1.9
Health care and social asst.	(D)	3.1	(D)	9.7	8.4	11.6	8.9
Arts, entertainment and recreation	1.7	2.7	3.4	1.9	1.9	2.3	2.0
Accommodation & food services	3.2	3.9	6.1	8.8	5.6	6.3	6.7
Other services (except pub admin)	4.6	9.0	7.8	6.4	5.2	5.6	5.6
Government	33.7	11.6	15.1	17.4	24.1	16.6	18.5
Federal, civilian	23.4	0.6	1.1	3.8	12.4	4.9	3.9
Military	4.2	0.9	1.0	1.8	4.2	1.4	3.3
State and local	6.1	10.0	13.0	11.9	7.5	10.4	11.3
State government	(D)	0.8	1.3	0.7	1.3	3.0	3.3
Local government	(D)	9.2	11.7	11.2	6.2	7.3	8.0

Note: (L) Less than 10 jobs, but estimates are included in totals.
(D) Not shown to avoid disclosure of confidential information, but estimates are included in totals.
Source: USBEA, Regional Economic Accounts, 2011, CA25N.

Marine-Related Economic Activity

The Navy shares the use of the Potomac River with others, including commercial and industrial vessels (e.g., fuel barges, gravel barges), commercial fishing, and recreational users.

Marine Freight

The Potomac River's navigation south of Washington, DC is limited by its relatively shallow draft at a number of locations – e.g., vessel draft limits are 19.8 feet (ft) at the Matawoman Bar and 18.5 ft at the Hunting Creek Shoal.

One new major commercial user is the Mirant Morgantown coal-fired power plant, on the Maryland shore immediately south of the Harry Nice Bridge and across the river from NSF Dahlgren. The plant has constructed facilities that allow it to supplement the importation of coal by rail to include barges that will unload from a new 500-ft dock, with a conveyor system extending into the river approximately 836 ft. The facility is expected to receive four to five 20,000-ton barges per week, with each taking about 16 hours to unload, during both day and night. (There are also seasonal use variations, with more in the summer and winter, and fewer in the spring and fall.)

The environmental review for the Mirant facility cites John Morgan, a Potomac River pilot, who notes commercial traffic on the river as being one or two vessels a week (Maryland Power Plant Research Program [MPPRP], 2007). This, however, does not fit with data cited in *Waterborne Commerce of the United States* (US Army Corps of Engineers [USACE], 2008). This data source indicates that the Potomac River below Washington, DC moved freight weighing 3.4 million tons in 2008, primarily composed of petroleum and petroleum products and sand and gravel. These freight movements were achieved with 3,176 vessel trips upbound and 3,156 vessel trips downbound in 2008. It is not clear from these data sources whether all these vessels would traverse the PRTR, but it does set an order-of-magnitude, which translates to approximately 122 vessels per week.

Commercial Fishing

USBEA data on the forestry and fishing industry in Northumberland and Charles counties are suppressed (see Table 3.2-10), but Westmoreland County shows relatively high numbers in that category (3.1 percent). Although notable in percentage terms, these data translate to 186 jobs in Westmoreland. The other counties where these data are not suppressed are King George, with 0.7 percent, translating to 107 jobs, and St. Mary's, with 0.5 percent, translating to 303 jobs. It should be noted that the data refer to both forestry *and* fishing; consequently, they set the high end for potential fishing employment in these counties. It is revealing that in the discussion of Agriculture and Fisheries and the Economy in the draft *King George County 2012 Comprehensive Plan*, only farming is actually discussed; the context is one in which the declines in farm acreage and returns are noted (King George County, 2012, page 60).

For those counties that have forestry and fishing data suppressed in the USBEA's 2009 statistics, 2006-2010 American Community Survey five-year estimates of employment by industry provide some indication of the scale of employment in the local fishing industry. These estimates, presented in Table 3.2-11, show that Northumberland County had 230 persons engaged in the broad economic category of *agriculture, forestry, fishing and hunting, and mining* and that

Charles County had 301 persons so employed. Thus, for the five-county study area, it appears that no more than approximately 1,130 persons are likely to be employed in forestry and fishing.

Table 3.2-11
Employment in Agriculture, Forestry, Fishing and Hunting, and Mining (2006-2010)

Geography	Employed Persons	Percentage of Locality Total
King George Co.	114	1.1
Northumberland Co.	230	4.2
Westmoreland Co.	432	5.4
Charles Co.	301	0.4
St. Mary's Co.	600	1.2
Study Area	1,677	1.1
Maryland	14,783	0.5
Virginia	42,834	1.1
Source: US Census Bureau, 2012a, DP03 Selected Economic Characteristics.		

Other data on the fishing industry are available from various sources. The draft *King George County 2012 Comprehensive Plan* notes that there were 36 commercially registered watermen in King George County in 1998 and 38 in 1999 (King George County, 2012). Fishing catches in the county have varied but were 718,907 pounds in 1998, with a value of $384,604. The value of fishing catches in King George County in 2005 was $259,000. The 2006 Northumberland County *Comprehensive Plan* cites the value of fishing catches as $3,648,604 in 2002, but this county has frontage on the Chesapeake Bay (Northumberland County, 2006).

Commercial fishing in the Potomac River involves fishing, crabbing, and less frequently, oystering. Data compiled by the Potomac River Fisheries Commission (PRFC) for commercial fish harvests provide catch volumes by species and reach of the river, but not the value of the catch. Table 3.2-12 summarizes the data for the years 2001 to 2010. Of particular interest is the degree to which Area 1 (extending from the mouth of the Potomac River to Hollins Marsh, Virginia/Colton's Point, Maryland and corresponding to the LDZ – shown on Figure 3.11-6) accounts for the great majority (86 percent) of finfish landed. The majority of hard crabs also are harvested in Area 1, but substantial quantities also are harvested in Area 2 (extending upriver from Area 1 to the Harry Nice Bridge and corresponding to the MDZ) and in Area 3. The upstream reaches of the Potomac correspond to Areas 3 and 4, and are north of the Harry Nice Bridge to Possum Point, Virginia/Moss Point, Maryland, and upstream to the Woodrow Wilson Bridge, respectively. These areas account for very small proportions of finfish and oysters, but Area 3 accounts for 29 percent of the hard crab catch.

Over the ten-year period, for Areas 1 through 4 combined, PRFC data indicate that menhaden account for 64 percent of the finfish landed, with croaker and striped bass accounting for 14 percent and 11 percent, respectively (Cosby, PRFC, pers. comm., March 1, 2011). All other species were caught in low volumes.

Table 3.2-12
Potomac River Fisheries Commission Harvest Reports for 2001-2010

Species	Area 1		Area 2		Area 3		Area 4		Total Catch All Areas
	Total Catch	Per-centage	Total Catch	Per-centage	Total Catch	Per-centage	Total Catch	Per-centage	
Finfish (thousand lbs)	51,567	86%	2,296	4%	4,163	7%	1,649	3%	59,674
Hard Crabs (thousand lbs)	14,457	50%	5,031	17%	8,278	29%	1,027	4%	28,794
Oysters* (bushels)	4,000	20%	16,189	79%	190	1%	0	0%	20,379

Note: *Oyster data are for the 2000-2001 through 2009-2010 seasons.
Source: Cosby, PRFC, pers. comm., March 1, 2011.

Recreational Activities

In addition to fishing, maritime employment along the Potomac River includes recreation-oriented employment. However, data sources have a major limitation: a broad industry class that includes all *Arts, Entertainment, and Recreation*. The USBEA, Regional Economic Accounts (2011, CA25N) reports a total of 255 jobs in this industry class for King George County, 127 for Northumberland County, 205 for Westmoreland County, 1,096 for Charles County, and 1,196 for St. Mary's County. Thus, employment numbers in *all* types of recreation, arts, and entertainment activities are relatively small in the Virginia counties and also quite modest in the Maryland counties. The percentages of employment in this industry category are 2.3 percent in Maryland and 2.0 percent in Virginia, a higher share than in three of the study area's counties but less than in Westmoreland (3.4 percent) and Northumberland (2.7 percent) counties; in these two counties, however, the number of jobs is small – 205 and 127, respectively.

Additional data that may point to the significance of recreational maritime activity along the Potomac are the number of charter boat companies and marinas. The Virginia Charter Boat Association (Virginia Charter Boat Association, Not Dated) lists 17 captains and boats operating from Potomac River ports (including some from the Maryland side). Marinersguide.com lists 31 Potomac River marinas, docks, and boat ramps and storage, including 18 marinas on the Virginia side of the Potomac and 10 marinas on the Maryland side (Marinersguide.com, 2011). The *Potomac River Guide* (Potomac River Guide, 2007) lists seven marinas on the Potomac side of the Northern Neck. A recent guidebook to cruising the lower Potomac River (Rhodes, 2003) lists 28 public and private marinas between Nanjemoy Creek and the Bay on the Maryland side of the river, and 28 such facilities south of the Caledon Natural Area on the Virginia side. A study by the Maryland Department of Labor, Licensing, and Regulation on Hospitality and Tourism notes that the industry category of *Scenic and Sightseeing Water Transportation* (including charter fishing) in the state included 301 employed persons with a payroll of $5,373,415 in 2004 (Maryland Department of Labor, Licensing, and Regulation, 2006). Additional economic activity, both directly and indirectly linked to marine recreation, is also important in the study area, and would encompass restaurants, accommodations, travel services, and entertainment-related activities.

3.2.3 Housing

Data on recent trends in housing in the study area are shown in Table 3.2-13. As a whole, the study area experienced an increase (17.1 percent) in housing units between 2000 and 2006, which was a much higher rate of growth than that experienced in the two states on a statewide basis (7.2 percent for Maryland and 11.2 percent for Virginia). With a 4.8 percent increase over the period 2006-2010, the study area continued to outpace the states (3.4 and 4.2 percent, respectively). Among individual counties, King George experienced the highest growth rate in both periods (28.9 and 7.8 percent), followed by St. Mary's and then Charles in 2000-2006, and by Charles and then Westmoreland in 2006-2010.

Table 3.2-13
Total Housing Units 2000, 2006, and 2010

Geography	2000	2006	2010	Percentage Change	
				2000-2006	2006-2010
King George Co.	6,820	8,789	9,477	28.9	7.8
Northumberland Co.	8,057	9,075	8,995	12.6	-0.9
Westmoreland Co.	9,286	10,241	10,618	10.3	3.7
Charles Co.	43,903	51,392	54,963	17.1	6.9
St. Mary's Co.	34,081	40,140	41,282	17.8	2.8
Study Area	102,147	119,637	125,335	17.1	4.8
Maryland	2,145,283	2,300,567	2,378,814	7.2	3.4
Virginia	2,904,192	3,230,803	3,364,939	11.2	4.2

Sources: US Census Bureau, 2011b, Census 2000, QT-H4 Physical Housing Characteristics 2000; 2012b, Population Estimates Program, T2 Housing Unit Estimates 2006; 2011c, Census 2010, QT-H1 General Housing Characteristics 2010.

The tenure status of occupied housing units is shown in Table 3.2-14. The percentage of owner-occupied units is higher in the study area (76.4 percent) than in the two states as a whole (67.5 percent in Maryland and 67.2 percent in Virginia). All five counties exceed the states in this respect, with Northumberland recording the highest rate (83.3 percent), followed by Charles (78.7 percent), and King George (78.4 percent).

Table 3.2-14
Housing Tenure (2010)

Geography	Total Occupied	Owner-occupied		Renter-occupied	
		Number	Percent	Number	Percent
King George Co.	8,376	6,568	78.4	1,808	21.6
Northumberland Co.	5,540	4,613	83.3	927	16.7
Westmoreland Co.	7,310	5,591	76.5	1,719	23.5
Charles Co.	51,214	40,317	78.7	10,897	21.3
St. Mary's Co.	37,604	26,966	71.7	10,638	28.3
Study Area	110,044	84,055	76.4	25,989	23.6
Maryland	2,156,411	1,455,775	67.5	700,636	32.5
Virginia	3,056,058	2,055,186	67.2	1,000,872	32.8

Source: US Census Bureau, 2011c, Census 2010, QT-H1 General Housing Characteristics 2010.

The occupancy status of all units in 2010 is shown in Table 3.2-15. In the two states, the percentage of occupied units exceeds 90 percent, but in the study area, it is 87.8 percent. This difference is largely accounted for by the high vacancy rates in Northumberland and Westmoreland counties. In turn, these high rates are attributable to the high percentage of seasonal or recreational homes in these two counties: such homes account for 29.0 percent of all housing in Northumberland and 20.2 percent of all housing in Westmoreland. The distribution of vacant units either for rent or for sale among the five counties is generally similar to that of the two states – again with the exception of Northumberland and Westmoreland counties, where vacant units for rent are fewer than those for sale.

Table 3.2-15
Housing Occupancy Status (2010)

Housing Occupancy Status	King George	Northumberland	Westmoreland	Charles	St. Mary's	Study Area	Maryland	Virginia
Total Housing Units (100 percent):	9,477	8,995	10,618	54,963	41,282	125,335	2,378,814	3,364,939
Occupied (percent)	88.4	61.6	68.8	93.2	91.1	87.8	90.7	90.8
Vacant (percent)	11.6	38.4	31.2	6.8	8.9	12.2	9.3	9.2
Vacant for rent (percent)	3.8	0.9	2.0	1.9	2.3	2.1	2.6	2.5
Vacant for sale (percent)	1.2	2.2	2.1	1.8	1.2	1.6	1.4	1.3
Rented or sold, not occupied (percent)	0.3	0.7	0.3	0.4	0.4	0.4	0.4	0.4
For seasonal, recreational, or occasional use (percent)	3.0	29.0	20.2	0.8	3.0	5.3	2.3	2.4
For migrant workers (percent)	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Other vacant (percent)	3.3	5.6	6.5	1.9	1.9	2.7	2.6	2.5

Source: US Census Bureau, 2011c, Census 2010, QT-H1 General Housing Characteristics 2010.

The estimated number of housing units per structure is shown in Table 3.2-16, based on American Community Survey five-year estimates for the years 2006 through 2010. By far the largest category is single-unit detached, which in the study area accounted for 75.0 percent of total units in 2010, with higher percentages recorded for King George, Northumberland, and Westmoreland counties. Multi-unit structures were very uncommon in the study area, much more so than in the two states as a whole. There were high proportions of mobile homes in the three Virginia counties.

Table 3.2-16
Housing Units in Structure (percent) (2006-2010)

Number of Units in Structure	King George	North-umberland	West-moreland	Charles	St. Mary's	Study Area	Maryland	Virginia
1, detached	76.3	83.8	86.6	71.8	73.9	75.0	51.6	62.6
1, attached	3.8	0.8	0.4	16.4	6.9	9.8	21.1	10.3
2	1.6	0.6	0.0	0.7	1.0	0.8	1.8	1.7
3 or 4	2.8	0.8	1.4	2.2	2.4	2.2	2.4	2.7
5 to 9	2.3	0.0	0.5	2.8	4.1	2.8	5.3	4.8
10 to 19	2.9	0.6	1.2	1.5	3.4	2.1	8.5	5.8
20 or more	0.4	0.2	0.3	2.6	2.7	2.1	7.7	6.4
Mobile home	9.8	13.2	9.5	1.9	5.5	5.2	1.7	5.7
Boat, RV, van, etc.	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0

Source: US Census Bureau, 2012a, DP04 Selected Housing Characteristics.

Finally, Table 3.2-17 presents estimates of the median age of the housing structures, and median gross rents and median values for the years 2006 through 2010, for the counties and the two states (the study area median is not available). The two Maryland counties have a younger housing stock than the state as a whole, while in Virginia, King George has and Northumberland counties have a younger housing stock than the state. With respect to median gross rents, the two Maryland counties reveal median rents that are noticeably higher than that for the state as a whole: the highest rents are noted for Charles County ($1,307) and St. Mary's County ($1,123). In Virginia, state median rents are higher than those in two of the study-area counties ($772 in Northumberland and $888 in Westmoreland) and lower than those in the third ($982 in King George). For the Virginia counties, housing values follow a similar pattern, with the state exceeding the median value for owner-occupied housing for Northumberland and Westmoreland counties ($251,600 for Northumberland and $202,300 for Westmoreland, versus $255,100 for the state), and only King George County ($305,200) exceeding the median for Virginia.

Table 3.2-17
Median Year Housing Constructed, Median Gross Rent and Median Value (2006-2010)

Geography	Median Year Constructed	Median Gross Rent ($)	Median Value for Owner-Occupied Units ($)
King George County	1988	982	305,200
Northumberland County	1980	772	251,600
Westmoreland County	1975	888	202,300
Charles County	1986	1,307	355,800
St. Mary's County	1985	1,123	327,800
Maryland	1974	1,091	329,400
Virginia	1978	970	255,100

Source: US Census Bureau, 2012a, B25035 Median Year Structure Built; DP04 Selected Housing Characteristics.

3.2.4 Environmental Justice

Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, dated February 11, 1994, requires that federal agencies take appropriate and necessary steps, to the greatest extent practicable and permitted by law, to identify and address disproportionately high and adverse effects of federal projects on the health or environment of minority and low-income populations (EO 12898, 1994). Environmental justice (EJ) mandates that no minority or low-income population group shall bear a disproportionate share of potential adverse environmental impacts resulting from a major federal action, such as the Navy is proposing.

In order to determine whether a potentially affected EJ community is present within the study area, the CEQ in its *Environmental Justice: Guidance under the National Environmental Policy Act* (CEQ, 1997) offers the following guidelines:

1. Establish Study Area – Define the study area that could be affected by the project or proposal.
2. Identify Minority Populations – Using US Census data, identify minority communities or populations within the study area where either:
    a. Minority populations exceed 50 percent of the general population, or
    b. The minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population.
3. Identify Low-income Populations – Using annual statistical poverty thresholds from the US Bureau of Census's current Population Report, Series P-60, identify low-income populations in the affected area.
4. Evaluate Effects on Low-income and Minority Populations – Evaluate the effects of the Proposed Action on populations of concern to determine if the adverse impacts on these populations are disproportionately high or adverse when compared to the effects on the general population in the study area. (This is addressed in the Socioeconomic Impacts section of the Environmental Consequences chapter – 4. 2.)

Environmental Justice Study Area

For an analysis of EJ, the potential area of affect from the Proposed Action is defined as the five counties along the PRTR. These are: King George, Westmoreland, and Northumberland counties in Virginia, and Charles and St. Mary's counties on the north shore of the Potomac, in Maryland. This is the same study area used for the land use (Section 3.1) and socioeconomic (Section 3.2) analyses. This study area is where most project impacts would occur.

Population Characteristics of Study Area

Detailed social and economic characteristics of the study area and the respective counties are provided in EIS Sections 3.2.1 through 3.2.3, including demographic, housing, income, education, and employment data for the study area, the counties, and the two states. More-detailed data at the census tract level are provided for this EJ review, compiled from the US Census, and are displayed in a geographic information format using ESRI's ArcGIS software.

Populations of Concern

Definition of Communities of Concern

In an EJ analysis, populations or communities of concern (COCs) within the project impact area that may be adversely affected must be compared to a reference population. The reference populations in this case are those of the five counties in the study area and the populations of the states of Maryland and Virginia.

The present COC analysis begins by refining the geographic level of analysis to the census tracts. Those census tracts within the study area were examined. There are a total of 62 census tracts in the study area; of these, 49 census tracts are in Maryland and 13 census tracts are in Virginia. Two census tracts in Maryland and one in Virginia are not occupied by a resident population.

Definition of Minority Population

"Minority," as defined for EJ analysis purposes, is comprised of the following Census-defined populations:

- Native American and Alaskan Native
- Black or African American
- Hawaiian and Pacific Islander
- Asian
- Two or More Races
- Hispanic

In the Census, Hispanic origin is viewed as the heritage, nationality group, lineage, or country of birth of the person or the person's parents or ancestors before their arrival in the United States. People who identify their origin as Spanish, Hispanic, or Latino may be of any race. Consequently, for this analysis the minority population was compiled from Table P9 of Summary File 1 (SF 1) of the 2010 Census of Population and Housing, using the sum of the Hispanic population (of any race) plus the Non-Hispanic populations of Native Americans and Alaskan Natives, Black or African Americans, Hawaiian and Pacific Islanders, Asians, and Two or More Races – i.e., White Non-Hispanic populations are excluded from the minority count. For EJ analysis, the minority population is the aggregation of all minority persons.

Definition of Low-Income Population

The percentage of the population living below the Census-defined poverty level was used to define the low-income population in the study area. The percentage of the population for whom poverty was determined was identified from Table DP03 of the 2006-2010 American Community Survey five-year estimates at the census tract level.

Community of Concern Percent Thresholds

As noted, the CEQ approach is to identify the percentage of minorities and those in poverty at the appropriate unit of geographic analysis, such as the census tract level, and compare them to a reference population, with the five counties in the study area and the states of Maryland and Virginia adopted here as the references. Table 3.2-18 presents the minority population

percentages based on the 2010 Census for King George, Northumberland, Westmoreland, Charles, and St. Mary's counties. A notable concentration of minority populations assumes here a concentration that is a majority, i.e., 50.1 percent, or is 20 percent higher than that of the respective county. Thus, for the purpose of this EJ review, census tracts with minority population percentages that exceed the thresholds shown in Table 3.2-18 are classified as minority COCs.

Table 3.2-18
Community of Concern Thresholds (percent)

Geography	Minority Population		Low-Income Population	
	2010	Threshold	2006-2010	Threshold
King George Co.	25.4	30.4	7.1	8.5
Northumberland Co.	29.9	35.9	10.9	13.1
Westmoreland Co.	36.5	43.8	9.7	11.6
Charles Co.	51.6	50.1	5.2	6.2
St. Mary's Co.	23.5	28.2	7.1	8.5
Maryland	45.3	n/a	8.6	n/a
Virginia	35.2	n/a	10.3	n/a

Sources: US Census Bureau, 2012a, 2006-2010 American Community Survey 5-year estimates, DP03 Selected Economic Characteristics; 2012b, Census 2010, P9 Hispanic or Latino, and Not Hispanic or Latino by Race.

The estimated percentage of the population below the poverty level in the 2006-2010 American Community Survey in each of the counties in the study area is presented in Table 3.2-18. Applying the same criteria adopted for minorities (i.e., a majority or 20 percent higher than the percentage in the county) results in defining low-income population concentrations as those greater than the thresholds shown in the table.

Identification of Communities of Concern

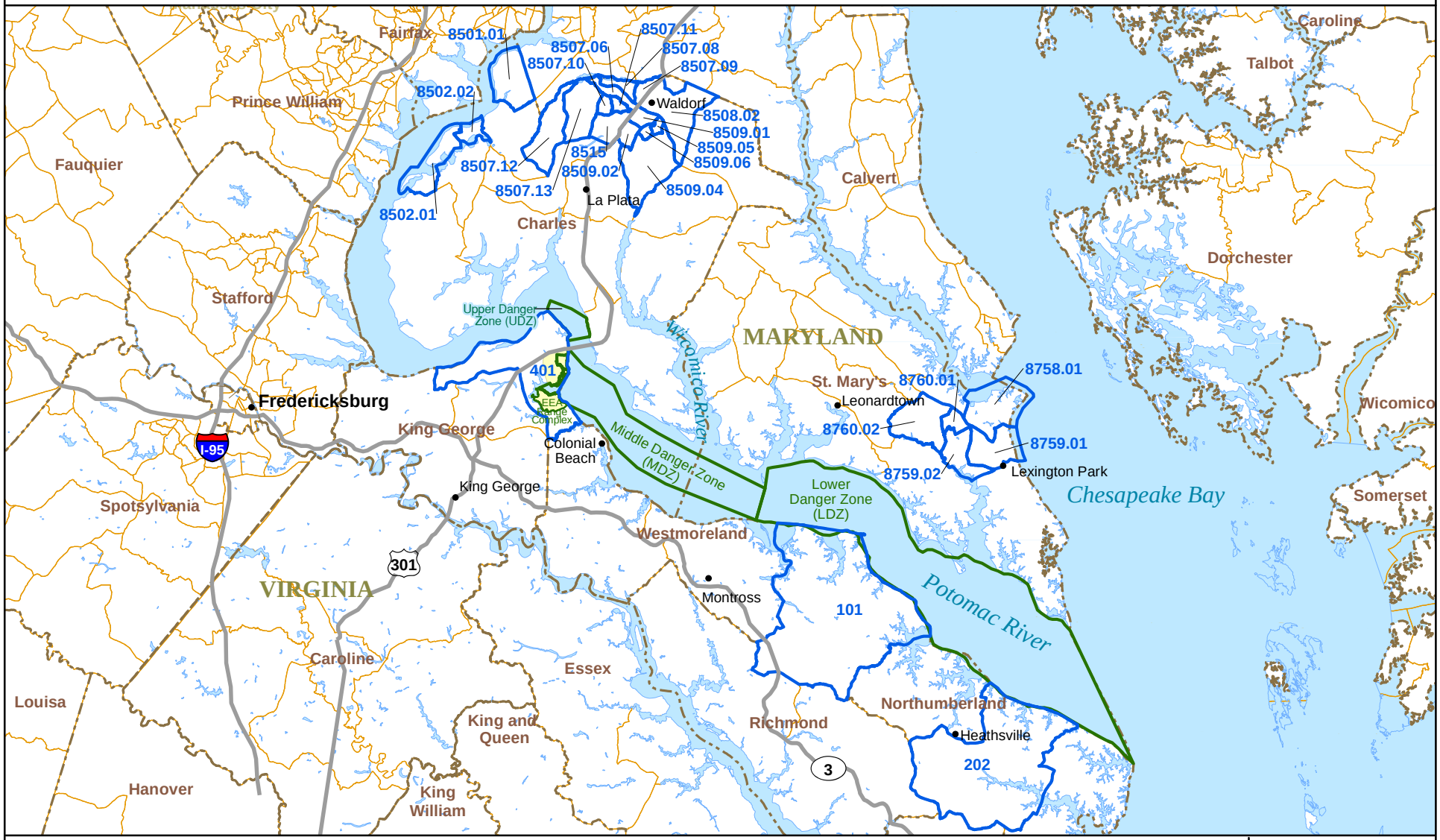
Table 3.2-19 presents the minority population percentages and low-income population percentages for the study area census tracts, and identifies the minority and low-income COCs. Of the 49 Maryland census tracts, 22 are defined as minority COCs. Of the 13 Virginia census tracts, 3 are defined as minority COCs. Fifteen of the census tracts in Maryland and 5 of those in Virginia are defined as low-income COCs. The following discussion reviews the locations of these communities.

Minority Populations

Applying the methodology noted above, the minority COCs in the study area were identified and mapped at the census tract level (Figure 3.2-2, Census Tracts with Environmental Justice Minority Populations).

In Maryland, of the 22 minority census tracts, 5 are in St. Mary's County and 17 are in Charles County. Only 3 of these are actually adjacent to the Potomac River – all in the northernmost part of Charles County, upriver from NSF Dahlgren and the UDZ. In Virginia, 1 minority census tract is in King George County, 1 is in Northumberland County, and 1 is in Westmoreland County.

Census Tracts with Environmental Justice Minority Populations



Census Tract
Minority Census Tract
County Boundary
Naval Support Facility Dahlgren
Potomac River Test Range (PRTR) Complex

4 0 4 Miles
6 0 6 Kilometers

N

NSWCDD EIS

Source: US Census Bureau, 2012b, P9 Hispanic or Latino, and Not Hispanic or Latino by Race 2010.

Figure 3.2-2

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Table 3.2-19
Minority and Low-Income Communities of Concern

Geography	Percent Minority	Percent Low Income	Geography	Percent Minority	Percent Low Income
King George Co.	25.4	7.1	Charles Co. (continued)		
Census Tract 401	**33.2**	4.7	Census Tract 8509.02	**54.8**	**6.8**
Census Tract 402	22.2	**9.1**	Census Tract 8509.04	**67.2**	3.4
Census Tract 403	22.0	**10.0**	Census Tract 8509.05	**60.8**	5.3
Census Tract 404	28.4	4.3	Census Tract 8509.06	**70.2**	**6.6**
Census Tract 405	21.5	3.3	Census Tract 8510.01	29.2	3.9
Northumberland Co.	29.9	10.9	Census Tract 8510.02	32.2	**6.9**
Census Tract 201	31.8	10.5	Census Tract 8511	21.4	1.7
Census Tract 202	**39.1**	**14.7**	Census Tract 8512	19.8	**7.6**
Census Tract 203	23.1	8.8	Census Tract 8513.01	13.6	2.0
Census Tract 9901	n/a	n/a	Census Tract 8513.02	25.8	2.3
Westmoreland Co.	36.5	9.7	Census Tract 8514	33.3	2.3
Census Tract 101	**51.9**	6.9	Census Tract 8515	**69.3**	1.1
Census Tract 102	39.9	8.1	Census Tract 9900	n/a	n/a
Census Tract 103	34.4	11.9	St. Mary's Co.	23.5	7.1
Census Tract 104	21.4	**11.7**	Census Tract 8750	11.0	2.8
Charles Co.	51.6	5.2	Census Tract 8751	14.3	4.6
Census Tract 8501.01	**70.4**	5.5	Census Tract 8752.01	11.1	6.1
Census Tract 8501.02	50.1	5.0	Census Tract 8752.02	13.6	3.8
Census Tract 8502.01	**55.1**	0.0	Census Tract 8753	17.6	8.0
Census Tract 8502.02	**50.6**	**9.5**	Census Tract 8754	14.6	5.5
Census Tract 8503	42.1	2.8	Census Tract 8755	19.9	6.0
Census Tract 8504	36.5	**10.3**	Census Tract 8756	18.2	2.9
Census Tract 8505	18.6	3.4	Census Tract 8757	9.3	7.2
Census Tract 8506	43.8	**7.3**	Census Tract 8758.01	**36.2**	**14.6**
Census Tract 8507.06	**69.2**	1.4	Census Tract 8758.02	15.0	1.3
Census Tract 8507.08	**67.2**	**7.4**	Census Tract 8759.01	**41.3**	**13.9**
Census Tract 8507.09	**79.9**	**8.4**	Census Tract 8759.02	**51.9**	**11.2**
Census Tract 8507.10	**63.5**	3.6	Census Tract 8760.01	**53.4**	**21.4**
Census Tract 8507.11	**74.5**	5.6	Census Tract 8760.02	**39.7**	4.9
Census Tract 8507.12	**58.1**	1.2	Census Tract 8761	16.4	6.4
Census Tract 8507.13	**55.3**	1.3	Census Tract 8762	17.8	8.0
Census Tract 8508.01	41.1	4.8	Census Tract 9900	n/a	n/a
Census Tract 8508.02	**55.3**	**8.9**	Maryland	45.3	8.6
Census Tract 8509.01	**68.6**	**12.9**	Virginia	35.2	10.3

Note: Bold text indicates population percentages of minority and low-income COCs.

Sources: US Census Bureau, 2012a, 2006-2010 American Community Survey 5-year estimates, DP03 Selected Economic Characteristics; 2012b, Census 2010, P9 Hispanic or Latino, and Not Hispanic or Latino by Race.

The minority census tract in King George County is the tract occupied by NSF Dahlgren, and is adjacent to the Potomac River and to the MDZ. The minority census tracts in Northumberland and Westmoreland counties also are adjacent to the Potomac River and are adjacent to the LDZ.

Low-Income Populations

Low-income COCs in the study area also were identified and mapped at the census tract level (Figure 3.2-3, Census Tracts with Environmental Justice Low-Income Populations).

Four of the 15 low-income census tracts in Maryland are in St. Mary's County and 11 are in Charles County. Three of the low-income census tracts in Maryland are adjacent to the Potomac River, in Charles County – 2 upriver from NSF Dahlgren and the UDZ, and 1 across the river from the facility and adjacent to the MDZ. In Virginia, 2 of the low-income census tracts are in King George County, 2 are in Westmoreland County, and 1 is in Northumberland County. Four of the low-income tracts are adjacent to the Potomac River – 1 upriver from NSF Dahlgren and the UDZ, 2 adjacent to the MDZ, and 1 adjacent to the lower LDZ. The fifth low-income census tract in Virginia, although not adjacent to the river, is immediately landward of the tract occupied by NSF Dahlgren.

3.2.5 Protection of Children

EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, was signed on April 21, 1997 (EO 13045, 1997). Because the scientific community recognized that children may suffer disproportionately from environmental health and safety risks, each federal agency is directed to identify and assess such risks, and consequently to ensure that its policies, programs, activities, and standards address effects on children. "Environmental health and safety risks" are defined as "risks to health or to safety that are attributable to products or substances that the child is likely to come in contact with or ingest." Covered regulatory actions that are affected by this EO are those substantive actions that concern an environmental health risk or safety risk that an agency has reason to believe may disproportionately affect children.

Children Under 18 Populations

Within the five-county study area, Census 2010 data on children under 18 were examined at the census tract level in order to identify any concentrations of minors. Table 3.2-20 presents the children under 18 population percentages based on the 2010 Census for King George, Northumberland, Westmoreland, Charles, and St. Mary's counties. On average, throughout the study area, such persons represented 25.7 percent of their respective tract populations (US Census Bureau, 2011c, DP-1 Profile of General Population and Housing Characteristics 2010).

An unusual concentration of children under 18 assumes here a concentration that is 10 percent higher than that of the respective county. Thus, census tracts with children under 18 population percentages that exceed the thresholds shown in Table 3.2-20 are classified as unusual concentrations of children.

Table 3.2-20
Concentration of Children Thresholds (percent)

Geography	Children Under 18 Population	
	2010	Threshold
King George Co.	27.7	30.5
Northumberland Co.	16.4	18.0
Westmoreland Co.	20.0	22.0
Charles Co.	26.5	29.2
St. Mary's Co.	26.2	28.9
Maryland	23.4	n/a
Virginia	23.2	n/a
Source: US Census Bureau, 2011c, Census 2010, DP-1 Profile of General Population and Housing Characteristics 2010.		

Table 3.2-21 presents the children under 18 population percentages for the study area census tracts and identifies the unusual concentrations. Of the 49 Maryland census tracts, 11 are defined as unusual concentrations of children. Of the 13 Virginia census tracts, 2 are defined as unusual concentrations. The locations of these census tracts are shown on Figure 3.2-4, Census Tracts with Concentrations of Children.

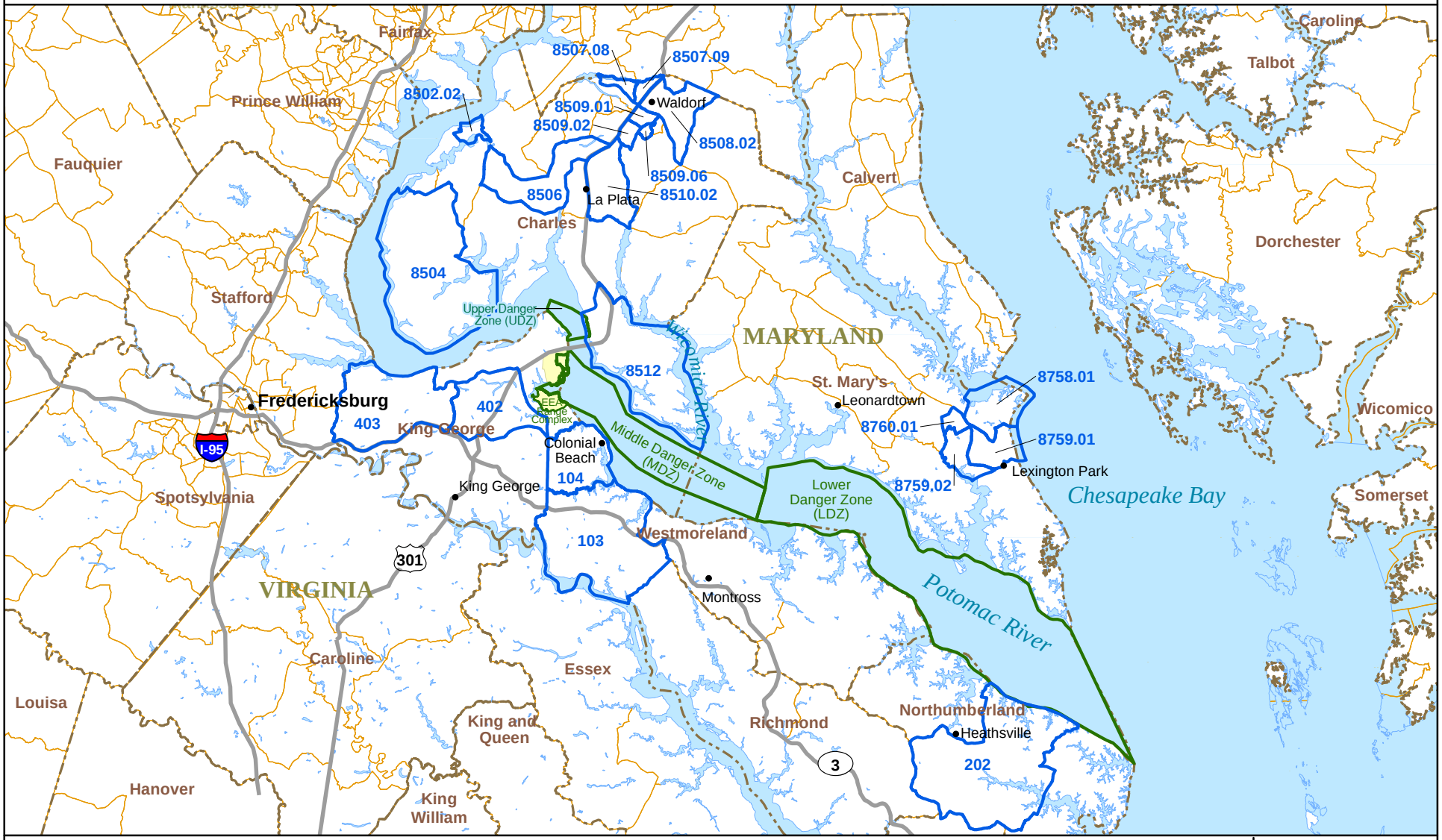
Table 3.2-21
Unusual Concentrations of Children

Geography	Percent Children		Geography	Percent Children
King George Co.	27.7		Charles Co. (continued)	
Census Tract 401	27.1		Census Tract 8509.02	25.4
Census Tract 402	26.4		Census Tract 8509.04	**29.6**
Census Tract 403	29.3		Census Tract 8509.05	28.1
Census Tract 404	28.9		Census Tract 8509.06	**29.2**
Census Tract 405	25.0		Census Tract 8510.01	18.2
Northumberland Co.	16.4		Census Tract 8510.02	25.2
Census Tract 201	**19.8**		Census Tract 8511	22.3
Census Tract 202	17.3		Census Tract 8512	21.7
Census Tract 203	13.3		Census Tract 8513.01	27.7
Census Tract 9901			Census Tract 8513.02	21.4
Westmoreland Co.	20.0		Census Tract 8514	24.3
Census Tract 101	18.4		Census Tract 8515	**29.4**
Census Tract 102	19.3		Census Tract 9900	
Census Tract 103	**23.6**		St. Mary's Co.	26.2
Census Tract 104	20.1		Census Tract 8750	26.4
Charles Co.	26.5		Census Tract 8751	25.1
Census Tract 8501.01	28.1		Census Tract 8752.01	27.6
Census Tract 8501.02	22.9		Census Tract 8752.02	26.8
Census Tract 8502.01	27.7		Census Tract 8753	19.7
Census Tract 8502.02	26.2		Census Tract 8754	27.6
Census Tract 8503	20.7		Census Tract 8755	**29.3**
Census Tract 8504	23.7		Census Tract 8756	26.4
Census Tract 8505	21.7		Census Tract 8757	24.3
Census Tract 8506	26.0		Census Tract 8758.01	**37.1**
Census Tract 8507.06	28.5		Census Tract 8758.02	24.4
Census Tract 8507.08	**29.3**		Census Tract 8759.01	27.9
Census Tract 8507.09	29.0		Census Tract 8759.02	**29.7**
Census Tract 8507.10	**30.7**		Census Tract 8760.01	**29.3**
Census Tract 8507.11	29.2		Census Tract 8760.02	28.0
Census Tract 8507.12	28.8		Census Tract 8761	23.8
Census Tract 8507.13	**29.2**		Census Tract 8762	17.6
Census Tract 8508.01	22.8		Census Tract 9900	
Census Tract 8508.02	24.4		Maryland	23.4
Census Tract 8509.01	**29.4**		Virginia	23.2

Note: Bold text indicates children under 18 population percentages of unusual concentrations of children.

Source: US Census Bureau, 2011c, Census 2010, DP-1 Profile of General Population and Housing Characteristics 2010.

Census Tracts with Environmental Justice Low-Income Populations



Census Tract
Low-Income Census Tract
County Boundary
Naval Support Facility Dahlgren
Potomac River Test Range (PRTR) Complex

4 0 4 Miles
6 0 6 Kilometers

N

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NAVSEA WARFARE CENTERS DAHLGREN

Source: US Census Bureau, 2012a, DP03 Selected Economic Characteristics 2010 5-year estimates.

Figure 3.2-3

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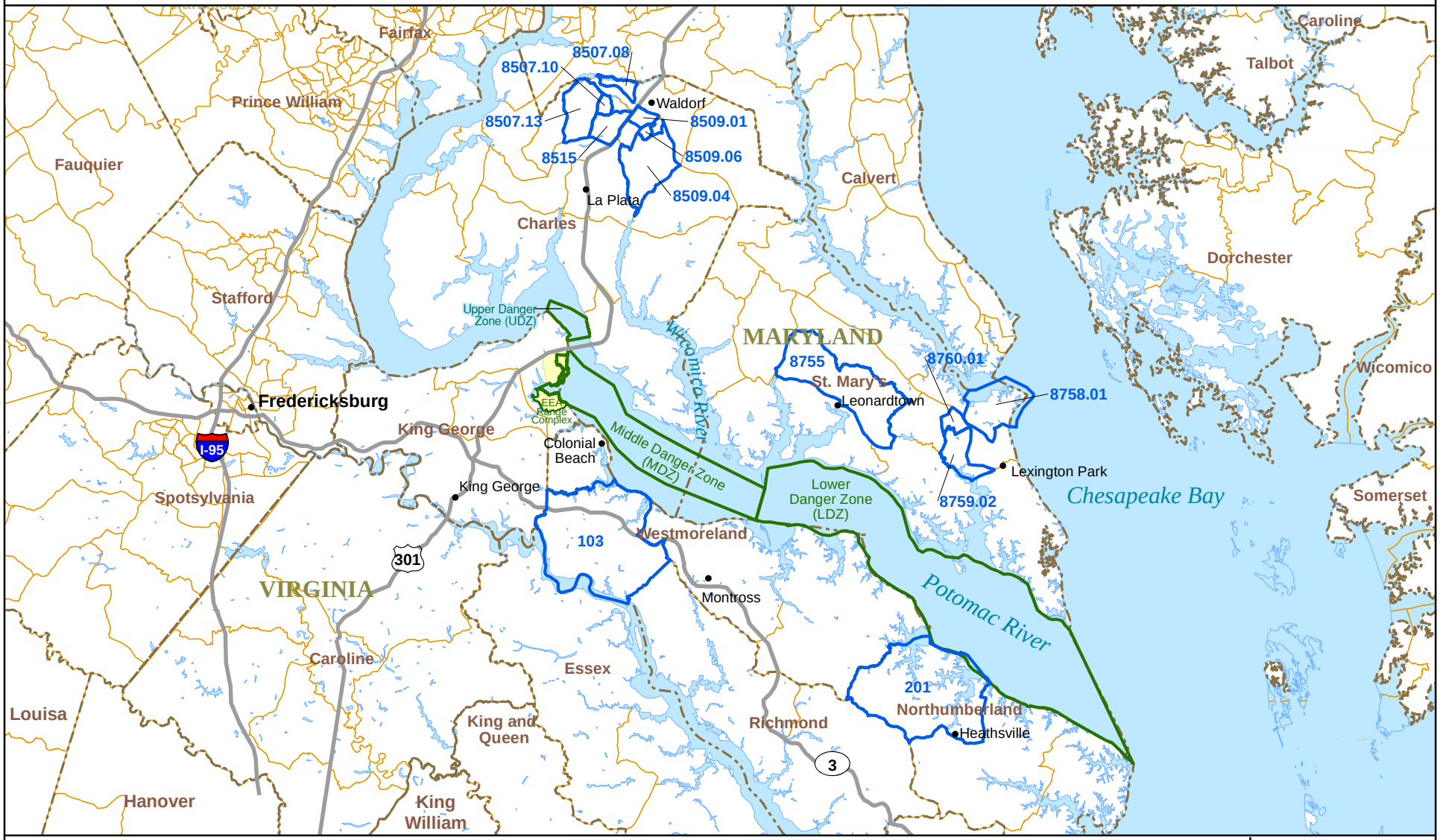
Census Tracts with Concentrations of Children



Census Tract
Unusual Concentration of Children Census Tract
County Boundary
Naval Support Facility Dahlgren
Potomac River Test Range (PRTR) Complex

4 0 4 Miles
6 0 6 Kilometers

N

NSWCDD EIS

NAVSEA WARFARE CENTERS DAHLGREN

Source: US Census Bureau, 2011c, DP-1 Profile of General Population and Housing Characteristics 2010.

Figure 3.2-4

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3.3 Utilities

NSF Dahlgren maintains and monitors the utility systems that support the installation and its tenants, including NSWCDD. In general, the current capacity of the utility systems is adequate to support the demand.

3.3.1 Electricity

Electrical power at NSF Dahlgren is provided by Dominion Virginia Power (DVP) via two 34.5-kilovolt (kV) feeders; the main substation is located near the Main Gate; from there, power is distributed through ten substations and switching stations. Four of the substations are 13.8-kV secondary, four substations are 4.16-kV secondary, and there are two 35-kV switching stations.

NSF Dahlgren's average annual electrical consumption for fiscal years 2005 through 2007 was approximately 110,500 megawatt-hours (MWH), with NSWCDD accounting for about 57,700 MWH, or 52 percent of the total (Prunty, pers. comm., March 5, 2008).

NSF Dahlgren, in conjunction with NSWCDD and its other tenants, conducted a study of electrical power needs and potential power supply alternatives to meet the growing demand for power on the installation (Naval Facilities Engineering Command [NAVFAC] Washington, 2010). The study concluded that the existing system is operating within its limits but is approaching the maximum rating.

DVP received approval on October 4, 2012 from the Virginia State Corporation Commission to build and operate a new 230 kV transmission line from DVP's 230 kV Birchwood-Northern Neck Line to a new substation at NSF Dahlgren (Dominion Virginia Power, 2011a, 2011b). This new infrastructure will meet long-term installation power demands and support the continued growth and economic development of King George County. The new infrastructure will also provide greater reliability and fewer service interruptions for the community. Construction is scheduled to begin in the spring of 2013 and finish in 2014.

3.3.2 Water and Wastewater

Three deep-water wells provide Mainside with drinking and domestic water. Dahlgren has a Community Permit for the Mainside water supply, issued by the Virginia Department of Health (VDH), with a maximum rated withdrawal capacity of 1.17 million gallons per day (gpd). The three wells can pump 385, 460, and 480 gallons per minute, respectively. Treatment consists of wellhead chlorination. Current storage capacity includes one 275,000-gallon (gal) ground-level storage tank with transfer pumps and four 100,000-gal elevated storage tanks (NSF Dahlgren and NAVFAC Washington, 2007).

The EEA water supply system is permitted as a Transient, Non-Community system by VDH. The maximum rated capacity is 31,200 gpd. Four service connections are tied to three storage tanks with a total capacity of 750 gals at the EEA (NSWCDL, 2006).

Wastewater on Mainside is collected and transported to a Navy-owned sewage treatment plant located at the southern end of Mainside via gravity sewers, force mains, lift stations, and pumping stations. There are approximately 50 miles of sewer distribution system lines and 40 pumping stations. The treatment plant discharges into Upper Machodoc Creek in accordance with a Virginia Pollutant Discharge Elimination System (VPDES) permit issued by VDEQ. NSF Dahlgren recently improved the treatment plant in compliance with VPDES General Permit requirements for total nitrogen and total phosphorus loading in treated effluent.

Domestic wastewater is treated using the following processes: dissolved-air flotation unit; first- and second-stage aeration basins set up for biological treatment removal; constructed wetland; ultraviolet-light disinfection system; re-aeration; and flow measurement. Under the permit, the wastewater effluent from the outfall at Upper Machodoc Creek is monitored periodically and the results are reported to VDEQ.

The treatment plant's permitted flow/average design flow is 0.72 million gpd. It can handle up to 1.4 million gpd on a short-term basis. However, highest average daily flows in the years from 2004 to 2006 were only 0.315 million gpd. Dewatered sludge is disposed of at the King George County landfill (NSWCDL, 2006 and NSF Dahlgren and NAVFAC Washington, 2007). Two buildings at the EEA – Buildings 9401 and 1105 – are served by septic systems.

Drinking and wastewater capacities are currently adequate to meet Dahlgren's needs. Between 2003 and 2007, average annual water usage at NSF Dahlgren was approximately 119 million gals, of which about 50 million gals, or 42 percent, were used by NSWCDD. Over the same period, an average of 124 million gals of wastewater was generated annually at NSF Dahlgren. Of these, about 52 million gals were produced by NSWCDD (Kelly, pers. comm., March 4, 2008).

3.3.3 Other Utilities

Dahlgren does not have a central heating plant (NSWCDL, 2006). There are separate fuel-fired heating systems that serve groups of buildings, while other buildings and on-base houses have their own boiler or electrical heat-pump heating and cooling systems.

Verizon provides telephone service. The network communication system is installed and maintained on-site.

Stormwater management is described in Section 3.7.3.4.

There is no natural gas service on the installation.

3.4 Air Quality

Air quality can be affected by air pollutants produced by: mobile sources, such as vehicular traffic, aircraft, and nonroad equipment; fixed or immobile facilities, referred to as stationary sources, such as industrial exhaust stacks and vents that are connected to boilers and generators; and other sources.

3.4.1 National Ambient Air Quality Standards

The US Environmental Protection Agency (USEPA), under the requirements of the 1970 Clean Air Act (CAA) as amended in 1977 and 1990, has established National Ambient Air Quality Standards (NAAQS) for six contaminants, referred to as criteria pollutants (40 CFR Part 50). These are carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter with diameters up to 10 µm and up to 2.5 µm (PM_{10} and $PM_{2.5}$), lead (Pb), and sulfur dioxide (SO_2). The NAAQS include primary and secondary standards and are summarized in Table 3.4-1. The primary standards were established at levels sufficient to protect public health with an adequate margin of safety. The secondary standards were established to protect the public welfare from the adverse effects associated with pollutants in the ambient air, such as damage to plants and ecosystems.

Areas that meet the NAAQS for a criteria pollutant are designated as being "in attainment." Areas where the criteria pollutant level exceeds the NAAQS are designated as "nonattainment." Based on the severity of the pollution problem, O_3 nonattainment areas are further classified as basic (formerly attainment for the revoked 1-hour O_3 NAAQS), marginal, moderate, serious, severe, or extreme. CO and PM_{10} nonattainment areas are classified as either moderate or serious. A maintenance area is an area that has been redesignated as an attainment area from a former nonattainment area. However, during the maintenance period, most of the CAA rules for a nonattainment area are still applicable to a maintenance area.

NSF Dahlgren is located in King George County, an area currently designated as being in attainment for all criteria pollutants. A portion of the PRTR's MDZ is located within Charles County, Maryland, an area designated as an ozone nonattainment area. The USEPA has published final rules on General Conformity (40 CFR Parts 51 and 93) that require federal agencies to ensure that their actions conform to the State Implementation Plan (SIP) in a nonattainment area. The SIP is the document which sets forth the state's strategies for achieving air quality standards. Conformity to a SIP, as defined in the CAA, means conformity to a SIP's purpose of reducing the severity and number of violations of the NAAQS to achieve attainment of these standards. The federal agency responsible for an action is required to determine if its action conforms to the applicable SIP. Since NSF Dahlgren is located in an attainment area, the conformity rule does not apply to the Proposed Action, except for those activities with the potential to occur in the MDZ within the Charles County boundary, such as aircraft and/or vessel operations. As aircraft and/or vessel operations within the MDZ would essentially remain at the same level under the Proposed Action as compared to existing conditions, there would be no foreseeable increase in emissions from these activities in the Charles County ozone nonattainment area. Consequently, the general conformity rule does not apply to the Proposed Action within this nonattainment area since no change in emissions would occur.

Table 3.4-1
Virginia and National Ambient Air Quality Standards for Criteria Pollutants

Pollutant and Averaging Time	NAAQS	
	Primary Standard[1]	Secondary Standard[1]
Carbon Monoxide		
8-Hour Maximum	9 ppm[3]	none
1-Hour Maximum	35 ppm[3]	none
Nitrogen Dioxide		
Annual Arithmetic Mean	100[2]	100
Ozone		
8-Hour Average	0.075 ppm[4]	0.075 ppm
Particulate Matter[8]		
PM_{10}		
24-Hour Average	150[5]	150
$PM_{2.5}$		
Annual Arithmetic Mean (over 3 years)	15[2]	15
24-Hour Average	35[6]	35
Lead		
Quarterly Arithmetic Mean	1.5[7]	1.5
Sulfur Dioxide		
Annual Arithmetic Mean	80[2]	---
24-Hour Maximum	365[3]	---
3-Hour Maximum	---	1300[3]

Notes:
1. All concentrations in micrograms per cubic meter of air (µg/m3) or, except where noted, in parts per million (ppm).
2. Not to be exceeded during any calendar year.
3. Not to be exceeded more than once a year.
4. Standard attained when 3-year average of annual 4th-highest daily maximum 8-hour concentration is below the level.
5. Standard attained when exceedance occurred no more than once per year over 3 years.
6. Standard attained when the annual highest 98th percentile of 24-hour concentration over 3 years is below the level.
7. The quarterly lead standard is not to be exceeded during any calendar quarter.
8. PM_{10} - particulate matter diameter of 10 microns or less; $PM_{2.5}$ - particulate matter diameter of 2.5 microns or less.

Sources: 40 CFR 50 and 9 VAC 5 Chapter 30 (8/1/07).

3.4.2 Greenhouse Gas Emissions and Climate Change

In addition to the criteria pollutants discussed above, greenhouse gases are compounds that contribute to the greenhouse gas effect. The greenhouse gas effect is the process by which certain gases in the atmosphere allow long-wave radiation in, but also keep short-wave radiation from escaping, which then warms the planet's lower atmosphere and surface. Greenhouse gases are transparent to long-wave radiation from the sun; this radiation passes through the atmosphere without being absorbed or reflected, and warms the earth’s surface. Greenhouse gases trap short-wave (infrared) radiation emitted by the earth’s surface, however, preventing it from dissipating into space and causing it to re-radiate down to the surface of the earth.

The primary long-lived greenhouse gases directly emitted by human activities are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Human-induced increases in these gases are the primary cause of the global warming observed over the last 50 years (Karl et al., 2009). Predictions of long-term negative environmental impacts due to global warming include sea level rise; changes in ocean pH (potential of hydrogen, a measure of acidity or alkalinity) and salinity; changing weather patterns with increases in the severity of storms and droughts; changes to local and regional ecosystems (including the potential loss of species); shrinking glaciers and sea ice; thawing permafrost; a longer growing season; and shifts in plant and animal ranges. The USEPA Administrator has recognized potential risks to public health or welfare and signed an endangerment finding regarding greenhouse gases under Section 202(a) of the CAA (74 Federal Register 66496; USEPA, 2009a), which finds that the current and projected concentrations of the six key well-mixed greenhouse gases – CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6 – in the atmosphere threaten the public health and welfare of current and future generations.

To estimate total greenhouse gas emissions, each greenhouse gas is assigned a global warming potential; that is, the ability of a gas or aerosol to trap heat in the atmosphere. The global warming potential rating system is standardized to CO_2, which is the dominant greenhouse gas both from natural processes and human activities, and is assigned a global warming potential equal to one. To simplify greenhouse gas analyses, total greenhouse gas emissions from a source are often expressed as equivalent emissions of CO_2, or CO_2 equivalents. The CO_2 equivalents is calculated by multiplying the emissions of each greenhouse gas by its global warming potential and adding the results together to produce a single, combined emission rate representing all greenhouse gases.

Federal agencies address greenhouse gases by reporting and meeting reductions mandated in federal laws, executive orders (EOs), and policies. Most recently, EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* (72 Federal Register 3919), and EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance* (74 Federal Register 52117), were enacted to address greenhouse gases, including greenhouse gas inventory, reduction, and reporting. In October 2009, USEPA issued its final rule on mandatory reporting of greenhouse gases (74 Federal Register 56260; USEPA, 2009b) that requires reporting by all stationary facilities that release annual emissions of 25,000 metric tons CO_2 equivalents.

3.4.3 Stationary and Mobile Sources

Criteria Pollutants

The majority of federal and state air quality regulations apply to stationary emission sources, which in Virginia are regulated by the VDEQ Division of Air Quality. NSF Dahlgren has a number of stationary fuel tanks, boilers, and generators that are permitted emission sources. NSF Dahlgren also has a number of VDEQ-permitted mobile sources, including diesel and gasoline generators and mobile fuel tanks.

Based on the type of pollutants emitted – criteria pollutants or hazardous air pollutants (HAPs) – the CAA sets forth permit rules and emission standards for sources of certain sizes. The New

Source Performance Standards apply to sources emitting criteria pollutants, while the National Emission Standards for Hazardous Air Pollutants apply to sources emitting HAPs. The USEPA oversees programs for stationary-source operating permits (Title V) for new or modified major stationary-source construction and operation. NSF Dahlgren maintains a VDEQ synthetic minor operating permit. The air emissions inventory conducted in the early 1990s did not indicate a requirement for a Title V Permit or monitoring.

NSF Dahlgren is not a major source for any criteria or hazardous air pollutants. Because NSF Dahlgren's annual emissions levels do not exceed the Title V major source threshold of 100 tons per year of any criteria pollutants, the installation is operating under a state synthetic minor operating permit (Registration No. 40307) instead of a major-source Title V permit. As part of the state operating permit requirements, the installation updates the Emissions Statement on an annual basis. VDEQ reviews permitted sources on-site every two years. The most recent on-base annual emissions from stationary sources as reported in the 2011 Emissions Statement are summarized in Table 3.4-2, which also includes the emissions of nitrogen oxides (NO_x) and volatile organic compound (VOC) as ozone precursors.

Table 3.4-2
NSF Dahlgren 2011 Annual Emissions Statement

Installation Total Emissions (tons/year)					
SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC
33.62	11.37	2.16	2.16	52.24	2.15

Source: NSF Dahlgren, 2012.

Greenhouse Gas Emissions

In accordance with the USEPA final rule on mandatory reporting of greenhouse gases, in 2009, NSF Dahlgren estimated the facility-wide total greenhouse gas emissions. Based on gasoline, fuel oil, and propane use, NSF Dahlgren estimated that in 2008 the facility generated a total of 9,702 metric tons of CO_2 equivalents, which is well below the reporting threshold of 25,000 metric tons CO_2 equivalents.

The potential effects of proposed greenhouse gas emissions are by nature global and may result in cumulative impacts, as individual sources of greenhouse gas emissions are not large enough to have any noticeable effect on climate change. Therefore, the impact of proposed greenhouse gas emissions to climate change is discussed in the context of cumulative impacts in Chapter 5.

3.4.4 Other Sources

NSWCDD's RDT&E operations have included releasing chemical simulants to test infrared-sensor chemical-agent detectors outdoors on the PRTR, as described in Chapters 1 and 2. Sensors have been tested by challenging them with a carefully-controlled cloud of chemical simulants released over the water. The simulants used absorb infrared radiation at wavelengths similar to the wavelengths absorbed by chemical warfare agents. Simulants used in operations in

2003, 2005, and 2009 included triethyl phosphate (TEP), glacial acetic acid (GAA), methyl salicylate (MeS), and 1,1,1,2-tetrafluoroethane (R-134) and 1,1-difluoroethane (R-152a), and/or SF_6 were used to calibrate the sensors. Because SF_6 is on USEPA's Greenhouse Gas Action List, its use is being phased out and NSWCDD is unlikely to use it in the future.

All chemical simulants previously used and proposed for future use are not considered criteria pollutants under the CAA and are not hazardous air pollutants. All simulants tested or proposed for use have low toxicity to humans and the environment. NSWCDD uses an air dispersion/deposition model to estimate the potential levels of downwind concentrations that would be generated, as well as the amount of each simulant that would be deposited on the water's surface prior to testing. The analysis uses the DoD-approved Vapor, Liquid, and Solid Tracking Model (VLSTRACK: Version 3.1.1) to calculate the concentration and deposition levels resulting from the testing under various release scenarios.

Since these chemicals have low toxicity and no established ambient air quality standards, the exposure guidelines established by the National Institute for Occupational Safety and Health (NIOSH) for protecting workers have been used as a basis for assessing effects (NSWCDL, 2002). Concentration levels modeled in 2002 for each simulant were within available NIOSH guidelines, and there were no potential air quality effects from releasing these chemicals during testing (NSWCDL, 2002).

Additional modeling and testing performed in 2003, 2005, and 2009 showed no significant impacts from the testing of chemical simulants. There were no observable environmental effects during or after testing (Bossart, letter, February 9, 2006; NSWCDL, 2004; NSWCDL, 2005; NSWCDL, 2009).

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3.5 Noise

3.5.1 Noise Fundamentals

Noise is definable as unwanted sound. Noise comes from numerous sources. Some noise is caused by activities essential to the health, safety, and welfare of a community (e.g., emergency vehicle sirens, garbage-collection operations, and construction and maintenance equipment). Other noise, such as traffic or aircraft noise, stems from the movement of people and goods. Although these and other similar activities are necessary to modern life, the noise they produce is sometimes undesirable and may detract from the quality of the living environment.

Noise can also be commonplace in areas near military installations. Military operations are often the sources of sounds (e.g., gunfire, detonations, aircraft flyovers, transport of heavy vehicles, etc.) that are experienced by the military community and the civilians who live and work around these installations.

The loudest sounds the human ear can hear comfortably have one trillion (1,000,000,000,000) times the acoustic energy of sounds the ear can barely detect. Because of this vast range, any attempt to represent the intensity of sound using a linear scale quickly becomes unwieldy. As a result, a logarithmic unit called the decibel (dB) is used to represent the intensity of sound.

In basic terms, sound as perceived by the ear is created by rapid changes in air pressure relative to ambient air pressure. For instance, an audio speaker in a car radio creates sounds by rapidly moving a speaker cone back and forth to create sound. The speaker cone moves back and forth rapidly to create high-frequency sounds, and more slowly to create low-frequency sounds. The ear drums of a person sitting in the car are also moving back and forth because of the higher and lower air pressure levels – or sound pressure levels – caused by the speaker cone relative to the ambient air pressure. This movement of the ear drum creates what is perceived as "sound."

Turning up the speaker volume does not change the frequencies of the sound – the speaker cone is still moving back and forth fast or slow to create the same higher or lower sound frequencies – but the music is louder because the speaker cone moves farther back and farther forth each time it travels.

By moving farther out or in, the speaker cone exerts more energy, thereby creating greater differences in pressure to the ambient air. A "blown" speaker is caused by applying too much volume, forcing the speaker to push air with so much force that it ruptures. Sound pressure levels are greatest at the source and decrease as one gets farther from the source; they are also influenced by environmental conditions. When a person is too close to the source of loud sound – such as sitting in a car with the volume turned excessively high for long periods of time – damage to the ear can occur.

In more technical terms, air pressure is the force experienced by an object divided by the area on which the force acts. The typical unit of measurement used to evaluate air pressure, for instance when filling an automobile tire to proper pressure is pounds per square inch (psi). However, when dealing with sound pressure levels, an international unit is what is commonly used. This unit is the Pascal (Pa), named after Blaise Pascal, a 17th-century French mathematician and physicist. One (1) psi is equal to 6,890 Pa. To capture the intensity of sound levels meaningfully over such a large range as that which the human ear can experience, the logarithmic dB is used;

this unit expresses the ratio of sound pressure to a reference standard. Specifically, the sound pressure level in dB is defined as 20 times the common logarithm of the ratio of sound pressure in Pa to the reference pressure (0.00002 Pa). Some typical levels of sound in dB are shown in Table 3.5-1.

Table 3.5-1
Typical Sound Levels

Source of Sound	Sound Pressure Level dB re 20 µPa
M1 Garand Rifle being fired at 1 m	168 dB
Jet engine at 30 m	150 dB
Rifle being fired at 1 m	140 dB
Threshold of pain	130 dB
Jackhammer at 1 m	approx. 100 dB
Major road at 10 m	80-90 dB
Normal conversation at 1 m	40-60 dB
Very calm room	20-30 dB
Leaves rustling; calm breathing	10 dB
Auditory threshold at 1kHz	0 dB
Source: Wikipedia (2010)	

3.5.1.1 Noise Frequency and Time Weighting

A number of factors affect sound as the human ear perceives it. These include the actual level of noise, the frequencies involved, the period of exposure to the noise, and changes or fluctuations in noise levels during exposure. In order to correlate the frequency characteristics from typical noise sources to the perception of the human ear, several frequency networks (systems of measuring units) have been developed. The most common noise frequency-weighting networks include the following, with examples relevant to this EIS:

- **A-weighted Scale** – The human ear cannot perceive all pitches or frequencies equally well. Reflecting this fact, measures can be adjusted, or weighted, to compensate for the human lack of sensitivity to low-pitched and high-pitched sounds. This adjusted measurement unit is known as the A-weighted decibel, or dBA. The dBA is used to evaluate noise from transportation activities (traffic and aircraft) and from small-arms firing. It is commonly expressed as an A-weighted sound exposure level (SEL).
- **C-weighted Scale** – The C-weighted scale measures more of the low-frequency components of noise than does the A-weighted scale. This unit, symbolized as dBC, is used for evaluating impulse noise and vibrations generated by heavy weapons such as artillery, mortars, armor (20 millimeters [mm] or greater) and explosive charges. C-weighted noise levels are often expressed as a C-weighted SEL (CSEL).
- **Peak Sound Level** – The peak sound level (dBP) is a flat-weighted scale that can be used to measure noise from small-arms (less than or equal to 20 mm) firing, heavy artillery, and explosives.
- **Day-Night Sound Level** – The day-night average sound level (DNL) is useful to account for the difference in response to noises that occur during sleeping hours as compared to

waking hours. This indicator is defined as the average sound level in decibels during a 24-hour period, with a 10-dB weighting (penalty) applied to nighttime sound levels. The 10-dB nighttime weighting accounts for the fact that noises at night sound louder because there are usually fewer noises occurring at that time.

Note that noise levels in one scale cannot be added or compared mathematically to levels in another scale.

3.5.1.2 Noise Metrics

Another factor that is relevant to the characterization and analysis of noise is whether the noise is continuous or impulse. Sources of continuous noise include highways, construction sites, and urban environments with heavy traffic and large airports. Impulse noise consists of almost instantaneous (thus impulse-like) sharp sounds, such as clicks, pops, and bangs. Sources of impulse noise include ordnance explosions and gun firing. Ambient noise conditions around NSF Dahlgren are influenced by the impulse noise from detonations at the EEA Complex, gun firing in the PRTR Complex ranges, and, to some extent, by the noise of military aircraft both on and off the installation.

Continuous noise is fundamentally different from impulse noise and noise threshold criteria for the two types differ. For example, permanent damage to unprotected ears due to continuous noise occurs at approximately 85 dB with an eight-hour-per-day exposure while the threshold for permanent damage to unprotected ears due to impulse noise is approximately 140 dB peak noise, with 100 exposures per day (Pater, 1976).

Given the difference between continuous and impulse noise, the variations in frequency and period of noise exposure, and the fact that the human ear cannot perceive all pitches and frequencies equally well, noise from military activities is measured using two different noise metrics that reflect the different noise characteristics: the DNL and the dBP. The DNL metric is normally used for evaluating cumulative effects from both continuous (e.g., aircraft noise) and impulse (e.g., gun firing) noise sources. The dBP metric is used to assess peak event noise from impulse noise sources such as gun firing.

3.5.2 Department of Defense Guidelines on Noise

The Department of Defense (DoD), including the Navy and the Army, has developed guidelines to define, identify, and assess noise impacts. DoD uses a widely-accepted metric – DNL – to measure noise. The DNL metric is recommended by USEPA and is used by most federal agencies, including DoD, the US Department of Transportation (USDOT), and the US Department of Housing and Urban Development (USHUD). DNL is the primary descriptor for evaluating military noise.

In addition to the DNL metric, the Army has developed weapons-noise guidelines for DoD facilities to describe the type of single-event peak impulse noise generated by the large-caliber weapons and explosives it commonly uses (United States Army Center for Health Prevention and Preventive Medicine [USACHPPM], 2005). Historically, the Navy has used the Army's guidelines to assess impulse-noise impacts in NEPA documents.

Both DoD's DNL guidelines and the Army's peak noise guidelines have been used to evaluate the existing noise environment at and around NSF Dahlgren under existing conditions and the three alternatives evaluated in this EIS. They are described in more detail below.

3.5.2.1 DNL Guidelines

Navy

The Navy has established the Range Air Installations Compatible Use Zones program (US Navy, 2008) to protect public health, safety, and welfare, and prevent encroachment from degrading the operational capability of air-to-ground ranges. The Range Air Installations Compatible Use Zones program includes range safety and noise analyses, and provides land use recommendations that aim to ensure compatibility with range safety zones (i.e., areas of varying levels of safety concerns due to potential weapons impact) and noise levels associated with the range activities. The Navy has defined three noise zones based on the A-weighted DNL (ADNL) metric and provides general action to be considered with respect to land use compatibility within these noise zones (Table 3.5-2).

Table 3.5-2
Navy Land Use Compatible Guidelines

Noise Zone	ADNL (dBA)	Land Use Compatibility
I	< 65	An area of minimal impact where sound attenuation is not needed.
II	65 – 75	An area of moderate impact where some land use noise controls are needed.
III	75 or above	The most severely impacted area, where the greatest degree of land use noise controls is needed.
Source: US Navy, 2008, OPNAVINST 3550.1A.		

The Navy guidance also provides for the use of the DoD's Blast Noise Prediction (BNOISE) program to establish ordnance blast-noise contours. As discussed below, BNOISE has been used when preparing this EIS to predict the C-weighted DNLs (CDNLs) for large-caliber gun firing and explosive-detonation noise.

Army

As explained above, DNL measurements are "weighted" to reflect what people may actually hear (A-weighting). In a similar way, intense, low-frequency noise that can cause vibration is weighted to what people may actually feel (C-weighting). Relating CDNL values (in dBC) to ADNL values (in dBA) for similar annoyance responses makes it possible to correlate a high-energy impulse-noise CDNL environment with an "equivalent" ADNL environment. For example, a CDNL of 62 dBC can be equated to an ADNL of 65 dBA, and a CDNL of 70 dBC can be equated to an ADNL of 75 dBA. The CDNL metric is commonly used for evaluating heavy-weapon noise (20 mm gun and greater) and it is applicable to NSWCDD, given the type of weapons tests conducted.

Table 3.5-3 shows the Army's land use planning guidelines with respect to military noise, including the correlated CDNL guidelines for impulse noise. The table shows the permissible levels for three types of military noise within three land use planning noise zones that are used for assessing land use compatibility.

Table 3.5-3
Army Land Use Planning Guidelines

Noise Zone	Aviation ADNL (dBA)	Impulse CDNL (dBC)	Small Arms PK15 (dBP)
I	<65	<62	<87
II	65-75	62-70	87-104
III	>75	>70	>104

Notes: ADNL – A-weighted Day-Night Levels.
CDNL – C-weighted Day-Night Levels.
N/A – Not Applicable.

Source: USACHPPM, 2005.

Noise-sensitive land uses typically include residential areas, schools, hospitals, and churches. It should be noted that the potential for annoyance from noise does not equate to the potential for a significant noise impact.

In accordance with Army guidance applicable to a typical military installation, an average of 250 (not 365) annual operation days was assumed in NSWCDD's DNL existing conditions analyses.

3.5.2.2 Peak Impulse Noise (dBP) Metrics and Guidelines

There are many reasons why people complain about gun-firing noise. Some individuals seem to be more physiologically reactive to intrusive sounds than others. Another variable is the degree of buffering provided by a building. For example, somebody living in a solid brick house with sealed windows would not experience the rattling that someone living in a wood-frame house with loose sashes would experience. This interaction of personal variables and building construction complicates the prediction and minimization of gunfire-related complaints.

People who complain about gun sounds tend to mind the most intense events. A straightforward way to measure the most intense events is using the peak sound pressure level (PK). In 1976, NSWCDD engineers and scientists published a method to predict whether people would complain about weapons testing (Pater, 1976). How peak noise level and complaints are correlated under this method is shown in Table 3.5-4. The guidelines developed by NSWCDD have proved useful in predicting complaints at the Aberdeen Proving Ground in Aberdeen, Maryland. As documented by Luz and Eastridge (Luz and Eastridge, 2001, as cited in USCHPPM, 2005), most complaints at Aberdeen Proving Ground are associated with peak levels between 115 and 130 dBP. These same guidelines have since been used in weapon-noise impact studies at many installations.

The PK 50 metric can also be used to define noise contours. This metric indicates that a specific noise peak level may occur with a 50 percent probability, meaning that half of the time a particular noise-generating event (such as firing a gun) will create a peak noise above this level and half the time below this level; therefore, it is comparable to a mean peak noise level.

Table 3.5-4
Peak Impulse Noise Guidelines

Sound Level (dBP)	Risk of Complaints	Recommended Action
<115	Low	Fire all programs.
115-130	Moderate	Fire important tests; postpone non-critical testing, if feasible.
130-140	High, and possibility of damage	Only extremely important tests should be fired.
>140	Threshold for permanent physiological damage to unprotected ears - High risk of physiological and structural-damage claims	Postpone all tests.

Source: USACHPPM, 2005.

Based on a comparison with the maximum PK noise measurements conducted in 2007 as well as the most recent 2010 measurements at nine sites around NSF Dahlgren and along the PRTR MDZ that correlate to specific gun-firing events, the noise analysis in this EIS presents predicted (modeled) noise conditions – in the next section for existing conditions and in Section 4.5 for all alternatives – using the PK50 contours that best approximate the reception of PK noise conditions around NSF Dahlgren (see Section 3.5.4).

3.5.3 Existing Noise Conditions

Ambient background noise levels in the vicinity of NSF Dahlgren are typical of a rural or semi-rural environment. The area is relatively quiet, but aircraft flying overhead, boats traveling on the river, and vehicular traffic on US Route 301 add noise intermittently.

3.5.3.1 Noise Sources

NSWCDD generates two types of noise that add to ambient noise levels:

1. **Ordnance tests** – Impulse noise from small-arms firing, large-caliber-gun firing, and explosive detonations on the EEA and PRTR range complexes.
2. **Aircraft flights** – Continuous noise from helicopters using the NSF Dahlgren airfield, aircraft brought from other airfields to be used in tests, and unmanned aerial vehicles (UAVs) launched from the land ranges of the PRTR Complex and the EEA Complex and flown within the special-use airspace (SUA).

3.5.3.2 Continuous Noise from Aircraft/Helicopter Activities

Since NSF Dahlgren's active runway has been closed to fixed-wing aircraft activities since 2007, the airfield currently provides only helicopter flight services from and to nearby military bases.

As discussed previously, the DNL metric is the most frequently used metric for aircraft-related noise. It represents the total sound exposure averaged over a period of 24 hours in an average operational day, with a weighting reflecting the greater sensitivity to noise during night-time hours. While DNLs for ambient noise conditions have not been modeled around the airfield, the frequency of flight operations for helicopters is very low – at most, ten flights a month. Such a

small number of flights would not generate DNLs of 65 dBA or higher in residential areas either on or off the installation.

3.5.3.3 Noise from UAV Activities

UAVs are used for a number of different activities, as described in Section 1.6.3. They are launched manually from anywhere on the PRTR land ranges or take off from one of two UAV runways on the Terminal Range and the EEA's Churchill Range, respectively (see Figure 1-12). They must remain within the SUA and usually fly at an altitude of between 2,000 and 3,000 ft above the PRTR Complex. When they fly near the ground, such as during takeoff and landing, the largest size UAV NSWCDD uses generate noise levels of approximately 80 dBA, which is similar to the noise from a passing heavy-duty truck. Therefore, the noise from UAV flight events is considered negligible.

3.5.3.4 Impulse Noise from Range Test Activities

Impulse noise at NSF Dahlgren is generated by large-caliber-gun and small-arms firing on the PRTR Complex land ranges and explosive detonations on the EEA Complex ranges.

Bow Shock

A large-amplitude compression wave that occurs in front of an object that moves faster than sound.

Large-caliber firing includes both explosive (live) and non-explosive (inert, also known as blind load and plug) projectiles. When a large-caliber live projectile is fired, there is impulse noise both when the gun is fired and when the projectile explodes/detonates at the target area; there is also bow-shock noise from the projectile. The firing of an inert projectile does not create an explosion when the projectile hits the target; only the firing of the gun creates an impulse noise, with the addition of bow shock noise from the projectile.

To ensure conservative results, the analysis of existing noise conditions presented in this chapter was developed using the annual average numbers of events that occur during particularly active years (see Section 1.5.1) namely:

- 4,700 projectiles fired from large-caliber guns
- 190 detonation events at the EEA Range Complex
- 6,000 bullets fired from small-caliber guns

In late 2006, NSWCDD installed and began testing a new type of weapon – a 32-megajoule (MJ) electromagnetic (EM) launcher. Rather than using explosives to propel projectiles, the EM launcher uses EM energy. Ultimately, EM launchers will fire projectiles that can reach speeds of more than seven times the speed of sound (outdoor testing at high speeds would take place on other ranges than NSWCDD's). Since being installed, EM launchers, located on the Missile Test Range, have been firing at progressively higher muzzle energy levels into a backstop; since October 2008, they have been firing in an open-air trajectory control structure that guides inert projectiles into a terminal catch chamber. In February 2009, EM launchers were fired at levels of around 16 MJ of muzzle energy. As part of the Proposed Action, EM launchers would operate over land and over water. Over land impacts are addressed in a separate NEPA document (NSWCDL, 2009). EM launchers would not fire projectiles at speeds faster than other projectiles fired at Dahlgren either over land or over water. When firing at speeds equivalent to existing

guns, EM launchers are considered to have the same impacts as other guns used and are included as an additional component of the baseline activities in Chapter 2. Therefore, EM launcher noise is included in the existing baseline conditions presented here.

3.5.3.5 Noise Management Process

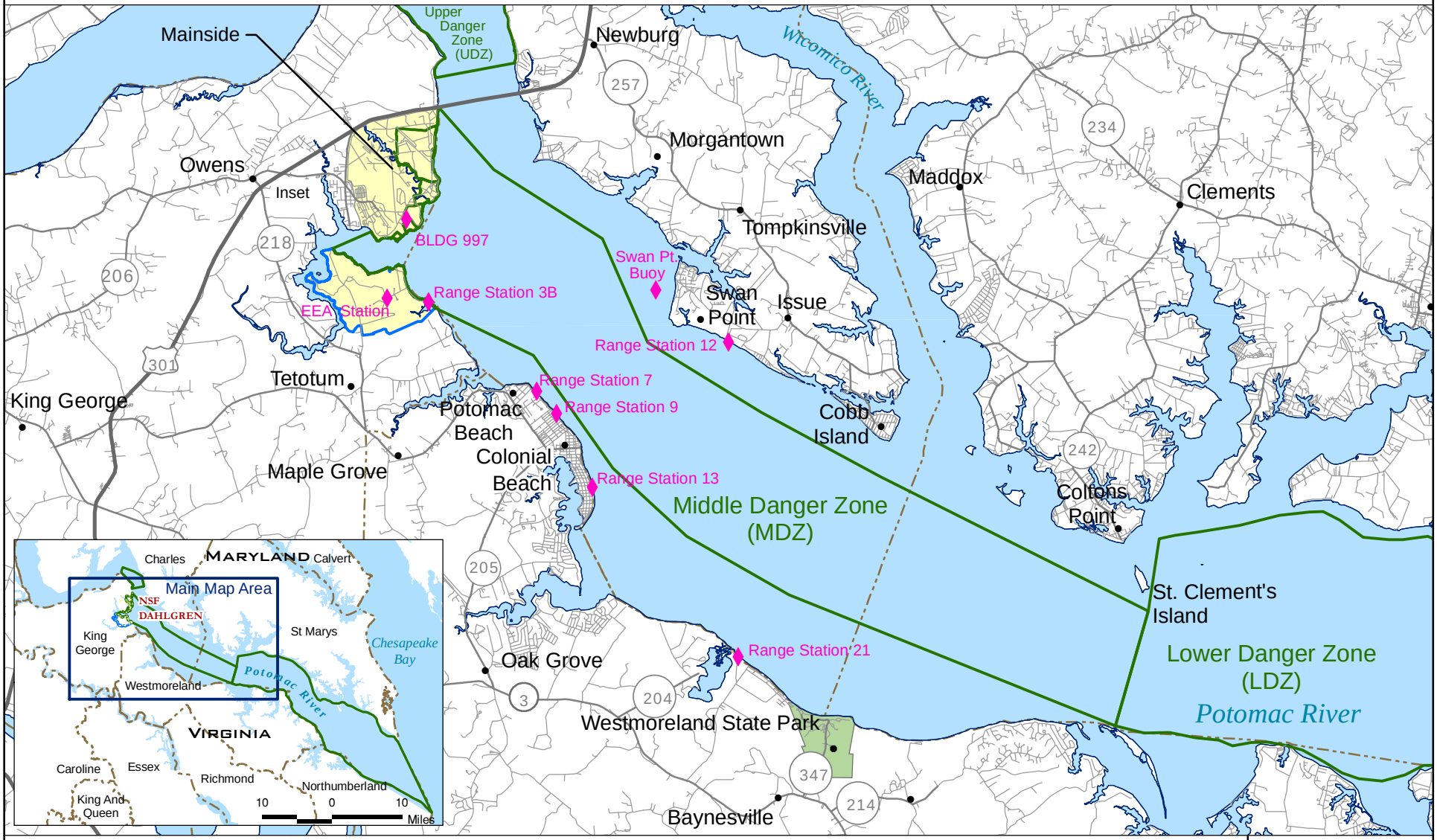
NSWCDD has developed and implemented a noise management process to monitor and control noise from its outdoor RDT&E activities (NSWCDL, 2011). As part of this process, NSWCDD uses a state-of-the-art Sound Intensity Prediction System (SIPS) to predict noise impacts to sensitive surface areas prior to gun firing and open detonation events. The SIPS computer model takes into account the amount of sound energy that would be released by the test, the landscape of the area, and current weather conditions, which strongly influence how sound is distributed over a particular area. SIPS, which has been used by NSWCDD since 1975, is recognized nationally as a valuable tool for the prediction of noise propagation, and has been deployed at other DoD heavy-weapons test sites.

In addition to using SIPS, procedures are in place to track, predict, and minimize noise effects, as follows:

- **Scheduling** – Whenever possible, gun-firing activities are conducted during normal business hours – Monday through Friday from 8 am to 5 pm. Because of the time it takes to set up tests in the morning, most gun firing gets underway around 9 to 10 am and then tails off after 3 to 4 pm.
- **Public Relations** – The Public Affairs Office (PAO) closely monitors and records any complaints involving noise and vibration. Naval Surface Warfare Center, Dahlgren Division maintains a website that provides: the Range Schedule; a toll-free Range/Weapons Testing hotline for daily information on range activities and test schedules; a toll-free number for noise comments and questions; and the local number for the NSWCDD PAO. In addition, the NSF Dahlgren PAO maintains a list of citizens who have requested notification when predicted noise levels will be greater than normal.
- **Ambient Peak-Noise Measurements –** Nine noise-measurement sites (Figure 3.5-1, Peak Noise Measurement Locations) are located around NSF Dahlgren and along the PRTR MDZ to monitor peak-noise levels during gun-firing and explosive-test events. Sound meters have been placed at these locations to monitor actual noise levels during ordnance events, provide feedback for improving the SIPS prediction model, and determine whether noise levels are acceptable at critical areas to continue the event. Handheld meters are also used to monitor noise when a potentially affected area does not have a previously-installed sound meter.

The NWSCDL noise management process manual (NSWCDL, 2011) includes an ordnance event decision process that determines whether or not an event may take place. This process is summarized in the text box on the following page.

Peak Noise Measurement Locations



Potomac River Test Range (PRTR) Complex

Explosives Experimental Area (EEA) Range Complex

Naval Support Facility (NSF) Dahlgren

County Boundary

Noise Monitoring Location

3 0 3 Miles

5 0 5 Kilometers

N

NSWCDD EIS

NAVSEA WARFARE CENTERS DAHLGREN

Source: NSWCDD GIS 2008

Figure 3.5-1

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Ordnance Event Decision Process

1. **Event Assessment**: To decide whether or not to proceed with an event given the potential noise impact, a SIPS analysis is required when one or more of the following conditions apply:
   - Gunfire:
     - Single shot (or single shots) from a 5" or larger gun
     - Live rounds with a caliber great than or equal to 57 mm
     - Rapid fire from a 76 mm or larger gun
   - Open detonation:
     - NEW of 30 or more (if the NEW for an Explosive Hazardous Waste [EHW] treatment exceeds 200 lbs, the ordnance will be earth-covered prior to treatment and SIPS is not required).

   Other noise-generating RDT&E will be evaluated on a case-by-case basis; for example, EM launcher operations do not require SIPS analysis. The event may proceed without SIPS analysis if the conditions provided above do not apply.

2. **SIPS Analysis:** If SIPS analysis is required, the decision to proceed with an event depends on the predicted sound intensity at critical surface areas:
   - If the sound intensity is predicted to be less than 130 dBP, then the event may proceed.
   - If the predicted sound intensity is greater than or equal to 130 dBP, then the event is postponed.

3. **Event Proceeds:** When proceeding with any ordnance event, actual noise levels will be monitored and recorded throughout the event:
   - For safety reasons, an open detonation will proceed to completion.
   - A gunfire event is dependent on actual sound meter data collected at critical surface areas for each shot or five rapid fire rounds:
     - If the actual measured noise level is less than 135 dBP, then the event will continue.
     - If the actual measured noise level is greater than or equal to 135 dBP and less than 140 dBP, the gun will fire one more round or 5 more rapid fire rounds, if necessary (the operation may be complete). Upon firing this round:
       - If the resulting actual noise level is greater than or equal to 135 dBP, the event will be postponed.
       - If the resulting actual noise level is less than 135 dBP, the event will continue.
     - If the actual noise level meets or exceeds 140 dBP, the event will either be cancelled or delayed until more favorable conditions—as demonstrated by SIPS predictions—are available.

   EM launcher RDT&E operations will continue if the actual measured noise level at the Montana shelter (on the installation) remains below 140 dBP and the actual measured noise level at the Swan Point buoy (see Figure 3.5-1) is less than or equal to 135 dBP. Otherwise, operations will be postponed for the remainder of the day. If the measured noise level at the Montana shelter exceeds 140 dBP, but the level at the Swan Point buoy does not exceed 135 dBP, a waiver may be granted, allowing the operation to continue.

   Other noise-generating RDT&E operations will continue if the actual measured noise level remains below 135 dBP. Otherwise, these operations will be postponed.

4. **Event Postponed:** When an event is postponed, additional SIPS analysis may be conducted until more favorable conditions are available. Otherwise, the Division Head is notified. The Division Head will either concur with the decision to postpone the event or will grant a waiver to allow the event to continue. Waivers may be granted when an event is critical; however, they cannot be applied if SIPS predictions or actual noise measurements at sensitive surface areas meet or exceed 140 dBP.

   In the event of a waiver, the following actions are taken:
   - The waiver is documented: the Division Head either drafts and signs the waiver or provides the waiver by email to Range Control, the Test Engineer, and the Safety and Environmental Office.
   - The event proceeds to completion—actual noise levels for each shot are monitored and recorded. If any measured noise meets or exceeds 140 dBP, the operation is again postponed and the postponement and the event postponement procedure starts over.

   If a waiver is not granted, the event will either be cancelled or delayed and the Test Engineer so notified. Unless cancelled, the event will be delayed until more favorable conditions are available, as verified by running SIPS again and following the noise guidelines.

3.5.3.6 Ambient Peak-Noise Measurements

Large-caliber Gun Firing

In 2007, noise monitors measured peak noise levels in one-second intervals for various gun-firing events, which included both inert- and live-firing events, at three on-installation and six off-installation locations. These peak-noise measurements for the largest guns in the events are summarized in Table 3.5-5. The overall worst-case recorded samples at off-installation sound-meter locations ranged from 122 dBP to 134 dBP. Based on further review of these samples, it was found that:

- One (1) sample from a total of 1,093 samples exceeded 130 dBP at the sound meter located at Range Station 7.
- Five (5) samples from a total of 1,706 samples exceeded 130 dBP at the sound meter located at Range Station 9.

Given such a low frequency of exceedances of 130 dBP, which is the threshold for high risk of noise complaints, the 2007 peak-noise measurements indicated that the off-installation sound-meter locations are within the area with moderate risk of noise complaints, as defined in Table 3.5-4.

Table 3.5-5
Range of Measured 2007 Peak Noise Levels (in dBP) during Large-Gun Firing Events

Measurement Location	Number of One-second Samples	Range of Recorded Peak Noise Levels (dBP)			
		5”/62 Gun	5”/54 Gun	76 mm Gun	Maximum
On-installation Locations					
#1 – Building 997	706	107 – 147	106 – 148	103 – 127	148
#2 –Range Station 3B	1,139	105 – 139	100 – 134	73 – 134	139
#3 – EEA Station 8	731	102 – 139	97 – 121	76 – 140	140
Off-installation Locations					
#4 – Swan Point Buoy	600	105 – 124	98 – 126	64 – 118	126
#5 – Range Station 7	1,093	101 – 129	100 – 132	81 – 121	132
#6 – Range Station 9	1,706	110 – 131	100 – 134	107 – 125	134
#7 – Range Station 12	1,113	90 – 125	92 – 129	109 – 122	129
#8 – Range Station 13	853	96 – 119	95 – 123	84 – 115	123
#9 – Range Station 21	1,121	101 – 119	79 – 118	65 – 122	122

Additional noise monitoring was performed in November 2009 to determine noise and vibration effects on historic structures when firing a large-caliber gun with explosive projectiles, as shown in Table 3.5-6. The historic structures were located at various distances from the gun firing point (see Appendix D, Figure 2). The noise and vibration measurement program took place during already-scheduled tests. Noise measurements were recorded during this particular group of tests because NSWCDD was firing the largest gun routinely fired on the PRTR – the 5”/62 caliber gun – with projectiles that contained the largest amount of detonation explosives typically used – approximately 9 pounds (lbs) net explosive weight (NEW).

Table 3.5-6
Airborne Peak Noise Levels from 5"/62 Live Firing Measured in 2009 at Historic Structures

Site	Firing Distance (yards)	Number of Shots Measured	Noise Level[2] (dBP)			Number of Events		
			Minimum	Mean	Maximum	< 115 dBP	115 – 130 dBP	> 130 dBP
Waverley House	5,300	15	115	117	120	0	15	0
	8,300	10	118	120	122	0	10	0
	16,700[1]	-	-	-	-	-	-	-
	21,600[1]	-	-	-	-	-	-	-
	25,700	1	118	118	118	0	1	0
Christ Episcopal Church	5,300	9	73	86	96	9	0	0
	8,300	7	86	93	100	7	0	0
	16,700	7	82	86	92	7	0	0
	21,600[1]	-	-	-	-	-	-	-
	25,700	10	82	88	102	10	0	0
Newtown Manor House	5,300	15	97	102	106	15	0	0
	8,300	4	90	100	107	4	0	0
	16,700	2	103	105	108	2	0	0
	21,600[1]	-	-	-	-	-	-	-
	25,700	5	91	100	105	5	0	0
Stratford Hall	5,300	13	86	98	108	13	0	0
	8,300	8	89	100	108	8	0	0
	16,700	8	86	99	107	8	0	0
	21,600	5	110	112	114	5	0	0
	25,700	11	103	106	110	11	0	0
Bell House (Geosonics sound level meter)	5,300[1]	-	-	-	-	-	-	-
	8,300[1]	-	-	-	-	-	-	-
	16,700	9	103	114	122	4	5	0
	21,600	3	105	109	112	3	0	0
	25,700	11	101	106	116	10	1	0
Bell House (B&K 2250 sound level meter))	5,300	14	95	111	126	11	3	0
	8,300	10	103	115	125	5	5	0
	16,700	8	105	114	122	4	4	0
	21,600	5	108	111	115	4	1	0
	25,700	11	102	110	116	10	1	0
Greg House	5,300	15	116	124	129	0	15	0
	8,300	10	116	124	128	0	10	0
	16,700[1]	-	-	-	-	-	-	-
	21,600[1]	-	-	-	-	-	-	-
	25,700	1	120	120	120	0	1	0

Notes:
1. No peak noise measurements were made.
2. Measurements were taken on November 16 and 17, 2009 at all locations except Waverley House and Newtown Manor, which were sampled only on November 16, 2009.

The overall worst-case recorded samples at off-installation sound-meter locations in 2009 ranged from 92 dBP to 129 dBP. There were no exceedances of 130 dBP, which is the threshold for high risk of noise complaints at off-installation historic structures from the 5”/62 caliber gun firings. The peak-noise measurements taken in 2009 indicated that the off-installation sound-meter locations are within the area with low or moderate risk of noise complaints, as defined in Table 3.5-4.

EM Launcher Firing

NSWCDD collected three sets of peak-noise measurements from operation of the existing 32-MJ EM launcher (railgun) system located in the Electromagnetic Launch Facility (EMLF) during the following three periods: from October 2006 to January 2007; from April 2007 to October 2008; and from December 2008 to January 2009. For all noise measurements, the system was operating at power levels considerably below 32 MJ because the pulse forming network (PFN) did not support higher power levels. Power levels increased from 0.8 MJ in the early tests to 16 MJ in the latest group of tests evaluated here.

These three sets of noise measurements, all recorded at on-installation receptors, were as follows:

- Between October 2006 and January 2007, peak noise levels were measured for 18 shots below the 8-MJ power level at an initial nine receptor locations (Figure 3.5-2, EM Launcher Firing Peak Noise Measurement Locations) with various combinations of the following:
  - Projectile weights of 5.3 lbs, 6.4 lbs, and 7.1 lbs.
  - Muzzle energy levels ranging from 0.8 MJ to 7.6 MJ.
- Between April 2007 and October 2008, peak noise levels were measured for more than 200 shots at various muzzle energy levels. During this round of sampling, measurements were taken at three of the original nine receptor locations – receptor locations #5, #6, and #8 – and three alternate measurement sites – Building 1425, the exterior of Building 1460, and the interior of Building 1460 – for a total of six locations (Figure 3.5-2). Muzzle energy levels for these measurements varied up to 12 MJ.
- Between December 2008 and January 2009, peak noise levels from additional tests were measured for 24 shots at receptor locations #5, #6, and #8 again, at two interior locations in Building 1425 (the office area and the warehouse area), at the exterior of Building 1460, and at two additional alternate locations – the fence line just south of US Route 301, and outside Dahlgren Elementary School – for a total of eight locations (Figure 3.5-2). Muzzle energy levels for these measurements varied up to 16 MJ.

The peak noise levels recorded during these three test rounds are summarized in Tables 3.5-7, 3.5-8, and 3.5-9, respectively. These data show patterns that are generally consistent with each other. They indicate that:

- There is no clear relationship between peak noise level and muzzle energy level, although the data suggest that there is a tendency for higher muzzle energy to generate slightly higher peaks.

EM Launcher Firing Peak Noise Measurement Locations

Noise Measurement Location
Additional Measurement Location
Electromagnetic Launch Facility (EMLF)

3,300 0 3,300 Feet

1,000 0 1,000 Meters

N

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Source: NSWCDD GIS 2008

Figure 3.5-2

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- For a given distance from the EMLF, sound propagation is generally not sensitive to the launch direction, except for receiving locations behind the EMLF and to the rear of the EM launcher's firing direction. The bulk of the high-bay EMLF building creates a shielding effect that attenuates launch noise. It is anticipated that the buildings behind the launch site as well as the surrounding forested area (Figure 3.5-2) effectively attenuate peak noise from EM launcher shots at off-installation locations beyond the northern boundary of the installation. This is supported by the relatively low peak-noise levels measured at Receptor #3 outside of the control van (Table 3.5-7), especially given its proximity to the noise source (only 302 ft north of the launch site, but with levels that are comparable to Receptor #5 levels 1,217 ft away), and at the fence-line receptor, near Route 301 (Table 3.5-9).
- Receptors #8 (EEA) and #9 represented off-base locations to the south and east, including potential receptors located on the Potomac River. Measured levels were either below 115 dBP (the majority of readings), indicating the likely low risk of generating complaints; or between 115 dBP and 130 dBP, indicating a moderate risk of generating complaints.
- All noise measurements at Dahlgren Elementary School show peak noise levels below 115 dBP, which indicates a low risk of generating noise complaints at both on-base school and housing areas.

Table 3.5-7
Measured Peak Noise Range from EM Launcher Shots (October 2006 – January 2007)

Receptor Location	Distance from EMLF (ft)	5.3-lb Projectile (6 Shots) Muzzle Energy – 0.8 – 5.4 MJ (dBP)	6.4-lb Projectile (2 Shots) Muzzle Energy - 6.2 – 6.3 MJ (dBP)	7.1-lb Projectile (10 Shots) Muzzle Energy - 3.7 – 7.6 MJ (dBP)
#1 Terminal Area	0	154 - 171	n/a	168 – 169
#2 Inside Bldg. 1410	33	152 – 154	n/a	164 – 169
#3 Outside Control Van	302	117 – 131	128 – 129	120 – 133
#4 Inside Control Van	302	100 – 113	114 – 115	104 – 117
#5 Bldg. 1180 Fence	1,217	121 – 129	131 – 131	130 – 139
#6 Bldg. 1400 Barricade	1,591	117 – 126	126 – 126	119 – 130
#7 Bldg. 1470 Intersection	3,425	106 – 118	118 – 125	112 – 123
#8 Line of Flight by Riverbank	5,302	102 – 115	106 – 111	93 – 123
#9 Terminal Range Barricade	6,998	99 – 109	112 – 115	103 – 120

Note: 1 mi = 5,280 ft.

Table 3.5-8
Measured Peak Noise Range from EM Launcher Shots (April 2007 – October 2008)

Receptor Location	Number of Measure-ments	Peak Noise (dBP) under Lowest Muzzle Energy (0.84 MJ)	Peak Noise (dBP) under Highest Muzzle Energy (13.49 MJ)	Lowest Range		Highest Range	
				Peak Noise (dBP)	Muzzle Energy (MJ)	Peak Noise (dBP)	Muzzle Energy (MJ)
#5 Bldg. 1180 Fence	205	121	--	110	2.35	144	6.73
#6 Bldg. 1400 Barricade	172	117	134	114	3.30	139	11.95
#8 LOF by Riverbank	179	102	115	91	6.54	123	7.38
Additional Sites							
Bldg. 1425	170	--	142	111	3.39	147	3.99
Bldg. 1460 Exterior	100	--	--	113	4.01	134	3.99
Bldg. 1460 Interior	73	--	--	85	9.67	123	6.31
Note: -- indicates that no readings were taken, as readings were limited to a total of three sites during each test.							

Table 3.5-9
Measured Peak Noise Range from EM Launcher Shots (December 2008 – January 2009)

Receptor Location	Number of Measurements	Peak Noise Range Muzzle Energy ~ 16 MJ (dBP)
#5 Bldg. 1180 Fence	19	137 – 151
#6 Bldg. 1400 Barricade	17	130 – 138
#8 LOF by Riverbank	18	110 – 121
Additional Sites		
Bldg. 1425 Office Area (Interior)	15	122 – 131
Bldg. 1425 Warehouse Area (Interior)	9	129 – 137
Bldg. 1460 Exterior	21	123 – 138
Fence Line @ US Route 301	24	109 – 120
Dahlgren Elementary School	17	91 - 113

3.5.4 Existing Conditions Noise Modeling

Peak blast noise levels and DNL levels (C-weighted DNL levels for explosive detonations and large-caliber guns and A-weighted DNL levels for small arms) can be predicted (modeled) using the DoD's weapons-noise models: the BNOISE2 for explosive detonations and large-caliber guns; and the Small Arms Range Noise Assessment Model (SARNAM) for small arms (smaller than or equal to 20 mm guns). Since explosive detonations, large-caliber guns, and small arms are used by NSWCDD, both the BNOISE2 and SARNAM models were applied for the purposes of the present analysis.

It should be noted that the EM launcher system at the EMLF is still in the testing stage, with limited noise measurements available. As noted above, the measurements to date do not show a close correlation between increasing power and noise. The existing data are not sufficient to develop a noise-prediction model that can be used to predict both peak and DNL levels for EM launcher firings as is possible for large-caliber guns, explosive detonations, and small arms. Therefore, no EM launcher noise modeling was conducted.

Unlike the training exercises at most military installations, which follow fixed firing schedules using specified types of guns for a specified number of rounds fired, NSWCDD's RDT&E activities vary considerably. Therefore, given the wide range of possible test scenarios for RDT&E guns, DNL levels were predicted based on particularly active years. This ensures that the modeling yields a worst-case description. The dBP metric and gun firing-associated complaint risk thresholds were also considered in order to evaluate potential existing noise effects.

3.5.4.1 Impulse Noise from Large-Gun Firing and Explosive Detonations

Given the dominant low-frequency component of large-gun firing and explosive-detonation noise, the cumulative CDNLs (250-day average) and peak blast noise levels in dBP from large-gun firing were predicted using the DOD's large-caliber weapon-noise model – BNOISE2, Version 1.3.2003-07-03 (US Army, 2003). The number of rounds used in the modeling for large guns are shown in Table 3.5-10. The NSWCDD SIPS model was also used to predict the worst-case peak noise from a 200-lb open-field detonation at Churchill Range in the EEA Complex (200 lbs NEW was used because larger NEW detonations are buried 8 ft deep).

Table 3.5-10
Existing Baseline Large-caliber Projectiles Fired Annually

Firing Range	Gun								
	5"/54	5"/62	8"/55	155 mm	76 mm	120 mm Mortar	81 mm Mortar	30 mm	35 mm
Number of Inert Projectiles									
AAFR	91	--	--	75	553	--	24	--	--
Main	763	55	15	--	1,604	--	--	--	--
Terminal	11	13	--	--	--	--	--	--	--
Number of Live Projectiles Fired to MDZ Target Areas									
AAFR	--	404	--	--	444	36	--	--	--
Main	--	--	16	--	--	--	--	165	358
Terminal	50	--	--	--	--	21	--	--	--
Number of Live Projectiles Fired to Upper LDZ Target Area									
Main			25						

BNOISE2 is an Army-developed computer program that calculates and displays blast-noise exposure contours resulting from specified activities involving large guns and high-explosive charges. BNOISE2 considers the type of weapon and ammunition, the number and time (day/night) of rounds fired, range attributes, weather, assessment procedures, and various metrics. It accounts for the spectra and directivity of both muzzle blast and projectile bow shock, which facilitates accurate calculation of propagation and sound frequency weighting. The source-model parameter values are based on empirical data, while the propagation algorithms are based on sophisticated calculations and experimental data.

In predicting annual average cumulative CDNL contours, the BNOISE2 BN3.2 weather-emulation option, which reflects average weather and propagation conditions, was applied. Figure 3.5-3 (Existing C-Weighted Day-Night Average Noise Contours with 8"/55 Gun Firing in the Middle Danger Zone) shows the modeled CDNL noise contours for both typical large-gun firing noise (Table 3.5-10) and the noise from the 190 baseline detonation events on the EEA Complex. Figure 3.5-4 (Existing Baseline Weighted Day-Night Average Noise Contours with

8”/55 Gun Firing in the Middle and Lower Danger Zones) depicts CDNL contours associated with the atypical 8”/55 gun live firing that occurs infrequently (25 rounds annually) and is aimed at a long-range target area in the upper LDZ (Table 3.5-10).

In predicting the event peak-noise contours, the BNOISE2-defined conservative water-propagation surface condition was used to account for the different behavior of sound intensity as it propagates over land or over water: water surfaces reflect greater sound intensity. The typical worst-case composite noise contours, depicting the combined worst-case peak noise levels resulting from all existing large-gun firing and detonation events, are presented in Figure 3.5-5 (Existing Composite Peak Noise Contours with 8”/55 Gun Firing in the Middle Danger Zone). Although live gun firing to a target area in the upper LDZ is atypical and takes place infrequently, a peak noise contour using an 8”/55 gun was also predicted and is depicted in Figure 3.5-6 (Existing Composite Peak Noise Contours with 8”/55 Gun Firing in the Lower and Middle Danger Zones).

Among the guns available as part of the BNOISE2 model, the 8”/55 gun was selected to be the worst case for noise levels. The largest gun frequently fired by NSWCDD is the 5”/62 gun, with the larger 155 mm gun fired occasionally, but the model did not include the 5”/62 gun. Also, selecting a gun that fires projectiles with larger amounts of explosives than fired today by NSWCDD, leaves room for experimental guns/projectiles in the future. NSWCDD does fire an 8”/55 caliber gun, but it is only used to fire canisters filled with projectile electronic components to assess how well they withstand launch shock. No live projectiles are fired from the 8”/55 gun.

3.5.4.2 Day-Night Noise Contours (CDNL)

The CDNL noise contours shown on Figure 3.5-3 indicate that:

- DNL noise contours equal or greater than 70 dBC (Noise Zone III in Table 3.5-3) from all large-gun firing and detonations are confined entirely within the installation or within the PRTR MDZ.
- DNL noise contours between 62 dBC and 70 dBC (Noise Zone II) extend slightly over land to the south and southeast of NSF Dahlgren and to parts of the river beyond the MDZ near the EEA Complex.

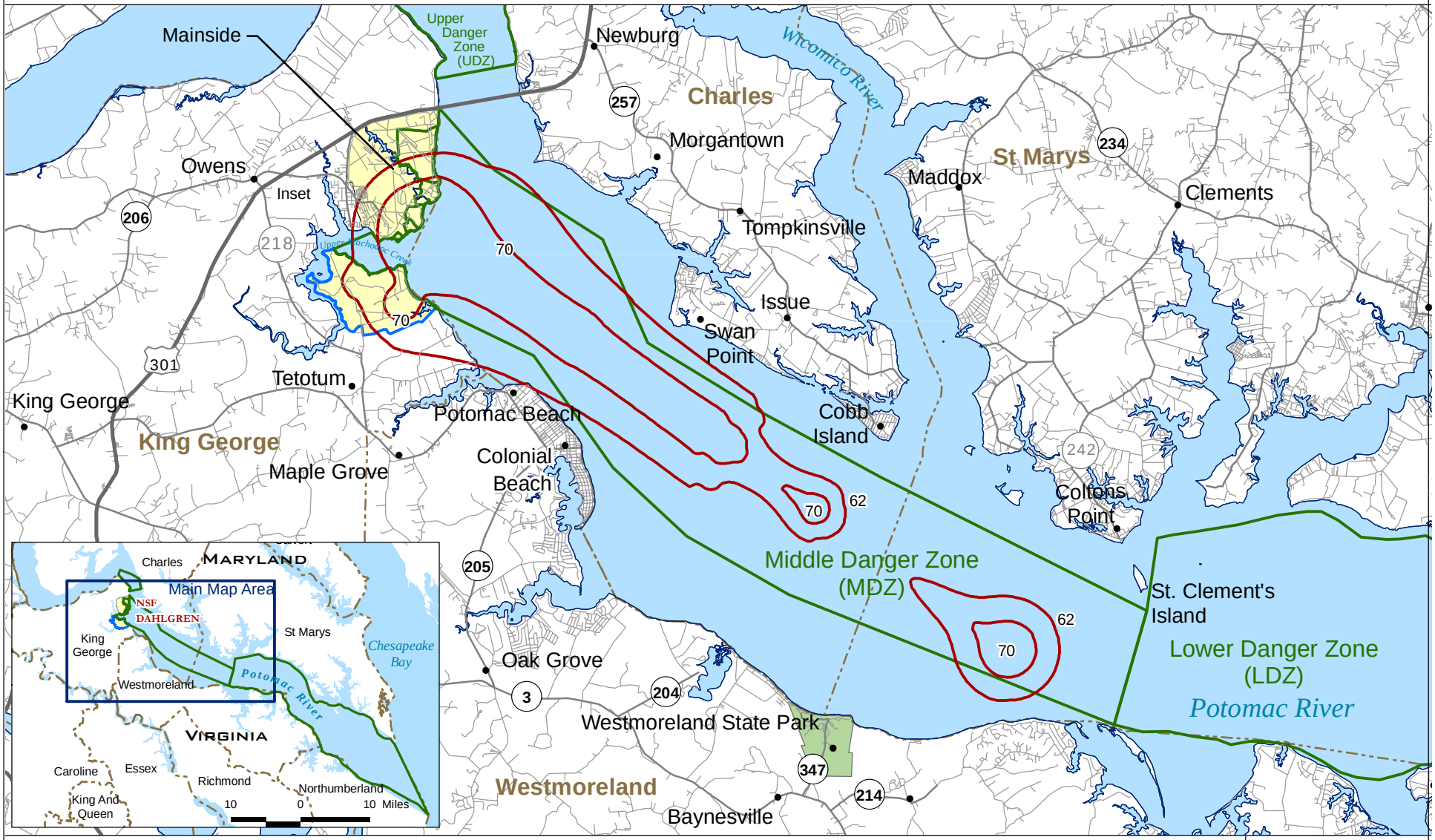
The presence of noise-sensitive land uses, such as housing, schools and medical facilities, is considered acceptable in Noise Zone I, but such land uses are not recommended in Noise Zone II. There are no schools or medical facilities within Noise Zone II, but there are approximately 70-80 residences in the area.

3.5.4.3 Peak-Noise Contours (dBP)

According to Army guidance, noise-sensitive land uses, such as housing, schools, and medical facilities, are discouraged in areas with noise levels between 115 and 130 dBP (moderate risk of noise complaints). Noise-sensitive land uses are strongly discouraged in areas with noise equal to or greater than 130 dBP (high risk of noise complaints).

Figure 3.5-5 shows the predicted existing composite PK50 noise levels generated by baseline large-gun firings and detonations including the 8”/55 gun, as shown in Table 3.5-10. Figure 3.5-7

Existing C-Weighted Day-Night Average Noise Contours with 8"/55 Gun Firing in Middle Danger Zone



C-Weighted Day-Night Average Noise Contours

Potomac River Test Range (PRTR) Complex

Explosives Experimental Area (EEA) Range Complex

County Boundary

Naval Support Facility (NSF) Dahlgren

3 0 3 Miles

5 0 5 Kilometers

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Sources: NSWCDD 2008-2011 and BNOISE2 Model

Figure 3.5-3

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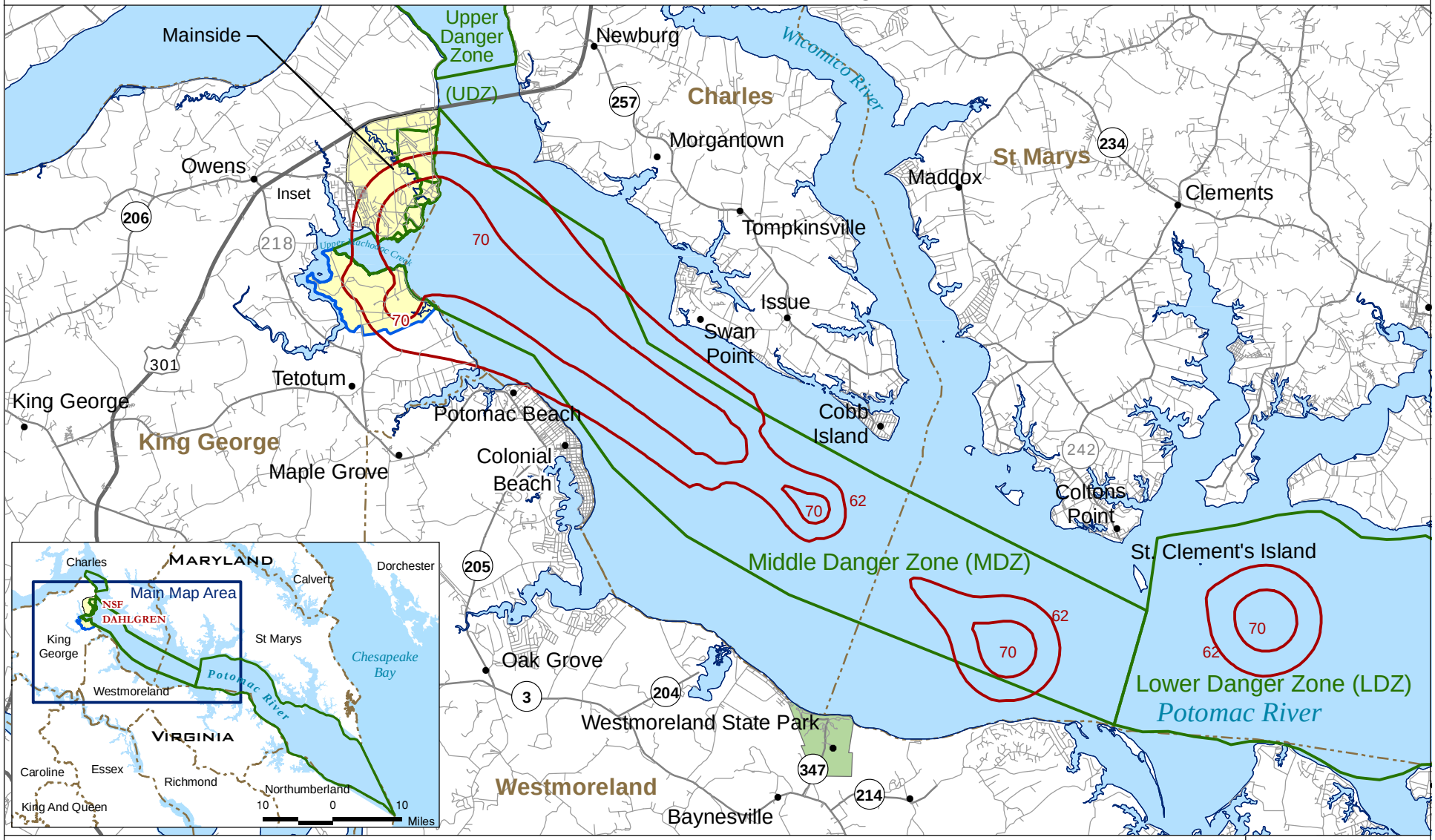
Existing Baseline Weighted Day-Night Average Noise Contours with 8"/55 Gun Firing in the Middle and Lower Danger Zones



Sources: NSWCDD 2008-2011 and BNOISE2 Model

Figure 3.5-4

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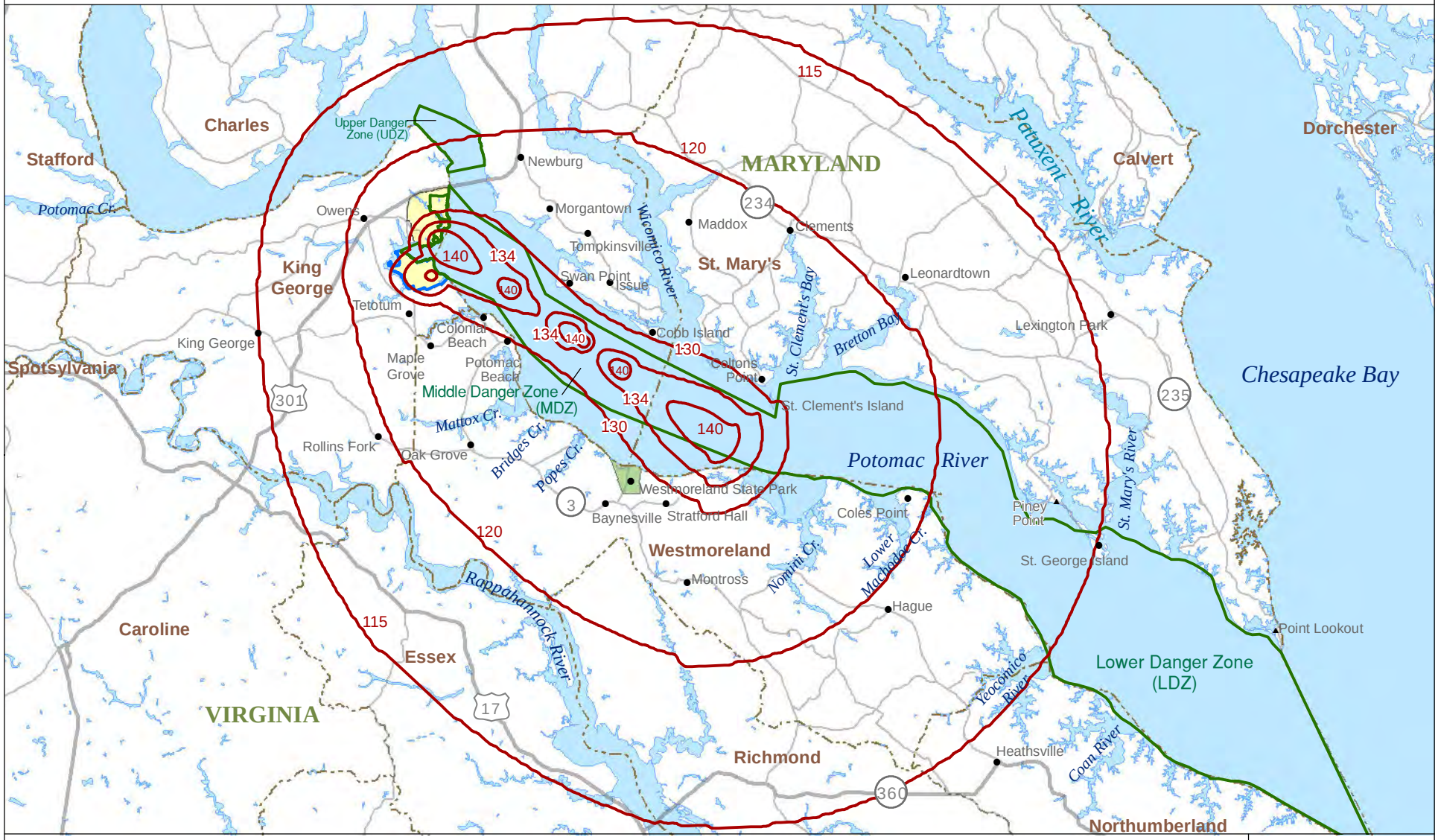
Existing Composite Peak Noise Contours with 8”/55 Gun Firing in Middle Danger Zone



Peak Noise Contours

Explosives Experimental Area (EEA) Range Complex

Potomac River Test Range (PRTR) Complex

County Boundaries

Naval Support Facility (NSF) Dahlgren

4 0 4 Miles

6 0 6 Kilometers

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Sources: NSWCDD 2008-2011 and BNOISE2 Model

Figure 3.5-5

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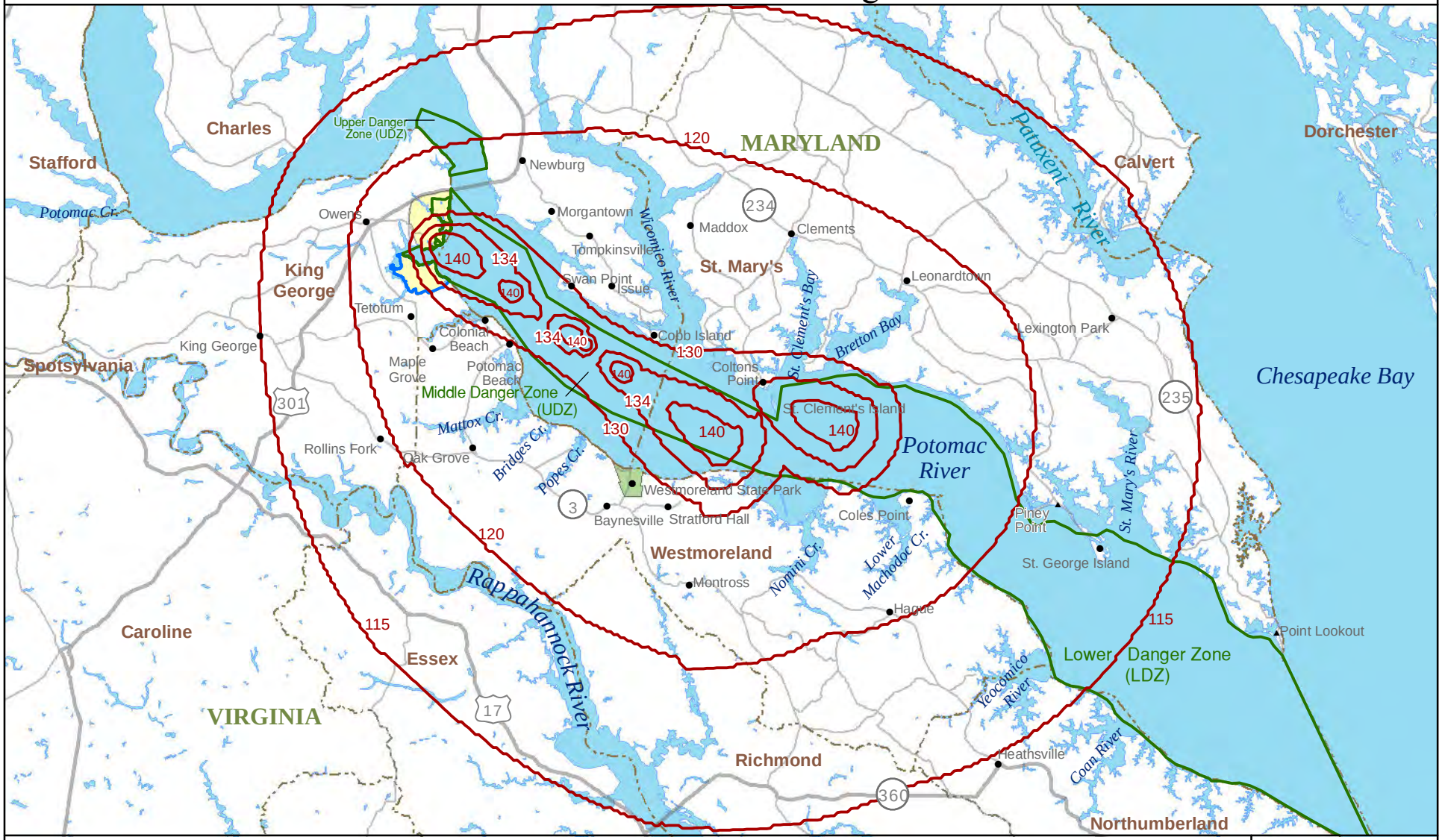
Existing Composite Peak Noise Contours with 8”/55 Gun Firing in the Lower and Middle Danger Zones



Sources: NSWCDD 2008-2011 and BNOISE2 Model

Figure 3.5-6

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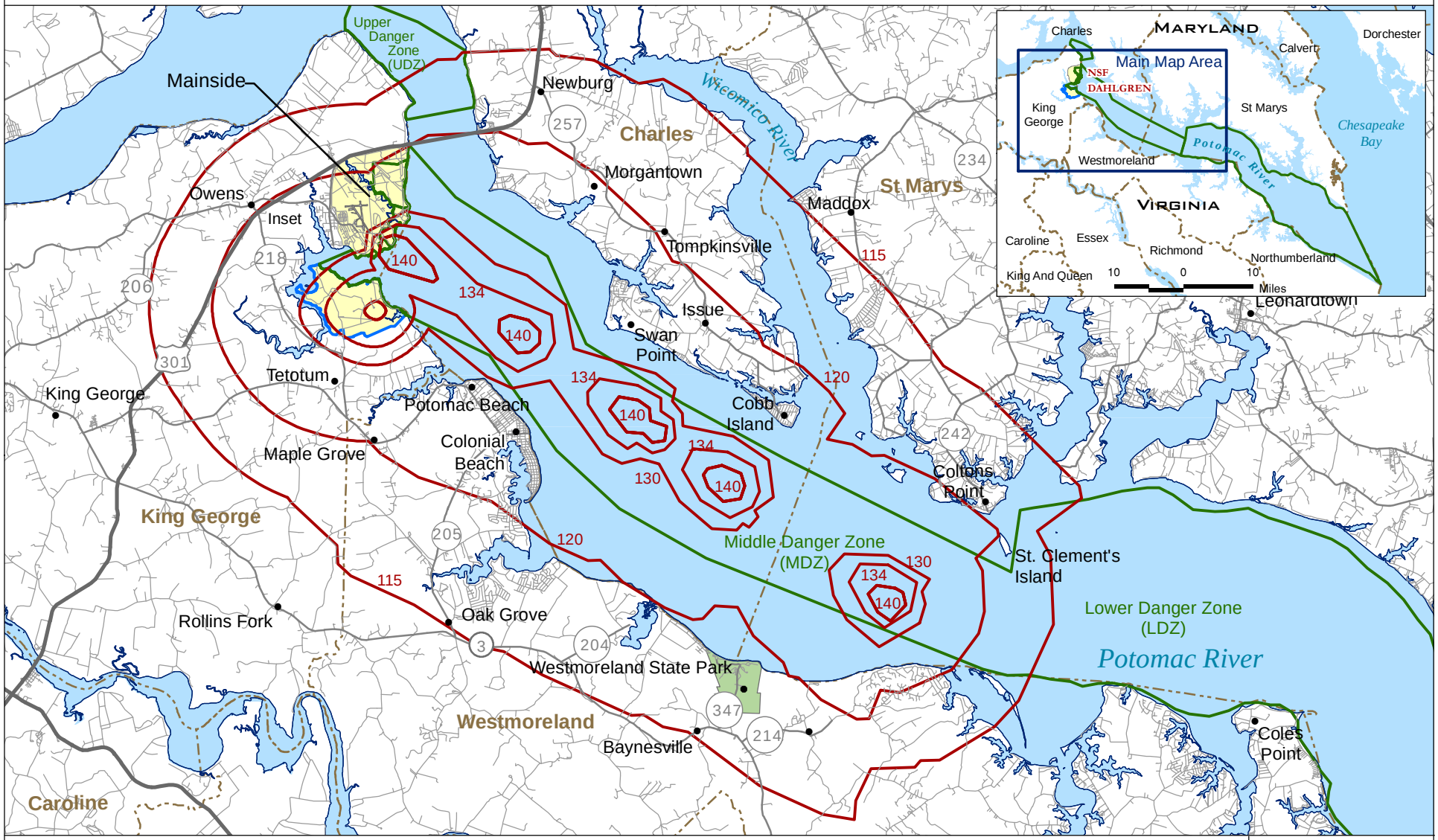
Existing Composite Peak Noise Contours without 8”/55 Gun Firing



Peak Noise Contours

Potomac River Test Range (PRTR) Complex

Explosives Experimental Area (EEA) Range Complex

County Boundary

Naval Support Facility (NSF) Dahlgren

3 0 3 Miles

5 0 5 Kilometers

N

Sources: NSWCDD 2008-2011 and BNOISE2 Model

Figure 3.5-7

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(Existing Composite Peak Noise Contours without 8”/55 Gun Firing) shows predicted PK50 contours based on the same firing data but without the 8”/55 gun. (As previously noted, the PK50 event contour represents the location where a stated noise value is exceeded 50 percent of the time with the remaining 50 percent being below the stated value.)

The validity of the peak noise contour modeling was verified by comparing the contours shown on Figure 3.5-6 with the 2007 measurements summarized in Table 3.5-5 (these measurements, like the Figure 3.5-5 contours, reflected the firing of large guns but not the 8”/55 gun). The comparison showed that the BNOISE2-predicted PK50 contours correlate well with the 2007 recorded maximum peak-noise levels. On this basis, the PK50 noise contours shown in Figures 3.5-5 and 3.5-7 can be considered to accurately reflect event peak-noise levels around NSF Dahlgren with and without 8”/55 gun events, respectively.

The greater extent of the composite peak-noise contour area in Figure 3.5-5 as compared to Figure 3.5-7 is essentially attributable to the noise generated by the 8”/55 gun, and, particularly, the live-firing events. The noise from firing the 8”/55 gun masks almost entirely all other gun-firing event noise. However, as indicated in Table 3.5-10, the worst-case existing baseline condition include only 15 inert and 16 live annual rounds for the 8”/55 gun, which is less than one percent of the entire annual number of large-gun rounds. This low frequency of tests shows that not only does Figure 3.5-5 represent the worst-case noise, but it also represents peak noise conditions that are unlikely to be experienced on most occasions when large-gun firing and explosive detonations occur. In the infrequent, atypical event that large guns are fired into a long-range target area in the upper LDZ, the contour area expands into the land areas along the PRTR LDZ as shown in Figure 3.5-6.

The composite contours of Figure 3.5-5 indicate that:

- Exterior noise levels of 140+ dBP essentially encompass the areas that are immediately adjacent to the firing and target points within the PRTR MDZ.
- The noise level area of 130 – 140 dBP (i.e., high risk of complaint) extends off-base over land immediately adjacent to the PRTR MDZ, such as Potomac Beach, Colonial Beach, Swan Point, Cobb Island, and Coltons Point.
- The 115 – 130 dBP exterior noise area encompasses almost all the areas along the Potomac River adjacent to the MDZ within approximately 10 miles of the river. Within this contour area, moderate noise complaints can be anticipated.

The composite contours of Figure 3.5-7 excluding 8”/55 gun noise contributions indicate that:

- Exterior noise levels of 140+ dBP essentially encompass the areas that are immediately adjacent to the firing and target points.
- The noise level area of 130 – 140 dBP (i.e., high risk of complaint) extends over some off-base land south of the EEA Complex, barely touching the shoreline of Potomac Beach.
- The 115 – 130 dBP exterior noise area encompasses almost all the areas along the Potomac River adjacent to the MDZ within approximately three miles of the river. Within this contour area, moderate noise complaints can be anticipated.

It should be noted that because the PK50 contours are tied to complaint risk rather than to a classified noise zone associated with average noise levels (e.g., CDNL), they should not be used as thresholds to determine potential noise-impact significance.

It should also be noted that, although the conservatively-predicted peak-noise contours show areas exposed to peak-noise levels above 140 dBP, NSWCDD's SIPS is an integral part of the noise-management procedures and would immediately stop a test, as needed, to ensure that no peak-noise level exceed 140 dBP when large-gun firing occurs.

3.5.4.4 Comparison of BNOISE-predictions with Measurements

The noise measurements collected during the November 2009 noise and vibration measurements taken at six historic structures provided data for a comparison of model-predicted noise levels to the maximum airborne noise levels recorded at each historic structure. The measured maximum peak noise level from the 5"/62 caliber gun and the BNOISE2-predicted noise levels are shown in Table 3.5-11. The results indicate that the BNOISE2 model-predicted average peak airborne noise levels were equal to or above the maximum recorded peak noise levels under normal weather conditions. Therefore, the BNOISE2 model, using average weather and propagation conditions, conservatively predicted, and sometimes slightly overestimated, the peak airborne noise levels on the PRTR from 5"/62 caliber gun firing under normal weather conditions.

Table 3.5-11
Comparison of BNOISE2-predicted Average Peak Noise Levels with Maximum Peak Noise Measurements for the 5"/62 Caliber Gun

Site	Measured Maximum Peak Noise (dBP)	BNOISE2-predicted Average Peak Noise (dBP)	Difference (BNOISE2 – Measurement) (dBP)
Waverley House	122	122	0
Stratford Hall	112	118	6
Newtown Manor House	108	114	6
Greg House	129	129	0
Bell House	126	127	1
Christ Episcopal Church	102	<115	N/A

3.5.4.5 Impulse Noise from Small-Arms Fire

Given the high-frequency characteristic of small-arms firing noise, the ADNL metric is the most appropriate metric to describe it. ADNLs were predicted using DoD's SARNAM (Version 2.6.2003-06-06). SARNAM is a computer model that provides the capability to calculate and display noise-level contours for firing operations at small-arms ranges. It considers the type of weapon and ammunition, number of rounds fired, time of day, range attributes such as size and barriers, etc. The model accounts for the spectra and directivity of both muzzle blast and projectile bow shock, and assumes a moderate downwind propagation condition. The source-model parameter values are based on empirical data. The modeling input data for each weapon type and annual rounds are presented in Table 3.5-12.

Table 3.5-12
Existing Baseline Small-Arms Rounds Fired Annually

Range	Machine Gun	
	.50 caliber (12.7 mm)	7.62 mm
Number of Inert (Blank) Rounds		
Machine Gun	2,565	285
Terminal	1,283	143
EEA – Churchill	641	71
EEA – Harris	641	71
Number of Live (Explosive) Rounds		
Machine Gun	135	15
Terminal	67	7
EEA – Churchill	34	4
EEA – Harris	34	4
Total Combined Small-Arms Rounds (.50 caliber + 7.62 mm)		
	6,000	

In predicting the annual average cumulative ADNL contours, a total of 6,000 rounds of firing were included:

- 90 percent were .50 caliber machine gun rounds.
- 10 percent were 7.62 mm caliber machine gun rounds.
- 95 percent of all rounds fired were inert (blank).
- 5 percent of all rounds fired were live.

These rounds are assumed to have been fired at three ranges:

- 50 percent at the Machine Gun Range.
- 25 percent at the Terminal Range.
- 25 percent at the EAA Churchill (12.5 percent) and Harris (12.5 percent) Ranges.

Figure 3.5-8 (Existing Small Arms A-Weighted Day-Night Average Noise Contours) displays the cumulative ADNL contours resulting from 6,000 annual rounds of small-arms firing. The contours indicate that:

- ADNLs at or greater than 75 dBA (Noise Zone III) and ADNLs between 65 dBA and 75 dBA (Noise Zone II) from small-arms firing remain entirely within individual firing ranges on the installation.

Figure 3.5-9 (Existing .50 CAL Peak Noise Contours) displays the estimated event peak noise contours resulting from small-arms firing from the Machine Gun Range. The contours indicate that:

- Noise Zone II (87 – 104 dBP) and III (>104 dBP) small-arms peak noise contours are essentially contained within the corresponding noise zones predicted from the baseline explosive detonations and large-gun firing CDNL noise contours shown in Figure 3.5-3.

3.5.5 Vibration Noise

In general, low-frequency impulse sound pressure generated by the detonation of explosive charges or large-caliber gun firing can cause structures to vibrate. Vibration consists of rapidly fluctuating motions with an average motion of zero. Residents of buildings exposed to vibration often perceive vibration as the rattling of loose windows and objects on shelves, and, sometimes, of the building itself.

There are two types of vibration – vibration transmitted through the ground and vibration transmitted through the air. Several different methods are used to quantify vibration amplitude. One method uses the peak particle velocity (PPV) in inches per second (in/sec) to describe the maximum instantaneous positive or negative peak of the vibration signal. PPV is often used in the monitoring of blasting vibration because it is related to the stresses experienced by buildings.

3.5.5.1 Ground-Borne Vibration

Ground-borne vibration originates from explosive detonations and other events, such as earthquakes, that radiate vibration energy into the soil. The face of the nearest foundation or underground building wall responds to the incident ground-borne vibration and propagates the waves throughout the building. The resulting ground-borne vibration is a function of the magnitude of the energy source, the distance from the source, the blasting-specific response characteristics of the transmitting media (rock/soil), and the response characteristics of the structural element (building). Vibration studies of coal mine detonations indicate that ground-borne vibration dominates in the near range while airborne vibration dominates at greater distances. For example, for a 100-lb charge, the ground-borne vibration is the dominant cause of building vibration if the building is located less than 500 ft from the detonation point. At distances greater than 500 ft, the airborne sound wave is the dominant cause of the vibration.

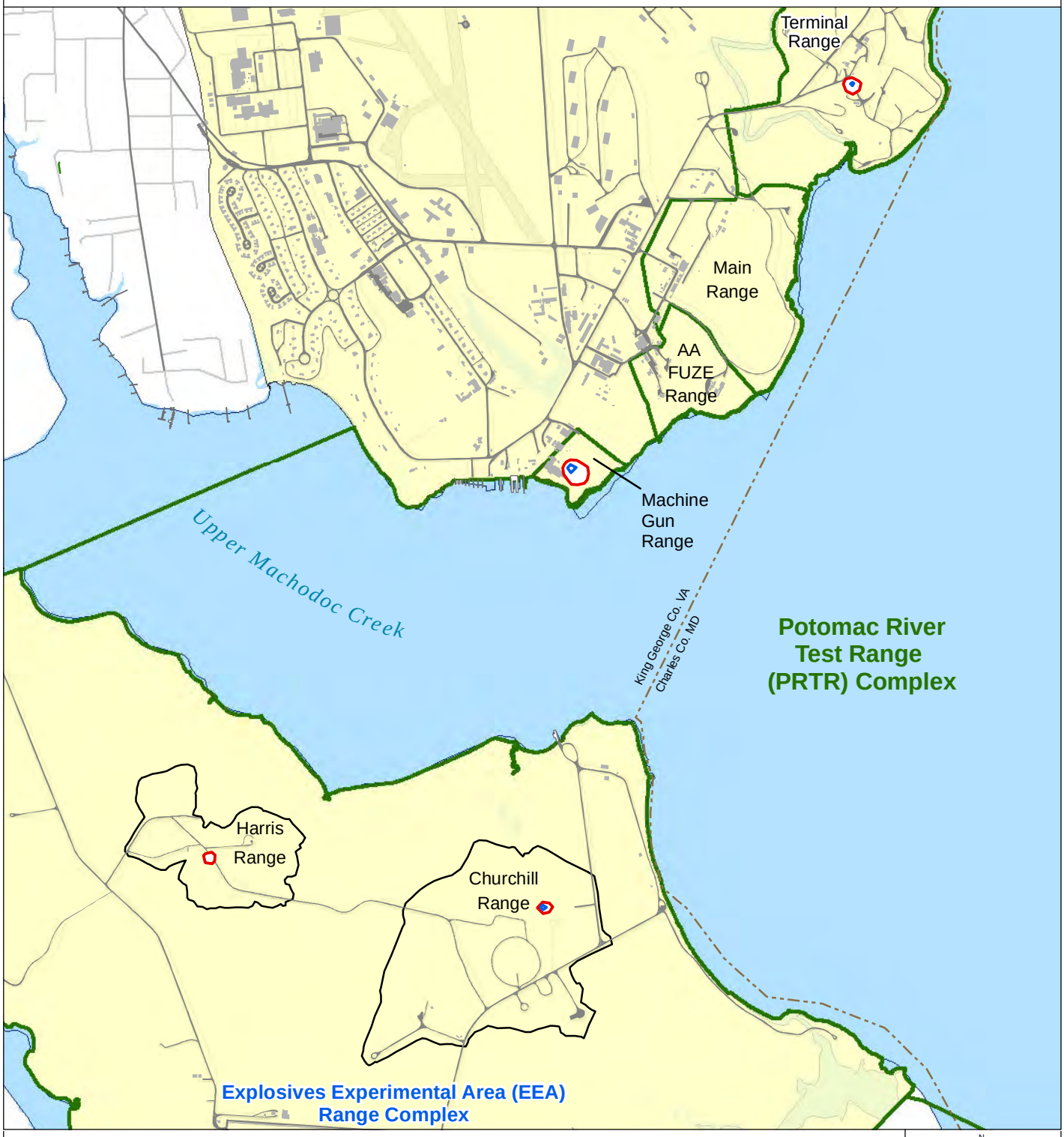
The US Bureau of Mines conducted an 18-month study at McAlester Army Ammunition Plant in 1988 (Siskind, 1989, as cited in USCHPPM, 2005) and found that:

- A PPV of 0.5 in/sec is the maximum ground-borne vibration threshold to prevent damage.
- A PPV of 2.0 in/sec is the threshold level at which minor structural damage may begin to occur in 0.01 percent of structures.

The NEW of EEA Range Complex detonations can vary from less than 1 lb to 1,000 lbs of explosives. The NEW can reach 200 lbs for an open detonation and 1,000 lbs for a buried detonation. For buried detonations, the depth will increase as the NEW increases. It is anticipated that, for the same amount of NEW and at the same measuring position, an open detonation would result in greater airborne vibration effects, while a buried detonation would generate greater ground-borne vibrations.

Ground-borne vibration data have been collected by NSWCDD for a buried 1,000-lb detonation to determine the worst-case vibration condition around the Churchill Range (Figure 3.5-10, Ground-borne Vibration Resulting from Buried 1,000-lb Detonation). Sensors were placed at radii of 75 ft, 225 ft, 675 ft, and 2,025 ft around the detonation point. Based on the

Existing Small Arms A-Weighted Day-Night Average Noise Contours



Contour Line 65 A-Weighted Decibel

Contour Line 75 A-Weighted Decibel

Naval Support Facility (NSF) Dahlgren

1,500 0 1,500 Feet

500 0 500 Meters

N

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Sources: NSWCDD 2008-2011 and BNOISE2 Model

Figure 3.5-8

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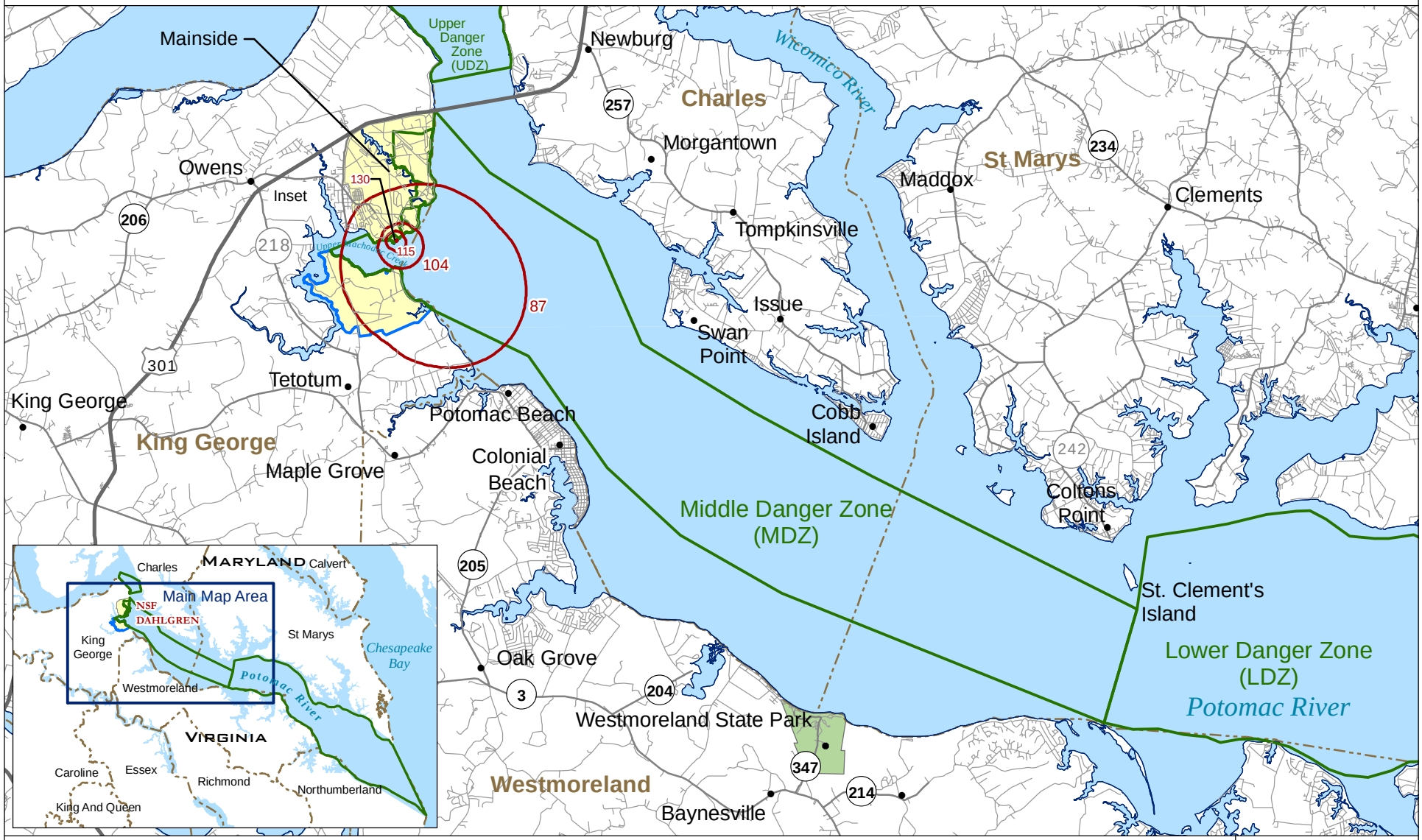
Existing .50 Caliber Peak Noise Contours



Sources: NSWCDD 2008-2011 and BNOISE2 Model

Figure 3.5-9

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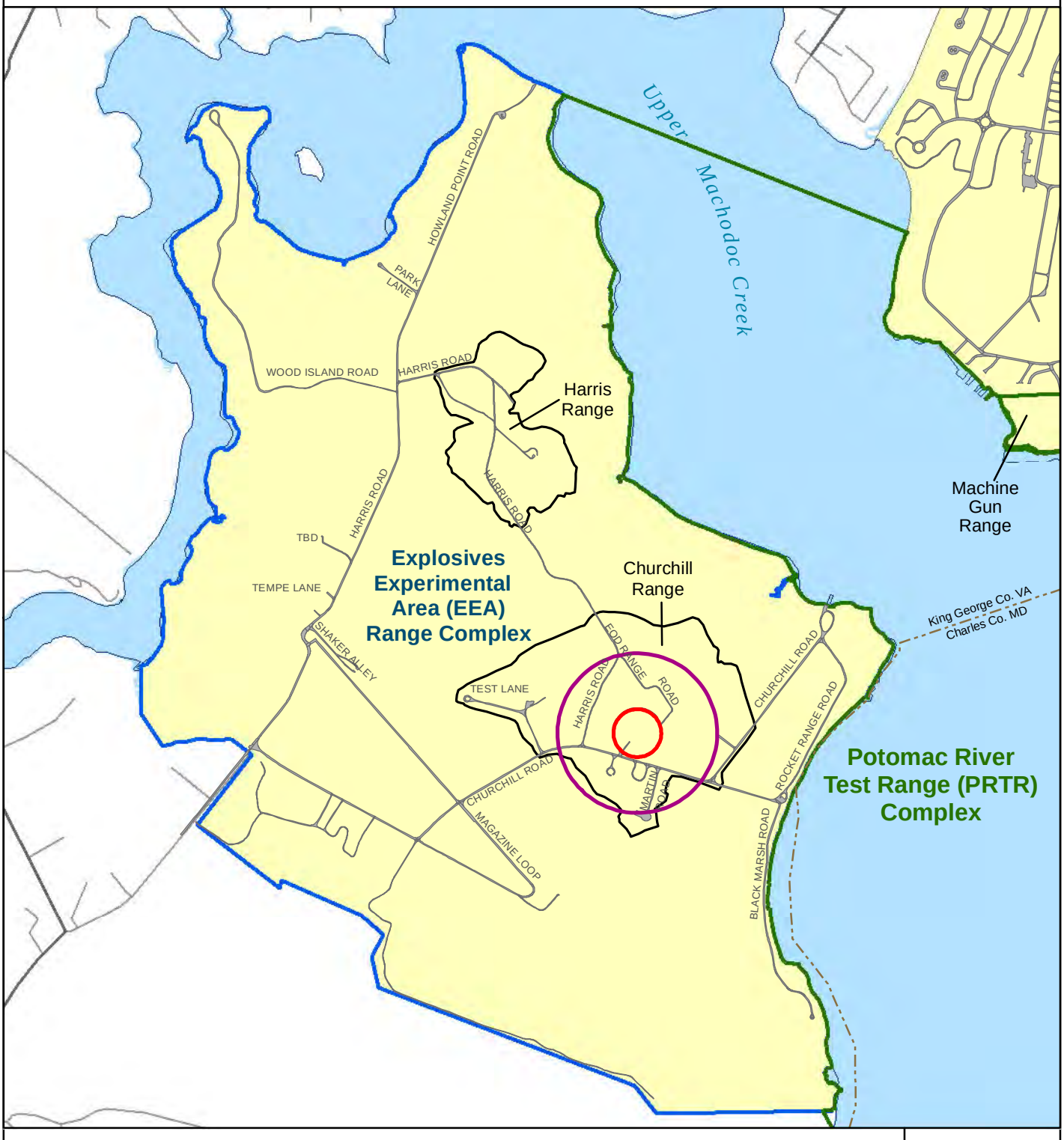
Ground-borne Vibration Resulting from Buried 1,000-lb Detonation



2.0 Inch/Second Structural-Damage Threshold at the 300-ft Radius

0.5 Inch/Second Vibration-Damage Threshold at the 1,000-ft Radius

Explosives Experimental Area (EEA) Range Complex

Potomac River Test Range (PRTR) Complex

Naval Support Facility (NSF) Dahlgren

1,800 0 1,800 Feet

600 0 600 Meters

N

NSWCDD EIS

NAVSEA WARFARE CENTERS DAHLGREN

Source: NSWCDD 2008-2011

Figure 3.5-10

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measurements of both lateral and vertical displacement velocity at these sensors, it was calculated that:

- The 0.5-in/sec vibration-damage threshold occurred at the 1,000-ft radius
- The 2.0-in/sec structural-damage threshold occurred at the 300-ft radius

Therefore, the worst-case ground-borne vibration resulting from a 1,000-lb buried detonation at the EEA Range Complex would not be likely to cause any damage to off-installation properties.

As described earlier, noise and vibration measurements were taken at six off-installation historical structures along the PRTR in November 2009 (see complete report provided as Appendix D) during ballistic tests of explosive 5”/62 projectiles fired at different distances down the PRTR. This monitoring program was to confirm that no buildings beyond NSF Dahlgren or along the PRTR experience vibration levels that could result in structural damage.

Ground and/or foundation measurements are summarized in Table 3.5-13 (see Appendix D for details). All measurements were below 0.1 in/sec and well below the 0.5 in/sec threshold and were virtually non-detectable. These results indicate that any risk of structural damage to the historic structures along the PRTR from large-gun firing is minimal.

3.5.5.2 Airborne Vibration

Most of the studies of airborne vibration and the damage guidelines derived from these studies used sonic booms as the source. However, vibration from open-area explosive detonations and large-caliber gun firing is similar to vibration from sonic booms.

Structural shaking or window rattling by airborne vibration can annoy building occupants and may cause structural damage (e.g., broken glass and plaster cracks). The US Bureau of Mines study (Siskind, 1989, as cited in USCHPPM, 2005) correlated airborne vibration levels with peak sound pressure levels likely to cause potential structural damage (Table 3.5-14). As shown in the table, homeowners become concerned about structural damage at levels far below those actually capable of causing such damage.

Based on Figure 3.5-5, only three buildings beyond NSF Dahlgren or the PRTR boundaries are expected to experience peak noise levels of 134+ dBP, which is the threshold for potential property damage as shown in Table 3.5-14.

The noise and vibration monitoring was conducted at six historical properties along the PRTR in November 2009 (see Appendix D) and included wall vibration measurements. Maximum vibration levels measured at the six historical structures were found to be below 0.5 in/sec, the level at which minor structural damage may begin to occur (see Table 3.5-15), with one exception. The airborne vibration levels measured at the wall of the Bell House showed one exceedance (0.54 in/sec) of the 0.5 in/sec threshold. However, since the 0.5 in/sec threshold was conservatively set as a potential effect level for glass in poorly-fitted windows with loose glass or plaster cracks on stressed walls, vibrations slightly above this level would not be expected to cause any structural damage to the house. As indicated in Table 3.5-14, a vibration level of 2.0 in/sec is the threshold level at which minor structural damage may begin to occur in 0.01 percent of structures (one in ten thousand). The highest measured wall vibration level at Bell House is still well below this threshold.

These results indicated that the potential for structural damage impacts from the firing of the largest gun fired with any frequency by NSWCDD is minimal.

Table 3.5-13
Ground and/or Foundation Vibration Measurements

Site	Firing Distance (yards)	Number of Shots Measured	Vibration Level[3] (in/sec)			Number of Events (Vibration Levels)		
			Minimum	Mean	Maximum	<0.1 in/sec	0.1 – 0.5 in/sec	>0.5 in/sec
Ground Vibration								
Stratford Hall	5,300	12	0.005	0.005	0.005	10	0	0
	8,300	7	0.005	0.005	0.005	7	0	0
	16,700	8	0.003	0.003	0.005	8	0	0
	21,600	5	0.003	0.005	0.008	5	0	0
	25,700	11	0.003	0.003	0.003	11	0	0
Waverley House	5,300	8	0.005	0.005	0.008	8	0	0
	8,300	8	0.005	0.005	0.008	8	0	0
	16,700[1]	-	-	-	-	-	-	-
	21,600[1]	-	-	-	-	-	-	-
	25,700	1	0.005	0.005	0.005	1	0	0
Bell House	5,300	-	-	-	-			
	8,300	-	-	-	-			
	16,700	1	0.005	0.005	0.005	1	0	0
	21,600[2]	-	-	-	-	-	-	-
	25,700[2]	-	-	-	-	-	-	-
Foundation Vibration								
Stratford Hall	5,300	12	0.0001	0.0003	0.0005	12	0	0
	8,300	8	0.0001	0.0002	0.0003	8	0	0
	16,700	9	0.0001	0.0005	0.0011	9	0	0
	21,600	5	0.0002	0.0010	0.0025	5	0	0
	25,700	12	0.0001	0.0002	0.0006	12	0	0
Waverley House	5,300	14	0.005	0.009	0.018	14	0	0
	8,300	10	0.004	0.006	0.008	10	0	0
	16,700[1]	-	-	-	-	-	-	-
	21,600[1]	-	-	-	-	-	-	-
	25,700	1	0.005	0.005	0.005	1	0	0
Bell House	5,300[1]	-	-	-	-	-	-	-
	8,300[1]	-	-	-	-	-	-	-
	16,700	8	0.003	0.006	0.012	8	0	0
	21,600[2]	-	-	-	-	-	-	-
	25,700	1	0.002	0.002	0.002	1	0	0

Notes:
1. No vibration measurements were made.
2. Levels were too low to be detected.
3. Measurements were taken on November 16, 2009 at all locations but on November 17, 2009 at the Bell House only.

Table 3.5-14
Potential Building Damage and Airborne Vibration Levels

Response	Vibration Level in inches per second (in/sec)	Peak Sound Level (dBP)
Concern by homeowner about structural rattling and possible damage	0.1	120
Glass and plaster cracks (worst case*)	0.5	134
Gypsum wallboard (worst case*)	0.75	141**
Structural damage to lightweight superstructure	>2.0	175**

Note: * Worst case = Poorly fitted loose window glass and stressed walls.

** NSWCDD predicts noise levels before firing based on weather conditions and monitors them after firing; noise levels are equal to or exceeding 130 dBP trigger noise reduction procedures detailed in the text box in Section 3.5.3.5.

Source: Siskind, 1989, as cited in USCHPPM, 2005.

Table 3.5-15
Wall Vibration Measurements

Site	Firing Distance (yards)	Number of Shots Measured	Vibration Level[3] (in/sec)			Number of Events		
			Minimum	Mean	Maximum	<0.1 in/sec	0.1 – 0.5 in/sec	>0.5 in/sec
Waverley House (exterior brick wall)	5,300	14	0.039	0.139	0.298	4	10	0
	8300	10	0.059	0.113	0.180	5	5	0
	16,700[1]	-	-	-	-	-	-	-
	21,600[1]	-	-	-	-	-	-	-
	25,700	1	0.059	0.059	0.059	1	0	0
Christ Episcopal Church (interior plaster)	5,300	8	0.001	0.003	0.006	8	0	0
	8,300	7	0.001	0.002	0.005	7	0	0
	16,700	7	0.001	0.003	0.005	7	0	0
	21,600	13	0.001	0.002	0.005	13	0	0
	25,700	10	0.000	0.002	0.006	10	0	0
Newtown Manor House (exterior brick wall)	5,300[2]	-	-	-	-	-	-	-
	8,300[2]	-	-	-	-	-	-	-
	16,700	1	0.00003	0.00003	0.00003	1	0	0
	21,600[2]	-	-	-	-	-	-	-
	25,700[2]	-	-	-	-	-	-	-
Stratford Hall (exterior brick wall)	5,300	13	0.004	0.012	0.020	13	0	0
	8,300	8	0.006	0.016	0.030	8	0	0
	16,700	9	0.004	0.015	0.037	9	0	0
	21,600	5	0.008	0.039	0.056	5	0	0
	25,700	12	0.001	0.016	0.024	12	0	0
Bell House (exterior front wall)	5,300[1]	-	-	-	-	-	-	-
	8,300[1]	-	-	-	-	-	-	-
	16,700	8	0.311	0.399	0.535	0	7	1
	21,600	3	0.086	0.245	0.480	1	2	0
	25,700	12	0.071	0.142	0.354	6	6	0
Bell House (exterior side wall)	5,300	13	0.005	0.037	0.225	12	1	0
	8,300	10	0.003	0.055	0.144	7	3	0
	16,700	7	0.001	0.058	0.144	6	1	0
	21,600	5	0.025	0.039	0.069	5	0	0
	25,700	9	0.017	0.027	0.043	9	0	0
Greg House (exterior front wall)	5,300	15	0.007	0.033	0.056	15	0	0
	8,300	10	0.018	0.030	0.046	10	0	0
	16,700[1]	-	-	-	-	-	-	-
	21,600[1]	-	-	-	-	-	-	-
	25,700	1	0.021	0.021	0.021	1	0	0

Notes:
1. No vibration measurements were made.
2. Levels were too low to be detected.
3. Measurements were taken on November 16 and 17, 2009 at all locations except Waverley House and Newtown Manor House, which were only sampled on November 16, 2009.

3.6 Cultural Resources

3.6.1 Regulatory Framework

The following federal laws, executive orders, and regulations require that cultural resources listed in or meeting the eligibility criteria of the National Register of Historic Places (National Register) be identified, evaluated, and considered while planning federal actions:

- Sections 106 and 110 of the National Historic Preservation Act (NHPA) of 1966, as amended
- Executive Order 11593, Protection and Enhancement of the Cultural Environment
- The National Environmental Policy Act (NEPA) of 1969
- OPNAVINST 5090.1C, Environmental and Natural Resources Program Manual

This EIS is also intended to support cultural resources reviews:

- Consultation under Section 106 of the NHPA of 1966, 16 U.S.C. § 470 et seq.
- Compliance with the Archaeological and Historic Preservation Act of 1974, 16 U.S.C. §.469
- Compliance with the Archaeological Resources Protection Act of 1979, 16 U.S.C. § 470aa
- Compliance with the Abandoned Shipwreck Act of 1987, 43 U.S.C. § 2101
- Compliance with the Protection of Historic Properties Act, 36 CFR Part 800
- Compliance with the Antiquities Act of 1906, 16 U.S.C. § 431-433

In compliance with these requirements, NSF Dahlgren has undertaken multiple cultural resources surveys of its property. The objectives of previous archaeological surveys were to: characterize the archaeological potential of the property; perform testing in conjunction with proposed project actions and in compliance with Section 106; and recommend whether any identified archaeological sites were eligible for listing in the National Register. The objectives of previous architectural resources surveys were to provide the documentary and physical evidence necessary to permit recommendations of National Register eligibility. Eligibility recommendations are based on National Register criteria and National Park Service (NPS) guidance for architectural integrity (United States Department of the Interior, National Park Service, 2002).

This section describes the findings of the cultural resources surveys undertaken at NSF Dahlgren and at archaeological sites and National Register-listed historic properties in and near the PRTR MDZ that have the potential to be affected by NSWCDD's activities.

3.6.2 Areas of Potential Effect (APEs)

Section 106 requires federal agencies to define and document the Area of Potential Effect (APE) in consultation with state historic preservation officers (SHPOs). The Maryland Historic Trust

(MHT) – the SHPO for the State of Maryland – and the Virginia Department of Historic Resources (VDHR) – the SHPO for the Commonwealth of Virginia – were consulted on the APEs described below. Both SHPOs concurred with the APEs in correspondence prepared in 2008 (Appendix E). According to 36 CFR § 800.16(d), the APE is the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties and prehistoric sites, if such exist. The APE is influenced by the scale and nature of the undertaking and may be different for different kinds of effects caused by the undertaking.

The two APEs delineated for this project, the Archaeological APE and the Historic Architectural APE, are described below.

3.6.2.1 Archaeological APE

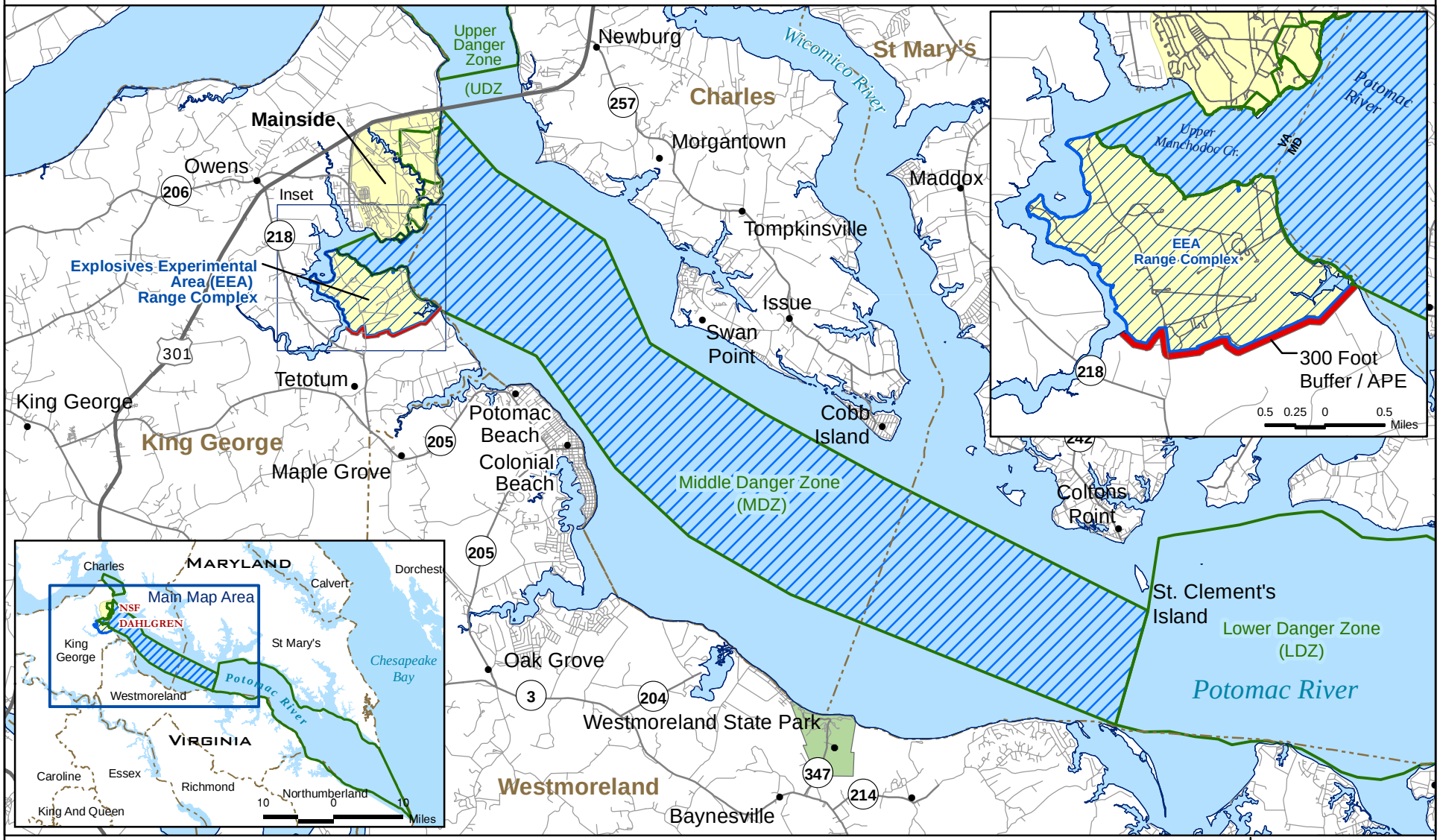
Traditionally, the Archaeological APE is concerned with direct effects and is defined by considering the areas of ground disturbance that would occur as a result of carrying out a proposed project action, such as building a new facility. In terms of the Proposed Action addressed in this EIS, the proposed activities would have little-to-no direct impact on archaeological resources within or near NSF Dahlgren, because no groundbreaking activities are proposed. However, indirect effects upon archaeological resources resulting from RDT&E activity-related noise are of potential concern, particularly with regard to shipwrecks in the Potomac River.

Therefore, the Archaeological APE is based on that portion of the PRTR that would be utilized during almost all RDT&E activities that generate noise, that is, the EEA from detonations and within the MDZ from large-caliber gun fire. In addition, the Archaeological APE includes a 300-ft-wide buffer zone along the southern boundary of the EEA from Upper Machodoc Creek to the Potomac River shoreline where indirect impacts resulting from activity-related noise may occur. The upper LDZ is used occasionally as a target area (the last time in 2009 when several rounds were fired into it), but the usage is so minimal that the APE boundary ends at the downriver MDZ boundary. Figure 3.6-1, Archaeological Area of Potential Effect, depicts the location of the Archaeological APE.

3.6.2.2 Historic Architectural APE

The Historic Architectural APE for this project was developed to account for potential direct and indirect effects of the worst-case scenario on previously identified and evaluated National Register-listed and National Register-eligible historic architectural resources in accordance with Section 106 of the NHPA. Therefore, the Historic Architectural APE includes areas where the Proposed Action may directly impact such resources, or may result in a change in character of their use or setting. In addition, the Historic Architectural APE also includes areas where the Proposed Action may indirectly cause the introduction of visual, atmospheric, or audible elements, such as vibrations, that might diminish significant features of such resources. As a result, the Historic Architectural APE encompasses portions of five counties, three in Virginia and two in Maryland. These include King George, Westmoreland, and Richmond counties in Virginia, and St. Mary's and Charles counties in Maryland. Figure 3.6-2, Historic Architectural Area of Potential Effect, illustrates the APE.

Archaeological Area of Potential Effect



Archaeological Area of Potential Effect (APE)

300 Foot Buffer / APE

Potomac River Test Range (PRTR) Complex

Naval Support Facility (NSF) Dahlgren

County Boundary

3 0 3 Miles

5 0 5 Kilometers

N

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NAVSEA WARFARE CENTERS DAHLGREN

Source: NSF Dahlgren, 2008

Figure 3.6-1

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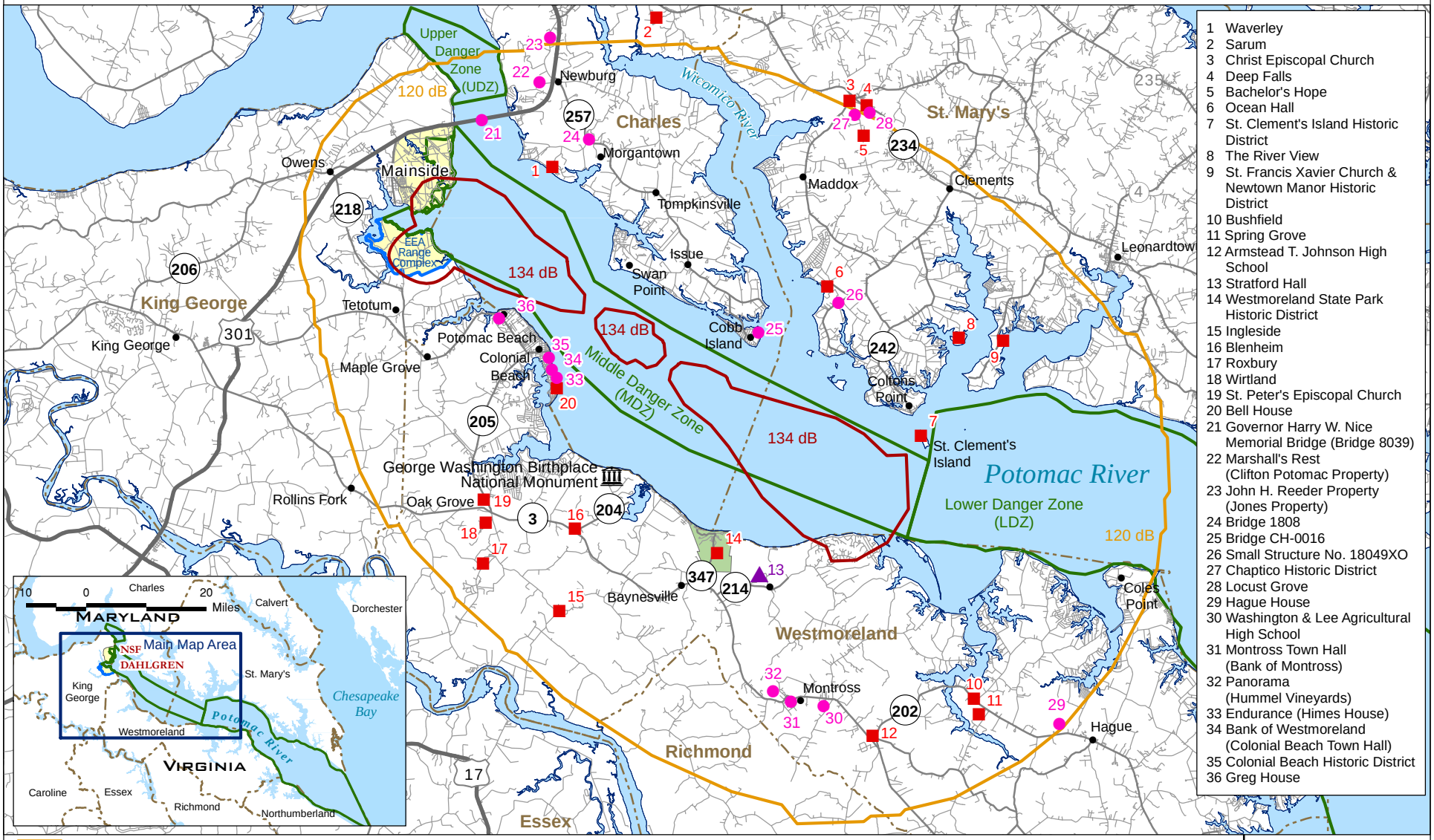
Historic Architectural Area of Potential Effect



1 Waverley
2 Sarum
3 Christ Episcopal Church
4 Deep Falls
5 Bachelor's Hope
6 Ocean Hall
7 St. Clement's Island Historic District
8 The River View
9 St. Francis Xavier Church & Newtown Manor Historic District
10 Bushfield
11 Spring Grove
12 Armstead T. Johnson High School
13 Stratford Hall
14 Westmoreland State Park Historic District
15 Ingleside
16 Blenheim
17 Roxbury
18 Wirtland
19 St. Peter's Episcopal Church
20 Bell House
21 Governor Harry W. Nice Memorial Bridge (Bridge 8039)
22 Marshall's Rest (Clifton Potomac Property)
23 John H. Reeder Property (Jones Property)
24 Bridge 1808
25 Bridge CH-0016
26 Small Structure No. 18049XO
27 Chaptico Historic District
28 Locust Grove
29 Hague House
30 Washington & Lee Agricultural High School
31 Montross Town Hall (Bank of Montross)
32 Panorama (Hummel Vineyards)
33 Endurance (Himes House)
34 Bank of Westmoreland (Colonial Beach Town Hall)
35 Colonial Beach Historic District
36 Greg House

Area of Potential Effect (APE)/120 Decibel Peak Noise Contour
134 Decibel Peak Noise Contour
National Historic Landmark/National Register Listed
National Register Listed
National Register Eligible
Naval Support Facility (NSF) Dahlgren
Potomac River Test Range (PRTR) Complex
County Boundary

3 0 3 Miles
6 0 6 Kilometers

N

Sources: BNOISE2 Model & NSWCDD SIPS Model

Figure 3.6-2

NSWCDD EIS
NAVSEA WARFARE CENTERS DAHLGREN

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Most RDT&E activities conducted at NSWCDD do not generate noise and vibration in the vicinity of the installation above ambient levels. However, activities associated with ordnance, particularly the firing of large-caliber guns on the PRTR, generate noise levels above ambient levels. The noise generated by ordnance is called impulse noise – each event can be singled out. This is different from continuous noise, such as that generated by a lawn mower.

According to research conducted by the US Bureau of Mines (Siskind, 1989, as cited in USCHPPM, 2005.), impulse noise resulting in potential vibration is typically noticed when noise levels reach 120 peak decibels (dBP). Similarly, low-frequency impulsive noise, such as large-gun firing and thunder, result in vibrations which can rattle loose window panes at levels starting at 120 dBP and may cause concern on the part of property owners. It is possible for window panes and plaster to crack in weak structures as a result of vibrations caused by sound pressure levels starting at 134 dBP. More extensive structural damage can occur at levels of 175 dBP or higher (see Section 3.5 for more information on noise and vibration).

To generate the noise contours shown in Figure 3.6-2, BNOISE2, a large-weapon noise-modeling software program developed by the US Army, was utilized (see Section 3.5 for more details). The model incorporates inputs such as types of weapons, weather, and sound-propagation surface conditions to predict peak-noise contours generated by ordnance used and expected to be used by NSWCDD.

The Historic Architectural APE is based upon peak-noise contours associated with multiple gun/projectile firings and detonations that would not occur simultaneously, but were combined in the noise modeling to form the worst-case scenario. The gun/projectile firings include the live and inert firing of multiple large-caliber guns at land-based ranges within the PRTR Complex. Detonations include the detonation of ordnance within the EEA Complex. Two key events help define the peak-noise contours which form the Historic Architectural APE featured in Figure 3.6-2. These events are:

- Live firing of 8” guns at a 27,500-yd distance from the Main Range of the PRTR Complex.
- Detonations of 200-lb NEW ordnance within Churchill Range at the EEA Complex and 1,000-lb NEW ordnance buried in the ground.

One 120-dBP noise contour and three 134-dBP noise contours depicted in Figure 3.6-2 represent locations where average peak-noise levels associated with these events are predicted to occur under a range of weather conditions.

Although the 120-dBP noise contour is below the property damage-causing threshold, it has the potential to concern affected property owners, as it has been determined that people begin to be concerned about damage at levels considerably below those actually capable of causing damage. Thus, it has been selected as the larger Historic Architectural APE for this project.

The three 134-dBP noise contours depicted in Figure 3.6-2 are situated within the 120-dBP noise contour. These include the westernmost, central and easternmost contours, and are described below:

- The westernmost contour reflects noise levels originating from guns fired from the Main Range of the PRTR Complex, and detonations within Churchill Range at the EEA Complex. The contour partially occurs on land within NSF Dahlgren and within the PRTR MDZ in the Potomac River.
- Two contours coincide with target areas in the river where live (explosive) projectiles and inert projectiles with live fuzes are fired from one of the land ranges into the MDZ. The central contour solely occurs within the PRTR MDZ. The majority of the easternmost contour occurs within the PRTR MDZ, while the southeast portion of the contour occurs in the Stratford Harbour development in Westmoreland County, Virginia.

When totally inert projectiles are fired, the only noise source is at the gun – there is no second noise source from an explosion at a target area down river. Consequently, the 120-dBP noise contour is much smaller when inert ordnance, which in the last fifteen years has been about three-quarters of the rounds fired, is used.

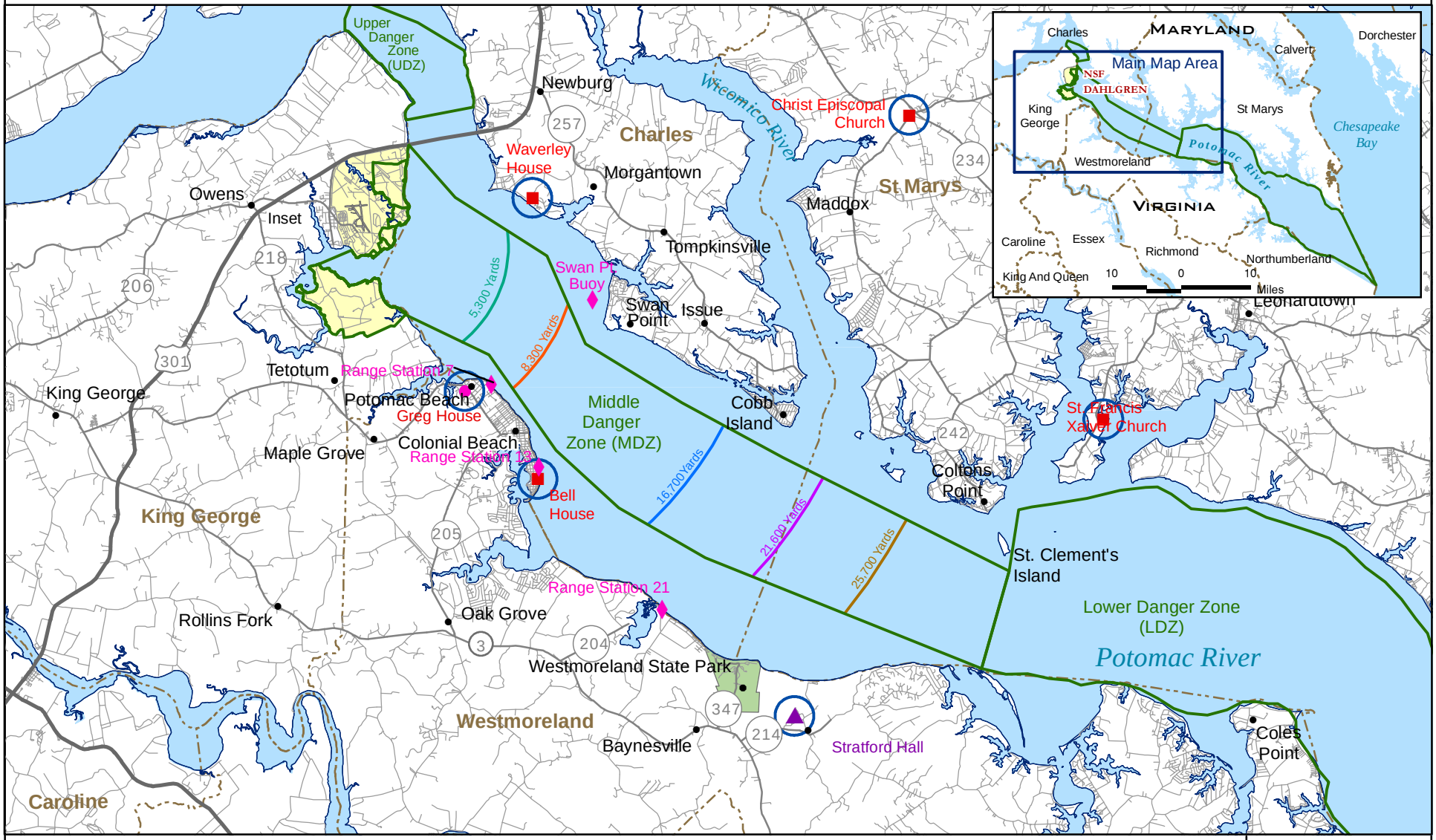
Although the Historic Architectural APE was delineated based on the live firing of the 8”/55 caliber gun, it should be noted that this gun has not been fired by NSWCDD with live projectiles since 2002, and contours are based on the BNOISE2 model assumptions for this gun. The gun was fired most recently in 2008 with a canister of electronic components of fuzes and projectiles as the payload to evaluate how well the components could withstand high gravitational forces during launching. When the 8” gun fires canisters, a reduced charge is used and the canisters contain no explosives. Even though the 8” gun today is used as a one-of-a-kind test fixture rather than to test the gun itself, noise modeling for the 8”/55 gun was used to help define the APE because it represents the future worst case for noise levels, making an allowance for future components – such as long-range projectiles – which may be noisier than current ones. The 5”/62 caliber gun is the largest gun fired frequently by NSWCDD, but it is not included in the BNOISE2 program and so could not be modeled. A somewhat larger-caliber gun, the 155 mm (6.1”) howitzer, is fired infrequently and normally not into the river. Figure 3.5-5’s noise contours are partially based on modeling of noise levels resulting from firing live projectiles from the 5”/54 and 155 mm guns but do not include the 8”/55 gun.

So few rounds are fired every now and then into the upper part of the LDZ compared to the thousands fired annually into the MDZ that the APE was based on targets in the MDZ only. Supporting this decision, noise and vibration measurements taken at the National Register-listed Newtown Manor House (St. Francis Xavier Church & Newtown Manor Historic District), which is located on the upper LDZ, during the firing of a few rounds into the LDZ in 2009, indicated no impact on the historic structure (see Figure 3.6-3, Selected Historic Structures, Measurement Sites, and Target Areas, and Appendix D).

3.6.3 Consulting Parties

In addition to notifying SHPOs and identifying historic properties within APEs that may be affected by the proposed undertaking, Section 106 requires federal agencies, such as NSF Dahlgren, to identify consulting parties with an interest in the effects of an undertaking on historic properties and seek ways to avoid, minimize, or mitigate any adverse effects on historic properties in collaboration with consulting parties. According to 36 CFR § 800.2(c), consulting parties include SHPOs (in this case, VDHR and MHT), representatives of local governments,

Selected Historic Structures, Measurement Sites, and Target Areas



- Selected National Historic Landmark/National Register Listed
- Selected National Register Listed
- Selected National Register Eligible
- Noise Monitoring Location
- Vibration and Noise Monitoring Site

Target Areas

- 5,300 Yards
- 8,300 Yards
- 16,700 Yards
- 21,600 Yards
- 25,700 Yards

- Potomac River Test Range (PRTR) Complex
- Naval Support Facility (NSF) Dahlgren
- County Boundary

Sources: BNOISE2 Model & NSWCDD SIPS Model

3 0 3 Miles

5 0 5 Kilometers

N

NSWCDD EIS

NAVSEA WARFARE CENTERS DAHLGREN

Figure 3.6-3

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individuals or organizations with a demonstrated interest in the undertaking, Native American tribes, and the public.

In 2008, NSF Dahlgren began the process of identifying and engaging consulting parties in accordance with Section 106. Specifically, the Navy included a list of up to 32 proposed consulting parties in correspondence sent to VDHR and MHT which notified them about the project, the proposed APEs, and requested their participation in compliance with Section 106 (see Section 3.6.2 and Appendix E). Both VDHR and MHT generally concurred with the list of proposed consulting parties in 2008. The list included local government agencies, historic preservation organizations, historical societies, and administrators of publicly-accessible historic properties situated within and adjacent to the Archaeological and Historic Architectural APEs in Virginia and Maryland. In addition, both VDHR and MHT indicated that Native American tribes and tribal organizations in Virginia and Maryland should also be invited to participate as consulting parties. Correspondence from both agencies pertaining to consulting parties is included in Appendix E.

In 2009, NSF Dahlgren invited 43 local government agencies, historic preservation organizations, historical societies, administrators of publicly-accessible historic properties, and Native American tribes with an interest in the proposed undertaking to participate in the Section 106 process for this project. Correspondence is included in Appendix E.

Of the 43 invited entities, three within the Historic Architectural APE responded that they would like to be considered consulting parties as part of this project:

- Stratford Hall, Stratford, Virginia (National Historic Landmark [NHL]/National Register-listed)
- Charles County Historical Trust, Newburg, Maryland
- Charles County Government, Planning & Growth Management, La Plata, Maryland

Correspondence is included in Appendix E.

As the project progresses, it is anticipated that the Advisory Council on Historic Preservation (ACHP) will be notified about this project. The ACHP provides guidance and advice concerning the operation of the Section 106 process. According to 36 CFR Part 800, Appendix B, ACHP may choose to participate in the Section 106 process as a consulting party when an undertaking:

- Has substantial impacts (adverse effects) on important historic properties.
- Presents important questions of policy or interpretation.
- Has the potential for presenting procedural problems, including, but not limited to, disputes among or about consulting parties which ACHP's involvement could help resolve.
- Presents issues of concern to Native American tribes (36 CFR Part 800, Appendix B).

3.6.4 Noise and Vibration Monitoring

In 2009, Christ Episcopal Church, a National Register-listed resource just beyond the 120-dBP peak-noise contour of the Historic Architectural APE, submitted a letter to NSWCDD in

response to its request to participate in the Section 106 process as a consulting party. The church expressed concern regarding possible impacts that vibrations associated with outdoor RDT&E activities at NSF Dahlgren may have on the church, and noted that during test events, vibrations were felt and windows rattled. Furthermore, the church also expressed concern about the accuracy of noise models upon which the Historic Architectural APE is based, and whether structural damage may occur near the 120-dBP contour despite documentation to the contrary. Members of the church requested that noise and vibration monitoring take place at the church to determine whether outdoor RDT&E activities have the potential to cause damage to the church. The correspondence is included in Appendix E.

The noise models described in Sections 3.5 and 3.6.2.2 were employed to develop the Historic Architectural APE, and are conventional tools utilized by numerous military installations to conservatively forecast weapons noise. These models have been developed through stringent validation procedures based on a vast quantity of field measurements. However, in order to address concerns raised by Christ Episcopal Church, NSWCDD opted to monitor noise and vibration levels at six historic architectural resources within the 120-dBP contour of the Historic Architectural APE during large gun/projectile operations.

The six selected resources included National Register-listed and eligible resources in Virginia and Maryland. Three resources were selected in Virginia:

- Stratford Hall (NHL/National Register-listed)
- Bell House (National Register-listed)
- Greg House (National Register-eligible)

Three resources were selected in Maryland:

- Waverley (National Register-listed)
- Christ Episcopal Church (National Register-listed)
- Newtown Manor House (St. Francis Xavier Church & Newtown Manor Historic District) (National Register-listed)

The six resources are depicted on Figures 3.6-2 and 3.6-3, and described in Table 3.6-1 and Table 3.6-2.

Three of the six resources had been invited to participate in the Section 106 process because of their publicly accessible status. The resources included Christ Episcopal Church, as noted above, and Stratford Hall and the Bell House. Of these three resources, only Stratford Hall accepted the invitation to become a consulting party.

The six resources were selected to participate in the noise and vibration monitoring study based on several factors, including:

- Proximity to NSF Dahlgren and the PRTR
- Building type
- Construction materials
- Owner concern

Table 3.6-1
National Register-Listed Resources Outside NSF Dahlgren

Map Number	Resource Name	Location	Description	Status	Within APE	Outside APE
1	Waverley	Waverly Point Road Newburg Charles County, MD	Federal-style brick home built between 1782 and 1823	National Register-listed, 1987	X	
2	Sarum	Budds Creek Road (Maryland State Route 234) Newport Charles County, MD	"Virginia-style" home, built ca. 1680; oldest documented structure in Charles County.	National Register-listed, 1974		X
3	Christ Episcopal Church	**Church:** 25390 Maddox Road Chaptico St. Mary's County, MD **Parish Hall:** 37497 Zach Fowler Road Chaptico St. Mary's County, MD	Congregation was established in 1640; Colonial-style brick church was constructed in 1736 and is one of the oldest in continual use in the United States.	National Register-listed, 1994		X
4	Deep Falls	Deep Falls Road Chaptico St. Mary's County, MD	Built in 1745 by the Thomas family.	National Register-listed, 1975		X
5	Bachelor's Hope	Manor School Road Chaptico St. Mary's County, MD	Two-story, three-bay brick dwelling constructed in the 18th century.	National Register-listed, 2007	X	
6	Ocean Hall	Bushwood Road Bushwood St. Mary's County, MD	Built before 1670, Ocean Hall is the oldest surviving home in Maryland.	National Register-listed, 1973	X	
7	St. Clement's Island Historic District	St. Clement's Island St. Mary's County, MD	Small, deserted island in the Potomac River, which marks the location of the first landing of the English settlers of Maryland and the first Catholic mass held in the New World.	National Register-listed, 1972	X	
8	The River View	Burch Road St. Mary's County, MD	Built in the early 18th century by the Gardiner family, this property is notable for its smokehouse, shed, and log quarters – the largest grouping of such buildings in St. Mary's County.	National Register-listed, 1976	X	
9	St. Francis Xavier Church and Newtown Manor Historic District	Newtown Neck Road (Maryland State Route 243) Leonardtown St. Mary's County, MD	Part of the manor house is thought to date to the 1600s; otherwise constructed in 1767, these buildings, including a frame church, brick manor house, and the surrounding 700-ac farm comprise an example of a self-contained Jesuit community.	National Register-listed, 1972	X	

Table 3.6-1 (Continued)
National Register-Listed Resources Outside NSF Dahlgren

Map Number	Resource Name	Location	Description	Status	Within APE	Outside APE
10	Bushfield	367 Club House Loop Virginia State Route 708 Mount Holly Westmoreland County, VA	Early-18th-century home once owned by George Washington's brother; renovated in 1919 in the Colonial Revival style by architect Waddy Butler Wood.	National Register-listed, 2004	X	
11	Spring Grove	Virginia State Route 202 Mount Holly Westmoreland County, VA	Federal-style estate is an outstanding example of early-19th century architecture in rural Virginia.	National Register-listed, 1985	X	
12	Armstead T. Johnson High School	Virginia State Route 202 Montross Westmoreland County, VA	High school constructed in 1937 specifically for African-American students during the era of segregation; funded by Works Progress Administration (WPA) and donations from community.	National Register-listed, 1998	X	
13	Stratford Hall	Great House Road Stratford Westmoreland County, VA	Built in the 1730s by the Lee family, this H-shaped brick building is a notable example of an early Georgian-style home. It was the birthplace of General Robert E. Lee, Commander of the Confederate armies, as well as the home of two signers of the Declaration of Independence, Richard Henry and Francis Lightfoot Lee.	NHL/National Register-listed, 1966	X	
14	Westmoreland State Park Historic District	Westmoreland State Park, Westmoreland County, VA	One of six planned state parks conceived by the Commonwealth of Virginia during the 1920s and 1930s, the park was jointly developed between 1933 and 1943 by the Civilian Conservation Corps, NPS, and Virginia Commission on Conservation and Development. Park consists of a beach, cliffs, wetlands, ravines, and heavily forested areas; includes cabins, campgrounds and recreational areas.	National Register-listed, 2005	X	
15	Ingleside	Virginia State Route 638 Oak Grove Westmoreland County, VA	Built as Washington Academy in 1834; Classical Revival-style building was based on the Virginia Capitol in Richmond.	National Register-listed, 1977	X	
16	Blenheim	Virginia State Route 3 Oak Grove Westmoreland County, VA	Colonial-style home built by William Augustine Washington, George Washington's half-brother, in 1780.	National Register-listed, 1976	X	
17	Roxbury	Virginia State Route 638 Oak Grove Westmoreland County, VA	Built in 1861, this home's mid-Victorian style is more commonly found in the north.	National Register-listed, 1977	X	
18	Wirtland	Virginia State Route 638 Oak Grove Westmoreland County, VA	Built in 1850 by Dr. William Wirt, Jr., this home is one of the few examples of domestic Gothic Revival-style architecture in Westmoreland County.	National Register-listed, 1977	X	

Table 3.6-1 (Continued)
National Register-Listed Resources Outside NSF Dahlgren

Map Number	Resource Name	Location	Description	Status	Within APE	Outside APE
19	St. Peter's Episcopal Church	Virginia State Route 3 Oak Grove Westmoreland County, VA	Built in 1849, this church is a rare example of the Gothic Revival style; Washington, Monroe, and Lee families worshipped at the church.	National Register-listed, 2004	X	
20	Bell House	821 Irving Avenue Colonial Beach Westmoreland County, VA	Shingle-style frame house erected ca. 1883 when Colonial Beach emerged as a popular waterfront resort; acquired by family of Alexander Graham Bell in 1886.	National Register-listed, 1987	X	

Table 3.6-2
National Register-Eligible Resources Outside NSF Dahlgren

Map Number	Resource Name	Location	Description	Status	Within APE	Outside APE
21	Governor Harry W. Nice Memorial Bridge (Bridge 8039)	US Route 301 over the Potomac River Newburg Charles County, MD	This 1.7-mi-long bridge was built between 1939 and 1940 as part of Maryland's Primary Bridge Program which was initiated in the 1930s to provide access to previously isolated areas in Maryland; the only known example of a metal cantilever bridge in Maryland.	National Register-eligible, 2001	X	
22	Marshall's Rest (Clifton Potomac Property)	11985 Edgehill Road Newburg Charles County, MD	Built in 1847, this home is a representative example of a mid-19th-century farmhouse with Federal-style influences.	National Register-eligible, 1997	X	
23	John H. Reeder Property (Jones Property)	11450 Edgehill Road Newburg Charles County, MD	Built ca. 1865, this property is a good example of a mid-19th-century I-house with associated outbuildings, including barns, spring house, and smokehouse, all of which have retained integrity.	National Register-eligible, 1997		X
24	Bridge 1808	Maddox Road (Maryland State Route 238) over Burroughs Run Vicinity of Maddox St. Mary's County, MD	Bridge was built in 1929 by the State Roads Commission as part of the St. Mary's County road expansion; survives as a significant example of a single-span closed concrete-arch bridge with pierced concrete parapets.	National Register-eligible, 2001	X	
25	Bridge CH-0016	Rock Point Road over Ditchley Prong Vicinity of the Village of Wayside Charles County, MD	Built in the 1920s, this single concrete beam- span bridge with concrete parapets is a representative example of its type, and has retained a high degree of integrity.	National Register-eligible, 2001	X	

Table 3.6-2 (Continued)
National Register-Eligible Resources Outside NSF Dahlgren

Map Number	Resource Name	Location	Description	Status	Within APE	Outside APE
26	Small Structure No. 18049XO	Maryland State Route 520 over Branch of Whites Neck Creek Bushwood St. Mary's County, MD	Built in the 1930s-40s, bridge is an example of a concrete slab structure with concrete pier abutments, wing walls, and balustrade which has retained integrity.	National Register-eligible, 1997	X	
27	Chaptico Historic District	Chaptico St. Mary's County, MD	This cluster of 18th-, 19th-, and early-20th century religious, commercial, and residential buildings form a rare surviving village center which originated in the 18th century in St. Mary's County.	National Register-eligible, 2004	X	
28	Locust Grove	25434 Hurry Road Chaptico St. Mary's County, MD	Built ca. 1850, this home is a good example of well-preserved 19th-century domestic architecture. The interior features rare examples of Greek Revival-style woodwork and faux graining.	National Register-eligible, 2004		X
29	Hague House	Virginia State Route 202 Hague Westmoreland County, VA	Built during the late 18th century by John and Joseph Hague, this one-and-a-half story, four-bay wood-frame residence was transformed into the rear ell of a newly-constructed two-story residence around 1900.	National Register-eligible, 1996	X	
30	Washington & Lee Agricultural High School	16380 Kings Highway (Virginia State Route 3) Montross Westmoreland County, VA	Built ca. 1930, this is a one-and-a-half story, brick, Cape Cod-style school building.	National Register-eligible, 2000	X	
31	Montross Town Hall (Bank of Montross) ***DEMOLISHED IN 2001***[1]	100 Hawthorne Street Montross Westmoreland County, VA	Built in 1925 by Edward G. "Peck" Heflin, this one-and-a-half story brick, Classical Revival-style house had a flat roof and arched windows. It served as the second location of the Bank of Montross, established in 1908, and later the Montross Town Hall; demolished in 2001.	National Register-eligible, 2000	X	
32	Panorama (Hummel Vineyards)	1005 Panorama Road Montross Westmoreland County, VA	Built in 1932 in the Georgian style by the last private owners of Stratford Hall Plantation (home of Robert E. Lee), the bricks of this three-story house are thought to have been made at Stratford Hall.	National Register-eligible, 2004; nominated to the National Register in 2008; National Register listing pending	X	

Table 3.6-2 (Continued)
National Register-Eligible Resources Outside NSF Dahlgren

Map Number	Resource Name	Location	Description	Status	Within APE	Outside APE
33	Endurance (Himes House)	29 Irving Avenue South Colonial Beach Westmoreland County, VA	Built in 1906 in the Queen Anne style based upon a Sears, Roebuck, & Co. pattern, this two-story, three-bay, side-passage, double-pile house is located in an area known as "The Point," laid out around the turn of the 20th century by the Colonial Beach Improvement Company.	National Register-eligible, 2001; also located within the potentially National Register- eligible Colonial Beach Historic District.	X	
34	Bank of Westmoreland (Colonial Beach Town Hall)	18 Irving Avenue North Colonial Beach Westmoreland County, VA	Built in 1904 by the Mumford Company of Cape Charles, VA, this one-story, three-bay, side-passage commercial bank building is located in downtown Colonial Beach; converted to function as Bank of Westmoreland in 1907; currently functions as Town Hall of Colonial Beach.	National Register-eligible, 2001; also located within the potentially National Register- eligible Colonial Beach Historic District.	X	
35	Colonial Beach Historic District[2]	Colonial Beach Westmoreland County, VA	District encompasses a 56-acre portion of Colonial Beach, a resort town on the Potomac River; primarily includes vernacular residential and commercial buildings constructed between 1900 and 1920.	National Register-eligible, 2001	X	
36	Greg House	1763 McKinney Boulevard Colonial Beach, Westmoreland County, VA	Built ca. 1925, this one-and-a-half story, three-bay, center-passage, double-pile, frame, bungalow, sits atop a promontory overlooking the Potomac River.	National Register-eligible, 2008	X	

[1] Brenda Reamy, Town Manager, Montross, Virginia, pers. comm., October 14, 2009.

[2] *The Town of Colonial Beach Comprehensive Plan, 2009-2029* indicates that a preliminary historic district is proposed within the Point and older sections of the Central Area of Colonial Beach. The preliminary district encompasses the majority of the Colonial Beach peninsula, and includes the 56-acre Colonial Beach Historic District which was determined National Register eligible by VDHR in 2001. The 2009 plan indicates that research and documentation must occur within the preliminary historic district to develop precise district boundaries for a National Register nomination form. Upon completion, the form would be submitted to VDHR for review, approval, and eventual listing in the National Register. Following listing of the district in the National Register, the 2009 plan indicates that town officials should also consider its designation as a local historic district which would be subject to local zoning ordinances and design review procedures (Town of Colonial Beach, 2010).

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Letters were sent to owners of the six resources in June and October 2009 requesting their participation in the study, and all agreed to participate. VDHR, MHT, Charles County Historical Trust, and Charles County Government Planning and Growth Management were also notified of the study during the same period. Correspondence is included in Appendix E.

Gun/projectile activities at NSF Dahlgren were monitored by noise specialists at the six resources on November 16 and 17, 2009. These dates were selected because 5”/62 guns with live projectiles were being fired from the AA Fuze Range at multiple target areas in the PRTR. The 5”/62 gun is the largest and loudest gun fired frequently at NSF Dahlgren. Figure 3.6-3 shows the historic structures where noise and vibration levels were measured, range stations where noise levels were measured, and target areas used on the two days of firing.

Although the Historic Architectural APE was delineated based in large part on the live firing of projectiles from the 8”/55 caliber gun – which is larger and louder than the 5”62 caliber gun – firing the 8” gun for these tests was not possible because it is no longer used to fire live projectiles. The 155 mm howitzer (equivalent to a 6.1” caliber gun and hence louder than the 5”62 caliber gun) is fired infrequently, and in fact, was not fired in 2009 at all. If the 155 mm howitzer were scheduled for testing downrange on the PRTR in the future, the noise model would be used to predict noise contours prior to use. As the 5”/62 projectiles were the largest caliber rounds that had associated noise and vibration measurements, they were selected for the study.

To monitor the noise and vibration effects of the 5”/62 gun on the six resources, noise specialists affixed sensors to the buildings and grounds. Noise and vibration levels were recorded during the firing of the guns from the AA Fuze Range of the PRTR Complex, and also during detonation of the projectiles in target areas in the PRTR.

Detailed results of the noise and vibration measurements at six historic structures near NSF Dahlgren on November 16 and 17, 2009 are included in Appendix D. Peak noise levels (described in Section 3.5.4.3) ranged from 89 to 129 dBP. Vibration levels (described in Section 3.5.5) ranged from not detectable to slightly above 0.5 in/sec. The threshold level for minor structural damage caused by vibrations is 2.0 in/sec. Vibration levels measured at the six resources were well below the threshold level. Therefore, the results indicate that noise and vibration levels associated with live firing of the 5”/62 caliber gun did not result in structural damage to the six resources.

Furthermore, the peak noise levels measured during firing of the 5”/62 gun over the course of the two-day period are comparable, and in some cases lower – particularly at locations away from the PRTR shore line – than predicted noise contours depicted in Figure 3.5-5. Therefore, noise and vibration monitoring indicate that noise models utilized to develop noise contours depicted in Figure 3.5-5 appear to be accurate. The BNOISE2 model-predicted contours are conservative in nature, and thus ample enough to take into account certain physical and atmospheric conditions that may result in variable noise and vibration levels associated with gun/projectile operations. As a result, it is likely that the noise model utilized to develop the Historic Architectural APE is also accurate.

Results of the noise and vibration monitoring study have been used to assist in the assessment of the Proposed Action on historic architectural resources described in Section 4.6.2.

3.6.5 Prehistoric Context

The paleoenvironment and temporal divisions of the Prehistoric cultural sequence relevant to NSF Dahlgren and vicinity are discussed below.

3.6.5.1 Paleoenvironment

NSF Dahlgren is located on the western banks of the Potomac River in the Tidewater Region at the northern tip of Virginia's Northern Neck (the geographic name for the area between the Potomac and Rappahannock Rivers), in King George County, Virginia. This area is classified as the Coastal Plain Physiographic province of the Middle Atlantic Region. The tilted beds of the Coastal Plain extend offshore some 50 to 75 mi to the edge of the North American continent (the continental shelf). The continental shelf has not always been submerged. During the Pleistocene, sea levels lowered, exposing the shelf; streams then flowed across the shelf, carving valleys. As the Pleistocene waned about 10,000 years ago and the Holocene began, temperatures warmed, northern glaciers melted, and sea levels rose again, flooding the shelf and submerging these valleys. The Chesapeake Bay is one of these submerged Pleistocene valleys.

The stream-cutting of the Pleistocene that created Chesapeake Bay also led to the dissection of the Coastal Plain into several peninsulas. The northernmost of these, known as the Northern Neck, is bounded by the Potomac River to the north, the Chesapeake Bay to the east, and the Rappahannock River to the south.

The environment of the Coastal Plain in the Middle Atlantic region has generally remained relatively stable for the past 3,000 years. When the Pleistocene ended and the ice sheets retreated about 10,000 years ago, a gradual warming trend occurred and open tundra and boreal forest environments were replaced by mixed deciduous environments more typical of southern temperate zones. An essentially modern climate and environment had become established. Evidence for cultural adaptation to the changing environment is evident through artifact and settlement pattern variation. Major developments in cultural patterns recognized in the Virginia archaeological record are referred to by period and are described in the following section.

3.6.5.2 Prehistoric Cultural Sequence

The prehistoric cultural sequence for the Chesapeake Watershed and the Northern Neck region of Virginia closely follows the more general sequence defined for the Middle Atlantic Region. The following subsections provide summary information on this chronology, organized by the three major prehistoric adaptive trends (Paleo-Indian, Archaic, and Woodland) as they pertain to Virginia. The temporal divisions are based on technological advancements, the stylistic evolution of the lithic (stone) tool kit, and changes in subsistence strategies related to a changing environment and resource base.

Paleo-Indian Period – 12,000 BC to 8,000 BC

Near the end of the last ice age, about 12,000 years ago, the food supply of Paleo-Indian people increased and became more stable. With milder weather, more animals and plants survived and climatic conditions became more favorable. The Paleo-Indians of Virginia were "hunter-foragers," whose primary means of subsistence was hunting large mammals, supplemented by gathering wild plants and seeds. They lived in small family bands whose numbers would

increase or decrease through marriage, death, and other factors. These bands were widely scattered and "semi-nomadic," moving from place to place to take advantage of seasonal and ephemeral food resources.

The Flint Run Paleo-Indian Complex, located in the upper Shenandoah Valley, is one of Virginia's more important Paleo-Indian period resources (Gardner, 1974). This complex, excavated primarily in the early 1970s, is a series of sites generally located around a cluster of toolstone quarries that lead to a significant leap in the understanding of Paleo-Indian lithic procurement strategies. No Paleo-Indian sites have been recorded within the boundaries of NSF Dahlgren.

Archaic Period – 8,000 BC to 1,200 BC

Early Archaic Period

Early in the Archaic Period – from 8,000 to 6,000 BC – hunting remained the primary means of subsistence. Like the Paleo-Indian peoples before them, Early Archaic groups traveled in mobile bands, although it appears they did not travel quite so widely nor so frequently as their predecessors. Lithic technology advanced and stoneworking methods were adapted to better utilize higher-quality toolstones, such as chert and rhyolite, and to better exploit new and emerging faunal resources. Use of lower-quality toolstones obtained from local sources, such as quartz and quartzite, is also evident. As sea levels rose during this period and the Middle Archaic Period, coastal and lower riverine Paleo-Indian sites located along then-existing shorelines were submerged by rising sea levels.

As in the Paleo-Indian Period, Early Archaic Period groups lived in mobile bands. There is evidence that these bands moved across more tightly defined areas and traveled less frequently than did bands during the Paleo-Indian Period. In Virginia and throughout the Middle Atlantic region, Early Archaic sites frequently occur on large river terraces or upland surfaces (Johnson, 1986).

Within the boundaries of NSF Dahlgren, two archaeological sites have been recorded that contain artifacts diagnostic to the Early Archaic Period. Tests excavations at site 44KG168 yielded a LeCroy-type, bifurcate-base projectile point. The generally accepted date range for this point type is 8,000 to 5,000 BC. Investigations at site 44KG113 revealed the presence of a MacCorkle-type bifurcate-base projectile point. The general date range for this point type is 7,000 to 4,000 BC.

Middle Archaic Period

By the middle of the Archaic Period – from 6,000 to 3,000 BC – the climate had become warmer and drier. Lithic technology advanced further; techniques like pecking, grinding and polishing were being used to produce new kinds of tools that were used specifically for activities such as woodworking, seed grinding, and nut cracking.

As the food supply grew and more effective subsistence strategies were developed, populations began to rise. Middle Archaic sites are larger and more numerous. Many coastal and lower riverine bands began to establish semi-permanent fishing camps along the shores of the rivers and bays. During this period sites also began to appear in locations that had not previously been exploited, such as upland swamps and interior ridge tops.

Within NSF Dahlgren, one site has been recorded with temporally diagnostic artifacts indicating a Middle Archaic Period occupation. Shovel-test excavations at site 44KG218 yielded a Halifax-type side-notched projectile point. This point type, referred to alternately as a Brewerton type point, dates from 4,000 to 2,000 BC.

Late Archaic Period

By the end of the Archaic Period – from 3,000 to 1,200 BC – lithic technology had again advanced. Archaeological evidence indicates production of more advanced ground stone tools, such as axes and adzes and the first use of heavy stone bowls, called soapstone bowls, made from steatite. It has been suggested that soapstone bowls may indicate the use of direct-heat cooking, while others suggest a more symbolic function for these items (Maryland Department of General Services [DGS] and MHT, 1998).

Sea-level rise began to slow during this period, leading to the stabilization of riverine and estuarine environments and the growth of significant populations of shellfish and anadromous fish (fish that breed in fresh water but live their adult lives in more saline waters). Evidence from Late Archaic sites excavated in the Piedmont region of Central Virginia indicates that seasonal camp sites were located within or adjacent to forests containing nut-bearing trees. Exploitation of permanent food resources such as nuts led to the eventual increase of the more sedentary lifeways that come to fruition during the Woodland Period.

By the end of the Archaic Period and the beginning of the Woodland Period, a dramatic increase in the number of sites had occurred, suggesting both an increase in overall population and a movement into new environmental zones.

Multiple Late Archaic Period sites have been identified at NSF Dahlgren. Investigations at site 44KG112 revealed the presence of a Koens-Crispen-type broadspear point. This point type dates from 2,000 to 1,200 BC and is emblematic of Late Archaic Period stone-tool technology. Site 44KG157, a shell midden site that ranges in date from the Late Archaic through the Woodland Periods, has been determined eligible for listing in the National Register. Site 44KG217, also known as Black Marsh 1, was recommended National Register-eligible but has not yet been evaluated by VDHR (NSF Dahlgren and Engineering Field Activity Chesapeake, 2006).

Woodland Period – 1,200 BC to 1607 AD

The Woodland Period is most notably characterized by the introduction of pottery. The earliest recognized ceramic pottery type in the region is the Marcey Creek Type, a steatite tempered ceramic that dates to between 1,200 and 800 BC (Maryland DGS and MHT, 1998). The shell-tempered and net-impressed Mockely-Type pottery is characteristic of the middle part of the Woodland Period, and the cord-marked Potomac Creek Type typifies later woodland pottery styles. The appearance of pottery indicates changes in the social and political organization of production (Maryland DGS and MHT, 1998). This shift could either represent a move toward intensive harvesting of wild plant resources or the early foundations of domestication.

Other technological innovations include the development of the bow and arrow and associated stone-tool refinements, which took place during the early part of the Woodland Period. Also, a shift from curated biface tool forms – often produced using hard-to-procure high-quality lithic material – to a more expedient form produced using local quartz and quartzite, is evident during the Woodland Period.

The size and complexity of villages and settlement clusters increased as the Woodland Period advanced. Groups in the Middle Atlantic began to develop fortified villages, inter-tribal alliances, specialized societal roles, and more-refined religious and socio-political complexity.

Several sites recorded at NSF Dahlgren have yielded temporally diagnostic artifacts from the Woodland Period. At site 44KG105 test excavations yielded Popes Creek-type pottery fragments. The Popes Creek pottery type is typically thick-walled, net-impressed, sand-tempered pottery that dates from 500 BC to 300 AD. Excavations at site 44KG170 also yielded Popes Creek-type pottery fragments, and Carbon 14 dating of a sample from a pit feature at this site yielded a calibrated date range of 405 to 20 BC. A number of other Woodland Period sites have also been identified at NSF Dahlgren, according to records on file at the VDHR.

Evidence of prehistoric-period occupation on islands in the Potomac River within the vicinity of NSF Dahlgren was identified on St. Clement's Island. Several archaeological sites interpreted as prehistoric shell middens have been identified on the island. One shell midden was comprised of culturally distinct strata dating to the Middle and Late Woodland and Contact Periods (Site 18ST686, St. Clement's Island Midden [West Area I]) while another was dated to the Late Woodland Period (Site 18ST441, Borrow Pit [Field #3]). Two additional shell midden sites identified on the island did not contain culturally diagnostic artifacts (Site 18ST440 [Field #2] and Site 18ST439 [Field #1]), and their cultural affiliation is unknown.

In addition to the above-mentioned sites, an archaeological investigation in the 1960s identified a shell midden containing a burial on the eastern shore of the island (Site 18ST18, Blackistone Island [St. Clement's Island]) (MHT, 2003). This site was dated to the Woodland Period based on the presence of pottery. During the investigation, the site was excavated and the remains reportedly donated to the Smithsonian Institution. Recent investigations of the area by the MHT noted that the shoreline in the vicinity of this site has been extensively disturbed by rip-rap constructed for erosion control, as well as by hurricane activity. It was noted that the site has likely been completely destroyed by erosion and/or construction of rip-rap.

Contact Period

During the middle and late 16th century, Spanish, French, and English expeditions visited the Chesapeake Bay and its tributaries. While not specifically documented, it is likely that initial contact between Europeans and native groups in the vicinity of NSF Dahlgren occurred at this time. In 1607 the construction of a fort at Jamestown, Virginia by the English ushered in a period of more sustained contact and, ultimately, signaled the demise of existing native lifeways.

A 1648 treaty opened the Northern Neck, including the present-day NSF Dahlgren vicinity, to settlement. At this time, it is believed that the Machoatick band may still have inhabited the portion of the Northern Neck that includes NSF Dahlgren (NSF Dahlgren and Engineering Field Activity Chesapeake, 2006). Continued occupation from the Late Woodland Period into the 17th century is evidenced in the archaeological record at NSF Dahlgren (site 44KG137).

3.6.6 Historic Context

The following sections portray the historic context of the Archaeological and Historic Architectural APEs, including a historic overview of the Potomac River and the five counties within and adjacent to the Historic Architectural APE. A brief history of the installation property prior to construction of NSF Dahlgren is also provided in the King George County, Virginia overview. The historic context concludes with a brief history of NSF Dahlgren.

3.6.6.1 Potomac River in Vicinity of NSF Dahlgren

The Potomac River has served as a major transportation route over time. From its headwaters in Fairfax Stone, West Virginia, the river travels through four states before flowing into Chesapeake Bay approximately 45 mi southeast of NSF Dahlgren. Tributaries in the vicinity of NSF Dahlgren include the Port Tobacco and Wicomico Rivers and Nanjemoy and Rosier Creeks in Maryland; within NSF Dahlgren, Gambo Creek crosses through the northern portion of the installation (Mainside), Upper Machodoc Creek separates the northern and southern portions of the installation (Mainside and the EEA Complex, respectively), and Black Marsh Creek flows from the southeastern end of the installation (on the EEA complex). Several bays are located farther south along the east and west banks of the river, including Nomini, St. Clement's, and Breton.

European explorers first visited the Potomac River during the middle and late 16th century. Settlement along the Potomac River Tidewater Region began in the middle of the 17th century and prompted the need for river crossings. Due to the river's wide expanse, ferry crossings provided the only practical solution, and by the early 18th century, Virginia began to establish service to Maryland (Wilstach, 1921). Hooes Ferry, established in the vicinity of present-day NSF Dahlgren, was one of the earliest river crossings in the Northern Neck (circa. 1720) (King George County, 2008; Wilstach, 1921). Crossings on smaller, surrounding creeks and rivers would also have been necessary as settlement expanded.

Other vessels plying the waters during this period included merchant ships carrying cargo between ports. The closest major port to present-day NSF Dahlgren was in the town of Dumfries, Virginia, several miles upriver. The need for navigation along the river led to the use of lightships, and, later, the construction of lighthouses in the Potomac River. During the 19th century, several existed within the vicinity of present-day NSF Dahlgren, including at Mathias Point to the north and on St. Clement's Island to the south (Payette, 1999).

Downed row galley ships in the Wicomico River attest to maritime activity in the area during the American Revolution (1776-83) (MHT, 1997; NSF Dahlgren and Engineering Field Activity Chesapeake, 2006). Over the course of the 19th century, activity on the river between the newly established Washington Navy Yard in Washington, DC and the Chesapeake Bay increased greatly, starting with the War of 1812 (1812-14) and heightening through the Civil War (1861-65). During this time, ships of the British, United States, and Confederate States armies and navies traversed the river (NSWCDL, Not Dated).

Major batteries were constructed along the river during the Civil War to control movement on the waterway, including one at Mathias Point, north of present-day NSF Dahlgren, where the

river curves. A number of Confederate ships and fewer United States ships were sunk, burned, or otherwise lost in the river during the war (MHT, 1997; Naval Historical Center [NHC], 2008).

The 19th and 20th centuries saw the establishment of gun-proving grounds along the river by the Navy, first at the Washington Navy Yard, then at Indian Head, Maryland, and then at what was initially the "Lower Proving Ground," at Dahlgren, Virginia. Mine-testing conducted approximately 30 mi downriver from present-day NSF Dahlgren off Piney Point, Maryland utilized the U-1105, or Black Panther, a German submarine acquired by the United States as a war prize after World War II. The wreckage of the ship was designated as Maryland's first historic shipwreck preserve in 1994. Portions of the lower Potomac River continue to be utilized for testing by the Navy today.

3.6.6.2 County Histories

King George County, Virginia

King George County, Virginia, home of present-day NSF Dahlgren, was formed by the Virginia colonial legislature in 1720 out of the upper portion of what was then Richmond County. In 1776, the county expanded to include Potomac River frontage. Throughout the 17th and 18th centuries, Virginia's agricultural economy was rooted in the plantation/slave tobacco-farming system. Within the area later developed as the Dahlgren Naval Proving Ground, several plantations were present during this period. Plantations of the Hooes and Dade families occupied much of the land north of Upper Machodoc Creek (Barnesfield Plantation; Potomac View; Berry Plain; "The Cottage;" Plentiful Farm; Monmouth; and Bethany plantations) (NSWCDD, 1998; NSF Dahlgren and Engineering Field Activity Chesapeake, 2006). Tetotum Plantation was located to the south of Upper Machodoc Creek, in an area historically known as Pumpkin Neck. The plantation is believed to have been established by members of the Hooe [sic] family (NSWCDD, 1998).

The area surrounding the future location of the town of Dahlgren remained sparsely settled until the mid-19th century. By the 1860s, small settlements were concentrated along the Potomac River shoreline. During the Civil War, large portions of King George County were occupied by Union soldiers. A number of Confederate networks were also established in the county because of its riverfront location and proximity to Maryland. Within the present location of Dahlgren, suspected Confederate activities resulted in the burning of the Hooes' 18th-century home on Barnesfield Plantation by Union forces (NSWCDL, 1992; Haynes, Not Dated; Wilstach, 1921).

After the Civil War, King George County remained rural, consisting primarily of small farms. Of the plantations that once occupied present-day NSF Dahlgren, Barnesfield Plantation remained and functioned both as a plantation and dairy, which was established in the 1920s (VDHR, 1998; Naval Facilities Engineering Command [NAVFAC], Chesapeake Division, 1991; NSF Dahlgren and Engineering Field Activity Chesapeake, 2006). Other plantations developed into small communities, including an African-American community on the lands of Plentiful Farm. Dahlgren Naval Proving Ground was established on the grounds of "The Cottage" plantation in 1918 (NSWCDD, 1998; NSF Dahlgren and Engineering Field Activity Chesapeake, 2006).

Westmoreland County, Virginia

In 1651, what was the original Northumberland County, Virginia was divided into four new counties – Northumberland, Lancaster, Richmond and Westmoreland counties. The boundaries of Westmoreland County were redrawn a number of times, with the final adjustments made in 1778 (Norris, 1983). During the Colonial era, cheap land, established Protestantism, friendly Indians, and a distant government were all powerful draws for settlers to this area. By 1660, nearly all the waterfront property and much of the interior of the Northern Neck of Virginia had been settled (Norris, 1983).

In the 18th and 19th centuries, Westmoreland County was the birthplace of several prominent Americans, including George Washington in 1732; James Monroe, the fifth President of the United States, in 1758; and Robert E. Lee, Commander of the Confederate armies during the Civil War, in 1807. Their birthplaces are located along the Potomac River southeast of NSF Dahlgren. Plans are afoot to reconstruct Monroe's birthplace. Lee's birthplace, Stratford Hall, is on the National Register and is a National Monument. Washington's birthplace at Pope's Creek, with buildings reconstructed in 1931, is a National Monument.

Another connection to early American history in Westmoreland County is Leedstown, located just south of the Historic Architectural APE on the shores of the Potomac River. On February 27, 1766, Thomas Ludwell Lee and Richard Henry Lee brought together 115 patriots, who drew up and signed the Leedstown Resolutions, a Declaration of Independence that preceded Thomas Jefferson's by more than ten years (Norris, 1983).

During the 19th century, Westmoreland County's economy was (and still remains) primarily based in agriculture. However, one major economic generator for the county is the tourist destination of Colonial Beach. It began its existence as a bathing and fishing resort in the 19th century, with visitors arriving by boat from Washington, DC. Recreation activities included bathing at the mile-long sandy beach, fishing, and boating. In the latter part of the 19th century, Colonial Beach became known as "the playground on the Potomac." The area prospered as a resort destination during the late 19th and early 20th centuries, and the lure of beaches and waterfront property started a building boom of Victorian-style homes, summer cottages and large hotels. During the mid-to-late 20th century, Colonial Beach declined as vacationers' preferences changed in favor of ocean beach resorts rather than riverfront resorts. Legalized gambling and destructive fires contributed to the area's deterioration. In more recent times, however, Colonial Beach has rebounded, based on its proximity to Washington, DC and Richmond, Virginia (Colonial Beach, 2006).

Currently, farming (particularly dairy farming), fishing, and forestry remain vital parts of the Westmoreland County economy. However, the county is working to diversify, bringing in new, small manufacturing businesses, and strengthening its ties with NSF Dahlgren. Historical tourism also provides a strong economic base for the county (Westmoreland County, Virginia, Not Dated).

Richmond County, Virginia

Captain John Smith, who led the first European colonization at Jamestown, Virginia, was the first Englishman to set foot in present-day Richmond County. He came first in 1607 as a prisoner

of Native American Chief Powhatan, and returned in 1608 with a group from Jamestown to explore the Rappahannock River (Harper, 1992).

The county was established in 1692. Its county seat is the Town of Warsaw, located southeast of the Historic Architectural APE. Tobacco, specifically of the sweet-scented Oranco variety, was the major cash crop of Richmond County during the Colonial era. At that time, tobacco was so valued in Virginia that it was used as a means of monetary exchange, since coinage from other parts of the world was rare in the colonies (Harper, 1992).

Throughout this primarily rural county's history, farming, fishing, and forestry have been its main sources of income. In the 20th and 21st centuries, natural resources and government have defined Richmond County's economy, employing over half the working population. Tourism also comprises a large part of the local economic base (Virginia Economic Development Partnership, 2007).

St. Mary's County, Maryland

The first settlers of Maryland came to present-day St. Mary's County in 1634. They sailed from the Isle of Wight, England on two ships – the *Ark* and the *Dove*. They landed at St. Clement's Island, located in the Potomac River at the southwestern edge of the MDZ. They chose this as their first landing site because of its strategic location at a distance from the possibly hostile Native Americans. Upon landing, they celebrated the first known Catholic mass within the thirteen colonies (Hammett, 1977). Soon after landing, the colonists established friendly relations with the Native Yeocomico tribe. Governor Leonard Calvert traded axes, hoes, hatchets, and cloth with the tribe within a 30-mi area that was roughly contiguous with present-day St. Mary's County (Hammett, 1977).

The first settlement in Maryland was established at St. Mary's City, located east of the Historic Architectural APE. Until the first decade of the 18th century, the citizens of St. Mary's County were almost entirely immigrants (Hammett, 1977). Although St. Mary's County was a Catholic colony, settlers of any religion were welcome. However, Protestants took control in 1689 and forbade Catholics from holding office, serving on juries, or bearing arms (Reno, 2004). By 1695, there were 1,049 taxable settlers in St. Mary's County, and Protestants succeeded in transferring the capital of Maryland from St. Mary's City to Annapolis, which remains the seat of Maryland's state government today (Hammett, 1977).

Like many of the surrounding counties, St. Mary's County was heavily dependent upon tobacco cultivation and the fishing industry. During the Civil War, Maryland was a Union state. However, because of its dependence upon the tobacco/slave farming system, St. Mary's County heavily supported the Confederacy. In 1977, historian Regina Combs Hammett wrote that, in some parts of St. Mary's County, the Civil War was referred to as "the War of Northern Invasion." Many St. Mary's County residents participated by smuggling food and supplies across the Potomac River into Confederate Virginia. Until the Draft Act was passed in 1862, only four St. Mary's County residents had enlisted in the Union Army (Hammett, 1977).

During World War II (1939-1945), St. Mary's County's focus began to shift from agriculture and fishing to include a major military facility, Naval Air Station Patuxent River. "Pax River" (as it is commonly known) now covers 6,500 acres along the Patuxent River waterfront well east of the Historic Architectural APE, and is home to the Navy's principal Naval aircraft RDT&E and fleet-support facilities. Pax River has had a dramatic effect on the local economy, and now

employs approximately 22,400 military and civilian personnel, and defense contractors (Maryland Department of Business and Economic Development, 2011).

Despite the influx of new residents and technology, present-day St. Mary's County has a strong historical consciousness. St. Mary's City is now an 800-acre archaeology and living history museum. The museum has over 5 million artifacts from St. Mary's City, and visitors can experience a reconstructed historic town, including a tobacco plantation, a farm, and the State House (Historic St. Mary's City, 2011).

Charles County, Maryland

Charles County originally comprised an area much larger than its current boundaries. It was created by Cecil Calvert, the second Lord Baltimore, in 1650. It included all of present-day Charles County, as well as parts of present-day Calvert, St. Mary's, and Prince George's counties. During this time, southern Maryland was plagued by political struggle and hostility between the area's Puritan settlers and Roman Catholic England. George Calvert, the Catholic third Lord Baltimore, wanted to establish a colony free of religious persecution. In 1658, with this goal in mind, and to honor the first Lord Baltimore, Charles Calvert brokered the county's rededication with its current boundaries (Brown, 1976).

Early settlers of Charles County benefited from prime farming conditions, and focused their efforts on the cultivation of tobacco, which was grown in the area to the almost complete exclusion of other crops (Brown, 1976). The major settlement of colonial Charles County was Port Tobacco. Due to the popularity of agriculture and the fact that easy access to the Potomac River made major seaports unnecessary, Charles County was very rural. The only town in the county within the Historic Architectural APE that appeared upon a list of Maryland towns published in 1871 was Newburg, which was described as "a small post office" (Brown, 1976).

Between the 1600s and the Civil War, Charles County residents experienced stability, interrupted briefly by the War of 1812, during which the British Navy maintained fleets in the Potomac River. After the War of 1812, as the economy began to diversify, fishing was a major industry in the area. By 1832, there were 150 fisheries on the Potomac River, which employed 6,500 people (Charles County Historic Preservation Advisory Council, 2004).

During the Civil War, Charles County also primarily sympathized with the Confederacy, largely due to its tobacco/slave-dependent economy. As a result, and because of its location on the Union-Confederate border, the area was occupied by Union troops. Many Charles County men joined the Confederate Army (Charles County Historic Preservation Advisory Council, 2004).

After slavery was banned in Maryland in 1864, tobacco farming began to decline. By the end of the 19th century, producing tobacco without slave labor was so expensive that farmers could barely cover the cost of production. As a result, many farmers diversified their production. Aided by new railroads, farmers could take a variety of goods to market, and many even turned to canning. The first cannery in Charles County opened in La Plata in April 1883, and many others followed. Fisheries also regained their prominence in the area during this time (Brown, 1976).

In the 20th and early-21st centuries, military installations and legalized gambling have brought new economic bases to Charles County (Brown, 1976). Now considered part of the Washington-Arlington-Alexandria Metropolitan Area, the county has struggled to balance suburban development with the preservation of forest and agricultural lands. The county's managed-

growth strategy, outlined in its 2006 Comprehensive Plan, is to direct 75 percent of its growth to the Development District, encompassing the towns of Waldorf and Bryans Road and the area in between, located approximately 20 mi north of the Historic Architectural APE (Charles County, 2007).

3.6.6.3 History of NSF Dahlgren and NSWCDD

Pre-Installation History (1840s-1918)

The origins of the NSF Dahlgren site and NSWCDD – the Navy's RDT&E center – can be traced to the 1840s, when efforts began to improve Naval ordnance. In 1842, Congress authorized the creation of the US Navy Bureau of Ordnance and Hydrography as part of the modernization of the Navy. The purpose of the new bureau was to develop and construct shipboard weapons and projectiles, and conduct hydrographic studies for navigation purposes (Rife and Carlisle, 2006).

Two years later, federal government and Navy officials, including the Secretary of State and Secretary of the Navy, were killed by a test firing of the "Peacemaker," a 12" gun aboard the *USS Princeton*. Following this tragedy, an investigation led to multiple recommendations for Navy operations, including establishment of quality-control review for guns, and an onshore practice battery to test and range guns prior to their installation aboard ships (Rife and Carlisle, 2006).

In 1847, Lt. John A. Dahlgren (1809-70) was assigned to the Washington Navy Yard. He was an experienced oceanographer, a professor of gunnery, and had an interest in Naval technology. He was charged with transforming the Washington Navy Yard into an ordnance establishment. One of Lt. Dahlgren's top concerns was gun ranging. When produced, each new gun had slightly different characteristics, requiring that it be test-fired repeatedly to determine its range so that it could accurately hit its target when used in battle. Lt. Dahlgren established an "Experimental Battery," mounted on a gun deck overlooking the Anacostia River, with a range of five miles. It had a clear line of sight across the Potomac River to a target area just upriver from the City of Alexandria, where Reagan National Airport is situated on fill today. Lt. Dahlgren also designed special instruments, including a gunner's quadrant for measuring distances, and an alidade for recording the impacts of shots. The Anacostia battery became the prototype for shore-based Naval gun testing (Rife and Carlisle, 2006).

American Civil War and the Turn of the 20th Century (1860s-1900s)

In 1862, during the Civil War, Congress created the US Navy Bureau of Navigation. This action resulted in a reorganized Bureau of Ordnance (BUORD), led by Dahlgren, who was promoted to Rear Admiral that year. The BUORD's sole purpose was to focus on the development of US Naval guns and ordnance (Rife and Carlisle, 2006).

A decade later, naval gun ranges had increased to the point that the Navy shifted the Experimental Battery to the Severn River, across from the US Naval Academy in Annapolis, Maryland. In 1890, the advent of all-steel ships and even longer-range guns prompted a move to a new 13,000-yd testing facility on the Potomac River at Indian Head, Maryland. Still, by the turn of the 20th century, the Indian Head proving ground was quickly becoming obsolete due to the creation of longer guns with greater power. For example, stray shots, flying pieces of armor,

and bands from shells would occasionally fly into nearby civilian and military residences (Rife and Carlisle, 2006).

Indian Head as a proving ground reached the breaking point when the demands of World War I (1917-18) lead to exponential increases in gun testing. Also, full-elevation testing and accurate ranging of the powerful 16" battleship gun developed in 1914 could not be achieved within the confines of Indian Head. As a result, the US Navy began to consider a more isolated location for its proving ground (Rife and Carlisle, 2006).

Establishment of Dahlgren Naval Proving Ground (1918)

A new proving ground had several requirements. It had to be close to the Washington Navy Yard's Navy BUORD and gun factory and Indian Head's powder factory. It also had to be undeveloped, and able to accommodate a long range. During the height of US involvement in World War I, Congress authorized the acquisition by the Navy of a tract of land that included 994 acres between Machodoc Creek and the Lower Cedar Point Lighthouse on Mainside. The isolated site provided a straight, almost unimpeded, over-water range of nearly 90,000 yds toward Chesapeake Bay. Guns could efficiently be shipped by barge from the Washington Navy Yard foundry. Money was appropriated for a new long-range proving ground at Machodoc Creek on April 26, 1918. Breaking with Navy tradition, in which bases were named after the place in which they were located, the site was named after Rear Admiral Dahlgren. As an afterthought, the local post office was renamed "Dahlgren," and Navy tradition was preserved (Rife and Carlisle, 2006).

Dahlgren Naval Proving Ground, 1918-30s (Inter-war Period)

By August 1, 1921, BUORD had transferred almost all of its ordnance work from Indian Head to Dahlgren Naval Proving Ground, and subsequent development followed. Because of its isolated location, the Navy provided both residential and community-support facilities for its officers and personnel. By December 1921, construction was completed on the Commandant's Quarters, the Administration Building, a Recreation Hall, a machine shop, and shell storage and loading buildings (Rife and Carlisle, 2006).

The conclusion of World War I in November 1918 led to a sharp decrease in ordnance testing, but by 1923, Dahlgren Naval Proving Ground's developmental and experimental work was increasing as budgets were slashed. The rigor of RDT&E work increased when Dr. Louis Thompson became the civilian director in April 1923. Thompson's work was experimental and based in the Navy's post-war interest in physics and high-level mathematics.

Some of the most notable studies and projects accomplished during the decade included:

- Thermodynamics of guns
- Fuel oil ignition by projectile bursts
- Tracer shells
- Mechanically timed fuzes
- Illuminating and marker projectiles

- Anti-submarine ordnance fuzes
- Aerial bomb tests

Prescient and decades ahead of their time were studies conducted from 1919-25 of automatically piloted and radio-controlled aircraft, or flying bombs, much like today's unmanned aerial vehicles or drones. Carl L. Norden worked with Dahlgren Naval Proving Ground's scientists and engineers on these projects as well as improving bombsights. As Naval research funds dwindled, these projects were put aside in 1925 in favor of Norden's bombsight program.

As work increased at Dahlgren Naval Proving Ground, so did development of infrastructure. The Navy's Bureau of Yards and Docks was responsible for housing design and layout at Mainside. The bureau opted to adopt the newest theories of suburban planning in its vision for the installation, including the incorporation of main thoroughfares, curving streets, parks and open spaces. The military increasingly adopted these community-planning concepts after World War I to create cohesive installations. Residences constructed during this era were primarily built in the Colonial Revival and Craftsman styles, both popular domestic building modes in the US during the early 20th century. Other developments during this era included the construction of a golf course on reclaimed marshland in the central part of the officer housing area in 1927 (NAVFAC, 1994b).

A general store was also constructed at the installation. However, over time, it became apparent that it could not support the shopping needs of those living there, and therefore, every week an individual would drive to Fredericksburg for supplies. Eventually, the military and civilian population constructed a larger store, thereby decreasing the need to navigate the dirt roads to Fredericksburg, which could be especially treacherous in winter before they were paved in the 1930s (McCollum, 1976).

Industrial development also occurred at Dahlgren Naval Proving Ground in the 1920s and 30s. The Main Battery was established at Mainside during this era near the confluence of the Potomac River and Upper Machodoc Creek. The battery was comprised of laboratories, munitions-storage facilities, watch towers, firing batteries, weapons-testing structures, and other features. In the 1920s, many key facilities were erected, including the Lab & Air Compressor House (Building 249) and material-storage structures, magazines, batteries, gun racks and gun emplacements, to name a few. In 1923, the lab served as the Ballistic Measurement and Instrument Lab for preliminary ballistics and metallurgical research, and played an important role in the improvement of Naval gunnery accuracy (NAVFAC, 1994a).

The wharf area was also developed at Mainside during the inter-war period. Situated downrange from the Main Battery on the northern banks of Upper Machodoc Creek, the wharf played a role in the transportation of general supplies, heavy machines and gun barrels. In 1919 and 1920, multiple structures were erected in the wharf area, including a dock, coal pier and wharf house (NAVFAC, 1994a).

Aviation played an important role at Mainside. In 1919, the US Marine Corps built a ramp and hangar for seaplanes. In 1921, Building 110B, a land plane hangar, was built. Land-based aircraft used a grass field, although stumps in the field remained a hazard until 1925. In 1935, the grass field was replaced with a paved runway. In early aviation testing, pilots did not have radios to communicate with the base, and would instead transmit messages via carrier pigeon (McCollum, 1976).

Aviation supported the proof-firing tests. Measurements of temperatures at altitudes above 20,000 ft were also taken. These data was necessary for computing air density at high altitudes, which affected a round's performance in flight. Aircraft also supplemented watercraft in spotting artillery and patrolling the range area.

Aircraft were also used for testing all types of aviation ordnance and equipment, including bombsights, bomb racks and shackles, and weapons. In 1931, Dahlgren Naval Proving Ground began flight tests of Norden's Mark XV bombsight, a vast improvement over earlier models, and considered one of the most effective weapon systems of World War II (1941-45). Dr. Thompson worked with Norden to perfect the design over the next few years. The installation's role in the development of the Norden Mark XV bombsight, a form of analog computer, rooted it firmly within the field of mechanical computational technology, or computers (Rife and Carlisle, 2006). Aviators practiced both horizontal and dive bombing, and often experimented with high-altitude horizontal bombing. The increased number of high-altitude bombing experiments prompted the Secretary of the Navy to restrict air space north and south of the installation in the early 1940s.

A ten-year post-World War I "holiday" in capital ship building came to an end in 1932 with the election of Franklin D. Roosevelt, former Assistant Secretary of the Navy, as President of the United States. Roosevelt's New Deal extended to the Navy. By the end of 1934, 150 new ships were under construction or in planning. The installation's proving work boomed. The pace of experimental research also quickened. Projects included:

- Determination of ballistic qualities of all types of guns and shells
- Research to improve armor plate
- Development of improved 8" armor-piercing projectiles
- Development of new fuzes (Rife and Carlisle, 2006).
- Knowledge gained from the studies was applied during World War II.

Dahlgren Naval Proving Ground, World War II (1941-45)

Beginning with mobilization in 1940 and escalating when the United States entered World War II in December 1941, Dahlgren Naval Proving Ground underwent a massive expansion. Increased proof-testing requirements for surface guns and aviation ordnance triggered a transformation at the installation. In terms of size, the installation expanded by 3,500 ac in 1944, including the acquisition of the Pumpkin Neck test area at the mouth of Upper Machodoc Creek, the site of the present-day EEA. In addition, five range stations were added to the Potomac River range in Virginia.

The installation underwent dramatic industrial expansion. A 23-mi rail spur was constructed between Dahlgren and Fredericksburg to facilitate movement of heavy goods. The Main Battery at Mainside expanded as well, and the testing regime expanded tenfold, with millions of rounds fired from guns of every caliber and millions of pounds of powder expended. As the Navy's principal proving ground, all types of Navy ordnance, including guns, fuzes, and lot samples of projectiles, ammunition, and aerial bombs, were proof-tested prior to being deployed to fighting ships at sea. The airfield was expanded, and an Aviation Experimental Laboratory was established to develop and test rocket-propelled armor-piercing bombs, incendiary bomb clusters, and experimental target-identification bombs (Rife and Carlisle, 2006).

New laboratories and range facilities were built to perfect existing ordnance and develop new types, such as rockets and the variable time (radio proximity) fuze – a major advance that allowed a projectile or bomb to sense and explode near a target rather than needing to make direct contact. Within the Main Battery, boiler houses, 14 new magazines, armament facilities such as ten major-caliber gun emplacements, 17 small-caliber gun emplacements, offices, towers, and huts were erected to assist in the war effort. The wharf area at Mainside also expanded. For example, crane runways were erected for gantry cranes used to load and unload ships. A power house, boat-parts building, office, and rocket-assembly building were constructed at this time.

To accommodate new workers, 30 buildings were constructed in the officer housing area at Mainside. These included simplified Colonial Revival-style buildings and community support structures such as a dispensary, barracks, chapel, theater, library, and school (NAVFAC, 1994b; Rife and Carlisle, 2006).

Major achievements during World War II included the development of the Mark XV Norden bombsight and radio proximity fuze. Both these instruments improved the accuracy of aerial bombing campaigns. Furthermore, scientists played a tangential role in the Manhattan Project by developing and testing the ballistic qualities of gun-assembly bombs (Rife and Carlisle, 2006).

Cold War and Post-Cold War Eras (1946-Present)

After World War II, Dahlgren Naval Proving Ground continued testing gun components, projectiles, and fuzes. However, this role gradually became a smaller portion of its work as it built upon its early use of simple computers in developing new technologies and evolved into one of the Navy's primary research centers.

During the 1950s, the United States was in the height of the Cold War (1946-89) with the Soviet Union. The Cold War was essentially a conflict between American democracy and Soviet communism that led to an ongoing threat of nuclear war between the two nations. As a result, the US military focused on developing new technologies that would put the United States at an advantage. In 1953, the Navy sponsored development of the Naval Ordnance Research Calculator and selected Dahlgren Naval Proving Ground as its installation site. the Naval Ordnance Research Calculator was designed to perform the large calculations related to ordnance development, and was used to compute trajectories for the first US Army ballistic missile system, known as Jupiter (Rife and Carlisle, 2006).

In 1955, Rear Admiral Frederic S. Withington designated Dahlgren Naval Proving Ground as the prime BUORD agency for computation, exterior/rigid and body/terminal ballistics, and warhead characteristics. To better handle this new responsibility, Withington authorized the creation of three new laboratories: Computation and Exterior Ballistics (K); Warhead and Terminal Ballistics (T); and Weapons Development and Evaluation (W). The following year, Withington again expanded the installation's responsibilities by assigning the HERO program to the W Laboratory, beginning its extensive work in the area of EM technology and safety (Rife and Carlisle, 2006).

The Cold War escalated in the mid-1950s, and in 1957, the Soviet Union launched the Sputnik I satellite, causing panic in the United States. Two years later, the Naval Space Surveillance Operations Center was established at the installation's Computation and Analysis Laboratory, part of the K Laboratory, to monitor foreign satellites passing over the United States. (This facility was

re-designated the Naval Space Surveillance System in 1961.) Also in 1959, the Navy officially recognized the change in the installation's mission from traditional proving ground to research and development facility by changing its name from the Naval Proving Ground to the Naval Weapons Laboratory (Rife and Carlisle, 2006).

During the beginning and height of the Vietnam War (1960-1973), the installation became involved with a number of new projects, including:

- Satellite geodesy
- Projectile and warhead development
- Development and testing of armor materials
- Vulnerability studies of air and ground targets
- Weapons-systems aiming data
- Computation models for surface warfare exercises
- Computer simulation of ship-loading programs for POLARIS submarines
- Testing and evaluation of gun systems
- Operation and study of lasers

In 1964, a new Computation and Analysis building was constructed for K Laboratory, ushering the installation into a new era of technology. This was followed in 1968 by a restructuring of the Naval Weapons Laboratory, which eliminated the three-laboratory system, replacing it with five main technical departments and a number of support departments (Rife and Carlisle, 2006).

At the beginning of the 1970s, with the Vietnam War still underway, the installation was once again awarded more responsibilities. The Navy designated it as its lead laboratory for biological, chemical, and surface weapons, with a particular focus on surface gunnery systems. In 1972, new computing technology, in the form of a 6700 mainframe computer, replaced NORC (Rife and Carlisle, 2006). Two years later, after the Vietnam War – though not yet the Cold War – had ended, the Navy consolidated the Dahlgren Naval Weapons Laboratory with the White Oak Naval Ordnance Laboratory, located in Silver Spring, Maryland. This created the Naval Surface Weapons Center (NSWC), "the Navy's largest RDT&E center" (Finch, 2003). The two sites were identified as the Dahlgren Laboratory (NSWCDL) and White Oak, respectively (Rife and Carlisle, 2006).

In 1976, the Navy chose the NSWC to develop the proposed Aegis Combat System, designed to use powerful computers and radars to track and destroy enemy targets and to defend against air, surface, and subsurface threats. This brought NSWC into the emerging field of systems engineering. Other technological advances created during the late 1970s and early 1980s included targeting software for Tomahawk sea-launched cruise missiles, the Phalanx close-in anti-ship missile system, and improvements to the Aegis system. As a result of NSWC's work on the Tomahawk program, the Cruise Missile Weapons Systems Division was established in 1984, and two years later NSWC became the lead laboratory for the standard surface-to-air missile. Recognition of the expanded areas of interest at NSWC resulted in a name change in 1989 to the Naval Surface Warfare Center (NSWC) (Rife and Carlisle, 2006).

As the Cold War began to draw to a close later that year, the US military's – and therefore the installation's – focus shifted toward conflicts in the Middle East. NSWC played a large role in the early-1990s Operations Desert Storm and Desert Shield. Among the contributions from NSWC to these conflicts were upgrading threat libraries for Saudi Arabian ships; developing chemical/biological/radiation defense systems; and creating an Identification Friend-or-Foe device to help distinguish types of ground vehicles in order to prevent friendly-fire incidents (Rife and Carlisle, 2006).

In 1991, President George H.W. Bush announced a downsizing of the US military. In January 1992, under the Defense Base Closure and Realignment (BRAC) Commission, the Navy combined three entities: Dahlgren, White Oak, and Panama City, Florida Coastal Systems Station into the new Dahlgren Division of the Naval Surface Warfare Center (NSWCDD). In the early-to-mid 1990s, new programs at NSWCDD included the Naval Warfare Analysis Center and the DoD's Counterdrug Technology Development Program. In the late 1990s, as the US military's focus shifted away from traditional warfare and toward counter-terrorism measures, Admiral Jay L. Johnson established the Naval Operations Other Than War Technology Center at the installation (Rife and Carlisle, 2006).

As a result of the 1992 BRAC action, White Oak Laboratory closed in 1997. Personnel and functions from that facility were reassigned to Naval Surface Warfare Centers at Dahlgren; Panama City, Florida; Carderock, Maryland; and Indian Head, Maryland. In 1999, as part of the DoD's chemical and biological defense program, work began at the installation on a new chemical-biological laboratory. In 2003, major reorganizations began to more effectively address new threats to security and to counter terrorism (Finch, 2003). The mission of the center, presently known as NSWCDD, is described in Section 1.3.

3.6.7 Archaeological Resources

As discussed in Section 3.6.2, the Archaeological APE for this EIS includes the EEA, a 300-ft buffer south of the EEA between Upper Machodoc Creek and the Potomac River, and the PRTR MDZ in the Potomac River (Figure 3.6-1). This Archaeological APE is concerned with *indirect effects* upon archaeological resources resulting from testing-related noise, particularly with regard to shipwrecks in the Potomac River.

3.6.7.1 Archaeological Study Area

For comparative purposes, a broader study area that incorporates land and water areas outside of the Archaeological APE was developed. This study area includes the Mission Area and Ranges on Mainside on NSF Dahlgren; Upper Machodoc Creek and its banks in the vicinity of NSF Dahlgren; the width of the Potomac River from NSF Dahlgren to within roughly one mile east St. Clement's Island; and islands within the Potomac River in the vicinity of the Archaeological APE. This study area provides a broader context within which to interpret previously identified sites within the Archaeological APE, as well as to evaluate the potential for additional, as-yet-unidentified sites to be present.

3.6.7.2 Previously Identified Archaeological Resources

Archaeological data were collected for previously identified sites and resources within the Archaeological APE and the broader study area. Information was gathered from several repositories as well as through Internet searches. NSF Dahlgren provided archaeological survey reports and geographic information system (GIS) mapping noting previously identified sites and existing conditions on the installation. Archaeological site file forms from VDHR provided further information on archaeological sites identified across the study area. In addition, reports and site forms on file at MHT and the Naval History and Heritage Command (NHHC) provided information on maritime sites, including shipwrecks and other submerged resources, in the study area.

The archaeological data collected were reviewed, and the following categories of information were noted:

- Previous archaeological surveys
- National Register-listed resources
- National Register-eligible resources
- Previously identified resources determined not eligible
- Previously identified but unevaluated resources

As the Archaeological APE includes land and water areas, the discussion of collected information is presented in three subsections: Terrestrial Resources, Resources on Islands in the Potomac River, and Maritime Resources. A summary of all sites identified within the Archaeological APE follows a more detailed discussion of resources within the larger study area.

Previous Terrestrial Archaeological Surveys

Numerous archaeological studies conducted at NSF Dahlgren during the past few decades, as well as earlier regional studies along the Potomac River, have identified terrestrial archaeological sites within the study area. A large percentage of the studies on base were conducted in the 1990s and identified sites throughout the installation. Ongoing studies continue to produce new information about archaeological resources at NSF Dahlgren.

William Dinwiddie of the Smithsonian Institution conducted studies in the Northern Neck of Virginia along the Potomac River in 1891 and 1892, naming many sites for the small tributaries along which they were discovered (Holmes et al., 1891). Within the boundaries of NSF Dahlgren, he identified the sites Black Marsh 1 and 2, which are on the EEA (associated with Sites 44KG117 and 44KG118).

In 1979, American University conducted the Potomac River Archaeology Survey. This work included a preliminary reconnaissance of the EEA, which identified 16 potential archaeological sites based on the presence of artifacts and/or shell concentrations (14 prehistoric; one historic; and one with both prehistoric and historic components) (NSWCDL, 1992; NSF Dahlgren and Engineering Field Activity Chesapeake, 2006). The majority of the potential sites were noted to be located in the southern portion of the EEA; however, the potential sites have not been registered with the VDHR and their exact locations are unclear from the documentation reviewed for this report.

During the 1990s, the Mary Washington College (MWC) Center for Historic Preservation conducted surveys throughout NSF Dahlgren. In 1995, a walkover of the EEA was conducted by staff of MWC and Ms. Patricia Albert of NSF Dahlgren. Another walkover conducted in 1997 by MWC revisited sites identified by American University and identified four new domestic sites; these additional four sites have not been registered with the VDHR (NSWCDD, 1998; NSF Dahlgren and Engineering Field Activity Chesapeake, 2006).

Beginning in the 1990s, a number of environmental assessments (EAs) were conducted at NSF Dahlgren in response to proposed improvements at the facility. The EAs were prepared by several consulting groups including Greenhorne & O'Mara; Malcolm Pirnie, Inc.; Geo-Marine, Inc.; Geophex; TAMS/Earth Tech; and The Louis Berger Group. As part of these EAs, the proposed locations of project-specific impacts were reviewed for their potential archaeological sensitivity. While most of these assessments did not recommend additional archaeological work, a few did recommend that archaeological surveys be undertaken (NSWCDL, 1992 and NSF Dahlgren, 2006).

As part of the proposed construction, installation, and operation of the Naval Ordnance Transient Electromagnetic Simulator (NOTES) facility, a Phase 1 archaeological survey was conducted by Malcolm Pirnie, Inc. (NSWCDL, 1992). The archaeological survey investigated a proposed location on the EEA, one of four alternative locations for the facility (three on Mainside and one on the EEA). This survey did not identify any archaeological resources within the proposed project area on the EEA.

The EA to build and operate the Electromagnetic Research and Engineering Facility (EMREF) and Counter Explosive Test Facility (CETFAC) structures included an archaeological survey conducted by the Louis Berger Group (NSF Dahlgren and Engineering Field Activity Chesapeake, 2006). The survey was conducted at the two alternative locations proposed for CETFAC on the EEA and identified two prehistoric archaeological sites (Sites 44KG117 and 44KG118) (NSF Dahlgren and Engineering Field Activity Chesapeake, 2006).

Most recently, proposed activities associated with shoreline-stabilization projects at NSF Dahlgren were determined to have an adverse effect on previously identified National Register-eligible archaeological sites at the facility (Sites 44KG105 and 44KG157) (NDW, 2007). A Memorandum of Agreement between the VDHR and NSF Dahlgren was prepared in order to mitigate impacts to these resources. Mitigation actions were to include "documentation, systematic surface collections, onsite monitoring during construction, use of logging mats, post-construction site assessments, revision to sites forms, artifact analysis, and production of a technical report detailing these actions" (NDW, 2007). A report is not yet on file with the VDHR for this project.

Installation-wide documentation of the NSF Dahlgren facility has included an Historic and Archaeological Resource Protection (HARP) Plan prepared in 1992 (NAVFAC, 1992). In addition, NSF Dahlgren is currently preparing an Integrated Cultural Resources Management Plan (ICRMP) that will provide a comprehensive view of existing conditions on the installation (Albert, pers. comm., April 29, 2009).

Previously Identified Terrestrial Archaeological Resources

Because NSF Dahlgren is located on the banks of the Potomac River and has multiple tidal tributaries throughout the property, it has both prehistoric and historic archaeological potential.

Previous studies have identified dozens of terrestrial archaeological sites within the archaeological study area, largely in the vicinity of these waterways. Approximately 40 of these sites are registered with the VDHR; an additional 18 unconfirmed sites on file with NSF Dahlgren are not yet registered with the VDHR. Figure 3.6-4, Terrestrial Archaeological Resources Within or in the Vicinity of APE, notes the general location of sites registered with the VDHR and four of the unconfirmed sites on file with NSF Dahlgren; the locations of the four unconfirmed sites are based on GIS mapping provided by NSF Dahlgren in 2008. Of the sites registered with the VDHR and the four unconfirmed sites noted from mapping provided by NSF Dahlgren, six are within the Archaeological APE on the EEA. No archaeological sites have been identified within the 300-ft buffer south of the EEA, which is part of the Archaeological APE.

Of the sites registered with the VDHR, approximately one fourth date solely to the prehistoric period. Prehistoric activities identified include lithic and shell processing as well as domestic camp sites occupied from the Early Archaic through the Late Woodland Periods. Another quarter of the sites date solely to the historic period and represent domestic trash scatter and structural remains dating from the 17th century through the first half of the 20th century. Half of the sites identified components from both the prehistoric and historic periods, showing continual occupation of the study area for thousands of years.

National Register-Listed Terrestrial Resources

No previously identified sites within the study area are listed in the National Register.

National Register-Eligible Terrestrial Resources

Two of the previously identified sites within the study area were evaluated by VDHR and determined eligible for listing in the National Register (VDHR, 2008a). These sites – Site 44KG105 - Payne Site and Site 44KG157 – were identified as lithic-manufacturing and shell-processing sites dating from the Archaic and Woodland Periods; these sites are situated along the Potomac River and along Gambo Creek where it flows into the river, respectively.

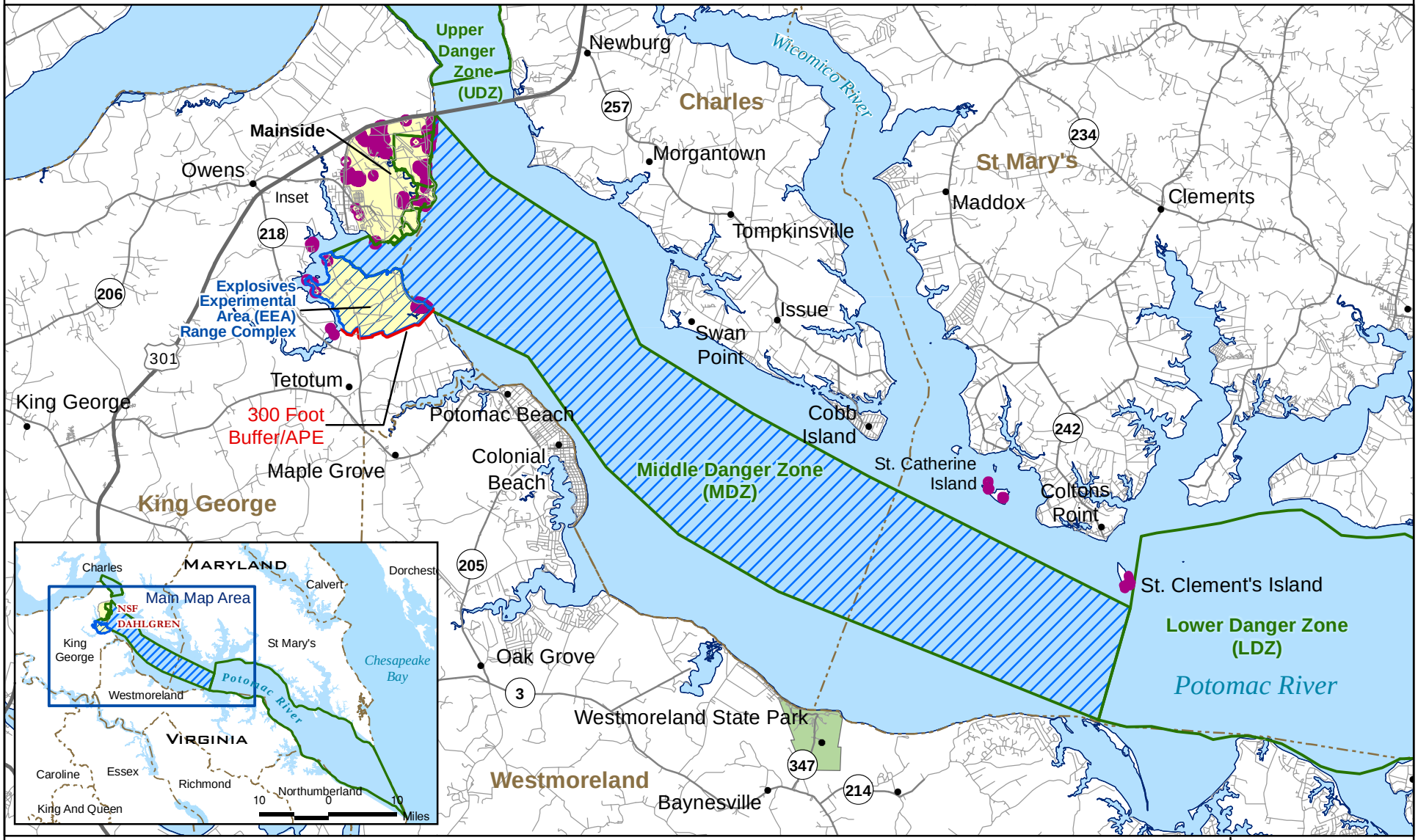
Previously Identified Terrestrial Resources Determined Not Eligible

Three sites at NSF Dahlgren in the vicinity of the study area were determined not eligible for listing in the National Register due to a lack of integrity from previous disturbances, such as agricultural or other development activities (Sites 44KG112, 44KG113, and 44KG152).

Previously Identified, Unevaluated Terrestrial Resources

The majority of previously-identified terrestrial archaeological sites within the study area, including the six located within the Archaeological APE, remain unevaluated by the VDHR, and their National Register-eligibility status is uncertain at this time. Through previous archaeological surveys, some of these sites have been recommended as potentially eligible for listing in the National Register, while others were noted as disturbed or destroyed and were not recommended as eligible for listing due to a lack of site integrity.

Terrestrial Archaeological Resources Within or in the Vicinity of Area of Potential Effect



Archaeological Area of Potential Effect (APE)

300 Foot Buffer / APE

Potomac River Test Range (PRTR) Complex

Naval Support Facility (NSF) Dahlgren

Approximate Location of Previously Identified Terrestrial Archaeological Resource

County Boundary

3 0 3 Miles

5 0 5 Kilometers

N

NSWCDD EIS

NAVSEA WARFARE CENTERS DAHLGREN

Sources: NSF Dahlgren, 2008 (archeological resources within NSF Dahlgren property)
VDHR, 2008 (archaeological resources in Virginia, outside of Dahlgren Property)
MHT, 2008 (archaeological resources in Maryland)

Figure 3.6-4

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Documentation for these sites was limited. Prehistoric sites include shell middens and lithic scatter from which diagnostic projectile points and pottery fragments were also recovered. Many of these historic sites represent domestic trash scatter associated with plantations/farmsteads as well as with the period of establishment of the installation. A small number of foundations and possible outbuilding depressions, including the possible Barnesfield Dairy operation (Site 44KG165), were recorded. Pier remains, designated a terrestrial archaeological site with VDHR, were identified along Upper Machodoc Creek several hundred feet south of the Archaeological APE (Site 44KG38).

Of the six terrestrial archaeological resources within the Archaeological APE, one was recommended as potentially eligible for listing in the National Register following an archaeological survey. This site – Site 44KG117 – Black Marsh 1 – is a Late Archaic/ Transitional Period lithic and shell-processing camp situated between Black Marsh and the Potomac River in the southeast portion of the EEA (NSF Dahlgren and Engineering Field Activity Chesapeake, April 2006). A nearby site – Site 44KG118 – Black Marsh 2 – containing lithic scatter dating to the Middle Archaic Period, was not recommended as eligible for listing in the National Register due to a lack of integrity (NSF Dahlgren, 2006). As noted above, the VDHR has not yet evaluated the eligibility of these sites and their status remains unknown to date. The remaining four sites are on-file with NSF Dahlgren and have not been registered with the VDHR (MWC 17, MWC18, MWC 19, and MWC 34). These sites are situated in the northwest portion of the EEA near Upper Machodoc Creek, and may represent historic domestic deposits identified on the EEA by MWC in the 1990s; however, the exact nature of their cultural affiliation and their level of integrity is not clear from available information.

Previous Archaeological Surveys on Islands within the Potomac River

During the later part of the 20th century, a number of archaeological surveys were conducted on islands in the Potomac River in association with planned erosion-control projects. In particular, surveys were conducted on St. Catherine Island, near the mouth of the Wicomico River, and on St. Clement's Island near Coltons Point, Maryland.

Surveys were conducted on St. Catherine Island in the 1980s by staff of Historic St. Mary's City Research Lab. These non-systematic surface surveys identified a small number of prehistoric- and historic-period sites across the island.

In the late 1990s, surveys were conducted on St. Clement's Island by the Center for Historic Preservation at MWC, under subcontract to Dames & Moore. A Phase I survey on the southwestern end of the island identified a prehistoric site, which a Phase II evaluation determined eligible for inclusion in the Maryland Register of Historic Properties (Maryland DGS and MHT, 1998). An archaeological investigation on the island in the 1960s also identified a prehistoric-period site, discussed below.

National/State Register-Listed Resources

No previously identified sites situated on islands within the Potomac River study area are listed in the National Register.

National/State Register-Eligible Resources

One previously identified site situated on an island within the Potomac River study area has been evaluated by the MHT and determined eligible for inclusion in the Maryland Register of Historic Properties. Located on the southwestern edge of St. Clement's Island, this site was identified and evaluated in the late 1990s by MWC (Maryland DGS and MHT, 1998). The site was interpreted as a prehistoric shell midden with culturally distinct strata dating to the Middle and Late Woodland and Contact Periods (Site 18ST686, St. Clement's Island Midden [West Area I]). Archaeological analysis of the site revealed the central portion of the midden to be intact; the northern and southern extents were disturbed and the southeastern limit was eroding into the Potomac River.

Previously Identified Resources on Islands Determined Not Eligible

No previously identified sites situated on islands within the Potomac River study area have been evaluated and determined ineligible for listing in the National Register.

Previously Identified, Unevaluated Resources on Islands

Four previously identified, unevaluated archaeological sites on islands within the Potomac River study area are on file with the MHT. These sites are located on St. Catherine and St. Clement's Islands.

Three of the sites were identified on St. Catherine Island in the 1980s by MWC. One site was interpreted as a Late Woodland Period shell midden located along high ground at the southeastern end of the island (Site 18ST441, Borrow Pit [Field #3]). The other two sites were identified at the northern end of the island and included a historic house site and shell midden situated on the northern peninsula of the island (Site 18ST440, Field #2), and a scattering of 18th century artifacts and shell (Site 18ST439, Field #1).

One previously identified, unevaluated archaeological site is located on St. Clement's Island, along its southeastern shore. This site, identified in 1963 by Commander G. Braley and B. Bruce Powell, was interpreted as a prehistoric burial within a shell pit, or possible shell midden (Site 18ST18, Blackistone Island [St. Clement's Island]). The burial was excavated by Braley and Powell, and the skeleton was eventually donated to the Smithsonian Institution in Washington, D.C. The precise location of the burial site, however, was not recorded and remains unknown.

The 1963 National Register Nomination Form for the St. Clement's Island Historic District noted the potential for additional burials to be present in the vicinity of Site 18ST18. A field visit by the MHT in 2003 noted extensive disturbance in the area due to erosion and construction of riprap which had likely completely destroyed the site. An examination of the eroded bank at that time showed no evidence of archaeological resources.

Previous Maritime Archaeological Surveys

A number of surveys of the Lower Potomac River found in the MHT and the NHHC repositories identified shipwrecks and other submerged archaeological resources within the vicinity of the archaeological study area, which includes the Potomac River from NSF Dahlgren to St. Clement's Island. Shipwrecks and other submerged archaeological resources within the Potomac River are within the purview of the state of Maryland, and the MHT's Maryland Maritime

Archaeology Program (MMAP) in Crownsville, Maryland houses their archives. The Navy, however, retains jurisdiction over all naval wrecks within the river, and has information specific to these vessels in its repository at the Washington Navy Yard in Washington, D.C.

Research in the 1980s for the newly established MMAP notes a *Phase I Underwater Archaeological Project* in the "quad file notes" of the MHT. This project is associated with submerged and partially submerged maritime features, such as an existing lighthouse, pier, and bridge within the vicinity of the Archaeological APE. However, the project appears to have been limited to the notation of maritime sites based on cartographic research and did not include underwater field investigation (Langley, pers. comm., October 16, 2008).

In 1997, the *United States Navy Shipwrecks in Maryland Inventory and Assessment* was prepared for the MHT; this report deals with vessels located in Maryland waters that fall under the jurisdiction of the NHHC (MHT, 1997). The study created a database of naval shipwrecks through documentary research at various national, state, and maritime archives as well as from private collections; field work was not conducted as part of this survey. The purpose of the study was to develop a system for assessing and evaluating naval shipwrecks and to serve as a "reference and planning document to manage naval wrecks" (MHT, 1997).

In the 1970s, Steve Wilkie and Gail Thompson conducted shoreline surveys of the Potomac River (De Sarran, pers. comm., October 14, 2008). More recent studies, noted below, utilized remote-sensing techniques to identify submerged sites in Maryland and Virginia waters.

The Institute of Maritime History conducted a Phase I reconnaissance survey of the Potomac River in St. Mary's County, from the mouth of the Wicomico River to Piney Point, Maryland (MHT, 2007). The survey conducted background research and utilized side-scan sonars to identify shipwrecks and other submerged historic resources for entry into an ongoing database of submerged sites in Maryland waters.

A Phase I survey of Navy shipwrecks and other submerged archaeological resources in the Lower Potomac River was conducted between 2003 and 2005 by staff of the Maryland's Office of Archaeology and volunteers (NHC, Friends of St. Clements Island-Potomac River Museum, and MHT, 2007). The survey area extended from around the Wicomico River southeast to St. Mary's River and included tributaries on both sides of the Potomac River. The project aimed to locate and catalogue submerged maritime archaeological resources through side-scan sonar and magnetometer surveys. An in-depth historic context against which to evaluate the significance of resources identified was also developed for this project.

Previously Identified Maritime Archaeological Resources

The Archaeological APE for the current EIS includes the portion of the Potomac River that corresponds with the boundaries of the PRTR MDZ from below the Nice Bridge south to St. Clement's Island. Research was conducted to identify submerged archaeological resources within the Archaeological APE as well as within the wider archaeological study area, which includes the river from NSF Dahlgren south to just east of St. Clement's Island, beyond the bounds of the MDZ. Archaeological resources identified consist primarily of shipwrecks but include submerged refuse dumps, pier remains, lighthouses, anchors, and the ruins of a tidewater mill. Due to the sensitive nature of Navy shipwrecks, and for consistency, none of the maritime resources identified within the study area are presented in a figure for this report.

The 1997 MHT survey of Navy shipwrecks identifies 66 naval shipwrecks in Maryland waters (MHT, 1997). A partial list of foundered Navy shipwrecks and aircraft wrecks in the lower Potomac River, which includes the river from Washington D.C. to the Chesapeake Bay, identifies 13 shipwrecks and 4 aircraft wrecks (NHC, 2008). The majority of the shipwrecks date to the Civil War period; a smaller number date to the mid-to-late 18th century; the remainder date to the first half of the 20th century. The aircraft wrecks noted in the database date to the first half of the 20th century. Some of the shipwrecks identified are within the archaeological study area and potentially within the Archaeological APE; these are discussed below. None of the aircraft identified in the NHHC database are within the archaeological study area (NHC, 2008).

Due to its historical significance and relative proximity to the Archaeological APE and study area, it is also worth noting the shipwreck of the USS *Tulip*, situated in the Potomac River. The *Tulip* was lost in 1864 when a boiler exploded, taking the lives of 49 people on board (MHT, 1997). An approximate location of this site was identified through the historic record (MHT, 1997), and more recently, the shipwreck site was identified through a remote sensing survey (MHT, 2007). The USS *Tulip* is located approximately seven miles southeast of the Archaeological APE and archaeological study area.

National Register-Listed Maritime Archaeological Resources

None of the previously identified maritime sites within the study area are listed in the National Register.

National Register-Eligible Maritime Archaeological Resources

None of the previously identified maritime archaeological sites within the study area have been determined eligible for listing in the National Register.

Previously Identified, Maritime Archaeological Unevaluated Resources

A number of previously identified maritime archaeological resources have been identified within the study area; however, to date the National Register-eligibility of these resources has not been evaluated by the MHT.

A survey utilizing historical records identified four maritime resources, comprised of six naval shipwrecks from the Civil War era, within or adjacent to the archaeological study area (MHT, 1997). They include two Confederate schooners – the *Somerset* and the *Christiana Keen* – and a US army transport – the *Frances Elmor*. Historic records note that all three vessels were captured and burned during Civil War fighting. The remaining three naval shipwrecks, identified as a single resource under the name *Three Boats*, were utilized as transport vessels during the Civil War when they were captured and destroyed by the US; the names of these three boats are unknown (MHT, 1997).

The exact locations of these six naval vessels have not been verified through the use of underwater survey methods; only their "general locations" within the Potomac River are noted in the MHT's *Inventory and Assessment* (MHT, 1997). Their general locations are noted as being in the vicinities of Nomini Bay, Upper Machodoc Creek, Bluff Point, and Swan Point. The general location depicted for the *Somerset* is close to, but outside of the Archaeological APE. Whether the remaining five naval shipwrecks lie within the PRTR MDZ portion of the Archaeological APE is unknown, as only their general locations are depicted.

In addition to the naval vessels identified with the NHHC, a number of other previously identified sites have been recorded with the MHT within or adjacent to the Archaeological APE. Some of these resources have been issued national Smithsonian site numbers by the MHT, while others were issued only "quad file note" numbers in the MHT's internal files. Two of these sites, discussed in more detail below, have been identified within the Archaeological APE.

Within the study area, a small number of side-scan sonar anomalies that may represent sunken vessels have been identified in the vicinity of St. Clement's Island (NHC, Friends of St. Clements Island-Potomac River Museum, and MHT, 2007). One of these sites known via an anomaly – Stratford Hall-QF05 (or STRATF QF05) – is located within the Archaeological APE. In addition, to the north and west of this, in the vicinity of Colonial Beach, Virginia, an 18th-century anchor known as the Dahlgren Anchor Site was identified within the Archaeological APE; the anchor has since been recovered by the US Coast Guard.

Pier remnants have also been noted within the study area on the Potomac River and on Upper Machodoc Creek, all outside of the Archaeological APE. Remains were identified in the Potomac River near St. Clement's Island (or Blackistone Island) in St. Mary's County, Maryland and along Lower Cedar Point in Charles County, Maryland, across from NSF Dahlgren. The MHT designated the pier remains as St. Clement's-QF04 and Colonial Beach North-QF15. Within Virginia, pier remains associated with an 18th-century or possibly earlier crossing of Upper Machodoc Creek called "Little Ferry" were identified southwest of the Archaeological APE in King George County; the VDHR designated the pier remains as terrestrial Site 44KG38.

The remains of a tidewater mill have been recorded by the MHT as Site 18ST539 in the waters off of Westmoreland State Park, Virginia. The site is usually submerged, but portions of the remains are exposed during low tide. A lighthouse located northeast of the Archaeological APE near Lower Cedar Point was also identified by the MHT.

Summary of Previously Identified Resources within Archaeological APE

No National Register-listed or -eligible archaeological resources have been identified within the Archaeological APE at NSF Dahlgren. However, eleven unevaluated archaeological sites have been recorded within or potentially within the Archaeological APE, and are on file with various agencies, including the VDHR, the MHT, NSF Dahlgren and the NHHC. These sites include six terrestrial archaeological sites and five maritime archaeological resources; the exact location of three of the unevaluated maritime archaeological resources (comprised of five Navy shipwrecks) is unknown, but a recent study depicts them potentially within the Archaeological APE (MHT, 1997).

Conditions of some of these resources are known based on previous archaeological and historic architectural surveys, and in some cases archaeologists have made recommendations regarding their National Register eligibility based on National Register criteria. As noted in the prior subsection on terrestrial resources, one of the sites in the Archaeological APE was recommended as eligible for listing in the National Register (44KG217-Black Marsh 1), while a second was recommended as ineligible (44KG218-Black Marsh 2) (NSF Dahlgren, 2006). Another site identified within the Potomac River portion of the Archaeological APE, an 18th-century anchor, has since been removed to a pier; however, the possibility that an associated shipwreck may be present in the vicinity of the anchor site should be noted. Historic records of the Navy

shipwrecks indicate that shipwrecks within the Archaeological APE were burned and/or destroyed when lost during the Civil War.

Table 3.6-3 identifies eleven archaeological resources within or potentially within the Archaeological APE. As noted above, the VDHR and the MHT have not yet evaluated these sites and therefore their National Register-eligibility status remains undetermined.

Table 3.6-3
Archaeological Resources Within or Potentially Within the Archaeological APE

Resource Name	Resource Type	Recommendation and/or Condition of Resource	On File
44KG217 (Black Marsh 1)	Terrestrial	Recommended NRE[2]	VDHR and NSF Dahlgren
44KG218 (Black Marsh 2)	Terrestrial	Not recommended NRE[2]	VDHR and NSF Dahlgren
MWC17	Terrestrial	Unknown[3]	NSF Dahlgren
MWC18	Terrestrial	Unknown[3]	NSF Dahlgren
MWC19	Terrestrial	Unknown[3]	NSF Dahlgren
MWC34	Terrestrial	Unknown[3]	NSF Dahlgren
Colonial Beach South QF04 (Dahlgren Anchor Site)	Maritime	Anchor recovered from site by US Coast Guard in 1990[4]	MHT
STRATF QF05 [side-scan sonar anomaly]	Maritime	Unknown[4]	MHT
Christiana Keen[1]	Maritime	Burned and sunk[5]	NHHC
Frances Elmor[1]	Maritime	Burned and sunk[5]	NHHC
Three Boats[1]	Maritime	"Destroyed" and sunk[5]	NHHC

[1] Resource located within or potentially within the Archaeological APE (MHT, 1997).
[2] NSF Dahlgren and Engineering Field Activity Chesapeake, 2006.
[3] GIS data from NSF Dahlgren, 2008.
[4] Site file forms at MHT.
[5] MHT, 1997.

3.6.8 Historic Architectural Resources

3.6.8.1 Resources outside NSF Dahlgren

Multiple historic architectural resources have been surveyed within or immediately adjacent to the Historic Architectural APE outside NSF Dahlgren in Virginia and Maryland. In Virginia, approximately 335 resources have been surveyed according to the VDHR (Williams, pers. comm., December 8, 2008). Approximately 330 of the 335 resources are located within the 120-dBP noise contour, and five are located in the vicinity of the 134-dBP noise contour. In Maryland, approximately 320 resources have been surveyed according to MHT (MHT, 2008). All the resources in Maryland are located within or close to the 120-dBP noise contour.

Impacts of the Proposed Action on previously identified National Register-listed and National Register-eligible historic architectural resources within the Historic Architectural APE will be evaluated in this document. Twenty National Register-listed resources are located within or immediately adjacent to the 120-dBP noise contour, as depicted on Figure 3.6-2 and indicated in Table 3.6-1. Of these 20 resources, eleven are located in Virginia and nine in Maryland. Sixteen National Register-eligible resources are located within or immediately adjacent to the 120-dBP noise contour, as depicted on Figure 3.6-2 and indicated in Table 3.6-2. Of these 16 resources, eight are located in Virginia and eight in Maryland.

3.6.8.2 Resources within NSF Dahlgren

In the 1990s, several historic architectural resources surveys were conducted at NSF Dahlgren. The two most conclusive surveys included:

- Inventory of Standing Structures Within the Operations and Industries Area at The Dahlgren Laboratory of the Dahlgren Division, Naval Surface Warfare Center (NAVFAC, 1994a);
- Architectural Investigations Undertaken in the Dahlgren Residential Area, Naval Surface Warfare Center, Dahlgren Laboratory, Dahlgren, Virginia (NAVFAC, 1994b).

These surveys concluded that four proposed historic districts are located at Mainside:

- Residential Historic District within the Community Support Area
- Main Battery Historic District within the PRTR and Mission Area
- Wharf Area District within the Mission Area
- Airfield Historic District within the Mission Area

In 1994, VDHR issued an opinion that NSF Dahlgren constitutes a single National Register-eligible historic district known as Naval Surface Warfare Center, Dahlgren Laboratory. VDHR indicated that the single district should consist of several discontiguous areas, including the industrial testing area, the airfield area, and the residential area (Miller, letter, April 25, 1994). VDHR, NSF Dahlgren, and NSWCDD have not concurred on the boundary (VDHR, 2008b). Therefore, for the purposes of this EIS, impacts of the Proposed Action on the four districts will be evaluated.

The four districts are shown in Figure 3.6-5, Historic District Locations. It should be noted that the proposed Main Battery and Wharf Area Districts, as well as the southern portion of the proposed Residential District and most of the Airfield District, fall within the 134-dBP noise contour.

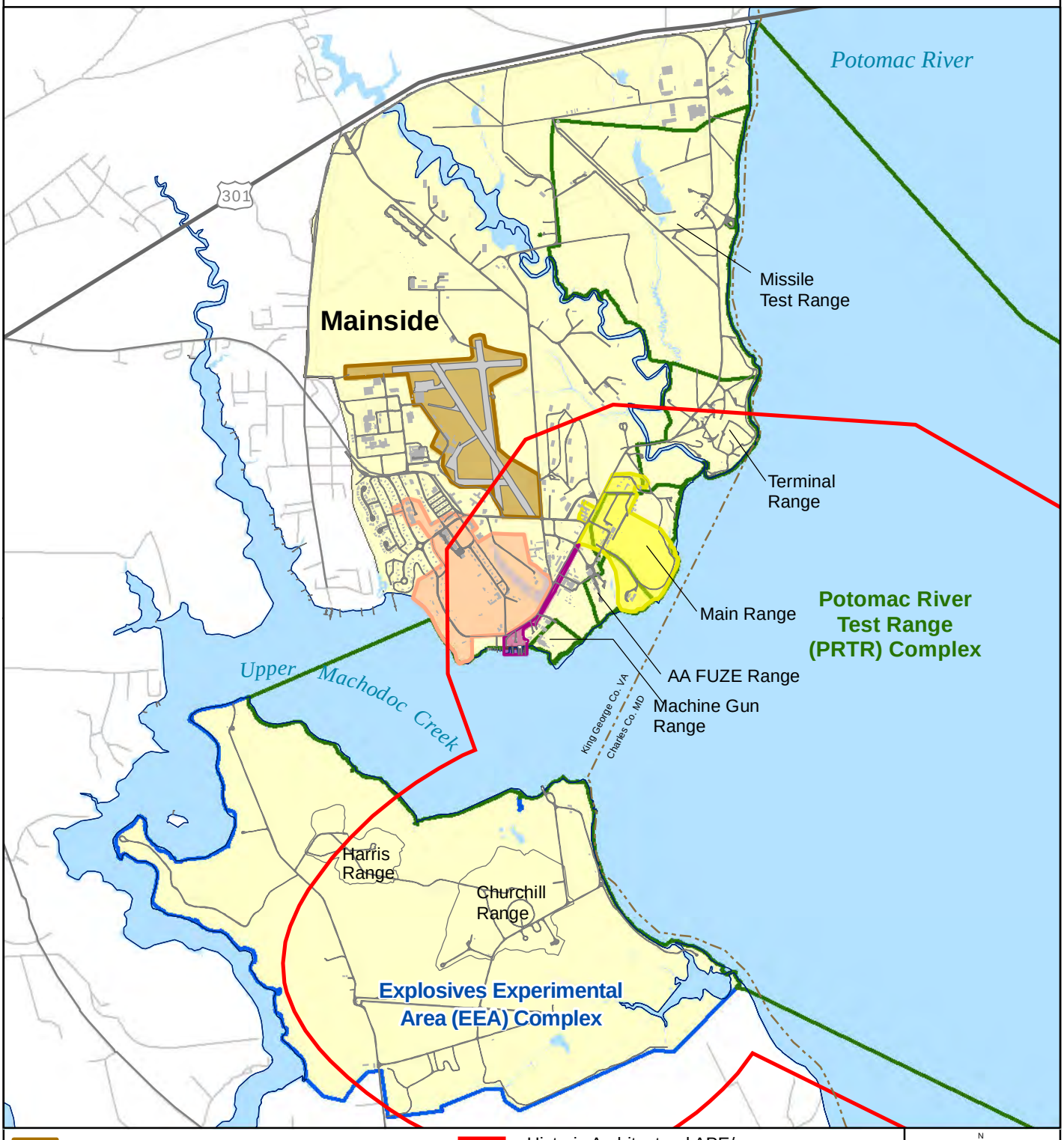
Tables 3.6-4 through 3.6-7 identify contributing and non-contributing resources within the four districts delineated in 1994. NPS defines contributing resources as components within an historic district that add to its historic character and possess architectural integrity. NPS defines non-contributing resources as components within historic districts that do not contribute to its significance, and usually consist of resources which post-date the period of significance of the district (United States Department of the Interior, National Park Service, 2002).

In 2004, based on the 1994 installation-wide survey and a survey of the residential area (David, Sadler &Whitehead, 2003) prepared for a Navy/Private Venture action to privatize housing, VDHR determined the Residential Historic District eligible for listing in the National Register under Criteria A and C for its historic and architectural significance (VDHR, 2004). The district

is eligible under Criterion A for its role as the residential support area for personnel involved in the primary mission of weapons testing. The district is also eligible under Criterion C because it represents the Navy's adaption of suburban planning trends and architectural styles popular between the 1920s and 1940s. Its planned community reflects the suburban planning ideal through curvilinear streets, open vistas, and landscape features that create a pastoral, rural setting (NAVFAC, 1994b).

NSF Dahlgren recently resurveyed the installation, including the four historic districts. When finalized and reviewed by VDHR, this survey may result in changes to the definition of the historic districts. For the time being, the 1994 survey of the installation supplemented by the 2003 survey of the residential area form the basis for Section 106 determinations.

Historic District Locations



Source: NSWCDD, 2008-2011

Figure 3.6-5

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Table 3.6-4
Proposed Residential Historic District (1994)

Building No.	Original Use	Date	Contributing	Non-Contributing
Not Applicable (N/A)	Joy Park	c. 1945	X	
N/A	Parade Ground	c, 1919	X	
60	Tool Shed	1920	X	
64	Canteen Garage	1921		X
101	Administration Building	1920	X	
105	Dormitory	1920		X
106	Dormitory	1920		X
112[1]	Mess Hall	1920		X
117	Assembly Hall	1921	X	
119	School	1921	X	
132	Water Tower	1920	X	
183	Barracks	1942	X	
184	Sewer Pump House	1942	X	
192	Dispensary	1942	X	
193	School	1942	X	
193A/B	School	1951		X
193E	School	1990		X
193F	Gymnasium	1993		X
195[2]	Gate House	1942	X	
215	BOQ	1942		X
216	Officers' Club	1942		X
217	BOQ	1942		X
220	Boiler House	1942	X	
222	BOQ	1918	X	
222A	Wood House	1919	X	
222B/C	Garage	1934	X	
240	Community Storage	1986		X
243	Community House	1940		X
246	Dispensary	1919	X	
267	Laundry	1944	X	
322	Railroad Station	1943	X	
431	Chapel	1945	X	
431A	Boiler House	1945	X	
501	Inspector's Quarters	1921	X	
501A	Garage	1921	X	
503	Housing	1921	X	
503A	Garage	1921	X	
506	Housing	1921	X	

Table 3.6-4 (Continued)
Proposed Residential Historic District (1994)

Building No.	Original Use	Date	Contributing	Non-Contributing
506A	Garage	1921	X	
507	Housing	1921	X	
507A	Garage	1921	X	
508	Housing	1921	X	
508A	Garage	1921	X	
509	Housing	1921	X	
509A	Garage	1921	X	
510	Housing	1939	X	
512	Housing	1939	X	
513	Housing	1939	X	
514	Housing	1939	X	
516	Housing	1939	X	
518	Housing	1951		X
518A	Garage	1951		X
600	Housing	1921	X	
600B	Garage	1920	X	
601	Housing	1921	X	
601B	Garage	1920	X	
800	Housing	1939	X	
801	Housing	1939	X	
802	Housing	1919	X	
802B	Garage	1920	X	
803	Housing	1941	X	
804	Housing	1919	X	
805	Housing	1941	X	
806	Housing	1919	X	
806B	Garage	1920	X	
807	Housing	1941	X	
808	Housing	1919	X	
808A	Hen House	1919	X	
809	Housing	1941	X	
810	Housing	1919	X	
810B	Garage	1919	X	
811	Housing	1942	X	
812	Housing	1919	X	
812A	Garage	1919	X	
813	Housing	1942	X	
814	Housing	1919	X	

Table 3.6-4 (Continued)
Proposed Residential Historic District (1994)

Building No.	Original Use	Date	Contributing	Non-Contributing
814B	Garage	1919	X	
816	Housing	1919	X	
816A	Hen House	1919	X	
818	Housing	1941	X	
820	Housing	1941	X	
822	Housing	1941	X	
824	Housing	1941	X	
909	Colored Dormitory	c. 1918	X	
1130	Storage Building	1952		X
1164	Tennis Courts	1943	X	
1166	Tennis Courts	1941	X	
1271	Golf Course	1927	X	
1278	Golf Clubhouse	1964		X
1282	Gas Station	1965		X
1294	Locker Room	1968		X
1384[3]	Gardeners Storage Building	1921		

[1]Building demolished according to NSF Dahlgren GIS data prepared in 2008.
[2]Located outside boundary of proposed district.
[3]Located within boundary of proposed district but not documented in the 1994 survey report.

Table 3.6-5
Proposed Main Battery Historic District (1994)

Building No.	Original Use	Date	Contributing	Non-Contributing
102	Bombproof	1920	X	
111	Tech Library	1920	X	
143	Toilet	1942	X	
160	Emplacements	1942	X	
161	Bombproof	1942	X	
181	Shell House	1942	X	
186	Office	1942	X	
207	Loaded Projectile Magazine	1942	X	
210	Boiler House	1942	X	
218	RDT&E Laboratory	1942		X
234	Boiler House	1920	X	
235	Shell House	1941		X
236	Case Packing House	1943	X	
239	Oil House	1920	X	
249	Lab & Air Compressor House	1920	X	

Table 3.6-5 (Continued)
Proposed Main Battery Historic District (1994)

Building No.	Original Use	Date	Contributing	Non-Contributing
252	Ordnance Shed	1920	X	
253	Gun Emplacements	1920	X	
254[1]	Broadside Battery	1921	X	
260	High Explosive Magazine	1920	X	
270	Gun Parking Platform	1927	X	
276	Black Powder Loading House	1942	X	
277	Women's Restroom	1942	X	
306	Lookout Tower	1942	X	
310[2]	Bomb Spotting Station	1975		X
312[2]	Case Storage	1943	X	
316	Magazine	1942	X	
326	Lookout Tower	1943	X	
339	Boiler House	1960		X
364[1]	Weapons Factory	1975		X
406	Boiler House	1950		X
415	Velocity Instrument Building	1951		X
440	Oil Storage	1945	X	
441[2]	Inert Storage	1945	X	
445	Kerosene Storage	1943	X	
460	Static Loading Tower	1946		X
463	Quonset Hut	1949		X
930	Armco Hut	1952		X
931	Armco Hut	1952		X
932	Armco Hut Case Storage	1952		X
940	Armco Hut	1952		X
941	Armco Hut	1948		X
942	Fuze Conditioning Building	1951		X
943	Ammunition Assembly	1952		X
948	Black Powder Loading House	1952		X
991	Heating Plant	1952		X
998	Case Storage	1953		X
1112	Personnel Shelter	No date available		X
1113	Case Storage	1953		X
1114	Locker/Lunchroom	1953		X
1157	Tunnel-Steel Plate	1953		X
1279	Gun Racks	1953		X

[1]Building demolished according to NSF Dahlgren GIS data prepared in 2008.
[2]Building slated for demolition according to NSF Dahlgren.

Table 3.6-6
Proposed Wharf Area Historic District (1994)

Building No.	Original Use	Date	Contributing	Non-Contributing
100	Yardcraft Admin.	1991		X
107	Wharf House	1920	X	
177[1]	Dock	1919	X	
178[1]	Coal Pier	1919	X	
288	Yardcraft Office	1943		X
318[1]	Crane Runway	1944	X	
319	Power House	1943	X	
347	Boat Parts Building	1945	X	
430[1]	Rocket Assembly Building	1945	X	
453	Rigging Loft	1945	X	
1175[1]	Crane Runway	1943	X	
1299[1]	Engine & Parts Storage	1968		X

[1] Building demolished according to NSF Dahlgren GIS data prepared in 2008.

Table 3.6-7
Proposed Airfield District (1994)

Building No.*	Original Use	Date	Contributing	Non-Contributing
110B	Land Plane Hangar	1921	X	
150	Land Plane Hangar 1	1941	X	
185	Garage Hangar 1	1943	X	
185T	Office	ca. 1970		X
194	Hangar 2	1942	X	
423	Acceleration Building	1945	X	
458	Machine Gun Bulk Hangar	1946		X
1174	Ground Plane and Turntable # 1	1959		X
1177	C.A.D. Firing Pads	1959		X
1277	Electric Com/Fac	1964		X
1280	Control House/Turntable #2	1964		X
1331	Misc Open Storage	1971		X

*Although not shown in the table, the airfield landing strip or runway is considered to be a contributing resource to the historic district because it was designed for conducting experimental tests of aviation weapons and equipment during World War II (NAVFAC, 1994a).

3.6.9 American Heritage Rivers

In addition to archaeological and historic architectural resources, American Heritage Rivers are also located within the Archaeological and Historic Architectural APEs. In 1998, the Potomac River was designated an American Heritage River under the authority of President Clinton's EO 13061, Federal Support of Community Efforts along American Heritage Rivers, which was enacted in 1997. The Potomac American Heritage River covers the entire 14,670-square-mile Potomac watershed, including major tributaries such as the South Branch, North Branch, Shenandoah, Monocacy, Anacostia, and Occoquan Rivers. This watershed extends through four states (Virginia, West Virginia, Maryland, and Pennsylvania) and Washington, DC (USEPA, 2009).

As an American Heritage River, the Potomac's unique place in American history and culture has been officially recognized. To devise plans to benefit the river and surrounding communities, an acting River Navigator has been appointed under the auspices of the lead agency, NPS-National Capital Region. The role of the River Navigator is to facilitate the application of existing federal programs and resources to the needs of the river, including natural resource and environmental protection, economic revitalization, and historic preservation.

Key stakeholders and partners of the Potomac River American Heritage River initiative are represented by the Friends of the Potomac River, a non-profit corporation which helps communities throughout the watershed in their efforts to conserve natural resources and create new business opportunities while retaining their distinctive local character and traditions. Key federal partners include:

- USEPA (Office of Water, Region 3, and Chesapeake Bay Program Office)
- US Fish and Wildlife Service
- US Department of Agriculture-Natural Resources Conservation Service
- US Department of Agriculture-Forest Service
- US Army Corps of Engineers
- US Department of Housing and Urban Development
- US Department of the Interior, Office of Surface Mining
- Chesapeake Bay Program's Federal Agencies Committee

Although the Potomac River is not a National/State Register-listed resource, the American Heritage River program acknowledges the important role that the river has played in the historic development of its watershed and the nation.