The State of the Dragon Run Watershed:
Status of Natural Resources

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By the Dragon Run Steering Committee,
Middle Peninsula Planning District Commission

Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL & RECREATIONAL RESOURCES

Chesapeake Bay Program
A Watershed Partnership

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Chapter 1: Introduction

The Dragon Run "encompasses some of the most extensive and unspoiled swamp forest and woodland communities in Virginia" (Belden, Jr. et al, 2001). Bisecting Virginia's Middle Peninsula, this fresh and brackish water stream (**Figure 1**) meanders forty miles along and through nontidal and tidal cypress swamp. The watershed is mostly undeveloped and privately owned and encompasses approximately 140 square miles (90,000 acres) of rural landscape – primarily forests, farms, and wetlands. The spring-fed Dragon Run flows through Essex, King and Queen, Middlesex, and Gloucester Counties into the estuarine Piankatank River and the Chesapeake Bay.

Figure 1. The Dragon Run

The watershed's wilderness is both expansive and unique. The Dragon Run contains the northernmost example of the Baldcypress-Tupelo Swamp natural community in Virginia and the best example north of the James River (Belden, Jr. et al., 2001). Based on his investigations, one researcher observes that the Dragon Run is a "100 year old time capsule," resembling coastal plain streams in the Chesapeake Bay watershed at the turn of the 20th century (Garman, 2003).

This report attempts to document the status of the natural resources in the Dragon Run watershed as part of a comprehensive watershed management planning effort. *The State of the Dragon Run Watershed* is intended as an environmental baseline to which to compare the results of watershed management planning on the watershed's unique natural resources.

Chapter 2: Natural Resources in the Dragon Run

Physical and Environmental Factors

Located within the coastal plain physiographic province, Virginia's Middle Peninsula is bordered by the Rappahannock River to the north, the York River to the south, and the Chesapeake Bay to the east. At the Middle Peninsula's center, the Dragon Run watershed expands outward from its 40-mile fresh and brackish water stream that runs through Essex, Gloucester, King and Queen, and Middlesex Counties. The watershed encompasses 90,000 acres or 140 square miles and exhibits topography typical of coastal plain stream systems in Virginia. **Table 1** shows watershed area by locality.

County	Area within Locality (acre)	% of Total Watershed	% of Locality within Watershed
Essex	18466.6	20.6	10.1
Gloucester	5671.7	6.3	3.1
King and Queen	46425.1	51.7	22.2
Middlesex	19207.7	21.4	16.3
Total	89771.1	100	

Table 1. Dragon Run watershed statistics by locality (from MPPDC, 2001).

The Dragon Run watershed, state hydrologic unit CO2, is a fourth-order stream system that is nontidal freshwater above the U.S. Route 17 bridge and tidal freshwater from the U.S. 17 bridge to its mouth at Meggs Bay (**Figure 2**). At its mouth, it forms the estuarine Piankatank River and eventually drains into the Chesapeake Bay (**Figure 3**). The Dragon Run's streamflow is supported by underground springs, feeder swamps, and surface waters. Significant tributaries include Dragon Swamp, Yonkers Swamp, Exol Swamp, Timber Branch Swamp, Briery Swamp, Holmes Swamp, White Marsh, Zion Branch, Carvers Creek, Mill Stream, and Meggs Bay (MPPDC, 2001).

The Dragon Run watershed lies within the transitional Oak-Pine vegetation region. Land cover data indicate that the watershed is 80.3-83.9% forested and wetlands, 15.1-18.4% agricultural, and 1.0-1.3 % commercial and residential (MPPDC, 2002; DCR, 2003b). Although loblolly pine originally appeared in the forest as scattered associates of oaks and other hardwoods, loblolly pine plantations are increasingly common.

The relatively intact watershed contains many unique resources. Natural heritage resources are abundant in the Dragon Run (see **Appendix A**). Several rare natural communities occur in the Dragon Run, including Baldcypress-Tupelo Swamp, Tidal Baldcypress-Tupelo Swamp, Tidal Baldcypress Woodland/Savanna, Fluvial Terrace Woodland, and Tidal Freshwater Marsh.

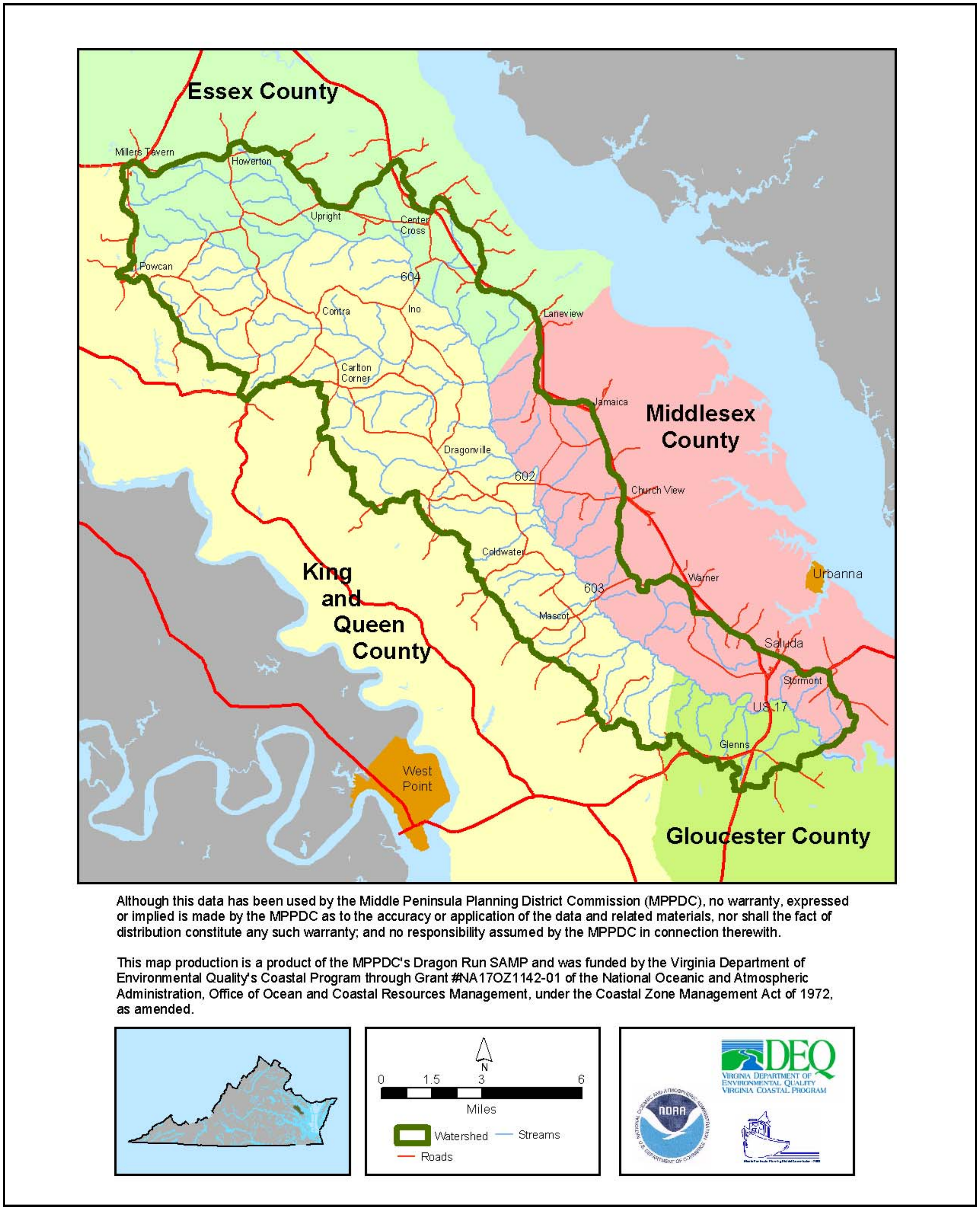

Figure 2. The Dragon Run watershed boundary showing villages and towns (from MPPDC, 2003b).

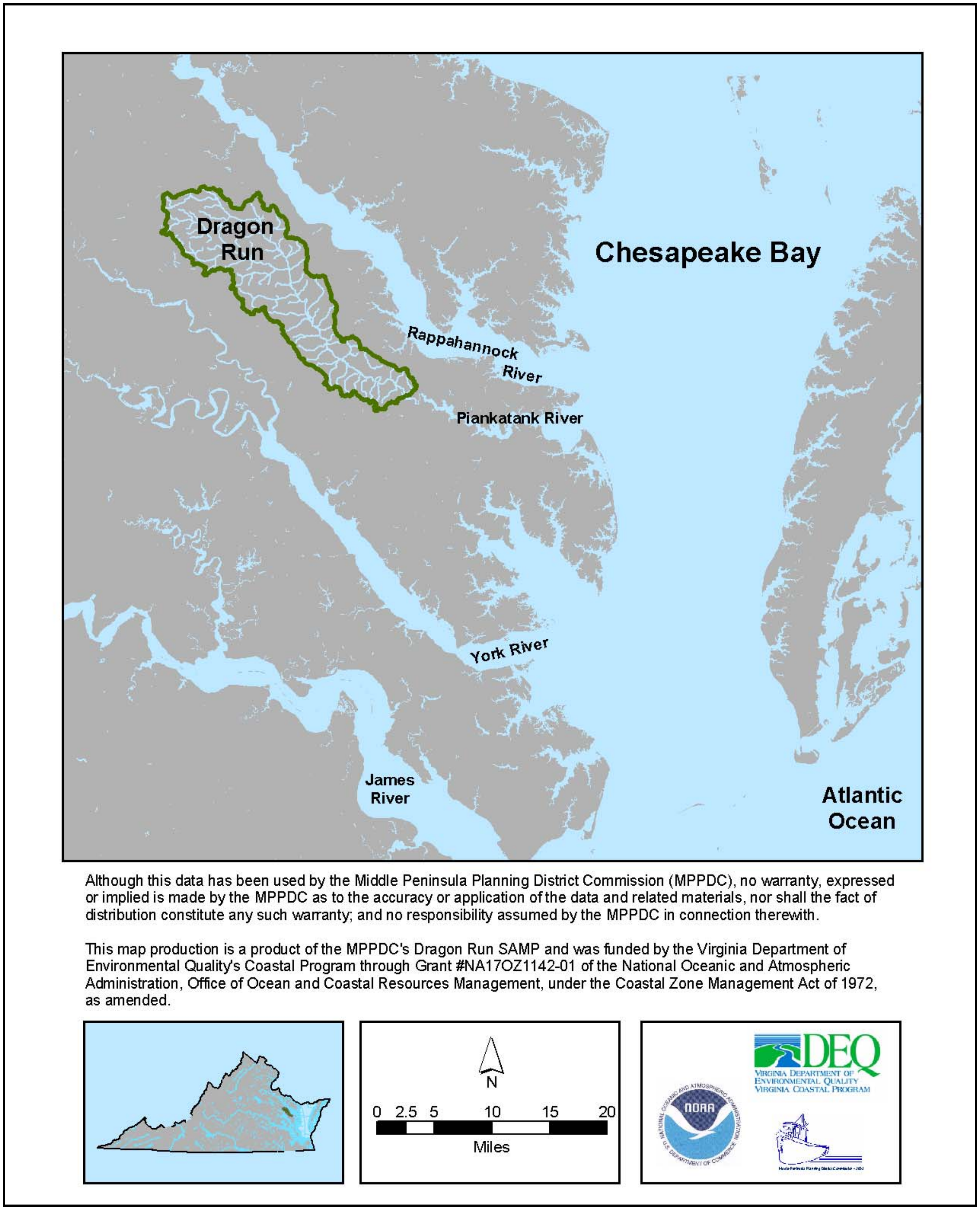

Figure 3. The Dragon Run watershed (in green) flowing into the Piankatank River and the Chesapeake Bay (from MPPDC, 2003b).

The Baldcypress-Tupelo Swamp community harbors a number of rare plant and animal species. Rare animals include bald eagle, great purple hairstreak, blackwater bluet, robust baskettail, cypress sphinx, Selys' sunfly, fine-lined emerald and Southern pitcher-plant mosquito. Rare plants include cuckooflower, red turtlehead, Parker's pipewort, pineland tick-trefoil, river bulrush, Northern purple pitcher-plant, and cypress-knee sedge (Belden, Jr. et al., 2001; Belden, Jr. et al., 2003). The Dragon Run also harbors a number of rookeries for colonial water birds, such as egrets and herons. Natural communities that occur in the headwaters of the Dragon Run include: Coastal Plain/Piedmont Bottomland Forest; Coastal Plain/Piedmont Acidic Seepage Swamp; and Coastal Plain Semipermanent Impoundment (Belden, Jr. et al., 2003).

In addition to natural heritage resources, the Dragon Run supports a diversity of freshwater and estuarine fishes, aquatic macroinvertebrates, freshwater bivalves (primarily unionid mussels), and herptefauna (amphibians and reptiles) (McIninch et al., 2003). At least forty-five fish species from nineteen families have been collected in the Dragon Run, representing a mixed assemblage of mostly lowland freshwater forms that is highly dynamic spatially and temporally (see **Appendix B**). At least sixty-five macroinvertebrate species from fourteen orders and forty-seven families have been recorded from the Dragon Run (see **Appendix B**).

The watershed contains limited examples of invasive, or non-native, species, again emphasizing a relatively intact natural system. Currently, blue catfish, common reed, Asiatic dayflower and Japanese stiltgrass occur in the Dragon Run in limited quantities.

According to the National Wetland Inventory, wetlands along the Dragon Run (**Figure 4**) are Palustrine, mostly Forested Wetlands except for Emergent Wetlands in Meggs Bay. U.S. Route 17 is the approximate demarcation between tidal wetlands and non-tidal wetlands. The hydrologic regime of most Dragon Run wetlands is Seasonally Flooded, Seasonally Flooded-Saturated, or Temporarily Flooded (Belden, Jr. et al., 2001).

The U.S. Geological Survey (USGS) maintained a streamflow gaging station at Church View (Route 602) from 1943 to 1981 that received drainage from 60% of the watershed (84 square miles) and has maintained a streamflow gaging station at Mascot (Route 603) since 1981 that receives drainage from 75% of the watershed (105 square miles). Median daily streamflow at Mascot from 1981 to 1999 was 79 ft^3/sec and varied between 0.01-6050 ft^3/sec. Median daily streamflow at Church View from 1943 to 1981 was 57 ft^3/sec and varied from 0-3790 ft^3/sec. Compared to other coastal plain stream systems such as the Chickahominy River (New Kent County), the Mattaponi River (King William County), and Cat Point Creek (Richmond County), the Dragon Run exhibits lower median daily streamflow per square mile of drainage area. Base flow, fed primarily by groundwater discharge, accounts for two-thirds of the Dragon Run's total streamflow, with the remaining third attributable to surface water runoff.

Of the annual precipitation, only one-third becomes streamflow, with two-thirds lost to evapotranspiration. Seasonally, streamflow is highest in the spring and lowest in the fall (MPPDC, 2001).

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This map production is a product of the MPPDC's Dragon Run SAMP and was funded by the Virginia Department of Environmental Quality's Coastal Program through Grant #NA17OZ1142-01 of the National Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resources Management, under the Coastal Zone Management Act of 1972, as amended.

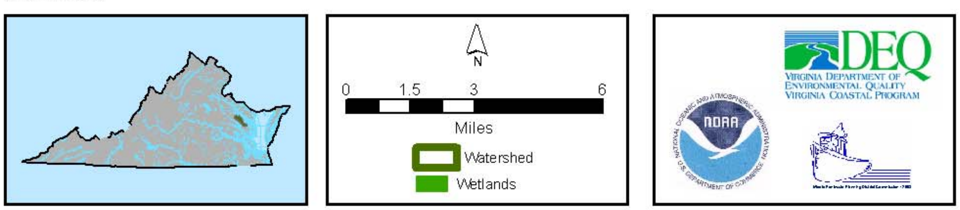

Figure 4. Wetlands in the Dragon Run watershed (from MPPDC, 2003).

Geological features are described by the following excerpt from *A Natural Heritage Inventory of the Dragon Run Watershed* (Belden, Jr. et al., 2001):

Surficial deposits of riverine terraces bordering Dragon Run from the vicinity of the Essex-Middlesex county line to Meggs Bay belong to the Shirley Formation and the Sedgefield Member of the Tabb formation. The middle Pleistocene Shirley Formation consists of light- to dark-gray, bluish-gray and brown sand, gravel, silt, clay, and peat; the Sedgefield Member is of upper Pleistocene age and consists of pebbly to bouldery, clayey sand and fine to medium, shelly sand grading upward to sandy and clayey silt. Somewhat higher topography away from the waterway is underlain by the Chesapeake Group. This consists of fine to coarse quartzose sand, silt, and clay (variably shelly and diatomaceous) deposited in shallow waters of the upper Pliocene and lower Miocene periods. At still higher elevations, the Windsor Formation is found, consisting of gray and yellowish to reddish-brown sand, gravel, silt, and clay of lower Pleistocene or upper Pliocene age. At higher elevations southwest of Dragon Run, two other formations are prevalent, both of upper Pliocene age. The Bacons Castle Formation is characterized by gray, yellowish-orange, and reddish-brown sand, gravel, silt, and clay and the Moorings Unit by white, light gray, and grayish-yellow quartzose sand and clay to grayish-brown clayey silt and silty clay.

Watershed elevation ranges from 180 feet to near sea-level. Detailed soils information (see **Appendix C**) can be found in the *Soil Survey* for each county (Note: King and Queen County does not have a published *Soil Survey*). Many of these soils are considered prime farmland and are suitable for silviculture. Generally, soil associations are as follows:

Essex County

Emporia-Slagle-Atlee; Rumford-Suffolk-Emporia - somewhat excessively drained to moderately well drained loamy and sandy soils (Hoppe, 1989)

Middlesex County

Suffolk-Eunola-Remlik; Kempsville-Suffolk-Kinston; Emporia-Slagle-Nevarc - deep, well drained to poorly drained loamy or clayey soils (Newhouse et al., 1985); Pocaty-Kinston-Bibb - deep, very poorly to poorly drained organic and loamy soils that are flooded by fresh and brackish water (Newhouse et al., 1985)

Gloucester County

Suffolk-Eunola-Kenansville; Emporia-Hapludults-Wrightsboro - deep, well drained to moderately well drained loamy or clayey soils (Newhouse et al., 1980)

DCR's Shoreline Erosion Advisory Service identified five areas of streambank erosion in the lower Dragon Run (Vanlandingham, 2003). The lower Dragon Run undergoes an average of less than one foot per year of erosion that is mostly attributable to high water flow undercutting the stream bank during storms. These erosion "hot spots" are relatively few and small and are unlikely to cause impairment to the stream.

Water Quality

Water Quality Assessment

The primary water contaminant sources in the Dragon Run are point source discharges and nonpoint source pollution from precipitation (atmospheric deposition), residential land use, agricultural land use, and forested lands (MPPDC, 2002). According to the Virginia Department of Environmental Quality (DEQ), the Dragon Run generally exhibits medium nutrient levels and is listed as “impaired” for pH, fecal coliform bacteria, mercury, and lead (DEQ, 2002). Based on agricultural, urban, and forested pollution loadings potential determined by DCR, however, the overall nonpoint source pollution potential rating is low for the Dragon Run (DCR, 2002).

Point source discharges, which are permitted and monitored by the Virginia Department of Environmental Quality, are relatively easy to quantify and, in turn, control or track. Point source discharges to the Dragon Run include: stormwater runoff from a wood treatment facility (arsenic, chromium, copper) at Pitts Lumber Company, Inc. to an intermittent stream adjacent to U.S. Route 17 in Middlesex County (Permit #VA0083011); discharge from a sewage treatment plant (biological oxygen demand, total suspended solids, ammonia nitrogen, total residual chlorine, pH, fecal coliform) at Rappahannock Community College to an intermittent stream near Glenns in Gloucester County (Permit #VA0028461); and discharge from a wellwater treatment plant (pH, total suspended solids) at the Miller’s Square Subdivision to an intermittent stream near Miller’s Tavern in Essex County (Permit #VA0075302). According to the Shoreline Sanitary Survey (Smither et al., 2003), there are 9 other indirect sources of pollution, including five animal pollution sources (Middlesex County near Saluda and Stormont and Gloucester County near Glenns); a solid waste dumpsite in Middlesex County near Stormont; and a potential pollution source in Middlesex County in Saluda. Furthermore, a network of water quality monitoring wells is maintained at the Browning-Ferris Industries landfill in King and Queen County.

Throughout the Chesapeake Bay, atmospheric deposition (e.g. precipitation) contributes a significant amount of the total nutrient loadings in coastal waters (MPPDC, 2001). Air quality is not currently monitored in the watershed.

More than 90% of residents in Gloucester, King and Queen, and Middlesex Counties use on-site wastewater treatment systems, commonly known as septic systems (MPPDC, 2001). When operated properly, conventional septic systems remove nutrients and fecal coliform. Conventional septic systems can pose potential environmental and health risks due to inappropriate design, poor maintenance, poor soils, or inefficient nitrogen removal. Driven by changes to Department of Health regulations for on-site wastewater treatment systems (12 VAC 5-610-10 et seq. effective July 2000), the popularity of “engineered” on-site wastewater treatment systems is increasing. These alternative systems, when properly maintained, can be effective at removing nutrients and fecal coliform in areas where conventional septic systems are ineffective. Regardless of the type, however, improperly maintained or failing septic systems pose significant environmental and health risks by contributing nutrients, pathogenic bacteria, and viruses to groundwater.

Forested lands, representing a significant land area, yield low nutrient input to streams relative to other land uses in the watershed. Best Management Practices (BMPs) are designed to minimize these inputs. For example, forested riparian buffers provide effective protection for water quality. The watershed currently exhibits intact riparian buffers.

By contrast, agricultural land use in rural and semirural areas in Virginia can be the source of significant sediments, fecal coliform bacteria, and nutrients such as nitrogen and phosphorus. Nitrogen is transported through the groundwater, whereas phosphorus is generally transported on soil particles in surface water. BMPs such as fencing cattle out of streams, conservation tillage, and expanded riparian buffers are designed to minimize these inputs.

Residential and commercial land uses typically contribute less nutrients and sediments than agriculture, but more than forestry. These residential and commercial contributions are mainly attributable to reduced or no riparian buffers, chemical application for landscaping, and stormwater runoff.

Water Quality Monitoring

Water quality data sets in the watershed are sparse in quantity, duration, and parameters measured. Existing data sets include: STORET, a database managed by the Virginia Department of Environmental Quality (DEQ); data collections during fish surveys by the Virginia Department of Game and Inland Fisheries (DGIF) and Virginia Commonwealth University (VCU); data collections by the Chesapeake Bay National Estuarine Research Reserve in Virginia at the Virginia Institute of Marine Science (VIMS); and a now-defunct volunteer water quality monitoring program in the watershed (MPPDC, 2001).

Two stations are currently sampled regularly by the DEQ. Station DRN003.40 is located at the U.S. Route 17 bridge and Station DRN010.48 is located at the Route 603 bridge near Mascot. Data are available from DRN003.40 for the period 1968-1974 and 1992-present and from DRN010.48 for the period 1992-present. Samples are evaluated bimonthly for nutrients, fecal coliform, suspended solids, dissolved oxygen, pH, salinity, and temperature and are occasionally evaluated for pesticides, toxic metals, and other harmful compounds (MPPDC, 2001). The data sets collected at these sampling stations were used by the DEQ to list the Dragon Run as “impaired” for pH and fecal coliform bacteria. Fish tissue samples were used by the DEQ to list the Dragon Run as “impaired” for mercury and lead. The Virginia Department of Health issued a health advisory for the Dragon Run for mercury contamination in largemouth bass (DOH, 2003). The DEQ attributes the pH impairment to natural causes, citing the acidic nature of water in swamps. The DEQ lists the cause of the fecal coliform and mercury and lead impairments as unknown. Potential sources of fecal coliform bacteria include: wildlife; failing septic systems; and livestock. Potential sources of metals include: atmospheric deposition; automobile and roadway deposits; and industrial operations.

Data collected by the DGIF in 1995-1996 and 1998 includes temperature, Secchi depth, pH, dissolved oxygen, conductivity, salinity, alkalinity, hardness, and total dissolved solids. Nutrient data are very limited and were frequently below detection limits. Dissolved oxygen at sampling stations with no or low flow frequently violated daily minimum standards to support aquatic life (MPPDC, 2001).

VIMS data from 2000-2001 measured temperature, salinity, total dissolved solids, pH, dissolved inorganic nitrogen, and fecal coliform bacteria. Of specific note, samples from Briery Swamp exhibited high nitrate and fecal coliform levels, indicating the presence of subsurface agricultural or wastewater drainage (MPPDC, 2001).

A weekly volunteer water quality monitoring program collected data throughout the watershed during the period 1994-1997, although monitoring was not continuous at all eight sites. Measurements included dissolved oxygen, Secchi depth, water and air temperature, pH, and water color. The findings indicated: low dissolved oxygen during warm temperatures and high dissolved oxygen during cold temperatures; low Secchi depth values during the summer associated with algal blooms and storm events; and acidic pH values in the upper Dragon Run with slightly more basic pH values in the tidal waters (MPPDC, 2001).

Impervious Cover

The percentage of impervious surface is a key indicator of water quality status and stream health. The Dragon Run watershed exhibits low impervious cover and, in turn, is in good condition (e.g. natural heritage resources).

Impervious surfaces (e.g. paved streets and parking lots, rooftops) are areas that do not allow rainwater to infiltrate into the soil, promoting runoff to streams. Runoff is often at a higher volume and velocity than normal stream flow, frequently leading to stream erosion and instability. Runoff also carries pollutants that can lead to degraded water quality. The Center for Watershed Protection (2002) has developed a watershed vulnerability analysis that relies on an impervious cover model. The model indicates that watersheds are generally in good condition when impervious cover is less than 10%. From 10-25% impervious cover, watersheds are generally impacted, which means that they only partially support their intended uses (e.g. drinking, swimming, shellfish harvest). Above 25% impervious cover, watersheds generally do not support their intended uses at all.

Impervious cover can be estimated for the Dragon Run watershed. Based on 1994 aerial photography, 1.3% of the watershed is commercial or residential development. Conservatively assuming 100% imperviousness, the watershed is approximately 1.3% impervious surface, with the sparse road network adding modestly to this estimate. Since the Dragon Run watershed exhibits less than 10% impervious cover, the Center for Watershed Protection’s model (2002) predicts that it is in good condition, which is confirmed by the MPPDC’s Dragon Run Watershed Land-Water Quality Preservation Project (MPPDC, 2001).

Recreation and Access

Significant recreational activities and opportunities exist in the Dragon Run watershed, including hunting, fishing, hiking, and boating. Educational opportunities and activities also exist. Meanwhile, access often requires landowner permission; public access is limited.

Hunting represents a significant recreational activity that generates at least $300,000 per year in the watershed. Seventeen hunt clubs lease approximately 42,000 acres, or 46%, of land in the watershed for hunting - mainly deer, turkey, and waterfowl (MPPDC, 2002). At least five additional hunt clubs are not included in this estimate. Hunt club leases provide income to landowners and offer hunting access to many acres of private lands.

Fishing is also a significant recreational activity in the Dragon Run. According to the DGIF, the Dragon Run's share of the state's fishing value is more than $1.6 million, including trip related expenses such as food and lodging and transportation (MPPDC, 2002). Fishing by boat is popular in the lower Dragon, while bank and fly fishing are more common in the upper Dragon. Fishermen regularly use the public, unpaved lot at Route 603 near Mascot, and a public boat ramp exists at Harcum in the Piankatank River (Gloucester County). Otherwise, landowner permission is generally required.

The Virginia Birding and Wildlife Trail for the Coastal Area (DGIF, 2002) describes two sites within the Dragon Run watershed. First, Rappahannock Community College (public), located in Glenns on State Route 33 in Gloucester County, offers wooded trails adjacent to a tributary to the Dragon Run. Second, the Friends of Dragon Run (private) offer a birding trail with views of the Dragon Run and the Baldcypress-Tupelo Swamp community. The site is located near Mascot on Route 603 with parking in a public, unpaved lot. It is important to note that the Friends' site and adjacent properties are privately owned. Additionally, a 121-acre tract on Route 603 near Mascot is part of the Virginia Estuarine and Coastal Research Reserve System (public). The site can be accessed with permission and is used for research, long-term monitoring and education.

Besides the sites near Route 603, the Dragon Run Access Plan (MPPDC, 1994) indicates other traditional access sites in the watershed. Landowner permission is generally required at these sites, which include: Route 604 at the Essex/King and Queen county line (Byrd's Bridge); Route 602 at the Middlesex/King and Queen county line (Ware's Bridge); and U.S. Route 17 at the Middlesex/Gloucester county line (James Vincent Morgan Bridges).

Boating is also a significant recreational activity in the watershed. Motorized pleasure craft seasonally utilize the lower Dragon. Self-propelled boating is common from Route 602 to Meggs Bay. For example, waterfowl hunters often make short trips in canoes or jon boats, while guided and unguided paddling trips also occur. Several organizations offer guided paddling trips on the Dragon Run (**Figure 5**), including Gloucester County Parks and Recreation (2 trips/summer; ~30 people/summer); Chesapeake Bay

Foundation (since 1995, 56 trips; 1080 people; for middle and high school students in Middlesex and Gloucester Counties); Rappahannock Community College (1 3-day trip/year; ~20 people); and Friends of Dragon Run (15-20 trips/year; ~200 people/year). Some outdoor outfitters offer guided trips by appointment.

Figure 5. Guided paddling trip on the Dragon Run.

Watershed Education

Limited watershed education efforts include workshops, field trips, and publications. Soil and Water Conservation Districts, Virginia Cooperative Extension, and the Natural Resources Conservation Service offer a variety of workshops, seminars, and publications related to watersheds, nonpoint source pollution, agriculture, and forestry. These programs mainly target those involved in agriculture and forestry activities. Rappahannock Community College and the Chesapeake Bay Foundation both lead students on paddle trips. The Friends of Dragon Run offer paddle trips to citizens and decision-makers. Finally, local governments provide publications explaining land use regulations. For example, King and Queen and Middlesex Counties distribute fact sheets about pertinent ordinances to new and prospective property owners.

Infrastructure

<u>Road Network</u>
The road network within the watershed is sparse (**Figure 6**). The primary highways are U.S. Route 17, which runs north and south through Gloucester, Middlesex, and Essex Counties, and State Route 33, which runs east and west through King and Queen, Gloucester, and Middlesex Counties. These two highways intersect at Glenns in Gloucester County and Saluda in Middlesex County. A short length of State Route 198, a primary highway, runs east from Glenns in Gloucester County before leaving the watershed.

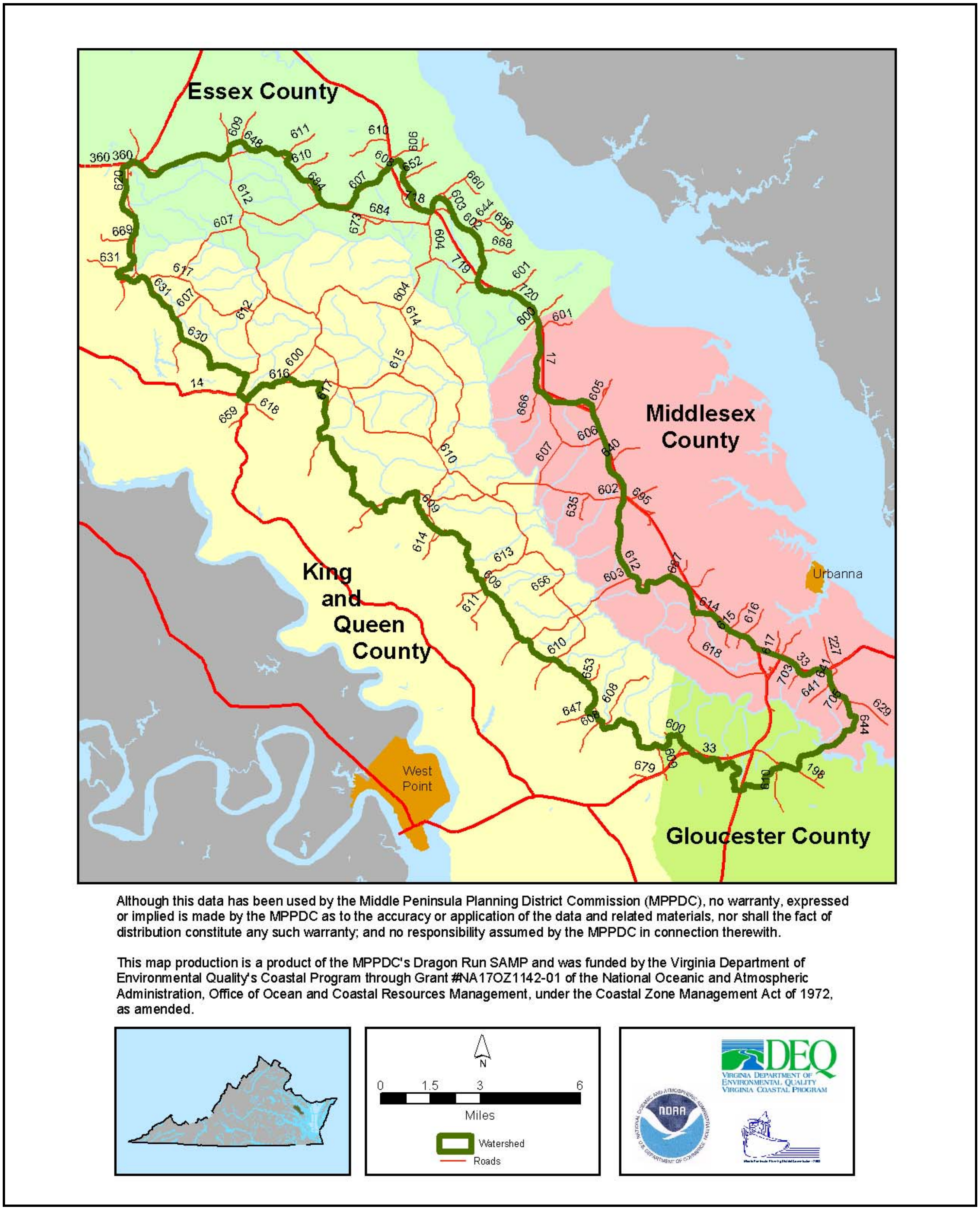

Figure 6. Road network in the Dragon Run watershed (from MPPDC, 2003b).

There is a sparse network of secondary roads, some of which serve as connectors along the road network. Route 603 and Route 602 both cross the middle Dragon Run and connect King and Queen and Middlesex Counties. Route 604 and Route 612 both cross the upper Dragon Run and connect Essex and King and Queen Counties. Route 684 serves as a connector between U.S. Route 17 and U.S. Route 360 in Essex County. Several other secondary roads serve as significant links within the road network. Examples of these are: Route 644 in Middlesex County; Routes 609, 610, 616, and 617 in King and Queen County; and Route 607 in Essex County. Finally, there is a network of unpaved logging, farm, and residential roads that access the more remote parts of the watershed.

Land Parcels

According to data collected in 2001, there are 3,073 parcels of land in the Dragon Run watershed (MPPDC, 2002). The distribution of parcels is: Essex (25%); Gloucester (11%); King and Queen (38%); and Middlesex (26%). The land area within the watershed is distributed as follows: Essex (21%); Gloucester (6%); King and Queen (52%); and Middlesex (21%). Comparing the distribution of parcels to the distribution of land area within the watershed, we find that Essex, Gloucester, and Middlesex Counties have a higher percentage of parcels than of land area, meaning that they have smaller average parcel sizes than King and Queen County. King and Queen County has a much higher percentage of land area than of parcels, indicating a much larger average parcel size than the other three counties.

Land ownership is almost entirely private. A considerable amount of private land is owned by timber interests. For example, the single largest owner, John Hancock Life Insurance Company, owns approximately 26,000 acres (28.9% of the watershed). Much of this timber land is, in turn, leased to hunt clubs. Public ownership includes the College of William and Mary (121 acres) and the Virginia Department of Transportation (fee simple and prescriptive easements for roads and right-of-way).

Structures

Interpretation of digital orthophoto quadrangles from 1994 revealed that there were 1,311 structures or clusters of structures (e.g. barns and accessory buildings) in the Dragon Run watershed (MPPDC, 2002). As expected, the majority of the structures are located along the primary highways and, to a lesser degree, along the secondary road network. It is likely that population growth and accompanying residential structures will continue to follow this pattern.

Conservation

The Virginia Division of Natural Heritage (DCR, 2003a) has established conservation planning boundaries (**Figure 7**) around natural heritage resources based on their habitat needs. These conservation sites represent the ideal conservation scenario for these state and globally rare resources. Some of these resources have been conserved, either through fee simple purchase or purchase of conservation easements (**Figure 8**). Conservation easements are held on 235 acres by the Virginia Outdoors

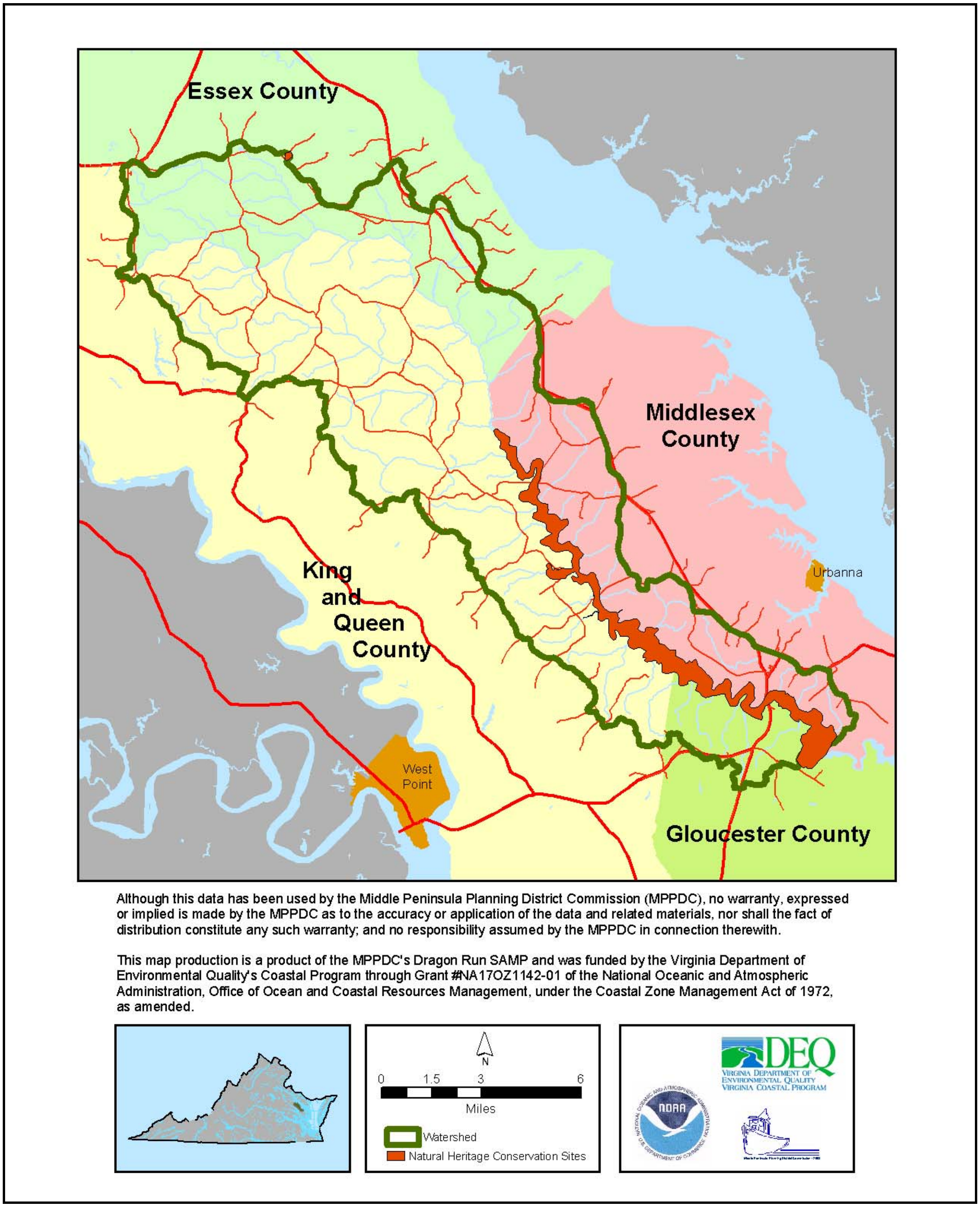

Figure 7. Natural heritage conservation sites for the Dragon Run watershed (from MPPDC, 2003b).

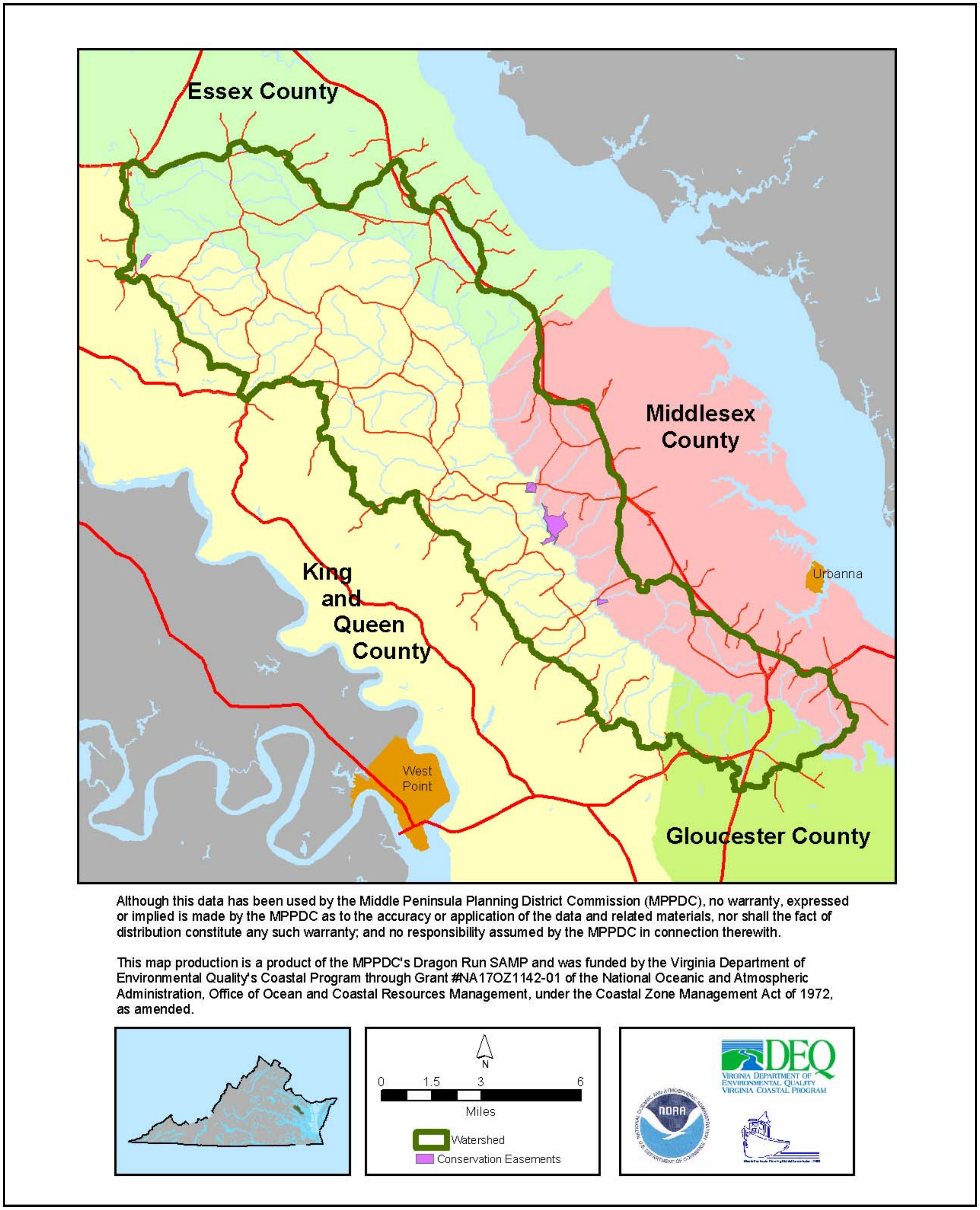

Figure 8. Conservation easements in the Dragon Run watershed (from MPPDC, 2003b).

Foundation, 72 acres by Friends of Dragon Run, and 32 acres by the Chesapeake Bay Foundation. The Nature Conservancy currently owns 452 acres and intends to purchase 2,440 acres over the next several months. Some of this land will ultimately be owned and managed by the Department of Forestry and the Middle Peninsula Chesapeake Bay Public Access Authority.

Identified Data Gaps

The status of invasive species in the Dragon Run is partially known. Efforts to gather more detailed information about invasive species, primarily common reed and blue catfish, are underway.

Other data gaps are not being addressed at this time. For example, there is scant information about migratory birds, other than highly specific research (e.g. bald eagle nesting assessment, colonial bird nesting assessment) and amateur observational records. Another data gap that is not currently being addressed is the source of water quality impairments (e.g. pH, fecal coliform, mercury, lead) for stream segments on the Virginia 303(d) list (DEQ, 2002). It is assumed that pH impairment is from natural sources (i.e. swamps are naturally acidic). Development of Total Maximum Daily Loads (TMDL) for impairments in Dragon Run stream segments are planned by the Virginia Department of Environmental Quality (DEQ) in 2010.

Chapter 3: Conclusion

The Dragon Run is a unique watershed from a natural, cultural, and historical perspective. Due to its relatively undeveloped condition, it harbors many unique resources unlike other places throughout the Chesapeake Bay watershed.

This report attempts to document the status of the natural resources in the Dragon Run watershed as part of a comprehensive watershed management planning effort. *The Dragon Run Watershed Management Plan* (2003b) is a collaborative endeavor designed to manage the watershed at an ecosystem-scale rather than on a solely jurisdictional basis. *The State of the Dragon Run Watershed* is intended as an environmental baseline to which to compare the results of watershed management planning on the watershed's unique natural resources.

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Appendix A: Natural Heritage Resources

Table 2 indicates the rare species and natural communities that have been found in the Dragon Run watershed, according to the Virginia Division of Natural Heritage (Belden, Jr. et al., 2001; Belden, Jr. et al., 2003).

SCIENTIFIC NAME	COMMON NAME	STATUS
Animals		
Atlides halesus	Great purple hairstreak	S2, S3
Enallagma weewa	Blackwater bluet	S1
Epitheca spinosa	Robust baskettail	S2
Haliaeetus leucocephalus	Bald eagle	S2
Helocordulia selysii	Selys' sunfly	S2
Isoparce cupressi	Cypress sphinx	S1, S3
Somatochlora filosa	Fine-lined emerald	S2
Wyeomyia haynei	Southern pitcher-plant mosquito	S1
Plants		
Bolboschoenus fluviatillis	River bulrush	S2
Cardamine pratensis	Cuckooflower	S1
Carex decomposita	Cypress-knee sedge	S2
Chelone oblique	Red turtlehead	S1
Desmodium strictum	Pineland tick-trefoil	S2
Eriocaulon parkei	Parker's pipewort	S2
Sarracenia purpurea var. purpurea	Northern purple pitcher-plant	S2
**Hottonia inflata	Featherfoil	S3
**Ranunculus flabellaris	Yellow water crowfoot	S3
Natural Communities		
Baldcypress-Tupelo Swamp		
Fluvial Terrace Woodland		
Tidal Baldcypress-Tupelo Swamp		
Tidal Baldcypress Woodland/Savanna		
Tidal Freshwater Marsh		

S1 = Extremely rare; usually 5 or fewer occurrences in the state; or may have a few remaining individuals; often especially vulnerable to extirpation.
S2 = Very rare; usually between 5 and 20 occurrences; or few occurrences with many individuals; often susceptible to becoming endangered.
S3 = Rare to uncommon; usually between 20 to 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances
** = No longer tracked by the Division of Natural Heritage; placed on watchlist due to an increased number of documented occurrences within the state since 2001

Table 2. Rare species and natural communities in the Dragon Run watershed.

The following descriptions of natural communities are taken from *The Natural Communities of Virginia* (Fleming et al., 2001).

Bald Cypress-Tupelo Swamps

Seasonally to semipermanently flooded forests of backswamps, sloughs, and low terraces of Coastal Plain rivers and large streams. These swamp forests are distributed throughout southeastern Virginia, north to Dragon Swamp (Gloucester, King and Queen, and Middlesex Counties). Habitats are deeply flooded (up to 1m) for part of the year; most retain at least some standing water throughout the growing season. Microtopography is often pronounced with small channels, swales, tree-base hummocks, and numerous bald cypress "knees." Tree canopies vary from mixed stands of bald cypress (Taxodium distichum), water tupelo (Nyssa aquatica), and swamp tupelo (N. biflora) to nearly pure stands of one species or another. The three dominants have complex competitive and successional relationships. As a rule, the two tupelos are less shade-tolerant than bald cypress and regenerate more readily by sprouting in cut-over stands. Thus, tupelos tend to become dominant when bald cypress stands are heavily logged. Green ash (Fraxinus pennsylvanica) and red maple (Acer rubrum) are occasional canopy associates and frequent understory trees. Carolina ash (F. caroliniana) is often dominant in the small tree and shrub layers, while vines of climbing hydrangea (Decumaria Barbara) are often abundant. Herb layers vary from sparse to rather lush. Most herbaceous plants of bald cypress-tupelo swamps are tolerant of muck soils and fluctuating water levels, or are capable of becoming established on tree hummocks, stumps, and logs. A few of the typical herbs are lizard's tail (Saururus cernuus), false nettle (Boehmeria cylindrical), Walter's St. John's-wort (Triadenum walteri), swamp beggar-ticks (Bidens discoidea), weak stellate sedge (Carex seorsa), giant sedge (Carex gigantean), taperleaf bugleweed (Lycopus rubellus), and pale mannagrass (Torreyochloa pallida). Although community types in this group are relatively common, high-quality specimens of the dominant trees are known to provide nesting habitats for the globally uncommon, state-rare eastern big-eared bat (Corynorhinus rafinesquii macrotis) and southern myotis (Myotis austroparius). Old-growth stands of bald cypress-tupelo swamp with trees up to 800 years old occur along the Blackwater River in Surry and Isle of Wight Counties. References: Fleming and Moorhead (1998), Parker and Wyatt (1975), Plunkett and Hall (1995).

Tidal Bald Cypress Forests and Woodlands

Coniferous or mixed swamp forests and woodlands occurring along the upper tidal reaches of rivers in southeastern Virginia. Examples are documented from the Dragon Swamp/Piankatank River (Gloucester, King and Queen, and Middlesex Counties), the Chickahominy River (Charles City, James City, and New Kent Counties), the James River (Isle of Wight and Surry Counties), and the wind-tidal Northwest River (City of Chesapeake). At some sites, these communities occur in ecotones between tidal marshes and non-tidal backswamps or uplands. Bald cypress (Taxodium distichum) dominates the open to very open canopy, with or without hardwood associates such as swamp tupelo (Nyssa biflora), water tupelo (Nyssa aquatica), and green ash (Fraxinus pennsylvanica). Stand structure and canopy cover range from closed forest to very open woodland. Shrub and herb layers are variable but generally contain a mixture of species characteristic of both marshes and swamps. Some well-developed tidal bald cypress forests appear floristically similar to palustrine bald cypress-tupelo swamps. Other stands have a nearly monospecific herb dominance by shoreline sedge (Carex hyalinolepis). In a unique, possibly fire-influenced, savanna-like stand on the Northwest River, the herbaceous dominants, in rough seasonal order, are silvery sedge (Carex canescens spp. Disjuncta), spikerushes (Eleocharis fallax and E. rostellata), marsh rattlesnake-master (Eryngium aquaticum var. aquaticum), and wild rice (Zizania aquatica var. aquatica). The environmental dynamics, compositional variation, *and state-wide distribution of this group are poorly known and need intensive study. Reference: Fleming and Moorhead (1998).*

Fluvial Terrace Woodlands
A somewhat enigmatic group of communities occurring on flat, sandy terraces and islands along Coastal Plain rivers in eastern Virginia. These habitats are elevated well above the level of adjacent swamps and are characterized by xeric, sandy soils and open forest or woodland vegetation. Single occurrences have been documented along the Nottoway River (Sussex County), Chickahominy River (New Kent County), Dragon Swamp (Middlesex County), and Mattaponi River (Caroline County). At all four sites, hickories (Carya pallida and C. alba) are dominant trees, with drought-tolerant oaks (Quercus falcate, Q. nigra, Q. marilandica, Q. alba) present in smaller numbers. Shrubs occurring at all or most sites include sand post oak (Q. margarettiae), horse-sugar (Symplocos tinctoria), American holly (Ilex opaca var. opaca), and eastern red cedar (Juniperus virginiana var. virginiana). Typical herbs include sedges (Carex albicans var. australis, C. pensylvanica, and C. tonsa), Canada frostweed (Helianthemum canadense), butterfly-pea (Clitoria mariana), late goldenrod (Solidago tarda), and prickly-pear (Opuntia humifusa). The Dragon Run site is anomalous in the presence (despite low soil pH and base status) of several calciphiles such as eastern redbud (Cercis canadensis var. canadensis), wild columbine (Aquilegia canadensis), smooth rock-cress (Arabis laevigata var. laevigata), robin's-plantain (Erigeron pulchellus var. pulchellus), and elm-leaved goldenrod (Solidago ulmifolia var. ulmifolia). A full understanding of the status and compositional relationships of this group will require additional inventory and assessment.

Tidal Freshwater Marshes
A diverse group of herbaceous wetlands subject to regular diurnal flooding along upper tidal reaches of inner Coastal Plain river and tributaries. Freshwater marshes occur in the uppermost portion of the estuarine zone, where the inflow of saltwater from tidal influence is diluted by a much larger volume of freshwater from upstream. Strictly speaking, freshwater conditions have salt concerntrations <0.5 ppt, but pulses of higher salinity may occur during spring tides or periods of unusually low river discharge. The most common species are arrow-arum (Peltandra virginica), dotted smartweed (Polygonum punctatum), wild rice (Zizania aquatic var. aquatica), pickerelweed (Pontederia cordata), rice cutgrass (Leersia oryzoides), tearthumbs (Polygonum arifolium and P. sagittatum), and beggar-ticks (Bidens spp.). Locally, sweetflag (Acorus calamus) and southern wild rice (Zizaniopsis miliacea) may form large dominance patches. Species diversity and vegetation stature vary with salinity, duration of inundation, and disturbance; the most diverse marshes occupy more elevated surfaces in strictly freshwater regimes. Mud flats that are fully exposed only at low tide support nearly monospecific stands of spatterdock (Nuphar advena), although cryptic submerged aquatic species may also be present. Tidal freshwater marshes are best developed on sediments deposited by large meanders of the Pamunkey and Mattaponi Rivers, although outstanding examples also occur along the Potomac, Rappahannock, Chickahominy, and James Rivers. These communities provide the principal habitat for the globally rare plant sensitive joint-vetch (Aeschynomene virginica). Chronic sea-level rise is advancing the salinity gradient upstream in rivers on the Atlantic Coast, leading to shifts in vegetation composition and the conversion of some tidal freshwater marshes into oligohaline marshes. Tidal Freshwater Marshes are also threatened by the invasive exotic marsh dewflower (Murdannia keisak). Several communities in this group are chiefly restricted to the Chesapeake Bay drainage basin and are considered globally rare or uncommon. References: Parker and Wyatt (1975), Perry and Atkinson (1997), Perry and Hershner (1999), McCoy and Fleming (2000).

Appendix B: Fish and Macroinvertebrates

Taken from McIninch et al., 2003:

List of fishes captured to date from Dragon Swamp, Piankatank River drainage.

Scientific Name	Common name
Petromyzontidae	**Lampreys**
Lampetra aepyptera	least Brook lamprey
Lepisosteidae	**Gars**
Lepisosteus osseus	longnose gar
Anguillidae	**Freshwater eels**
Anguilla rostrata	American eel
Clupeidae	**Shads and herrings**
Brevoortia tyrannus	Atlantic menhaden
Dorosoma cepedianum	gizzard shad
Alosa aestivalis	blueback herring
Alosa pseudoharengus	alewife
Engraulidae	**Anchovies**
Anchoa mitchilli	bay anchovy
Umbridae	**Mudminnows**
Umbra pygmaea	eastern mudminnow
Esocidae	**Pikes and pickerals**
Esox niger	chain pickerel
Esox americanus	redfin pickerel
Cyprinidae	**Carps and minnows**
Cyprinus carpio	common carp
Notemigonus crysoleucas	golden shiner
Semotilus atromaculatus	creek chub
Cyprinella analostana	satinfin shiner
Notropis amoenus	comely shiner
Notropis procne	swallowtail shiner
Notropis chalybaeus	ironcolor shiner
Hybognathus regius	eastern silvery minnow
Catostomidae	**Suckers**
Erimyzon oblongus	creek chubsucker

Ictaluridae	**Bullhead catfishes**
Ictalurus furcatus	**blue catfish**
Ameiurus catus	white catfish
Ameiurus nebulosus	brown bullhead
Ameiurus natalis	yellow bullhead
Noturus gyrinus	tadpole madtom
Aphredoderidae	**Pirate perches**
Aphredoderus sayanus	pirate perch
Fundulidae	**Killifishes**
Fundulus diaphanus	banded killifish
Cyprinodontidae	**Toothed minnows**
Cyprinodon variegatus	sheepshead minnow
Poeciliidae	**Live-bearers**
Gambusia holbrooki	mosquitofish
Moronidae	**Striped basses**
Morone saxatilis	striped bass
Morone americana	white perch
Centrarchidae	**Sunfishes**
Enneacanthus obesus	banded sunfish
Enneacanthus gloriosus	bluespotted sunfish
Pomoxis nigromaculatus	black crappie
Micropterus salmoides	largemouth bass
Micropterus punctulatus	spotted bass
Lepomis gulosus	warmouth
Lepomis auritus	redbreast sunfish
Lepomis macrochirus	bluegill
Lepomis gibbosus	pumpkinseed
Lepomis microlophus	redear sunfish
Percidae	**Perches**
Perca flavescens	yellow perch
Etheostoma olmstedi	tessellated darter
Sciaenidae	**Drums**
*Leiostomus xanthur*us	spot
Achiridae	**American soles**
Trinectes maculates	hogchoker

List of macroinvertebrates collected to date from Dragon Run, Piankatank drainage.

Order Annelida
- Family Oligochaetae
- Family Hirudinea
- Family Erpobdellidae
  - *Dina* sp.

Order Amphipoda
- Family Gammaridae
  - *Gammarus* sp.

Order Isopoda
- Family Asellidae
  - *Caecidotea* sp.

Order Megaloptera
- Family Corydalidae
  - *Nigronia serricornis*
- Family Sialidae
  - *Sialis* sp.

Order Diptera
- Family Simuliidae
- Family Chironomidae
- Family Ceratopogonidae
  - *Palpomyia* spp.
  - *Culicoides* spp.
  - *Probezzia* sp.
- Family Culicidae
  - *Culex* sp
- Family Tipulidae
  - *Tiplua abdominalis*
  - *Pilaria* spp.
- Family Empididae

Order Ephemeroptera
- Family Leptophlebiidae
  - *Leptophlebia* sp.
  - *Paraleptophlebia* sp.
- Family Baetidae
  - *Baetis* spp.
- Family Ephemerellidae
  - *Ephemerella* spp.
  - *Eurylophella temporalis*
- Family Caenidae
  - *Caenis* sp.
- Family Heptageniidae
  - *Stenonema modestum*

Order Trichoptera
- Family Calamoceratidae
  - *Anisocentropus* sp.
  - *Heteroplectron* sp.
- Family Hydropsychidae
  - *Cheumatopsyche* spp.
- Family Leptostomatidae
  - *Lepidostoma* sp.
- Family Phryganaeidae
  - *Ptilostomis* sp.
- Family Psychomyiidae
  - *Lype diversa*
- Family Polycentropodidae
  - *Polycentropus* spp.
- Family Leptoceridae
  - *Oecetis* spp.
- Family Molannidae
  - *Molanna blenda*
- Family Limnephilidae
  - *Pycnopsyche* spp.

Order Plecoptera
- Family Capniidae
  - *Allocapnia* sp.

Order Coleoptera
- Family Dytiscidae
  - *Hydroporus* spp.
- Family Gyrinidae
  - *Dineutes* sp.
- Family Haliplidae
  - *Peltodytes* sp.

Order Odonata
- Family Aeshnidae
  - *Boyeria vinosa*
  - *Nasiaschna pentacantha*
- Family Calopterygidae
  - *Calopteryx* spp.
- Family Lestidae
  - *Lestes* sp.
- Family Libellulidae
  - *Pachydiplax longipenis*
- Family Coenagrionidae
  - *Enallagma* spp.
  - *Ischnura* sp.
- Family Corduliidae
  - *Epitheca* sp.
- Family Gomphidae
  - *Gomphus* sp.

Order Hemiptera
Family Corixidae
Trichocorixa sp.

Order Bivalvia
Family Sphaeriidae
Pisidium sp.
Sphaerium sp.
Musculium sp.

Order Gastropoda
Family Ancylidae
Ferrissia sp.
Family Physidae
Physa sp.
Physella sp.
Family Hydrobiidae
Somatogyrus spp.
Family Planorbidae
Planorbula sp.
Gyraulus spp.
Family Lymnaeidae
Pseudosuccinea columella

Order Decaopda
Family Cambaridae
Cambarus sp.
Family Palaemonidae
Palaemonetes paludosus

Appendix C: Soils

Taken from the Electronic Field Office Technical Guides (NRCS, 2003).

Essex County
Kempsville sandy loam, 0 to 2 percent slopes
Kempsville sandy loam, 6 to 10 percent slopes
Rumford and Emporia soils, 15 to 20 percent slopes
Rumford and Slagle soils 6 to 15 percent slopes
Slagle fine sandy loam, 2 to 6 percent slopes
Slagle fine sandy loam, 6 to 10 percent slopes
Suffolk sandy loam, 0 to 2 percent slopes
Suffolk sandy loam, 2 to 6 percent slopes
Tetotum loam, 0 to 2 percent slopes
Tomotley fine sandy loam, 0 to 2 percent slopes

Gloucester County
Alaga loamy sand, 0 to 4 percent slopes
Eunola fine sandy loam
Fluvaquents, frequently flooded
Hapludults, sloping
Hapludults, steep
Kempsville fine sandy loam, 2 to 6 percent slopes
Ochlockonee-Ochlockonee variant complex
Ochrequults, nearly level
Ochrequults-Haplaquepts complex
Oster loamy fine sand
Pactolus loamy sand, 0 to 4 percent slopes
Psamments, nearly level
Psamments-Hapludults complex, sloping
Psamments-Hapludults complex, steep
Rumford loamy fine sand, 0 to 2 percent slopes
Rumford loamy fine sand, 2 to 6 percent slopes
Suffolk fine sandy loam, 0 to 2 percent slopes
Suffolk fine sandy loam, 2 to 6 percent slopes
Suffolk fine sandy loam, 6 to 10 percent slopes
Sulfaquents, frequently flooded
Wrightsboro fine sandy loam, 0 to 2 percent slopes
Wrightsboro fine sandy loam, 2 to 6 percent slopes

King and Queen County
Augusta fine sandy loam, 0 to 2 percent slopes, rarely flooded
Bojac loamy sand, 0 to 2 percent slopes, rarely flooded
Craven fine sandy loam, 0 to 2 percent slopes
Craven fine sandy loam, 2 to 6 percent slopes
Craven fine sandy loam, 6 to 10 percent slopes

Emporia sandy loam, 0 to 2 percent slopes
Emporia sandy loam, 2 to 6 percent slopes
Emporia sandy loam, 6 to 10 percent slopes
Emporia-Slagle-Rumford complex, 6 to 15 percent slopes
Emporia-Slagle-Rumford complex, 15 to 50 percent slopes
Kinston and Bibb soils, 0 to 2 percent slopes, occasionally flooded
Levy silt loam, 0 to 2 percent slopes, frequently flooded
Munden loamy sand, 2 to 6 percent slopes
Pits, gravel
Roanoke loam, 0 to 2 percent slopes, rarely flooded
Rumford loamy sand, 0 to 6 percent slopes
Rumford loamy sand, 6 to 10 percent slopes
Slagle sandy loam, 0 to 2 percent slopes
Slagle sandy loam, 2 to 6 percent slopes
Slagle sandy loam, 6 to 10 percent slopes
State fine sandy loam, 0 to 2 percent slopes
State fine sandy loam, 2 to 6 percent slopes
Suffolk sandy loam, 0 to 2 percent slopes
Suffolk sandy loam, 2 to 6 percent slopes
Wahee fine sandy loam, 0 to 2 percent slopes, rarely flooded

Middlesex County
Ackwater silt loam
Bama loam, 2 to 6 percent slopes
Bethera and Daleville soils
Catpoint loamy sand
Craven silt loam, 0 to 2 percent slopes
Craven silt loam, 2 to 6 percent slopes
Emporia loam, 0 to 2 percent slopes
Emporia loam, 2 to 6 percent slopes
Emporia-Nevarc complex, 6 to 15 percent slopes
Emporia-Nevarc complex, 15 to 45 percent slopes
Eunola loam
Kempsville sandy loam, 0 to 2 percent slopes
Kempsville sandy loam, 2 to 6 percent slopes
Kenansville fine sand
Kinston-Bibb complex
Myatt loam
Nansemond loamy fine sand
Ochlockonee silt loam
Pactolus loamy fine sand
Pocaty muck
Rumford fine sandy loam, 0 to 2 percent slopes
Rumford fine sandy loam, 2 to 6 percent slopes
Slagle silt loam, 0 to 2 percent slopes
Slagle silt loam, 2 to 6 percent slopes

Suffolk fine sandy loam, 0 to 2 percent slopes
Suffolk fine sandy loam, 2 to 6 percent slopes
Suffolk-Remlik complex, 6 to 15 percent slopes
Suffolk-Remlik complex, 15 to 45 percent slopes
Udorthents and Psamments, gently sloping