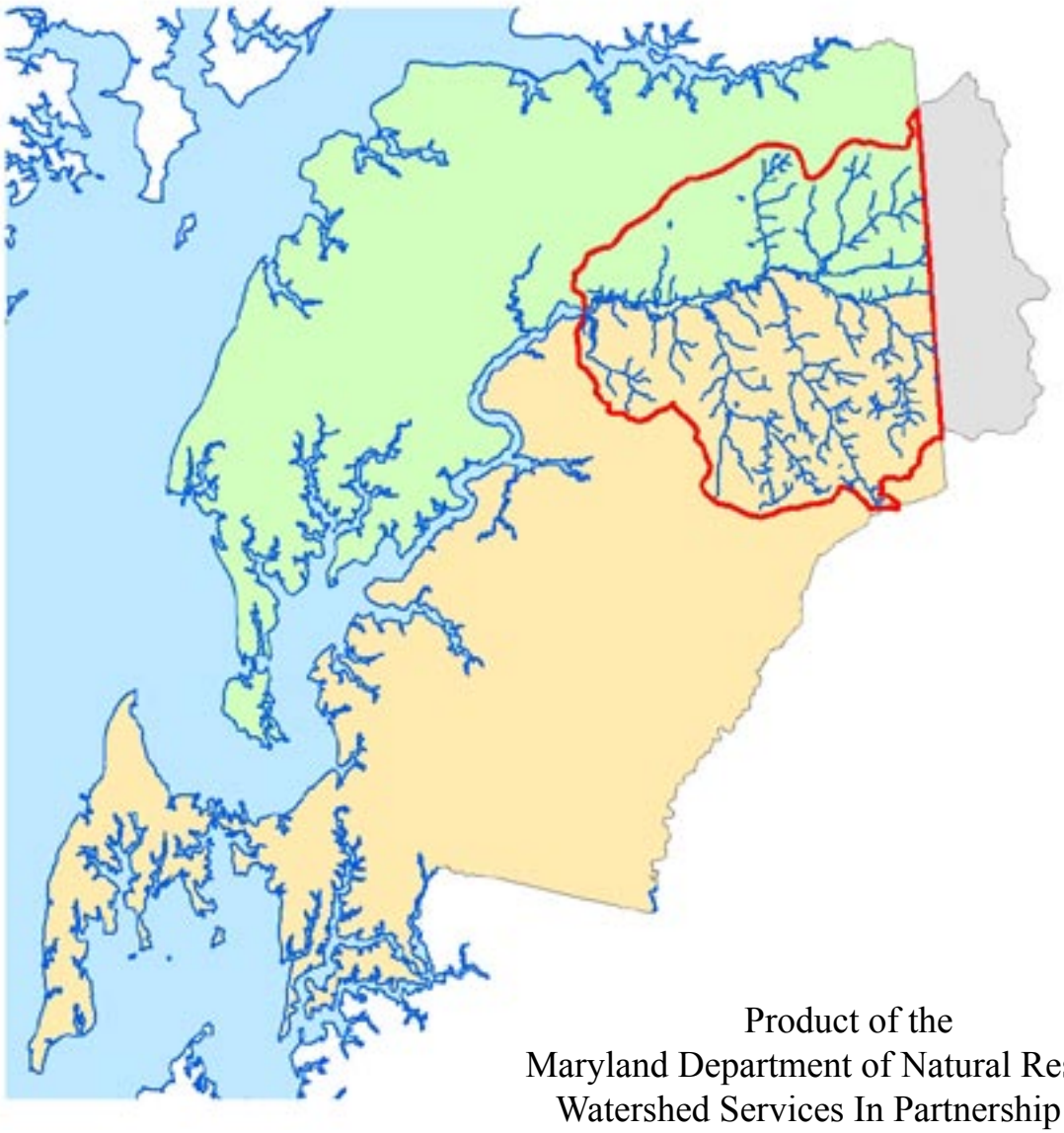
Characterization
Of The
Upper Chester River Watershed
In Kent County and Queen Anne's County, Maryland

March 2005

In support of a Watershed Restoration Action Strategy
for the Upper Chester River Watershed
by Queen Anne's County and Kent County



Product of the
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Queen Anne's County and Kent County

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Executive Summary

The Upper Chester River and its tributaries are part of the Chester River basin that drains to the Chesapeake Bay and then to the Atlantic Ocean. The Upper Chester River watershed covers 178 square miles in Maryland and Delaware. About 137 square miles of the Upper Chester River watershed are in Maryland, which includes 82 square miles in Queen Anne's County and 55 square miles in Kent County. Queen Anne's County and Kent County are receiving Federal grant funding to prepare a Watershed Restoration Action Strategy (WRAS) for their portion of the Upper Chester River Watershed.

As part of the WRAS project, the Maryland Department of Natural Resources (DNR) is providing technical assistance, including preparation of a watershed characterization (compilation of available water quality and natural resources information and identification of issues), a stream corridor assessment (uses field data to catalog issues and rate severity) and a synoptic survey (analyzes benthic macroinvertebrates, fish and water samples with focus on nutrients). The Counties will consider the information generated in these efforts as they draft the Watershed Restoration Action Strategy.

Water Quality

All water bodies in the Upper Chester River watershed have a designated use that appears in the Code of Maryland Regulations (COMAR), which is set by the State of Maryland following public hearings. The designated use for all waterbodies in the Upper Chester watershed is to support water contact recreation and protection of aquatic life. Water quality impairments that affect these designated uses include nutrients, sediment, fecal coliform bacteria, biological impairment (poor or very poor ranking for fish or benthic macroinvertebrates based on in-stream assessments) and methylmercury for ponds in the Millington Wildlife Management Area.

As a step toward eliminating nutrient-related impairments, draft Total Maximum Daily Load documents are anticipated to be available for public comment in 2005.

The Chester River mainstem shows some signs of eutrophication. Long term monitoring shows that clarity measured by secchi disk tends to be less than 0.5 meters and dissolved oxygen concentrations less than 5.0 mg/l sometimes occur in warm-weather months. For total nitrogen, the 1999 average was in the 2 to 3 mg/l range, which is greater than expectations for natural conditions (1 mg/l or less). For total phosphorus in 1999, the average was slightly greater than 0.1 mg/l. Also in 1999, algae populations as measured by Chlorophyll a averaged over 50 in micrograms per liter in upstream areas of the mainstem. Chlorophyll a concentrations more than twice that level were also measured in the river.

In nontidal streams, the presence of water quality issues varied based on 1999 monitoring data from five streams. Andover Branch exhibited the highest phosphorus concentrations, the greatest biological oxygen demand, the

densest algae bloom and the lowest dissolved oxygen. Red Lion Branch and Unicorn Branch exhibited the highest average total nitrogen concentrations at 6.46 and 7 mg/l respectively but other water quality measurements did not suggest that they had other in-stream water quality problems.

Point source contributions of nutrients associated with sewage effluent arise from two small wastewater treatment plants serving Millington and Sudlersville.

Natural Resources

Watershed geology is about 86% Eastern Shore Upland Deposit. The remaining 14% of the watershed includes Lowland Deposits, the Calvert Formation and the Aquia Formation that, together, tend to be in the vicinity of the Chester River mainstem and the mainstems of major tributary streams.

About 56% of the watershed is prime agricultural soil. Another 30% of local soils exhibit hydric characteristics that tend to be found in the Upland Deposit geologic area. The remaining 14% of soils includes: Sandy, excessively drained soils are generally located along the Chester River mainstem; soils with drainage limitations; soils with a perched water table, and; soils similar to prime agricultural soils that are steeper than 8% slope.

Green Infrastructure is a network of natural areas identified by DNR that are ecologically important on a statewide or regional scale, which includes portions of the Upper Chester River watershed. Green Infrastructure includes areas like large blocks of forest or wetlands, habitat for sensitive species and protected conservation areas. These areas are grouped into hubs that contain the bulk of these resources and corridors than link the hubs together. In the Upper Chester River watershed, Green Infrastructure hubs include significant areas of forest including over 10,400 acres in Queen Anne's County and nearly 7,360 acres in Kent County. Gaps in the hubs and in the corridors that link them tend to be in agricultural use. In Queen Anne's County, part of one hub is protected from conversion to development by Rural Legacy easements in the Chino Farms area. Also in Queen Anne's County, several small portions of the Green Infrastructure hub east of Route 313 is protected by agricultural easements and open space easements In Kent County, most of one large Green Infrastructure hub is protected by the Millington Wildlife Management Area.

About 16,200 acres of wetlands are identified in the watershed. They are widely dispersed and are mostly on private land. This wetland acreage includes numerous Delmarva Bays, which are wetlands that are isolated by surrounding uplands. Most wetlands in the watershed are not associated with floodplains. Compared to wetlands, 100-year floodplains are much more concentrated along the Chester River mainstem and some large tributary streams.

An assessment of stream buffer restoration opportunities in Maryland's portion of the Upper Chester River watershed was conducted using computerized GIS. Data used for streams and 2002 land use was generated by Maryland Department of Planning. Of the total 220 miles of stream identified, including both banks of the Chester River counted independently, 67% (147 miles) of riparian area had some form of naturally vegetated stream buffer. Less than one percent of the stream buffer was developed for nonagricultural use. Streams lacking naturally vegetated buffers, including all types of agriculture and barren land, accounted for over 32% (93 miles) of stream miles in total. Among the streams lacking naturally vegetated buffers, about 24 miles of stream flow through

areas of hydric soil. Restoration of natural vegetation on these hydric soils would have the potential to provide multiple benefits like shading streams, intercepting nutrients before they enter streams and restoring wetland habitats.

Living Resources and Habitat

Spawning of anadromous fish including white perch, yellow perch and herring is documented along the Chester River mainstem to about one mile upstream of Millington. Spawning is also documented in several Chester River tributaries in the watershed including Red Lion Branch, Unicorn Branch, Andover Branch, Mills Branch, an unnamed tributary east of Millington and an unnamed tributary near Chase Island. In most these water bodies, it appears that blockages associated with impoundments limit the extent of spawning for anadromous fish.

A fish consumption advisory is in affect for five fish species that may be caught in the watershed: Channel catfish and white perch from the Chester River, large and small mouth bass from any water body and bluegill from impoundments. Tissue from these fish species have been found to contain contamination from PCBs, pesticides and/or methylmercury.

Assessments of fish and benthic macroinvertebrates using Maryland Biological Stream Survey techniques have tended to rate most sites that have been assessed in the Upper Chester River watershed as good or fair. However, some sites were ranked as poor or very poor. These sites are listed for biological impairment on the State's list of impaired waters.

Maryland tracks sensitive species of six animals and 28 plants in the Upper Chester River watershed. These species are found in at least 22 Ecologically Significant Areas mapped by the DNR Natural Heritage program.

Land Use

Agriculture is the dominant land use in the Upper Chester River watershed according to Maryland Department of Planning 2002 data. This generalized land use category covers about 69% and 63% of the Kent County and Queen Anne's County respectively. Forest covers 29% of Kent County and 33% of Queen Anne's County. Developed lands are a minor land use in the watershed accounting for about 2% in Kent County and 4% Queen Anne's County. These developed lands appear to be dispersed in the watershed along roads or tidal portions of the Chester River.

Privately owned land covers about 96% the Upper Chester River watershed. About 10% of this private land (8,195 acres) is protected from conversion to developed land uses by some form of easement. These protective mechanisms include agricultural easements (4,060 acres), Rural Legacy easements (2,850 acres), open space easements via transfer of development rights (1,202 acres) and conservation easements/ownership (85 acres).

Public land that is managed for natural resource and recreational purposes covers about 4% of the watershed. This public ownership includes the Millington Wildlife Management Area (3,654 acres) and several small County parks totaling about 86 acres.

Average impervious cover for subwatersheds in the Upper Chester River watershed was estimated using land cover data collected in 1999-2001. Generally, impervious cover includes rooftops and roads that prevent stormwater from infiltrating in the ground. Significant water quality and habitat impacts are observed in streams in watersheds with average impervious cover of about 10% or greater. All subwatersheds in the Upper Chester River watershed have less than 2% average imperviousness.

Introduction

Watershed Planning Background

As a foundation for watershed monitoring, analysis and planning, the State of Maryland defined over 130 watersheds that cover the entire State in the 1970s. In 1998, the Maryland Clean Water Action Plan presented an assessment of water quality conditions in each of these watersheds. Based on these assessments, it also established State priorities for watershed restoration and protection.

In 2000, the Maryland Department of Natural Resources (DNR) initiated the Watershed Restoration Action Strategy (WRAS) Program as one of several new approaches to implementing water quality and habitat restoration and protection. The WRAS Program solicits local governments to focus on priority watersheds for restoration and protection. Since inception of the program, local governments have received grants and technical assistance from DNR for 20 WRAS projects in which local people identify local watershed priorities for restoration, protection and implementation.

Upper Chester WRAS Project

The Upper Chester River Watershed is in the Chester River basin that drains Maryland and Delaware as shown in Map1 Location. In Maryland, this watershed is designated as a Category 1 watershed for restoration in the Maryland Clean Water Action Plan. For Maryland's portion of the watershed, Queen Anne's and Kent Counties are working on a WRAS project to be completed in 2006. In the WRAS, the Counties will identify and prioritize local restoration and protection needs associated with water quality and habitat. To support the County effort, the Maryland Department of Natural Resources (DNR) is supplying grant funding and technical assistance including production of this Watershed Characterization.

Watershed Area By Jurisdiction In Square Miles For The Upper Chester River

Watershed Area	Jurisdiction			Total
	Queen Anne's County, MD	Kent County, MD	Delaware	
Upper Chester River	82	55	41	178

Map 2 WRAS Project Area shows Maryland's portion of the watershed in greater detail. It highlights subwatersheds defined by the State that are used for analytical purposes throughout the Watershed Characterization. The Watershed Characterization focuses primarily on Maryland's WRAS project area. Information on upstream areas of the Upper Chester River watershed in Delaware is occasionally presented when it is immediately available.

Purpose of the Characterization

To support the WRAS project, the Watershed Characterization helps to meet several objectives:

- Summarize immediately available information and issues
- Provide preliminary findings based on this information
- Identify sources for more information or analysis
- Suggest opportunities for additional characterization and restoration work.
- Provide a common base of knowledge about the watershed for government, citizens, businesses and other interested groups.

The Watershed Characterization adds to other efforts that are important for the County's WRAS project:

- Local investigation by the County
- Stream Corridor Assessment, in which DNR personnel physically walk the streams and catalogue important issues
- Synoptic water quality survey, i.e. a program of water sample analysis, that can be used to focus on local issues like nutrient hot spots, point source discharges or other selected issues. This is also part of the technical assistance offered by DNR
- Technical assistance and assessment by partner agencies or contractors

Moving Beyond The Characterization

In addition to the information presented in this document, it is important to identify gaps in available watershed knowledge and to gauge the importance of these gaps. As new information becomes available, the Watershed Characterization and other components of the WRAS should be updated and enhanced as needed.

Here are some examples of issues for potential additional work:

- Habitat: physical structure, stream stability, biotic community (incl. the riparian zone)
- Water Quantity: high water–storm flow and flooding; low water–baseflow problems from dams, water withdrawals, reduced infiltration
- Water Quality: water chemistry; toxics, nutrients, sediment, nuisance odors/scums, etc.
- Cumulative effects associated with habitat, water quantity and water quality.

Restoration and natural resource protection is an active evolving process. The information that supports the Watershed Restoration Action Strategy, including the Watershed Characterization, should be maintained as living documents within an active evolving restoration process. These documents will need to be updated periodically as new, more relevant information becomes available and as the watershed response is monitored and reassessed.

More Information Sources

The WRAS Program Internet home page has additional information on the program and an index of available electronic copies of WRAS-related documents that can be downloaded free of charge. Available documents include detailed program information, completed WRAS strategies, stream corridor assessments, synoptic surveys and watershed characterizations. Please visit the WRAS Home Page at http://www.dnr.state.md.us/watersheds/wras/

Additional information on over 130 watersheds in Maryland is available on DNR's Internet page Surf Your Watershed at http://www.dnr.state.md.us/watersheds/surf/index.html

The Maryland Clean Water Action Plan is available at www.dnr.maryland.gov/cwap/

Water Quality

Water quality is in many respects the driving condition in the health of Maryland's streams. Historically, efforts to protect water quality have focused on chemical water quality. More recently, additional factors are being considered like measurements of selected biological conditions and physical conditions that affect habitat quality in streams and estuaries. This expanded view is reflected current approaches to stream monitoring, data gathering, and regulation.

General context for the Watershed Restoration Action Strategy (WRAS) is presented in two maps. Map 1 Location shows its regional context. Map 2 Project Area shows streams, subwatersheds and selected cultural information.

Water Quality Standards and Designated Uses

All streams and other water bodies in Maryland are assigned a "designated use" in the Code of Maryland Regulation (COMAR) 26.08.02.08 associated with a set of water quality criteria necessary to support that use.

Maryland

In Maryland's portion of the Upper Chester River watershed, all streams and other surface waters are designated Use 1 for Water Contact Recreation and Protection of Aquatic Life. Maryland's 2002 water quality status report included three separate listings for surface waters in the Upper Chester River watershed (which is MD segment 02130510 in Federal HUC 02060002). (1)

- Tidal mainstem and tributaries that cover 2.3 square miles fully supports all uses.
- Nontidal, wadeable tributaries that cover 60.8 square miles fully support all uses. However, 17.5 miles of stream fail to support all uses associated with biological community impairment like siltation and low dissolved oxygen. The sources listed for the failure to support uses are habitat alteration and hydromodification.
- Unicorn Mill Pond covers 48 acres and fully supports all uses.

Delaware

According to Delaware's watershed assessment 305(b) report, the headwaters of the Chester River do not support their designated use for aquatic life or primary contact recreation. (2)

Use Impairments

Some streams or other water bodies in the WRAS project area cannot be used to the full extent envisioned by their designated use in Maryland regulation. In these waterbodies, water quality or habitat impairments are generally the cause. These areas, known as "impaired waters", are tracked by the Maryland Department of the Environment under Section 303(d) requirements of the Federal Clean Water Act. The impairments for Maryland's portion of the Upper Chester River are summarized below based on the final 2004 list. (3)

Bacteria

Upper Chester River tidal waters were initially listed for fecal coliform impairment in 1996. Sources are believed to nonpoint source and natural.

Biological Impairment

Several sites in the Upper Chester River watershed are listed for biological impairment by unknown causes: an unnamed tributary of Unicorn Branch that was first listed in 2002 and two sites on Andover Branch that were first listed in 2004. These sites are listed for biological impairment because assessments conducted by the Maryland Biological Stream Survey rated each site as either poor or very poor on the Indices of Biological Integrity for fish and/or benthic macroinvertebrates.

Methylmercury

Ponds in the Millington Wildlife Management Area were initially listed in 2004 for methylmercury in fish tissue based on sampling conducted by MDE in 2002. The source of the contamination was listed as atmospheric deposition. The tissue measurement listed is 341 mircograms per kilogram.

Nutrients

Upper Chester River tidal waters were originally listed in 1996 for nutrients originating from nonpoint and natural sources. This nutrient impairment is driving seasonally low levels of dissolved oxygen.

Sediment

The tidal portion of the Upper Chester River was first listed for impairment by sediments in 1996. The source of the sediment problem is believed to be nonpoint source and natural.

Total Maximum Daily Loads

In Maryland, the Department of the Environment (MDE) uses the 303(d) list of impaired waters to determine the need for establishing Total Maximum Daily Loads (TMDLs). A TMDL is the amount of pollutant that a water body can assimilate and still meet its designated use. A water body may have multiple impairments and multiple TMDLs to address them. MDE is responsible for establishing TMDLs. In general, TMDLs have two key parts:

1- Maximum pollutant load that the water can accept while still allowing the water body to meet its intended use.
2- Allocation of the maximum pollutant load to specific pollutant sources.

As of July 2004, completion of draft nutrient TMDLs for Maryland's portion of the Upper Chester River and the Middle Chester is projected for 2005. (4) Any additional Maryland TMDLs that may be needed will be drafted after that time.

Water Quality Monitoring and Analysis

The State of Maryland has collected water quality information each month from one long term sampling station in the tidal Chester River within the Upper Chester River watershed for many years. Map 3 Water Quality Monitoring shows that this station, ET4.1 is located mid channel in the Chester River. Samples are taken from a depth of about 20 feet. A summary of some findings from this station is listed below and in the adjacent graphs from DNR's Eyes on the Bay Internet sight: (5)

- Dissolved oxygen is usually greater than 5 mg/l but it has been measured as low as 4.5 mg/l in bottom water during warm-weather months. Concentrations above 5

mg/l are generally satisfactory for aquatic life but less than this begin to stress some species.
- Water clarity as measured by secchi depth tends to be less than half meter during warm-weather months. Clarity as low as one tenth meter has been measured. Secchi depths less than one meter tend to inhibit submerged aquatic vegetation because light is not penetrating deep enough to support plant growth.
- Salinity in 2004 tended to be less than 0.5 parts per thousand (ppt). In prior years salinity as high as about 4 ppt was measured. Measurements of lower salinity, like those commonly observed in spring, indicate greater flows of fresh water in the river compared to other periods.
- Monitoring of pH tends to vary between 6.5 and 8 but in 2004 it reached nearly 9.

Other Chester River mainstem stations sampled in 1999 present some additional findings that show variation up and down the river and during warm-weather months. Overall, the data demonstrate that the river is eutrophied with high algae populations fueled by excessive nutrients. (For more details, see Appendix B – Maryland Water Quality Summary):

- Dissolved oxygen was generally greater than 5 mg/l but was measured at lower concentrations near Foreman Branch during warm weather months.
- Water clarity was consistently less than one half meter.
- Salinity averages about 0.5 ppt near Mills Branch and rises on average to 3.6 near Foreman Branch.
- Total nitrogen (TN) averages in the 2 to 3 mg/l range but concentrations are significantly higher in spring.
- Total phosphorus (TP) slightly over 0.1 mg/l.
- Algae populations, as measured by chlorophyll A in micrograms per liter, averaged over 50 in the three upstream stations. Several algae blooms over 100 were measured.

Monitoring in five tributaries provides some additional insights into the sources of mainstem findings.

- Dissolved oxygen generally meets the State standard but Andover Branch experienced some very low levels of 2 mg/l or less.
- Biological oxygen demand (BOD) averages the lowest in Red Lion Branch and the highest in Andover Branch.
- Total nitrogen concentrations averaged the lowest in Mills Branch with slightly over 1 mg/l. In nontidal streams, anything over 1.0 mg/l may be considered high. Significantly higher average nitrogen concentrations where measured in Cyprus Branch and Andover Branch with 2.2 mg/l and 2.9 mg/l respectively. Even higher nitrogen concentration averages occurred in Red Lion Branch that exhibited 6.46 mg/l and Unicorn Branch that had 7 mg/l. These levels may impact tidal water downstream.
- Total phosphorus concentrations averaged less than 0.1 mg/l in all streams but one. Andover Branch's average was 0.4 mg/l. In nontidal streams, 0.1 mg/l may be considered high.
- Algae populations as measured by chlorophyll A were low overall in Red Lion, Unicorn and Cyprus Branches. Mills Branch and Andover Branch also tended to have similarly low algae levels but they both also had significantly higher algae blooms measured at about 52 mg/l and 165 mg/l respectively. Such high levels are indicative of eutrophication problems.

In comparing the tributary station data, Andover Branch appears to exhibit the greatest instream water quality problems based on BOD and algae findings.

Delaware

Headwaters of the Chester River in Delaware are entirely freshwater nontidal streams including Cypress Branch, Sewell Branch, Jordan Branch, Gravelly Run and numerous unnamed tributaries. These streams affect water quality in Maryland's Upper Chester River watershed by transporting nutrients, algae and sediment that add to those arising in Maryland. Water quality issues in Delaware that affect Maryland tend to be associated with nutrients and dissolved oxygen.

Nutrients overall in Delaware's Chester River headwaters have the following characteristics according to an assessment published in 2000: (6)

- Total nitrogen concentration overall is rated as moderate which is defined as between 1 and 3 milligrams per liter (mg/l).
- Total phosphorus concentration overall is rated as high which is defined as greater than 0.10 mg/l.

Water quality data collected between September 1997 and August 1999 for both Sewell Branch and Gravelly Run exhibited similar issues. (See Appendix C – Delaware Water Quality Summary for details):

- Average dissolved oxygen (DO) is less than 5 mg/l, which is low enough to stress fish. DO less than 3 mg/l was measured in both streams.
- Total nitrogen concentration varied from over 0.7 to 1.8 mg/l in Sewell Branch and from over 0.5 to nearly 2.9 mg/l in Gravelly Run. Measurements over 1.0 mg/l are considered to be high. High nitrogen levels typically do not contribute to local water quality problems in fresh water nontidal streams like those in Delaware. However, nitrogen may be transported downstream to "nitrogen-limited" estuarine waters like the lower Chester River where it may contribute to water quality problems including algae blooms and reduced dissolved oxygen.
- Total phosphorus concentration averaged over 0.3 mg/l in Sewell Branch and about 2.5 mg/l in Gravelly Run. Measurements over 0.1 mg/l are considered to be high. High phosphorus concentrations may contribute local water quality problems in freshwater if water flow is slow as in impoundments.
- Algae populations as measured by chlorophyll A can reach as high as 20 or 40 micrograms per liter. These levels suggest that the combination of high nutrient availability and slow moving water are allowing algae to reach densities that probably contribute to depressed dissolved oxygen levels.
- Bacteria known as enterococcus is tracked by Delaware. Monitoring found three streams that exceeded the Delaware water quality standard of 100 colonies per 100 milliliter: Cypress Branch, Sewell Branch and Gravelly Run. (7)

Point Sources – MDE Permits and Sewer Service Areas

Discharges from pipes or other "discrete conveyances" are called "point sources." Point sources may contribute pollution to surface water or to groundwater. For example, wastewater treatment discharges may contribute nutrients or microbes that consume oxygen (measured as Biochemical Oxygen Demand (BOD)) reducing oxygen available for other aquatic life. Industrial point sources may contribute various forms of pollution. Some understanding of point source discharges in a watershed can be useful in helping to identify and prioritize potential restoration measures.

There are four permitted discharges in the Upper Chester River watershed according to findings from the Maryland Department of the Environment (MDE) permit database as summarized below. Map 4 MDE Permits, Marinas and Local Sewer Service shows the distribution of permits across the watershed. Characteristics of these permitted discharges (volume, temperature, pollutants, etc.) are tracked by MDE and most is accessible to the public.

- The Millington Wastewater Treatment Plant (WWTP) is permitted to discharge up to 70,000 gallons per day (gpd). (Maryland permit 00DP0166, NPDES permit MD0020435.) The map also shows the 183-acre sewer service area that contributes to the WWTP.
- The Sudlersville WWTP is permitted to discharge up to 75,000 gpd. (Maryland permit 02DP0090, NPDES permit MD0020559.) The WWTP services a 156-acre sewer area.
- The Red Bird Egg Farm has an industrial permit for groundwater discharge (Maryland permit 00DP3101). The permit allows up to 600 gpd to be discharged from the facility's egg washing process.
- The State Highway Administration's Millington Shop has a general industrial stormwater discharge permit (Maryland permit 02SW1342).

Marinas

DNR records indicate that one marina is in the Upper Chester River watershed as shown on Map 4 MDE Permits, Marinas and Local Sewer Service. This facility does not offer pumpout facilities for boaters and it is not a member of DNR's Clean Marina Program.

Natural Resources

Water quality and quantity in surface waters and groundwater are greatly influenced by natural resources. Physical factors like geology and soils largely determine local topography, hydrology and potential for erosion. Variation of vegetation types in riparian areas and throughout the watershed produces additional influences that determine potential for stormwater infiltration or runoff and habitat quality. This chapter presents immediately available natural resource information for the Upper Chester River watershed.

Geology

Map 5 Geology shows that the Upper Chester River watershed shows that geology and surface hydrology are closely related. About 86% of the watershed is Eastern Shore Upland Deposit. The headwaters of most streams in the watershed originate in upland deposits.

The remaining 14% of the watershed's geology, including Lowland Deposits, the Calvert Formation and the Aquia Formation, tends to have important surface drainage features like the Chester River associated with them.

Soils

Soil type and moisture conditions greatly affect how land may be used and the potential for

vegetation and habitat on the land. Soil conditions are also one determining factor for water quality in streams and rivers. Local soil conditions vary greatly from site to site according to published information in soil survey reports for Kent and Queen Anne's Counties. A summary of this information called Natural Soils Groups is available from the Maryland Department of Planning (MDP) and is shown for the WRAS watershed in Map 6 Soils. The map aggregates the MDP information to help show the distribution of soils important to watershed planning in the watershed:

- Overall, about 56% of the watershed is prime agricultural soil that makes this area highly desirable for farming.
- About 30% of the watershed exhibits hydric characteristics. As the map shows, these soils tend to be located in areas remote to the Chester River mainstem.
- The remaining soil types, about 14% of the watershed, exhibit various limitations for agriculture. The most common type of limitation is sandy, excessively well drained conditions, particularly in the vicinity of the Chester River mainstem.

Green Infrastructure

Forest and wetlands lands in the Upper Chester River watershed, particularly extensive areas of contiguous natural lands, provide valuable water quality and habitat benefits. In general, actions taken to assure that forest cover will be maintained, to avoid fragmentation of forest, and to restore forest in areas that have been cleared will contribute significantly to improving the water quality in this watershed and to conserving the biodiversity of the State.

DNR has mapped a network of ecologically important lands, comprised of hubs and linking corridors, using several of the GIS data layers used to develop other indicators. Hubs contain one or more of the following:

- Areas containing sensitive plant or animal species;
- Large blocks of contiguous interior forest (at least 250 contiguous acres, plus the 300 foot transition zone);
- Wetland complexes with at least 250 acres of unmodified wetlands;
- Streams or rivers with aquatic species of concern, rare coldwater or blackwater ecosystems, or important to anadromous fish, and their associated riparian forest and wetlands; and
- Conservation areas already protected by public (primarily DNR or the federal government) and private organizations like The Nature Conservancy or Maryland Ornithological Society.

This "Green Infrastructure" provides the bulk of the state's natural support system. It provides ecosystem services, such as cleaning the air, filtering and cooling water, storing and cycling nutrients, conserving and generating soils, pollinating crops and other plants, regulating climate, protecting areas against storm and flood damage, and maintaining hydrologic function. For more information on the Green Infrastructure in Maryland, see www.dnr.maryland.gov/greenways/

Protection of Green Infrastructure lands may be addressed through various existing programs including Rural Legacy, Program Open Space, conservation easements and others. Within Program Open Space, the Green Print program helps to target funds to protect Green Infrastructure areas.

Map 7 Green Infrastructure shows that, from the statewide perspective that guided the analysis, several Green Infrastructure features are found in the Upper Chester River Watershed:

- Green Infrastructure hubs include significant areas of forest including over 10,400 acres in Queen Anne's County and nearly 7,360 acres in Kent County.
- Most significant gaps in Green Infrastructure hubs tend to be in agricultural use. These gaps could be considered to be outside of the hub if the landowner intent is to continue farming. However, these gaps could be considered as potential hub restoration areas if the land owner intent is to convert the land to forest or other natural resource use.
- Connections between Green Infrastructure hubs tend to occur along stream corridors. Significant areas of these Green Infrastructure corridors are in natural vegetation but extensive areas are also in agricultural use.
- Most of the Green Infrastructure land in the Upper Chester River watershed is not protected from conversion from natural resource use to other uses. For example, a portion of a Green Infrastructure hub may be partly protected by an agricultural easement, which prevents conversion to development, but it does not necessarily inhibit conversion of forest to active agricultural use.

Large Forest Blocks

Large blocks of forest provide habitat for species that are specialized for conditions with relatively little influence by species from open areas or humans. For example, forest interior dwelling birds require forest interior habitat for their survival and they cannot tolerate much human presence. Map 8 Forest Interior shows blocks of contiguous forest that are at least 50 acres in size with at least 10 acres of forest interior (forest edge is at least 300 feet away) that may be important locally within the watershed. This size threshold was chosen to help ensure that the forest interior is large enough to likely provide locally significant habitat for sensitive forest interior dwelling species. The forest interior assessment map differs from the Green Infrastructure assessment in that forest interior areas are more numerous and more widely distributed because the forest interior size threshold is lower. Several findings on Upper Chester River watershed forest interior can be seen on the map or interpreted in comparing it with the Green Infrastructure and protected lands maps:

- Large blocks of high quality forest interior habitat tend to be along tributary stream corridors or in headwater areas for those streams.
- The majority of forest interior habitat in the watershed is not protected from conversion to other land uses. DNR's Millington Wildlife Management Area (WMA) encompasses some large areas of high quality forest interior habitat. Easements held by the Maryland Environmental Trust (MET) include an area of forest interior in the southeast corner of the watershed near the Delaware State border.

Wetlands

As Map 9 Wetlands and 100-Year Floodplain shows, the majority of nontidal wetlands in the watershed are forested. According to the Maryland Department of Environment that contributed this section for the watershed characterization, other wetlands in the Upper Chester River watershed include estuarine vegetated wetlands, mudflats, freshwater tidal wetlands, forested wetlands flooded occasionally by spring tides, and nontidal wetlands. Most nontidal wetlands are associated with streams and floodplains. There are also a high number of nontidal wetlands known as Delmarva Bays, or Carolina Bays, on the Delmarva. These wetlands are small depressions of up

to nearly 20 acres in size, with a round, elliptical or irregular shape. Many Delmarva Bays are surrounded by a raised sandy rim. While the topography of the watershed is generally level, nontidal wetlands, associated streams, and floodplains are usually found in ravines of varying depths. Soils are often acidic, and become more so when drained.

Tidal Wetlands

Tidal wetlands in the entire Chester River watershed total approximately 16,204 acres, comprising 6.2% of the State's total tidal wetland acreage and ranking sixth among major basins with tidal areas. (8) High brackish marshes are the most common type, dominated by meadow cordgrass and spike rush or shrub-by marshelder and groundsel bush. This latter type of community is important habitat for birds, which often nest in the shrubs and feed in the herbaceous marshes. Freshwater (palustrine) wetlands typically have more diverse vegetation than the estuarine marshes, in which diversity is limited to a few species of salt tolerant plants. The three dominant vegetation communities in the freshwater tidal marshes of the Upper Chester watershed are pickerelweed/arrowarum, cattail, and big cordgrass. In the higher freshwater reaches, there are also some areas of tidally influenced red maple forest. Tidal wetlands have deep organic soils, which aid in chemical interactions for nutrient transformation. All tidal wetlands in the Upper Chester watershed are depicted on the map in the category "All Emergent" wetlands.

Tidal wetlands and the Chester River floodplain generally become more narrow and limited in extent in upstream areas. There is a large oxbow that appears to be forming west of Millington with more extensive tidal wetlands. A railroad bridge and embankment and parts of Millington have suffered from flood impacts in the past. The area may be susceptible to additional to flooding problems due to its location near the tidal/nontidal boundary. High tides will back up water flowing downstream from the headwaters and nontidal tributaries, resulting in higher flood peaks. East of Millington, the floodplain and wetland systems along Cypress Branch and Andover Branch are wider than the freshwater tidal reaches due to lower elevations. A Mill Pond is on Cypress Branch.

Delmarva Bays

Delmarva Bays are most commonly found along the Maryland-Delaware border in Kent, Queen Anne's, and Caroline Counties. The wetlands are typically isolated from surface water sources and surrounded by uplands, retaining water from precipitation and high groundwater levels and having seasonally high surface for extended periods. Water is often acidic. However, there is evidence that the Delmarva Bays in close proximity are connected to each other through groundwater flow. (9) The substrate usually lacks standing water by late summer or fall and is rapidly re-colonized by emergent plants. Dominant vegetation may be emergent, scrub-shrub, forested, or a mixture of these communities. Nontidal wetlands dominated by natural, long-term scrub shrub or emergent communities are unusual in Maryland. Many Delmarva Bays also support threatened or endangered species of herbaceous plants and amphibians, species which require seasonal fluctuations in water levels. Amphibians also require adjacent upland areas for most of their life cycle, and use the wetlands for breeding habitat. Several Delmarva Bays are often found in close proximity and designated as single complexes as designated nontidal wetlands of special State concern.

The location and configuration of the Delmarva Bays limits their capability to provide certain wetland functions. Despite being depressions and located often in headwaters,

they generally provide limited flood attenuation and water quality improvement benefits. The flat topography and raised rim around the Bays limit their intake of floodwaters or surface runoff. However, as a community type, the wetlands provide exceptional biodiversity and habitat benefits.

Many Delmarva Bays have been lost through direct and indirect impacts of drainage. Some drained Delmarva Bays were drained and converted to agricultural land and others suffered encroachment of woody vegetation resulting from drier water regimes.

Nontidal Wetlands of Special State Concern

There are numerous designated nontidal Wetlands of Special State Concern in the watershed in both Kent and Queen Anne's Counties. In Queen Anne's County, seven sites are identified: (10)

- Andover Flatwoods - This site consists of several Delmarva Bays with five rare plant species. The ecological significance of the site is threatened by encroachment of woody vegetation resulting from ditches in the wetland that drain surface water, and drainage from a channelized section of nearby Andover Creek. (11,12)
- Cleaves Fork - This site is a Delmarva Bay supporting a population of State endangered amphibian.
- Prices Chapel – The site consists of three seasonal ponds dominated by emergent vegetation, and supporting a rare herbaceous plant. Seasonal pond communities are uncommon, as they are often drained or filled for other land uses.
- Pristine Ponds - The site is a Delmarva Bay with both rare plant and animal (amphibian) species. Teats Branch Ponds Pristine Ponds South are also listed as part of the Pristine Ponds complex in some references, but are listed in regulations as a distinct nontidal wetland of special State concern.
- Teats Branch – The site is a seasonal pond adjacent to Pristine Ponds. The pond is dominated by emergent vegetation, which makes it an unusual community type. A State endangered and uncommon grass species, adapted to the flooding and drought conditions caused by fluctuating water levels, are found at the site.
- Templeville Ponds – The wetland complex consists of several Delmarva Bays, dominated by herbaceous plants and a buttonbush swamp, within an oak-pine forest. A State endangered sedge and an uncommon grass are found at the site.
- Unicorn Millpond – This site was created by an impoundment on Unicorn Branch and includes a lake and associated wetlands. The Unicorn Lake portion of the complex mimics the rare type of freshwater system once created by beavers, which were rare in this region as of the early 1990's. Six rare or uncommon plants are in the lake and associated wetlands. The lake also provides exceptional habitat for resident and migratory songbirds, waterfowl, and wading birds, as well as fish, reptiles and amphibians.
- While not currently designated as a nontidal wetland of special State concern, wetlands associated with Red Lion Branch may also support rare species or unusual community types and qualify for future designation.

In Kent County, an additional three areas are identified:

- Black Bottom Ponds – This wetland complex consists of several Delmarva Bays, with six state rare or endangered plants identified as of 1991. The natural dominant plant community is emergent.
- Massey Pond - is an excavated seasonal pond dominated by herbaceous species. A

State endangered amphibian population was reported at the as of 1991.

- Millington Wildlife Management Area Ponds contains a permanent, excavated pond of varying water levels and a shrub swamp. Shrub swamps are an unusual community type that lost to agricultural drainage ditching. The exposed mud banks support a State endangered sedge and aster species.

Wetland Function

Wetlands are associated with many beneficial functions, including water quality improvement through retention of pollutants, nutrients and sediment; nutrient transformation, attenuation of flood waters; maintenance of stream base flow; shoreline stabilization, and wildlife habitat. The ability to provide these functions varies, and certain wetlands may have limited capacity to perform certain functions.

In the Upper Chester watershed, wetlands in the floodplains probably have the capability to provide flood attenuation, but many man-made structures that may be damaged by floods are likely beyond the top of the ravines. Most wetlands adjacent to streams probably provide some discharge to help maintain base flow in streams. Wetlands that are seasonally flooded or wetter in headwaters are more important to maintaining stream base flow than ditched or drier wetlands.

Water quality functions, particularly nutrient transformation, are most effectively performed in wetlands with fluctuating water levels and high amounts of organic matter. Microorganisms in the soil transform nutrients such as nitrogen through the action of microorganisms, which uptake and convert biologically available nitrogen to nitrogen gas. Wetlands in fine-particle soils may also retain phosphorus. Wetlands in the Upper Chester watershed that are most likely to be particularly effective at water quality functions are the vegetated tidal wetlands, and wetlands along floodplains with high organic matter. Depressional wetlands that receive groundwater inputs may provide nutrient transformation to a lesser degree. However, wetlands may also discharge nutrients at the end of the growing season when plants are dormant.

Vegetated tidal wetlands are the most effective wetlands for providing natural shoreline protection.

Delmarva Bays and nontidal Wetlands of Special State Concern are exceptionally important for habitat and biodiversity.

Wetland Restoration

Map 11 Wetlands and 100-Year Floodplain shows areas of agricultural land or barren land that are on hydric soils. Some of these areas may have physical characteristics that would allow for relatively easy wetland restoration because wetlands regeneration could be accomplished by restoring natural hydrologic conditions. An additional key element in determining actual restoration potential for any site depends on landowner interest and the general need to maintain viable areas of agricultural production.

Conditions of local hydric soils vary significantly from site to site. For example, some hydric soils (Bibb) were found suitable for pasture if drained. Conversion of drained pastures may provide an opportunity for restoration. There are likely fewer areas of hydric soils in cropland than in lower Eastern Shore counties, due to the narrow width of the hydric soils in this watershed. (13) Sites on Portsmouth and Johnston soils may have the greatest potential for providing water quality benefits if restored, or if preserved as existing wetlands, due to high organic matter content and very poor

drainage. Portsmouth soils are often found in depressions, while Johnston soils are located along floodplains. Other very poorly or poorly drained soils with high organic matter may also be more likely to provide water quality benefits as restored wetlands over hydric soil areas with lower organic matter content. Restoration of hydrology may also reduce the acidity of the drained hydric soils. This may also aid in binding of phosphorus to clay particles. There is some evidence that this is highest in acidic or slightly acidic soils. (14)

Sites in the Millington vicinity with low elevations, and former wetlands, should be investigated that may provide some additional attenuation of flood waters while protecting the town structures and railroad bridges and embankment.

There have been at least 14 wetland restoration projects in the watershed from 1998-2003. This restoration is primarily undertaken by private landowners in partnership with Ducks Unlimited, the US Fish and Wildlife Service, and agricultural cost share programs. The total acreage is 174.5 acres which is mostly restored as riparian forested wetlands. There were approximately 31 acres established as emergent wetlands for wildlife habitat.

Protection of Wetlands

The Maryland Department of the Environment has reviewed wetland protection opportunities in the Upper Chester River watershed and identified several significant opportunities for protection:

- Oxbow wetland west of Millington
- Forested floodplain and wetland corridors, particularly around Millington
- Nontidal Wetlands of Special State Concern in the watershed and the areas known as the Delmarva Bays.

Floodplains

In the Upper Chester watershed, the 100-year floodplain tends to be concentrated close to the Chester River mainstem as shown on Map 9 Wetlands and 100-Year Floodplain. The floodplains that are large enough to be seen at the scale of the map tend to be located along the mainstem of the Chester River and several tributaries in Queen Anne's County.

Stream Buffers

The Upper Chester River watershed has about 220 miles of streams, including both banks of the Chester River, according to data from the Maryland Department of Planning. Map 10 Stream Buffers and Open Land on Hydric Soil shows the general land use adjacent to these streams using computerized GIS. This method of assessing buffer condition can be used in the absence of field data collected by stream corridor assessment. Findings of this assessment summarized in the table and the map suggest that opportunities for stream buffer restoration are available for further investigation.

Stream Buffer GIS Assessment – Upper Chester River Watershed

	Kent County		Queen Anne's County	
	Miles	Percent	Miles	Percent
Naturally Vegetated Buffers	54	71	93	65
Developed Lands	1	1	3	2
Open Land On Hydric Soil	2	3	22	15
Open Land On Other Soils	19	25	26	18
Total	76	100	144	100

Areas that lack naturally vegetated buffers are divided into three categories: Developed land, open land (agricultural land or barren land) on hydric soil and open land on non-hydric soils. Based on this limited assessment, creating naturally vegetated stream buffers on open land on hydric soil offers the greatest potential for improving water quality and habitat.

The map also shows stream buffer restoration projects for two years that DNR Forest Service has collected data. The database lists 16 projects stretching along nearly 17 miles of stream bank and covering nearly 300 acres.

Benefits of Stream Buffers

Natural vegetation in stream riparian zones, particularly forest, provides numerous valuable environmental benefits:

- Reducing surface runoff
- Preventing erosion and sediment movement
- Using nutrients for vegetative growth and moderating nutrient entry into the stream
- Moderating temperature, particularly reducing warm season water temperature
- Providing organic material (decomposing leaves) that are the foundation of natural food webs in stream systems
- Providing overhead and in-stream cover and habitat
- Promoting high quality aquatic habitat and diverse populations of aquatic species.

Headwater Streams

Headwater streams are also called first order streams. For many watersheds, first order streams drain the majority of the land within the entire watershed. Therefore, stream buffers restored along headwater streams tend to have greater potential to intercept nutrients and sediments than stream buffers placed elsewhere. In targeting stream buffer restoration projects, giving higher priority to headwater streams is one approach to optimizing nutrient and sediment retention.

Restoring headwater stream buffers can also provide habitat benefits that can extend downstream of the project area. Forested headwater streams provide important organic material, like decomposing leaves that "feed" the stream's food web. They also introduce woody debris that enhances in-stream physical habitat. The potential for riparian forest buffers to significantly influence stream temperature is greatest in headwater regions. These factors, in addition to positive water quality effects, are key to improving aquatic habitat.

Land Use Adjacent To Streams

One factor that affects the ability of stream buffers to intercept nonpoint source pollutants is adjacent land use. Nutrient and sediment loads from different land uses can vary significantly.

Stream buffers can effectively intercept nonpoint source sediment and phosphorus if these pollutants arising from land that is characterized by continuing soil disturbance/exposure. Examples of these land uses are some types of agriculture, poorly vegetated lawns and athletic fields, unpaved roads and parking areas.

Based on monitoring conducted in Maryland, nonpoint source nitrogen entering streams appears to be greatest from development using septic systems and from certain types of agriculture depending on past and present application of fertilizer and manure. Targeting stream buffer restoration, using deep-rooted vegetation, to these areas may intercept nitrogen in groundwater before it emerges in streams. Naturally vegetated stream buffers on hydric soil have the potential to intercept nitrogen

because plant roots are more likely to be in contact with groundwater for longer periods of time.

Optimizing Stream Buffer Restorations

Strategic targeting of stream buffer restoration projects may provide many different benefits. To maximize multiple benefits, site selection and project design need to incorporate numerous factors. For example, finding a site with a mix of attributes like those in the following list could result in the greatest control of nonpoint source pollution and enhancement to living resources:

- Land owner willingness / incentives
- Marginal land use in the riparian zone
- Headwater stream areas
- Soil type including hydric or highly erodible soils
- Selecting appropriate woody or grass species, natural vegetation for habitat
- Adjacent wetlands and habitat that may be enhanced.

Living Resources and Habitat

Living resources, including all the animals, plants and other organisms require water to survive. They and their habitats are intimately connected to water quality and availability. Living resources respond to changes in water and habitat conditions in ways that help us interpret the status of water bodies and the effects of watershed conditions. In some cases, water quality is measured in terms of its ability to support specific living resources like trout or shellfish. Information on living resources is presented here to provide a gauge of water quality and habitat conditions in the watershed. It is also a potential measure of efforts to manage water quality and watersheds for the living resources that depend on them.

Fish

According to a report to Maryland's Governor in June 2004 by DNR, the largemouth bass population in the Chester River has declined the past two years. The reasons for the decline are not known. Restoration and enhancement stocking of largemouth bass have begun and the situation is being monitored.

Map 11 Fish Spawning, Blockages and MBSS Index shows that spawning by white perch, yellow perch and herring has been documented up the Chester River mainstem past Millington into an unnamed tributary immediately north of Route 291 and in Andover Branch. Spawning also extends into several tributaries including Red Lion Branch, Mills Branch and an unnamed tributaries to the west of Mills Branch.

The limitation to spawning in local streams appears to be blockages, which are numerous in this watershed according to the data on the map from the DNR Fisheries Service database. Based on this remote assessment, it also appears that dams or weirs for impoundments create the blockage that limits spawning. While it is important to field verify local conditions, a listing of named blockages can be made based on the mapped information:

- Cypress Branch / Big Mill Pong, Little Mill Pond
- Andover Branch / Jones Lake
- Unnamed tributary east of Millington / Peacock Corner vicinity
- Unicorn Branch / Unicorn Mill Pond
- Red Lion Branch / Route 301 vicinity
- Pearl Creek / Route 544 vicinity

Fish Consumption Advisory

In June 2004, MDE issued revised fish consumption advisories for Maryland. (15) Specific areas of the Upper Chester River watershed are referenced and several statewide advisories affect portions of the watershed. In Delaware, fish consumption advisories do not affect Upper Chester River tributaries. (16)

In the summary table below, MDE's recommendations are listed in "meals per year". An easier way to consider the recommendation might be to think in terms of weekly menus. For example, it would be best to limit eating bluegill taken from ponds or lakes to less than two meals a week. For smallmouth and largemouth bass from ponds and lakes, the recommendation is to limit consumption to less than one meal per week for adults and less than one meal per month for children. (Children are more susceptible to toxicity than adults.)

Contaminants identified in the table can be briefly described. The concern is that these toxic compounds accumulate over time in the bodily tissues of fish and people who eat them. Eventually levels of these compounds in a person could reach levels that would cause health problems. These compounds are long-lived, toxic and carcinogenic. PCBs, polychlorinated biphenols, were once widely used (now banned in US) in electric transformers and other applications where heat resistance and electric insulation was needed. Pesticides, as referenced in the table, are various banned organochlorine pesticides like chlordane, DDT, dieldrin and heptachlor epoxide. Methyl mercury is the form of mercury that is most biologically active. It enters the atmosphere mostly from burning of coal and waste incineration and returns to land and water in dust and rain. Mercury is also commonly used in dry cell batteries and some lighting.

2004 Fish Consumption Advisories – Upper Chester River Watershed
Recommended Maximum Allowable Meals Per Year

Species	Area	General Population 8 oz meal	Women 6 oz meal	Children 6 oz meal	Contaminant
Channel Catfish	Chester River	59	45	35	PCBs, Pesticides
White Perch	Chester River	59	45	35	
Smallmouth Bass & Largemouth Bass	Lakes, Impoundments	48	48	24	Methyl-Mercury
	Rivers and Streams	No advisory	96	96	
Bluegill	Lakes and Impoundments	96	96	96	

Biological Monitoring In Streams

The Maryland Biological Stream Survey (MBSS) sampled stream conditions in the Upper Chester River watershed in 1995 and in 2004. Only 1995 information is available for use in this report. Conditions that underlie the indices are complex and apply primarily to a local stream segment. Typically, a stream segment ranks as a mix of good, fair, poor and/or very poor for the three indices. There is a tendency for good/fair conditions to be associated with watersheds with the least disturbance (natural vegetation, forest) and for poor/very poor conditions to be associated with greater disturbance (impervious area, agriculture, construction sites).

MBSS findings for 1995 relating to fish are summarized on Map 11 Fish Spawning, Blockages, And MBSS Index. The map shows that the many of sites sampled were in the good range. These findings are indicative of a relatively healthy fish population.

MBSS findings based on assessment of benthic macroinvertebrates (benthos or stream bugs) are shown on Map 12 Benthos - MBSS Index. The map shows that the majority of sites sampled were in the good range. These findings are indicative of a relatively healthy benthic community, which suggests that a combination of beneficial habitat and water quality were present at that time.

Viewing the two maps together, it can be seen that 1995 conditions in Red Lion Branch appear to be favorable for both fish and benthos. Several additional streams exhibited fish community conditions that received a rating of good:

- Andover Branch
- Unnamed tributary east of Millington
- Unnamed tributary at Chase Island.

Why Look at Benthos in Streams?

Unimpaired natural streams may support a great diversity of species like bacteria, algae, invertebrates like crayfish and insects to fish,birds, reptiles and mammals. All these groups of organisms have been extensively assessed relative to water quality and habitat quality. One group, benthic invertebrates, was found to serve as a good indicator of stream condition including water quality and habitat quality.

Benthic invertegrates are sometimes called "stream bugs" though that name overly simplifies the diverse membership of this group. This group includes mayflies, caddisflies, crayfish, etc., that inhabit the stream bottom, its sediments, organic debris and live on plant life (macrophytes) within the stream. Benthic macro-invertebrates are an important component of a stream's ecosystem.

The food web in streams relies significantly on benthic organisms. Benthos are often the most abundant source of food for fish and other small animals. Many benthic macroinvertebrates live on decomposing leaves and other organic materials in the stream. By this activity, these organisms are significant processors of organic materials in the stream. Benthos often provide the primary means that nutrients from organic debris are transformed to other biologically usable forms. These nutrients become available again and are transported downstream where other organisms use them.

Assessment of benthic organisms is a valuable tool for stream evaluation. This group of species has been extensively used in water quality assessment, in evaluating biological conditions of streams and in gauging influences on streams by surrounding lands. These organisms serve as good indicators of water resource integrity because they are fairly sedentary in

nature and their diversity offers numerous ways to interpret conditions. They have different sensitivities to changing conditions. They have a wide range of functions in the stream. They use different life cycle strategies for survival.

Sensitive Species

Sensitive species are generally recognized as being the plants or animals that are most at risk in regards to their ability to maintain healthy population levels. The most widely known are perhaps the State and Federally-listed Endangered or Threatened animals such as the bald eagle and Delmarva fox squirrel. In addition to charismatic animals such as these however, both the United States Fish and Wildlife Service and the Maryland DNR work through their respective Federal and State programs to protect a wide variety of declining non-game animals, rare plants, and the unique natural communities that support them.

For the purposes of watershed restoration, it is valuable to account for the known locations and areas of potential habitat for sensitive species in a given area. They are often indicators, and sometimes, important constituents, of the network of natural areas which form the foundation for many essential natural watershed processes. In fact, in addition to conserving biodiversity in general, protecting these species and/or promoting expansion of their habitats can be an effective component for a watershed restoration program.

DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation in different ways. Several sensitive species overlays are used by the State of Maryland to delineate habitat associated with these species. The purpose of utilizing these delineations is to help protect sensitive species by identifying the areas in which they are known to occur. Doing so allows DNR to work toward the conservation of these sensitive resources by evaluating potential impacts of proposed actions that may affect them. Specifically, working within an established procedural framework, the Wildlife and Heritage Service reviews projects and provides recommendations for activities falling within these overlays.

Map 13 Sensitive Species shows the general locations of sensitive species conservation areas in Maryland's Upper Chester River watershed. A complete list of rare species tracked by Maryland in the watershed is in the Appendix D Sensitive Species. (17)

The geographic areas covered by these overlays are course filters. To allow for uncertainty pertaining to interpretation discrepancies, the polygons used on the map to depict these locations have been buffered. Accurate on the ground information regarding species locations and habitat delineations for a specific area can be obtained from DNR's Natural Heritage Program. It is also important to note that outside of the Chesapeake Bay Critical Area, DNR generally only places requirements on projects requiring a permit/approval or those that are utilizing State funds. However, there are more broadly applied State and Federal laws and regulations that address "takings" of listed species. In addition, many counties have incorporated safeguards for areas associated with sensitive species into their project and permit review processes as well as adopting specific ordinances in some cases to protect them. In all instances, property owners are encouraged to seek advice on protecting the sensitive species / habitat within their ownership.

Ecologically Sensitive Area (ESA)

At least 22 ESAs are identified in the Upper Chester River Watershed as shown in Map 13

Sensitive Species. Each ESA contains one or more sensitive species habitats. However, the entire ESA is not considered sensitive habitat. The ESA is an envelope identified for review purposes to help ensure that applications for permit or approval in or near sensitive areas receive adequate attention and safeguards for the sensitive species / habitat they contain.

Wetlands of Special State Concern (WSSC)

At least 54 WSSCs are designated in the Upper Chester River Watershed. These selected wetlands, which generally represent the best examples of Maryland's nontidal wetland habitats, are afforded additional protection in State law beyond the permitting requirements that apply to wetlands generally. The Maryland Department of the Environment may be contacted for more information regarding these regulations. To help ensure that proposed projects that may affect a WSSC are adequately reviewed, an ESA is always designated to encompass each WSSC and the area surrounding it. For a listing of designated WSSC sites in Maryland see COMAR 26.23.06.01 at www.dsd.state.md.us

Natural Heritage Area (NHA)

No NHAs are located in the Upper Chester River Watershed. In general, NHAs are designated because they represent rare ecological communities. They are areas that provide important sensitive species habitat. They are designated in State regulation (COMAR 08.03.08.10) and are afforded specific protections in the Critical Area Law criteria. For proposed projects that could potential affect a particular NHA, recommendations and/or requirements may be put in place during the permit or approval process. These would be specifically aimed at protecting the ecological integrity of the NHA itself. To help ensure that proposed projects that may affect a given NHA are adequately reviewed, an ESA is always designated to encompass each NHA.

Land Use And Land Cover

Water quality in streams and rivers is greatly influenced by riparian area land, land use throughout the watershed, soils, vegetative cover and many other terrestrial factors. This chapter explores immediately available information that relate to land in the Upper Chester River watershed.

Land Use

Map 14 Land Use / Land Cover shows the distribution of major land use categories in the Upper Chester River watershed based on 2002 data produced by the Maryland Department of Planning. Agriculture represents roughly two-thirds of the land use in both Kent and Queen Anne's Counties. Together, forest and scrub account for roughly one-third. All forms of development cover only a few percent of the watershed in either jurisdiction.

Viewing these generalized land use categories as potential nonpoint sources of nutrients, agricultural lands are likely to contribute the greatest loads to local waterways. Developed lands may also contribute significant nutrient loads.

In light of the importance of agriculture in this watershed and much of the Eastern Shore, Federal funds have been targeted to provide assistance here. Maryland received $2.9 million from US Department of Agriculture under the 2002 Farm Bill for nine Eastern Shore counties to promote participation in three programs. This effort will help protect farmland and wildlife habitat, restore freshwater and tidal wetlands, as well as support the economic viability of agriculture: (18)

- The Farm and Ranch Lands Protection Program, which provides matching funds to help purchase development rights to keep ranch and farm lands in agricultural use;
- The Wildlife Habitat Incentives Program, a voluntary program that provides technical support and up to 75 percent cost share assistance to landowners who want to improve fish and wildlife habitat; and;
- The Wetlands Reserve Program, a voluntary program that helps landowners protect, enhance and restore wetlands on their property.

Protected Lands

As used in the context of watershed restoration, "protected land" includes any land with some form of long-term limitation on conversion to urban / developed land use. This protection may be in various forms: public ownership for natural resource or low impact recreational intent, private ownership where a third party acquired the development rights or otherwise acquired the right to limit use through the purchase of an easement, etc. The extent of "protection" varies greatly from one circumstance to the next. Therefore, for some protected land, it may be necessary to explore the details of land protection parcel by parcel through the local land records office to determine the true extent of protection.

For purposes of watershed restoration, an understanding of existing protected lands can provide a starting point in prioritizing potential restoration activities. In some cases, protected lands may provide opportunities for restoration projects because owners of these lands may value natural resource protection or enhancement goals.

Map 15 Protected Land and the following discussion summarize the status of protected lands in the Upper Chester River Watershed. (NOTE: Some land parcels may be affected by more than one type of protected land listed below. For example, government-owned land may also have a conservation easement on it.)

Public ownership of land for parks and natural resource management in the Upper Chester River encompasses about 3,739 acres in total. In this category, the largest area is DNR's Millington Wildlife Management Area that covers about 3,580 acres. DNR's Unicorn Lake Fish Management Area covers about 74 acres. Additionally in the watershed, Queen Anne's County owns about 83 acres and Kent County owns about three acres. There is no Federal land in the watershed.

Private land ownership and easements for conservation purposes is the largest category of protected land in the Upper Chester River watershed.

- Agricultural easements, intended to protect farming but not necessarily natural resources, cover about 4,060 acres of privately owned land.
- Rural Legacy easements are intended to protect rural character through purchase of development rights. The Rural Legacy Area shown on the map is associated with Chino Farms. It is an area that Queen Anne's County and the State of Maryland have selected to target funding for land

protection efforts. As of the beginning of 2005, protection under this program is in place on about 2,850 acres within the Upper Chester River watershed.

- Open space easements are land areas protected from conversion to development. Under programs in Queen Anne's County, these easements are established through two different types of transfer of development rights (TDRs) programs in which development rights are purchased and transferred from one parcel to another. As a result of these Queen Anne's County programs, 1,202 acres have been placed in deed restricted open space.
- Conservation ownership and easements are specifically intended to ensure management for natural resource protection and to prevent conversion to development. Maryland Environmental Trust easements and ownership by The Natural Conservancy encompass about 85 acres in the Queen Anne's County portion of the Upper Chester River watershed.

Impervious Area

Roads, parking areas, roofs and other human constructions are collectively called impervious surface. Impervious surface blocks the natural seepage of rain into the ground. Unlike many natural surfaces, impervious surface typically concentrates stormwater runoff, accelerates flow rates and directs stormwater to the nearest stream. Watersheds with small amounts of impervious surface tend to have better water quality in local streams than watersheds with greater amounts of impervious surface.

Map 16 Impervious Surface reflects data developed by the University of Maryland's Regional Earth Sciences Application Center (RESAC). It shows that the rural character of the Upper Chester River watershed contributes to vary low average imperviousness for all subwatersheds. Only small areas of development in this watershed may have sufficient impervious surfaces to significantly impact stream health.

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Appendix A - Glossary	
303(d)	A section of the federal Clean Water Act requiring the states to report waters impaired for the uses for which they have been designated, and the reasons for the impairment. Waters included in the "303(d) list" are candidates for having TMDLs developed for them.
305(b)	A section of the federal Clean Water Act that requires periodic assessment of the status of waters in a State or similar jurisdiction.
319	A section of the federal Clean Water Act dealing with non-point sources of pollution. The number is often used alone as either a noun or an adjective to refer to some aspect of that section of the law, such as grants.
8-digit watershed	Maryland has divided the state into 138 watersheds, each comprising an average of about 75 square miles, that are known as 8-digit watersheds because there are 8 numbers in the identification number each has been given. These nest into the 21 larger 6-digit watersheds in Maryland which are also called Tributary Basins or River Basins. Within the Chesapeake Bay drainage, 8-digit watersheds also nest into 10 Tributary Team Basins.
Anadromous Fish	Fish that live most of their lives in salt water but migrate upstream into fresh water to spawn.
Benthos	Organism that live on the bottom of a body of water.
BMP	Best Management Practice. As used here refers to on-the-ground approaches to control erosion, sedimentation, or stormwater movement.
CBNERR	The Chesapeake Bay National Estuarine Research Reserve in a federal, state and local partnership to protect valuable estuarine habitats for research, monitoring and education. The Maryland Reserve has three components: Jug Bay on the Patuxent River in Anne Arundel and Prince Georges' Counties, Otter Point Creek in Harford County and Monie Bay in Somerset County.
COMAR	Code Of Maryland Regulations (Maryland State regulations)
CREP	Conservation Reserve Enhancement Program, a program of MDA. CREP is a federal/state and private partnership which reimburses farmers at above normal rental rates for establishing riparian forest or grass buffers, planting permanent cover on sensitive agricultural lands and restoring wetlands for the health of the Chesapeake Bay.
CRP	Conservation Reserve Program, a program of Farm Service Agency in cooperation with local Soil Conservation Districts. CRP encourages farmers to take highly erodible and other environmentally-sensitive farm land out of production for ten to fifteen years.
CWAP	Clean Water Action Plan, promulgated by EPA in 1998. It mandates a statewide assessment of watershed conditions and provides for development of Watershed Restoration Action Strategies (WRASs) for priority watersheds deemed in need of restoration.

Appendix A - Glossary	
CWiC	Chesapeake 2000 Agreement watershed commitments. CWiC is a shorthand phrase used in the Chesapeake Bay Program.
CZARA	The Coastal Zone Reauthorization Amendments of 1990, intended to address coastal non-point source pollution. Section 6217 of CZARA established that each state with an approved Coastal Zone Management program must develop and submit a Coastal Non-Point Source program for joint EPA/NOAA approval in order to "develop and implement management measures for NPS pollution to restore and protect coastal waters".
CZMA	Coastal Zone Management Act of 1972, establishing a program for states and territories to voluntarily develop comprehensive programs to protect and manage coastal resources (including the Great Lakes). Federal funding is available to states with approved programs.
Conservation Easement	A legal document recorded in the local land records office that specifies conditions and/or restrictions on the use of and title to a parcel of land. Conservation easements run with the title of the land and typically restrict development and protect natural attributes of the parcel. Easements may stay in effect for a specified period of time, or they may run into perpetuity.
DNR	Department of Natural Resources (Maryland State)
EPA	Environmental Protection Agency (United States)
ESA	Ecologically Significant Area, an imprecisely defined area in which DNR has identified the occurrence of rare, threatened and/or endangered species of plants or animals, or of other important natural resources such as rookeries and waterfowl staging areas.
GIS	Geographic Information System, a computerized method of capturing, storing, analyzing, manipulating and presenting geographical data.
MBSS	Maryland Biological Stream Survey, a program in DNR that samples small streams throughout the state to assess the condition of their living resources.
MDA	Maryland Department of Agriculture
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
MET	Maryland Environmental Trust, an organization that holds conservation easements on private lands and assists local land trusts to do similar land protection work.
MGS	Maryland Geological Survey, a program in DNR
NHA	Natural Heritage Area, a particular type of DNR land holding, designated in COMAR
NOAA	National Oceanic and Atmospheric Administration, an agency of the US Department of Commerce that, among other things, supports the Coastal Zone Management program, a source of funding for some local environmental activities, including restoration work.

Appendix A - Glossary	
NPS	Non-Point Source, pollution that originates in the landscape that is not collected and discharged through an identifiable outlet.
NRCS	Natural Resources Conservation Service, formerly the Soil Conservation Service, an agency of the US Department of Agriculture that, through local Soil Conservation Districts, provides technical assistance to help farmers develop conservation systems suited to their land. NRCS participates as a partner in other community-based resource protection and restoration efforts.
PDA	Public Drainage Association
RAS	Resource Assessment Service, a unit of DNR that carries out a range of monitoring and assessment activities affecting the aquatic environment.
Riparian Area	1. Land adjacent to a stream. 2. Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e. a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines. (National Research Council, *Riparian Areas: Functions and Strategies for Management*. Executive Summary page 3. 2002)
SAV	Submerged Aquatic Vegetation, important shallow-water sea grasses that serve as a source of food and shelter for many species of fin- and shell-fish.
SCA(M)	Stream Corridor Assessment is an activity carried out by DNR Watershed Services in support of WRAS development and other management needs, in which trained personnel walk up stream channels noting important physical features and possible sources of problems.
SCD	Soil Conservation District is a county-based, self-governing body whose purpose is to provide technical assistance and advice to farmers and landowners on the installation of soil conservation practices and the management of farmland to prevent erosion.
Synoptic Survey	A short term sampling of water quality and analysis of those samples to measure selected water quality parameters. A synoptic survey as performed by DNR in support of watershed planning may be expanded to include additional types of assessment like benthic macroinvertebrate sampling or physical habitat assessment.
TMDL	Total Maximum Daily Load, a determination by MDE of the upper limit of one or more pollutants that can be added to a particular body of water beyond which water quality would be deemed impaired.

Appendix A - Glossary	
Tributary Teams	Geographically-focused groups, appointed by the Governor, oriented to each of the 10 major Chesapeake Bay tributary basins found in Maryland. The teams focus on policy, legislation, hands-on implementation of projects, and public education. Each basin has a plan, or Tributary Strategy.
USFWS	United States Fish and Wildlife Service, in the Department of Interior
USGS	United States Geological Survey
Water Quality Standard	Surface water quality standards consist of two parts: (a) designated uses of each water body; and (b) water quality criteria necessary to support the designated uses. Designated uses of for all surface waters in Maryland (like shell fish harvesting or public water supply) are defined in regulation. Water quality criteria may be qualitative (like "no objectionable odors") or quantitative (toxic limitations or dissolved oxygen requirements)
Watershed	All the land that drains to an identified body of water or point on a stream.
WRAS	Watershed Restoration Action Strategy, a document outlining the condition of a designated watershed, identifying problems and commiting to solutions of prioritized problems.
WSSC	Wetland of Special State Concern, a designation by MDE in COMAR.
WWTP	Wastewater Treatment Plant. Usually refers to sewage treatment facility.

Appendix B – Maryland Water Quality Summary
Upper Chester River Watershed Characterization
MDE Data Summarized By DNR Watershed Services

Chester River Station XII4711										
SAMPLE DATE	**SECCHI METERS**	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD5 MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
3/15/1999	0.3	11.5	2,600	1.4	7.2	1.8	3.043	0.0992	38	7.84
4/7/1999	0.2	6.9	2,400	1.3	6.9	1.4	2.773	0.1181	34	8.4
5/5/1999	0.4	8.4	4,500	2.4	7	4	2.151	0.1303	25.5	60.76
7/14/1999	0.3	5.3	8,500	4.7	6.4	1.5	1.121	0.0711	30.5	17.22
8/11/1999	0.4	5.1	11,200	6.3	6.1	1.5	1.086	0.0902	53	13.72
9/9/1999	0.3	4.2	9,600	5.4	6.4	2	1.261	0.1376	68	26.88
AVERAGE	0.32	6.9	6,467	3.6	6.7	2	1.9	0.11	41.5	22.5

Main Stem Station #1 on Map 3 Water Quality, Upper Chester River Watershed Characterization

Chester River Station CHE0347										
SAMPLE DATE	**SECCHI METERS**	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD5 MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
3/8/1999		12.1	1,020	0.5	7.1		3.529	0.1874	99	1.848
4/7/1999		6.9	1,160	0.6	7.1		2.96	0.1091	30	20.16
5/5/1999		9.6	2,530	1.3	7.2		8.08	0.1387	68	73.92
7/14/1999	0.4	5.1	6,652	3.6	6.9		1.513	0.1014	44	25.76
8/11/1999	0.4	5.1	10,539	6	6.1		1.066	0.0863	39.2	16.38
9/9/1999		6.2	8,210	4.5	6.7		1.248	0.1179	46.5	66.36
AVERAGE	0.4	7.5	5,019	2.8	6.9		3.1	0.12	54	34

Main Stem Station #2 on Map 3 Water Quality, Upper Chester River Watershed Characterization

Chester River Station CHE0367										
SAMPLE DATE	**SECCHI METERS**	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD5 MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
3/8/1999		12	481	0.2	7	1.2	3.611	0.1945	99.5	1.624
4/7/1999		8.4	470	0.1	7.2	3.6	2.919	0.0955	30	36.54
5/5/1999		11.5	1,160	0.6	8.9	5.2	2.109	0.143	56	121.8
7/14/1999	0.4	6.7	4,789	2.6	6.8	5.8	1.553	0.1463	58	101.36
8/11/1999		5.6	8,785	4.9	6.6	2.7	1.135	0.1074	56	41.58
9/9/1999		8.7	6,360	3.5	7.6	4.8	1.435	0.154	46	111.44
AVERAGE	0.4	8.8	3,674	2	7	3.9	2	0.14	58	69

Main Stem Station #3 on Map 3 Water Quality, Upper Chester River Watershed Characterization

Chester River Station CHE0410										
SAMPLE DATE	**SECCHI METERS**	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD5 MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
3/8/1999		11.5	161	0	6.6	0.4	2.822	0.0552	5.8	3.885
4/7/1999		7.6	159	0	6.9	2	2.714	0.0843	7	10.22
5/5/1999		10	260	0.1	7.8	4.3	2.57	0.1075	31	83.16
7/14/1999		7.7	3,240	1.7	7.4	4.4	1.55	0.1945	61	173.88
8/11/1999		6.1	6,570	3.6	7	3.6	1.231	0.1377	46	1.68
9/9/1999		6.2	4,320	2.3	6.9	4.2	1.579	0.1769	60	116.34
AVERAGE		8.2	2,452	1.3	7.1	3.2	2.1	0.13	35	65

Main Stem Station #4 on Map 3 Water Quality, Upper Chester River Watershed Characterization

Chester River Station CHE0440										
SAMPLE DATE	**SECCHI METERS**	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD5 MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
3/8/1999.		12.1	142	0.1	6.9	0.8	2.3172	0.0604	4	3.5
4/7/1999.		8.3	150	0	6.8	2.6	2.106	0.0841	12	6.16
5/5/1999.		7.4	177	0	7	3.3	2.929	0.0938	16	31.64
7/14/1999.		6.3	1,704	0	7.1	5.2	1.72	0.164		161.7
8/11/1999.		8.4	4,562	2.5	7.3	4.7	1.265	0.1398	33	1.96
9/9/1999.		6.6	1,840	0.9	7	5.2	1.704	0.1329	28	111.72
		8.2	1,429	0.6	7	3.6	2	0.11	19	53

Main Stem Station #5 on Map 3 Water Quality, Upper Chester River Watershed Characterization

Red Lion Branch RLB0024									
SAMPLE DATE	DO MG /L	CONDUCTIVITY µOMHOS /CM	SALINITY PPT	pH	BOD5 MG /L	TN MG /L	TP MG /L	TSS MG /L	CHLOROPHYLL µG /L
3/8/1999	12.5	175	0.1	7.4	0.8	5.5547	0.0415	3.5	2.94
4/7/1999	7.7	200	0.1	6.9	2.4	5.1152	0.0382	3.5	2.94
5/5/1999	9.3	193	0	7	0.7	6.0091	0.0414	2.4	1.68
7/14/1999	8.1	174	0	7.3	1.5	11.3104	0.074	2.4	0.72
8/11/1999	7.5	199	0.1	7.2	1.2	5.8612	0.0825	2.4	0.28
9/9/1999	7.2	202	0	7.2	1	4.8969	0.0879	2.4	0.48
AVERAGE	8.72	191	0.05	7.17	1.3	6.46	0.061	2.8	1.5

Tributary Station #1 on Map 3 Water Quality Monitoring, Upper Chester River Watershed Characterization

Unicorn Branch UNI0007									
SAMPLE DATE	DO MG /L	CONDUCTIVITY µOMHOS /CM	SALINITY PPT	pH	BOD5 MG /L	TN MG /L	TP MG /L	TSS MG /L	CHLOROPHYLL µG /L
10/29/1998	9	168	0.07	7.5	1.6	15.901	0.0189	1.5	1.44
11/18/1998	10.5	178	0	7.2	1.1	8.6841	0.0113	1.5	1.26
12/2/1998	11.1	159	0	7.9	1.6	7.65	0.0234	1.5	4.2
1/5/1999	12.3	180	0	6.5	3.4	10.677	0.068	10	6.72
1/19/1999	11	152	0.1	7.7	2.7	9.492	0.057	8	11.928
2/1/1999	12.7	191	0	6.9	2	6.8977	0.0373	2.4	2.66
2/17/1999	11.8	180	0	7.7	1.9	6.8894	0.0274	2.4	4.9
3/4/1999	10.9	176	0	7.4	3.1	6.4888	0.0316	3.1	7.812
3/8/1999	13.6	152	0.1	7.3	0.4	5.881	0.0305	3.7	9.24
4/7/1999	9	170	0	6.9	3.3	5.6967	0.0295	2.4	3.5
4/8/1999	9	159	0	7.2	1.2	10.011	0.0425	5.5	4.34
5/5/1999	9.4	171	0	7.8	1.8	6.0545	0.0265	4.7	18.76
5/6/1999	8.25	172	0	7.46	2.9	6.174	0.0308	5.1	7.7
6/9/1999	7.8	168	0	9.5	2	4.326	0.0358	2.4	3.24
6/21/1999	8.6	155	0	9.3	1.7	4.2573	0.0631	2.4	3.444
7/14/1999	6.4	144	0	7.9	1.7	4.01	0.03	2.4	2.053
8/11/1999	7	157	0.1	9.4	2	3.056	0.046	6.5	3.5
9/9/1999	7.3	167	0	7.7	1	4.5724	0.0189	2.4	1.8
AVERAGE	9.8	167	0.02	7.7	1.97	7.0	0.035	3.77	5.5

Tributary Station #2 on Map 3 Water Quality Monitoring, Upper Chester River Watershed Characterization

Mills Branch MZB0006									
SAMPLE DATE	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD5 MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
3/8/1999	12.1	237	0	7.1	1.1	2.307	0.1095	5.5	13.23
4/7/1999	8.8	223	0.1	7.2	2.3	1.883	0.1138	4.7	
5/5/1999	7.6	220	0.1	7.4	0.9	1.0283	0.0592	3	5.25
7/14/1999	6.9	256	0	7.6	1.5	0.7789	0.0699	5.3	1.82
8/11/1999	6.1	290	0.1	7.5	1.1	0.6678	0.0682	2.8	52.36
9/9/1999	6	344	0.1	7.5	1.8	0.6673	0.0667	2.4	0.28
AVERAGE	7.9	262	0.067	7.4	1.45	1.2	0.08	4	14.6

Tributary Station #3 on Map 3 Water Quality Monitoring, Upper Chester River Watershed Characterization

Cyprus Branch CYR0004									
SAMPLE DATE	DO MG /L	CONDUCTIVITY µOMHOS /CM	SALINITY PPT	pH	BOD5 MG /L	TN MG /L	TP MG /L	TSS MG /L	CHLOROPHYLL µG /L
3/8/1999	12.8	109	0	6.6	0.5	2.4205	0.0412	6.5	7.56
4/7/1999	7.5	120	0	6.7	3.2	2.206	0.0646	13	15.96
5/5/1999	7.5	152	0	6.9	2.4	3.402	0.0815	15	16.24
7/14/1999	6.4	173	0	7.2	4.4	1.891	0.0588	2.4	3.36
8/11/1999	6.1	210	0.1	7.5	1.2	1.3134	0.0478	2.4	38.5
9/9/1999	6.3	203	0	7.3	1.9	2.002	0.0454	2.4	8.4
AVERAGE	7.8	161	0.01	7	2.27	2.2	0.06	7	15

Tributary Station #4 on Map 3 Water Quality Monitoring, Upper Chester River Watershed Characterization

Andover Sewell Branch AND0014									
SAMPLE DATE	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD5 MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
3/8/1999	12.6	149	0.1	7.1	0.2	1.9539	0.066	5.1	4.2
4/7/1999	9.7	170	0.1	7.1	13.7	1.954	0.0998	6.7	5.04
5/5/1999	9.9	173	0	7.5	1	1.6048	0.0798	3.5	5.25
7/14/1999	1	307	0	9.2	10.9	7.48	1.5766	36	165.48
8/11/1999	2.2	233	0.1	7.3					
9/9/1999	6.2	223	0	7	4.4	1.267	0.1447	8	81.48
AVERAGE	6.9	209	0.05	7.5	6	2.9	0.4	12	52

Tributary Station #5 on Map 3 Water Quality Monitoring, Upper Chester River Watershed Characterization

Appendix C – Delaware Water Quality Summary

Excerpt From State of Delaware 2000 Watershed Assessment Report (305(b)), DNREC

Table III-4 Summary Statistics Used For Use Support Determinations for State of Delaware 2000 305(b) Assessment

Watershed	Segment Name	Segment ID	STORET Monitoring Station Numbers	Salinty (ppt) Avg	Temperature Centigrade		Dissolved Oxygen mg/l					Enterococcus Bacteria		pH		
					Max	90 th % tile	Min	Max	Avg	10 th % tile	25 th % tile	Geo Mean	90 th % tile	Min	Max	Avg
Chesapeake Drainage	Cypress Branch	DE 100-001	98 305(b)	--	--	--	--	--	--	--	--	--	--	--	--	--
	Sewell Branch	DE 100-002	112021	0.0	22.2	21.6	2.6	6.0	4.4	3.16	4.0	162	657	6.1	7.8	6.8
	Gravelly Run	DE 100-003	112031	0.0	24.7	24.5	1.7	7.0	4.8	2.78	4.4	158	1285	6.2	7.6	6.9

Table III-4 Summary Statistics Used For Use Support Determinations for State of Delaware 2000 305(b) Assessment - continued

Watershed	Segment Name	Segment ID	STORET Monitoring Station Numbers	Total Nitrogen mg/l			Total Phosphorus mg/l			Chlor-A ug/L	
				Min	Max	Avg	Min	Max	Avg	Avg	Max
Chesapeake Drainage	Cypress Branch	DE 100-001	98 305(b)	--	--	--	0.221	--	--	--	--
	Sewell Branch	DE 100-002	112021	0.770	1.800	1.173		0.435	0.308	12	40
	Gravelly Run	DE 100-003	112031	0.551	2.897	1.291	0.175	0.300	0.255	10	21

"--" = no data in the period of Sept 1, 1997 to Aug 31 1999
Enterococcus bacteria reported in colonies per 100 milliliters. Delaware standard: average not to exceed 100 colonies per 100 ml.

Table III-5 Use Support Determinations for the State of Delaware 2000 305(b) Assessment

Watershed	Segment ID	Segment Name	STORET Monitoring Station Numbers	Segment Length (miles) or area(acres or sq. miles)	Aquatic Life Support and Cause	Primary Contact Use Support	Secondary Contact Use Support	ERES	Public Water Supply	Agricultural Water Supply	Industrial Water Supply	Fish Advisories	Monitored	Evaluated
Chesapeake Drainage	DE 100-001	Cypress Branch	98 305(b)	12.2m	N	N	F			F	F		0.0	12.2
Chesapeake Drainage	DE 100-002	Sewell Branch	112021	18.8m	N, DO	N	F			F	F		0.0	18.8
Chesapeake Drainage	DE 100-003	Gravelly Run	112031	20.6m	N, DO	N	F			F	F		7.7	12.9

N= Not Supported, P= Partially Supported,81 F= Fully Supported, -- = not a designated use

Appendix D - Sensitive Species
Upper Chester River Watershed In Maryland

EXPLANATION OF RANK AND STATUS CODES

As of January 2003, the global and state ranking system is used by all 50 state Natural Heritage Programs and numerous Conservation Data Centers in other countries in this hemisphere. Because they are assigned based upon standard criteria, the ranks can be used to assess the range-wide status of a species as well as the status within portions of the species' range. The primary criterion used to define these ranks are the number of known distinct occurrences with consideration given to the total number of individuals at each locality. Additional factors considered include the current level of protection, the types and degree of threats, ecological vulnerability, and population trends. Global and state ranks are used in combination to set inventory, protection, and management priorities for species both at the state as well as regional level.

Blank means that no rank or status is assigned – all categories.

GLOBAL RANK

- G1 Highly globally rare. Critically imperiled globally because of extreme rarity (typically 5 or fewer estimated occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
- G2 Globally rare. Imperiled globally because of rarity (typically 6 to 20 estimated occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
- G3 Either very rare and local throughout its range or distributed locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range; typically with 21 to 100 estimated occurrences.
- G4 Apparently secure globally, although it may be quite rare in parts of its range, especially at the periphery.
- G5 Demonstrably secure globally, although it may be quite rare in parts of its range, especially at the periphery.
- GH No known extant occurrences (i.e., formerly part of the established biota, with the expectation that it may be rediscovered).
- GU Possibly in peril range-wide, but its status is uncertain; more information is needed.
- GX Believed to be extinct throughout its range (e.g., passenger pigeon) with virtually no likelihood that it will be rediscovered.
- G? The species has not yet been ranked.
- _Q Species containing a "Q" in the rank indicates that the taxon is of questionable or uncertain taxonomic standing (i.e., some taxonomists regard it as a full species, while others treat it at an infraspecific level).
- _T Ranks containing a "T" indicate that the infraspecific taxon is being ranked differently than the full species.

STATE RANK

S1 Highly State rare. Critically imperiled in Maryland because of extreme rarity (typically 5 or fewer estimated occurrences or very few remaining individuals or acres in the State) or because of some factor(s) making it especially vulnerable to extirpation. Species with this rank are actively tracked by the Natural Heritage Program.

S2 State rare. Imperiled in Maryland because of rarity (typically 6 to 20 estimated occurrences or few remaining individuals or acres in the State) or because of some factor(s) making it vulnerable to becoming extirpated. Species with this rank are actively tracked by the Natural Heritage Program.

S3 Rare to uncommon with the number of occurrences typically in the range of 21 to 100 in Maryland. It may have fewer occurrences but with a large number of individuals in some populations, and it may be susceptible to large-scale disturbances. Species with this rank are not actively tracked by the Natural Heritage Program.

S3.1 A species that is actively tracked by the Natural Heritage Program because of the global significance of Maryland occurrences. For instance, a G3 S3 species is globally rare to uncommon, and although it may not be currently threatened with extirpation in Maryland, its occurrences in Maryland may be critical to the long term security of the species. Therefore, its status in the State is being monitored.

S4 Apparently secure in Maryland with typically more than 100 occurrences in the State or may have fewer occurrences if they contain large numbers of individuals. It is apparently secure under present conditions, although it may be restricted to only a portion of the State.

S5 Demonstrably secure in Maryland under present conditions.

SA Accidental or considered to be a vagrant in Maryland.

SE Established, but not native to Maryland; it may be native elsewhere in North America.

SH Historically known from Maryland, but not verified for an extended period (usually 20 or more years), with the expectation that it may be rediscovered.

SP Potentially occurring in Maryland or likely to have occurred in Maryland (but without persuasive documentation).

SR Reported from Maryland, but without persuasive documentation that would provide a basis for either accepting or rejecting the report (e.g., no voucher specimen exists).

SRF Reported falsely (in error) from Maryland, and the error may persist in the literature.

SU Possibly rare in Maryland, but of uncertain status for reasons including lack of historical records, low search effort, cryptic nature of the species, or concerns that the species may not be native to the State. Uncertainty spans a range of 4 or 5 ranks as defined above.

SX Believed to be extirpated in Maryland with virtually no chance of rediscovery.

SYN Currently considered synonymous with another taxon and, therefore, not a valid entity.

SZ A migratory species which does not inhabit specific locations for long periods of time.

S? The species has not yet been ranked.

-B This species is migratory and the rank refers only to the breeding status of the species. Such a migrant may have a different rarity rank for non-breeding populations.

-N This species is migratory and the rank refers only to the non-breeding status of the species. Such a migrant may have a different rarity rank for breeding populations.

STATE STATUS

This is the status of a species as determined by the Maryland Department of Natural Resources, in accordance with the Nongame and Endangered Species Conservation Act. Definitions for the following categories have been taken from Code of Maryland Regulations (COMAR) 08.03.08.

- E Endangered; a species whose continued existence as a viable component of the State's flora or fauna is determined to be in jeopardy.
- I In Need of Conservation; an animal species whose population is limited or declining in the State such that it may become threatened in the foreseeable future if current trends or conditions persist.
- T Threatened; a species of flora or fauna which appears likely, within the foreseeable future, to become endangered in the State.
- X Endangered Extirpated; a species that was once a viable component of the flora or fauna of the State, but for which no naturally occurring populations are known to exist in the State.
- * A qualifier denoting the species is listed in a limited geographic area only.
- PE Proposed Endangered; a species whose continued existence as a viable component of the State's flora or fauna is determined to be in jeopardy.
- PT Proposed Threatened; a species of flora or fauna which appears likely, within the foreseeable future, to become endangered in the State.
- PX Proposed Endangered Extirpated; a species that was once a viable component of the flora or fauna of the State, but for which no naturally occurring populations are known to exist in the State.
- PD Proposed to be deleted or removed from the State Threatened & Endangered Species list.

FEDERAL STATUS

This is the status of a species as determined by the U.S. Fish and Wildlife Service's Office of Endangered Species, in accordance with the Endangered Species Act. Definitions for the following categories have been modified from 50 CRF 17.

- LE Taxa listed as endangered; in danger of extinction throughout all or a significant portion of their range.
- LT Taxa listed as threatened; likely to become endangered within the foreseeable future throughout all or a significant portion of their range.
- PE Taxa proposed to be listed as endangered.
- PT Taxa proposed to be listed as threatened.
- C Candidate taxa for listing for which the Service has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened.

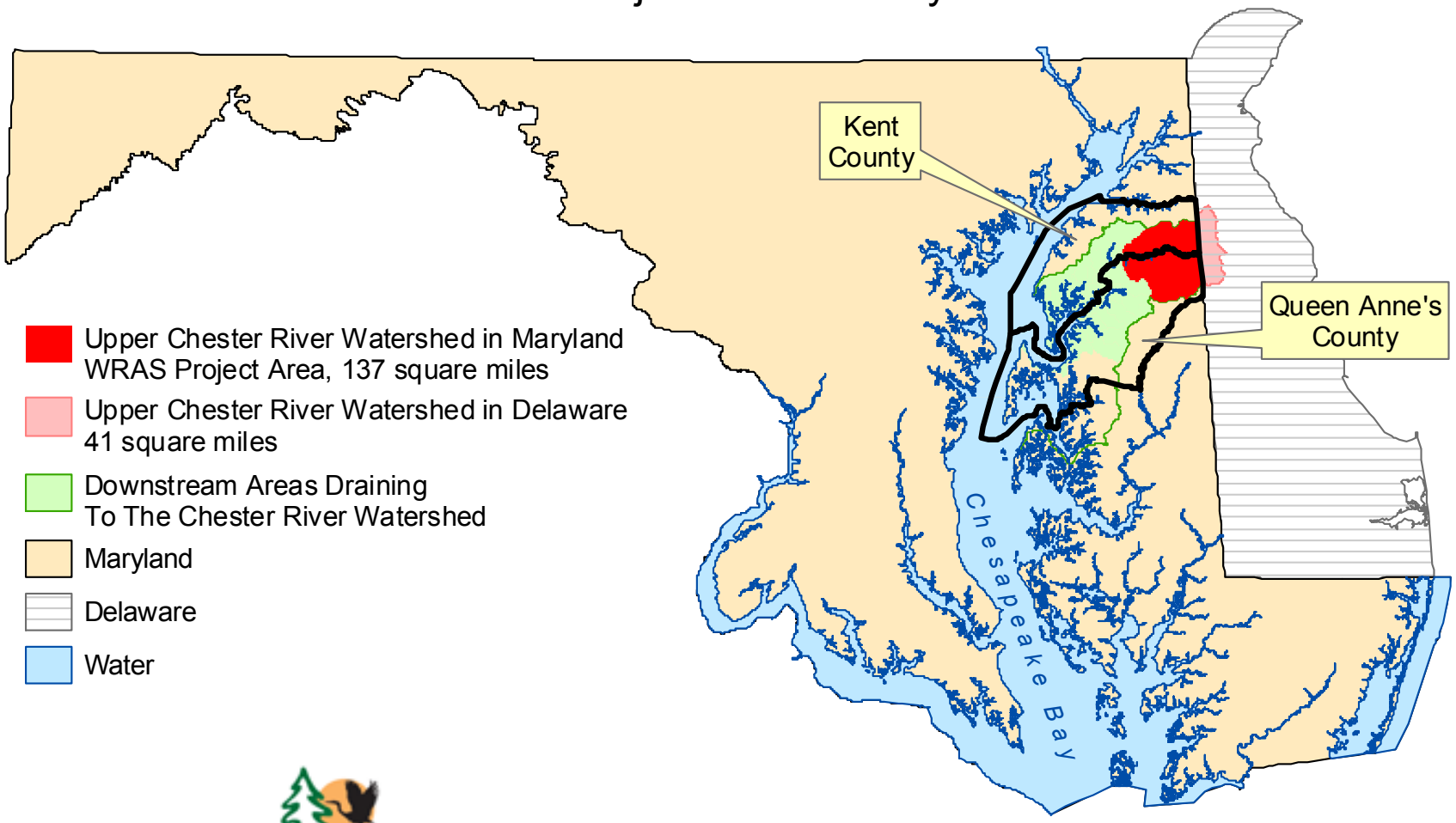
Current and Historical Rare, Threatened, and Endangered Species
Upper Chester River Watershed (02130510) January 2004
Kent and Queen Anne's Counties, Maryland

Scientific name	Common name	G-rank	S-rank	MD	US
Agalinis fasciculata	Fascicled gerardia	G5	S1	E	
Ambystoma tigrinum	Eastern tiger salamander	G5	S2	E	
Boltonia asteroides	Aster-like boltonia	G5	S1	E	
Calopogon tuberosus	Grass-pink	G5	S1	E	
Carex lacustris	Lake-bank sedge	G5	S2	T	
Carex lupuliformis	Hop-like sedge	G4	S1?		
Carex vestita	Velvety sedge	G5	S2	T	
Ceratophyllum echinatum	Prickly hornwort	G4?	S1	E	
Coelorachis rugosa	Wrinkled jointgrass	G5	S1	E	
Desmodium pauciflorum	Few-flowered tick-trefoil	G5	S1	E	
Eleocharis flavescens	Pale spikerush	G5	S1		
Eleocharis melanocarpa	Black-fruited spikerush	G4	S1	E	
Fimbristylis perpusilla	Harper's fimbristylis	G2	S2	E	
Haliaeetus leucocephalus	Bald eagle	G4	S2,S3B	T	LT
Hottonia inflata	Featherfoil	G4	S1	E	
Hyla gratiosa	Barking treefrog	G5	S1	E	
Hypericum adpressum	Creeping St. John's-wort	G2G3	S1	E	
Hypericum gymnanthum	Clasping-leaved St. John's-wort	G4	S1	E	
Iris prismatica	Slender blue flag	G4G5	S1	E	
Lampsilis radiata	Eastern lampmussel	G5	SU		
Linum intercursum	Sandplain flax	G4	S2	T	
Lophodytes cucullatus	Hooded merganser	G5	S1B,S2N		
Lysimachia hybrida	Lowland loosestrife	G5	S2	T	
Oxypolis canbyi	Canby's dropwort	G2	S1	E	LE
Paspalum dissectum	Walter's paspalum	G4?	S2	T	
Potamogeton pusillus	Slender pondweed	G5	S1		
Rana virgatipes	Carpenter frog	G5	S2	I	
Ranunculus ambigens	Water-plantain spearwort	G4	SH	X	
Rhynchospora scirpoides	Long-beaked baldrush	G4	S2	T	
Sagittaria engelmanniana	Engelmann's arrowhead	G5?	S2	T	
Sciurus niger cinereus	Delmarva fox squirrel	G5T3	S1	E	LE
Scleria reticularis	Reticulated nutrush	G4	S2		
Strophitus undulatus	Squawfoot	G5	S2	I	
Utricularia inflata	Swollen bladderwort	G5	S1	E	

Other: Colonial Waterbird nesting colony

Color code for rows: No color – plants
Yellow – animals (mammals, birds, etc.)

Map 1 Location: Upper Chester River Watershed
WRAS Project Area In Maryland

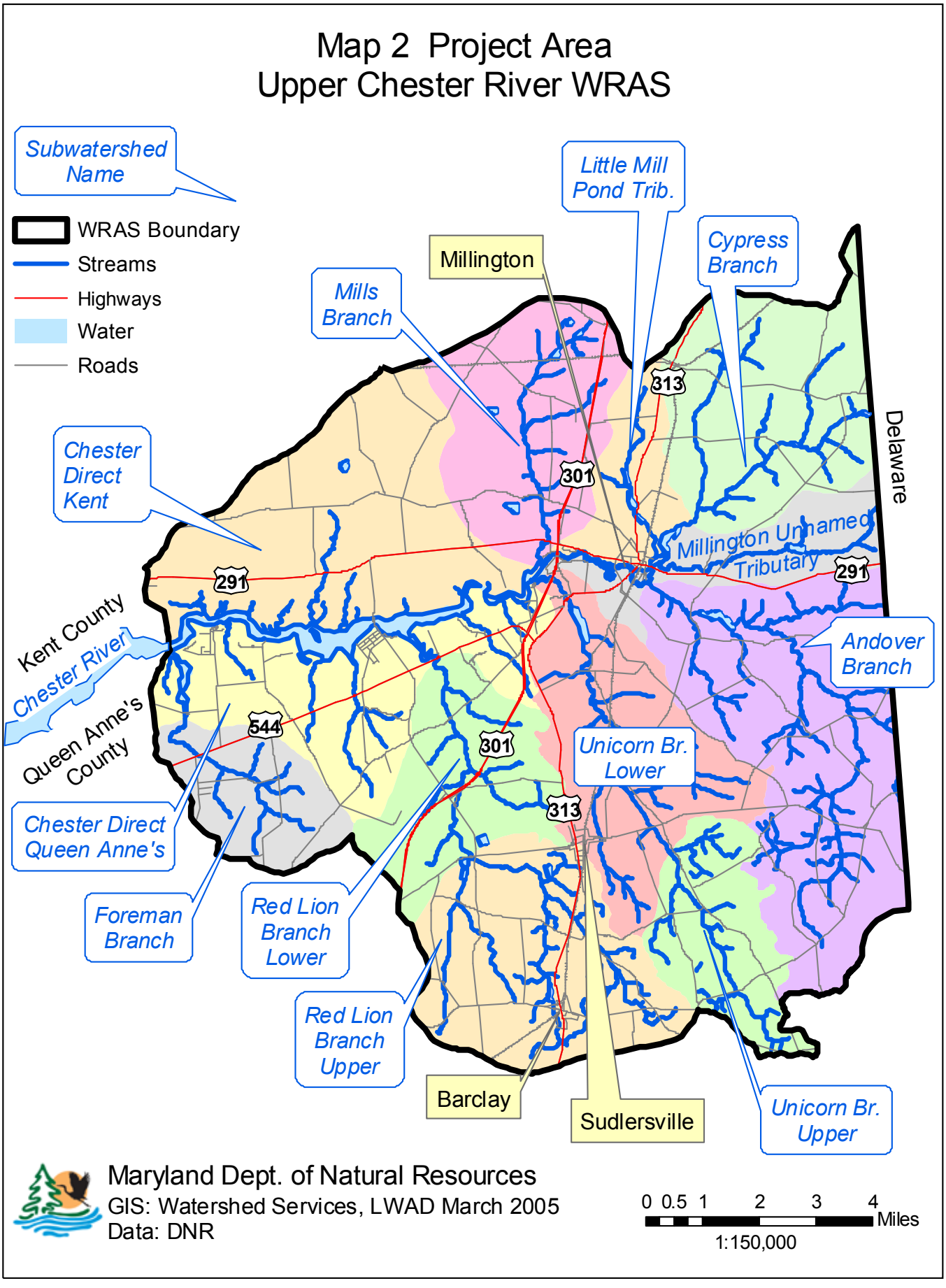


Maryland Dept. of Natural Resources
Watershed Services LWAD
March 2005

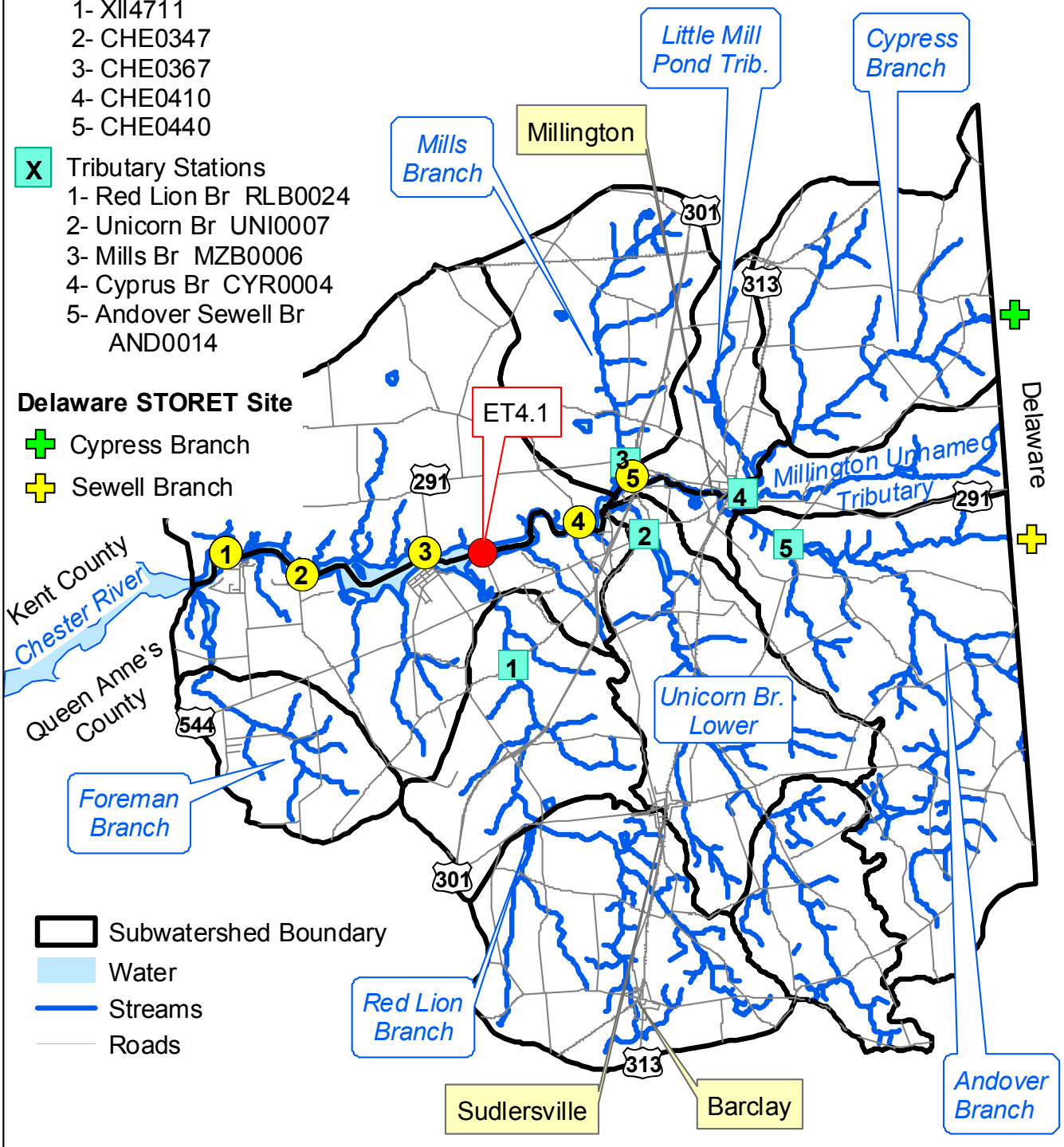
0 12.5 25 50 75 100
Miles

1:175,000

Map 2 Project Area
Upper Chester River WRAS



Map 3 Water Quality Monitoring
Upper Chester River WRAS



Maryland Dept. of Natural Resources
GIS: Watershed Services, LWAD March 2005
Data: DNR and MDE

0 0.5 1 2 3 4 Miles
1:150,000

Map 4 MDE Permits, Marinas and Local Sewer Service
Upper Chester River WRAS

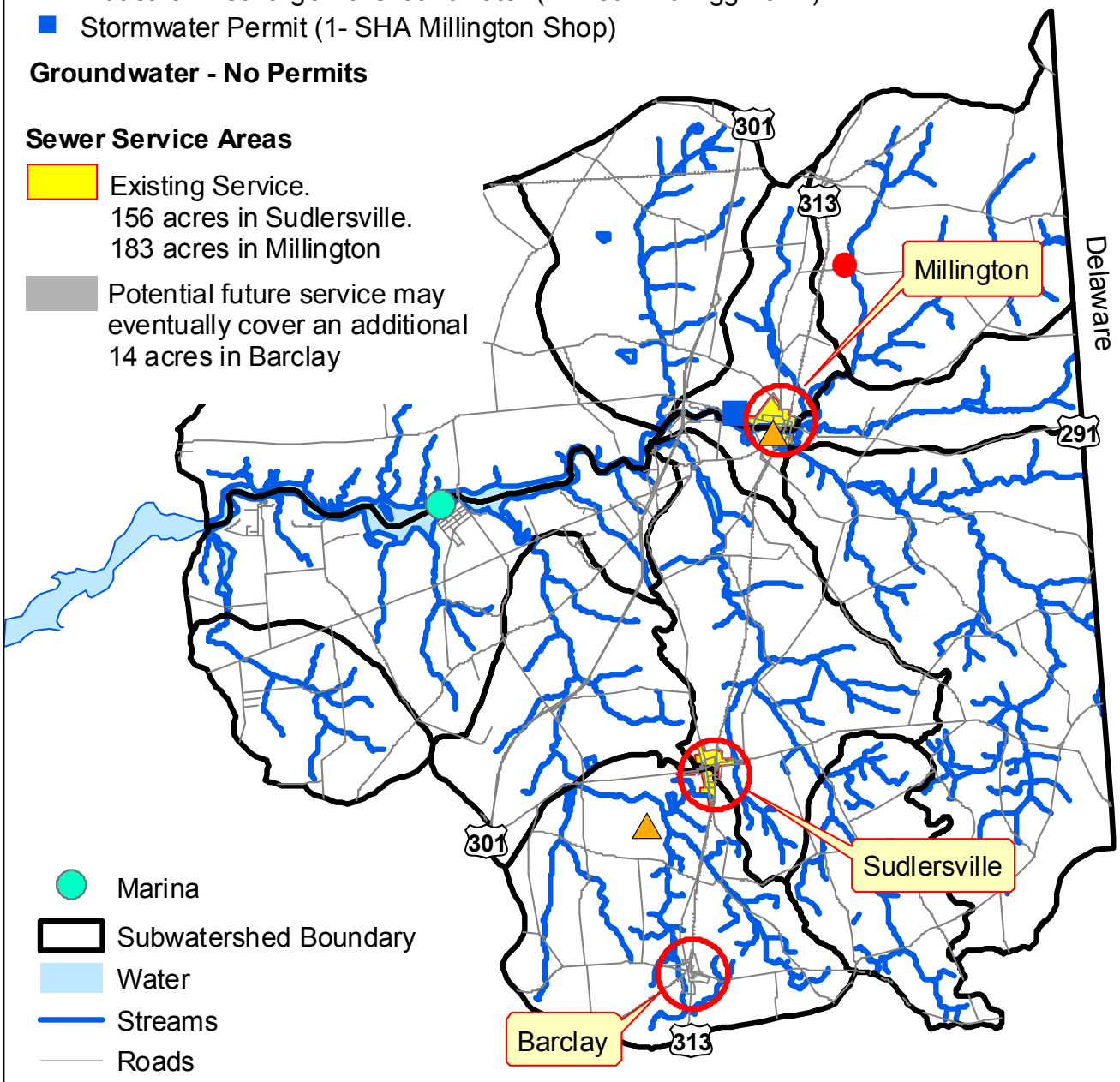
Surface Water Permits

- Sewage Effluent (2- Millington and Sudlersville)
- Industrial Discharge To Groundwater (1- Red Bird Egg Farm)
- Stormwater Permit (1- SHA Millington Shop)

Groundwater - No Permits

Sewer Service Areas

- Existing Service.
  156 acres in Sudlersville.
  183 acres in Millington
- Potential future service may eventually cover an additional 14 acres in Barclay



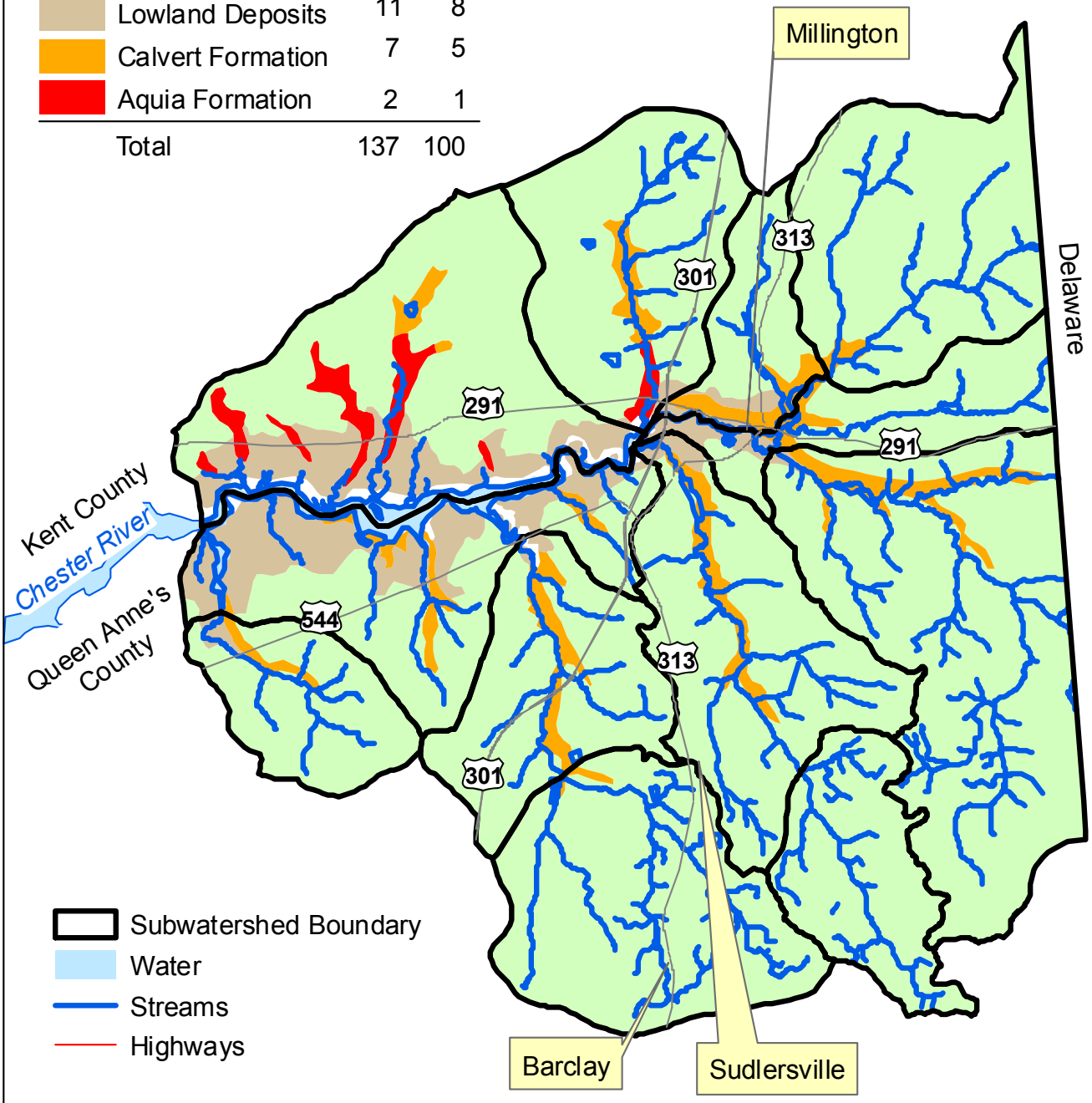
Maryland Dept. of Natural Resources
GIS: Watershed Services, LWAD March 2005
Marina Data: DNR 2002
Permit Data: MDE June 2004
Sewer Service Data: MDP June 2004

0 0.5 1 2 3 4 Miles

1:150,000

Map 5 Geology -- Upper Chester River WRAS

Maryland Eastern Shore Geology	Square Miles	%
Upland Deposit	117	86
Lowland Deposits	11	8
Calvert Formation	7	5
Aquia Formation	2	1
Total	137	100



Maryland Dept. of Natural Resources
GIS: Watershed Services, LWAD March 2005
Data: Maryland Geological Survey 1968

0 0.5 1 2 3 4 Miles

1:150,000

Map 6 Natural Soils Groups
Upper Chester River WRAS

Prime Agricultural Soils - 56% of Watershed

B1, E1, E3

Soils With Various Limitations

Like prime soils but steeper- B1b, E1b

Sandy, excessively well drained - A1

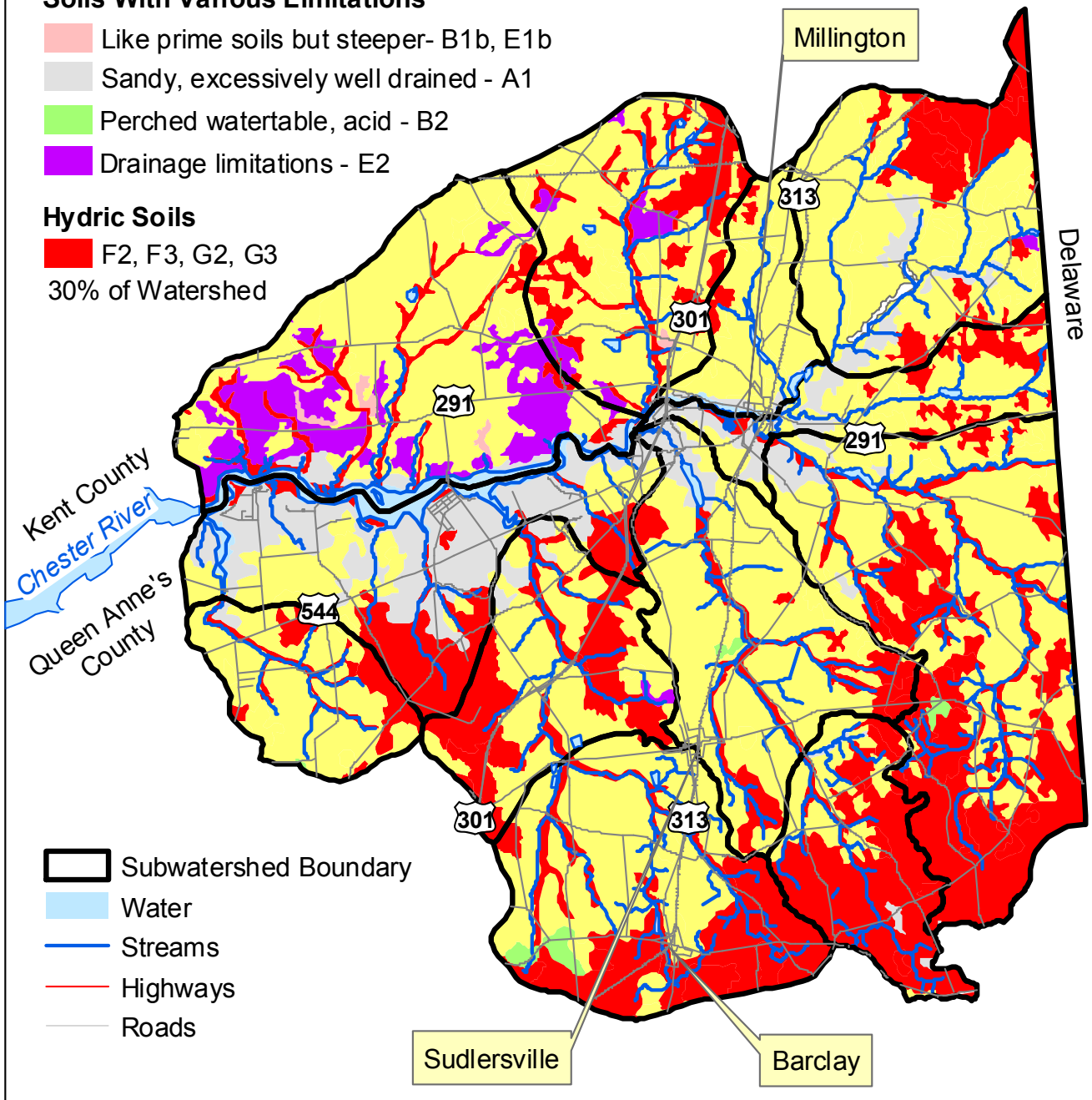
Perched watertable, acid - B2

Drainage limitations - E2

Hydric Soils

F2, F3, G2, G3

30% of Watershed



Subwatershed Boundary

Water

Streams

Highways

Roads

Maryland Dept. of Natural Resources

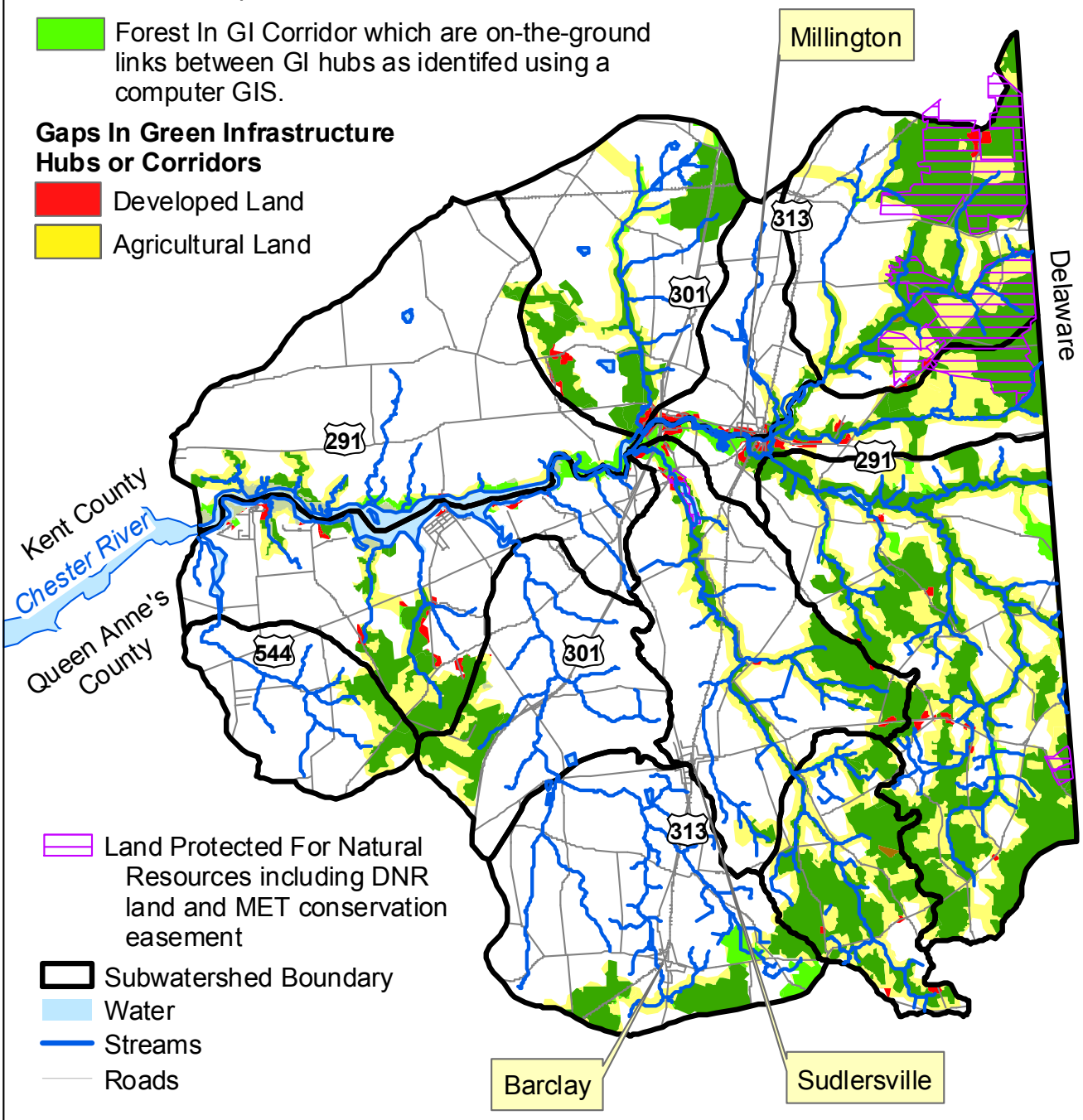
GIS: Watershed Services, LWAD March 2005

Data: MDP Natural Soils Groups, 1974

0 0.5 1 2 3 4 Miles

1:150,000

Map 7 Green Infrastructure
Upper Chester River WRAS

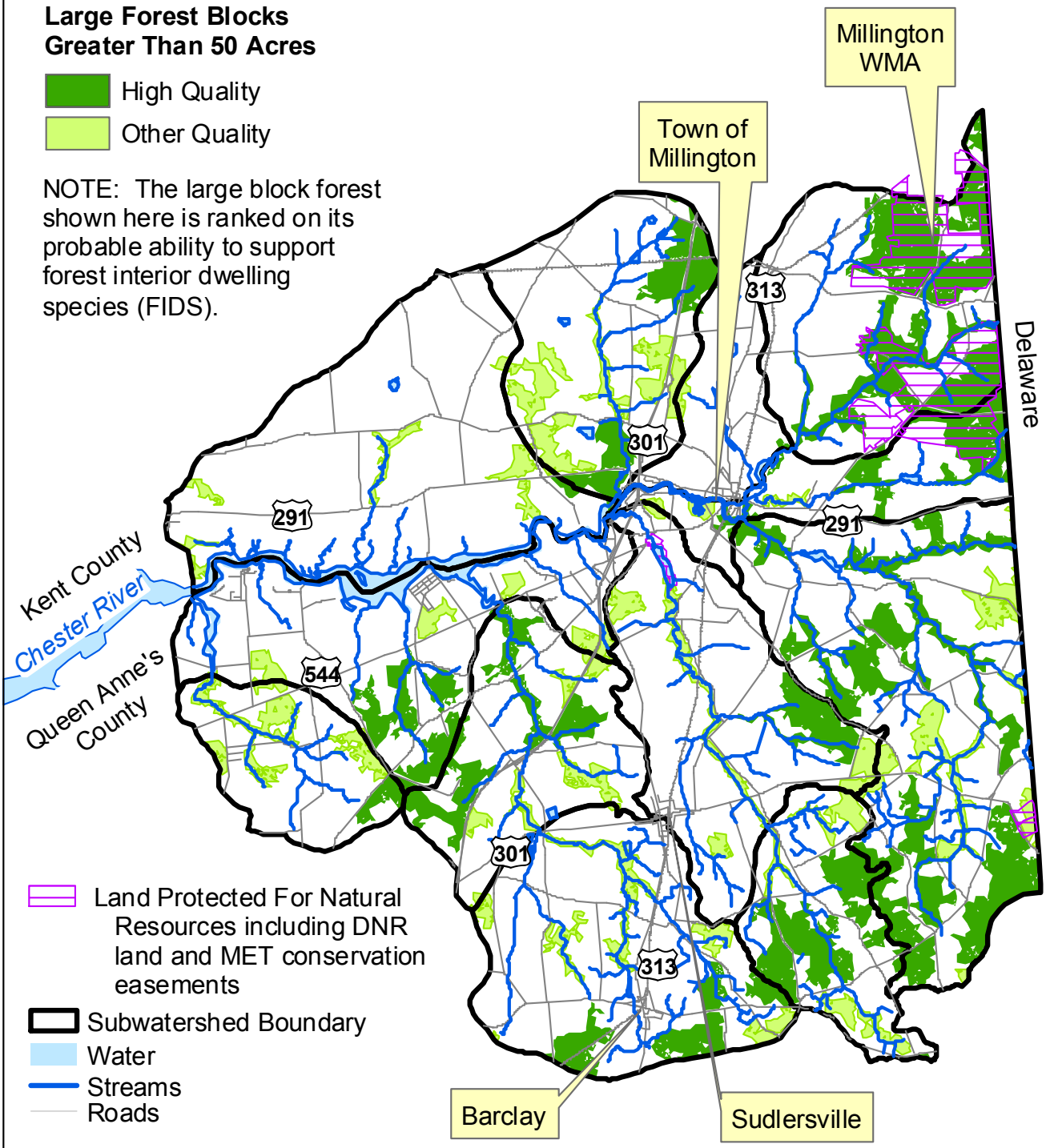


Maryland Dept. of Natural Resources
GIS: Watershed Services, LWAD March 2005
Data: MDP 2002 Land Use
DNR GI Hubs & Corridors 2000

0 0.5 1 2 3 4 Miles

1:150,000

Map 8 Forest Interior Habitat
Upper Chester River WRAS



Maryland Dept. of Natural Resources
GIS: Watershed Services, LWAD March 2005
Data: DNR FID Habitat 2000

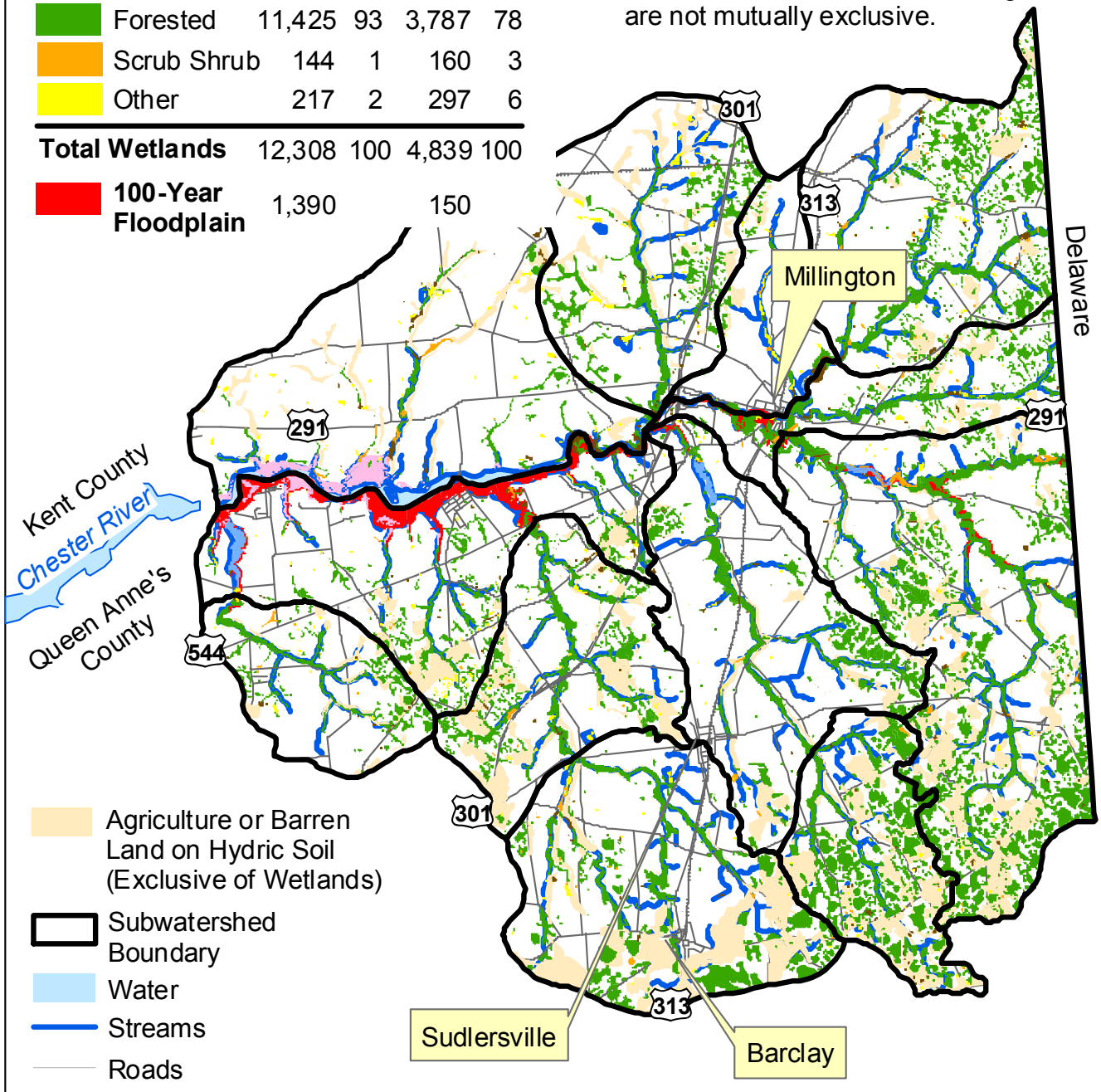
0 0.5 1 2 3 4 Miles

1:150,000

Map 9 Wetlands And 100-Year Floodplain Upper Chester River WRAS

Wetland Acreage	Queen Anne's Acres	%	Kent Acres	%
All Emergent	129	1	278	6
All Lacustrine	132	1	38	1
Palustrine				
Emergent	261	2	279	6
Forested	11,425	93	3,787	78
Scrub Shrub	144	1	160	3
Other	217	2	297	6
Total Wetlands	12,308	100	4,839	100
100-Year Floodplain	1,390		150	

NOTE: Floodplains sometimes include wetlands, i.e. their acreages are not mutually exclusive.



Maryland Dept. of Natural Resources

GIS: Watershed Services, LWAD March 2005
Wetlands Data: DNR. Floodplain Data: FEMA
Land Use and Soil Data: MDP

0 0.5 1 2 3 4 Miles

1:150,000

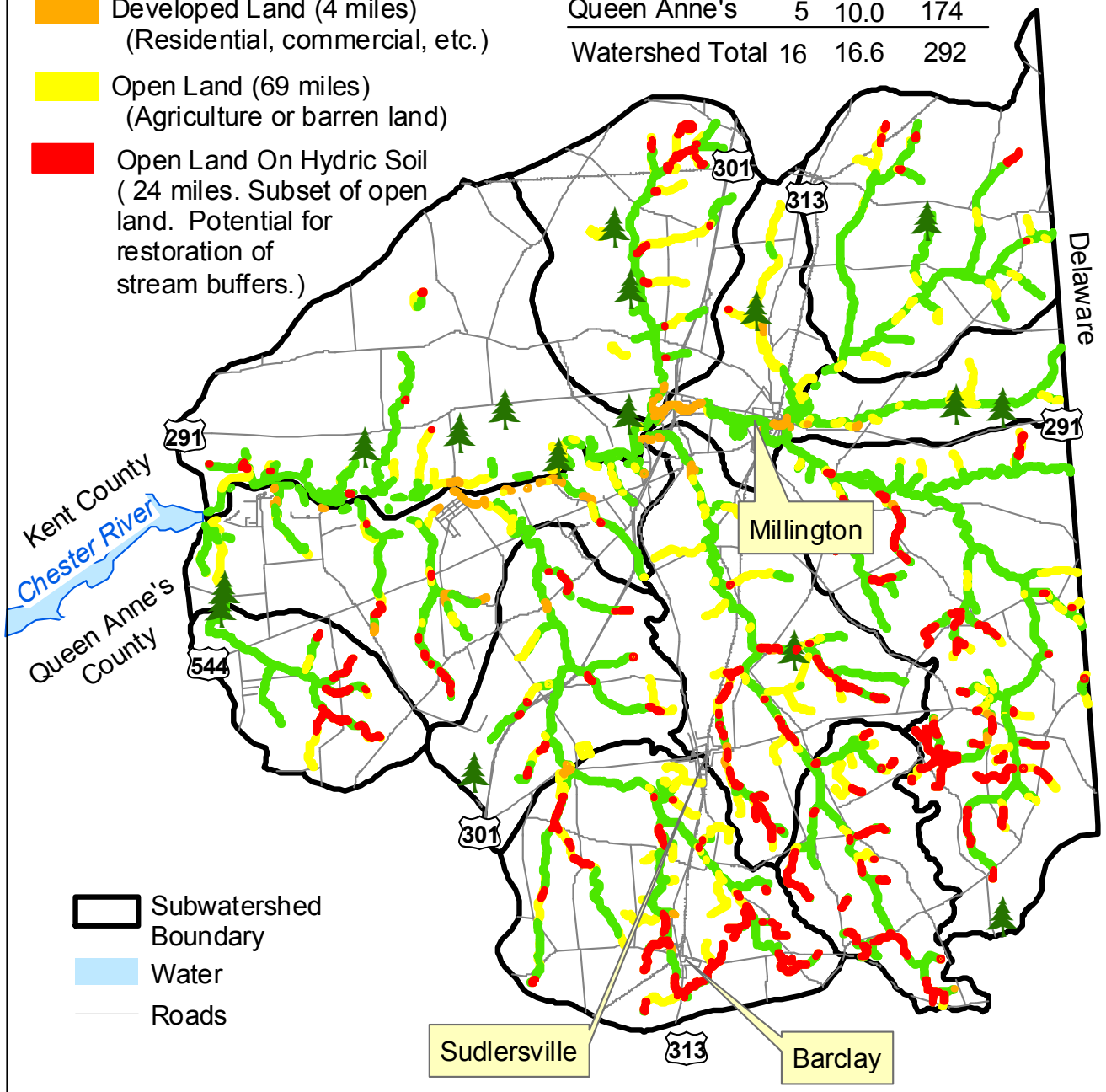
Map 10 Stream Buffers And Open Land On Hydric Soil
Upper Chester River WRAS

Stream Buffers (220 miles total)

- Natural Vegetation (147 miles) (Woodland, wetland, brush)
- Developed Land (4 miles) (Residential, commercial, etc.)
- Open Land (69 miles) (Agriculture or barren land)
- Open Land On Hydric Soil (24 miles. Subset of open land. Potential for restoration of stream buffers.)

Stream Buffer Plantings 2001-2002

County	Projects	Miles	Acres
Kent	11	6.6	118
Queen Anne's	5	10.0	174
Watershed Total	16	16.6	292

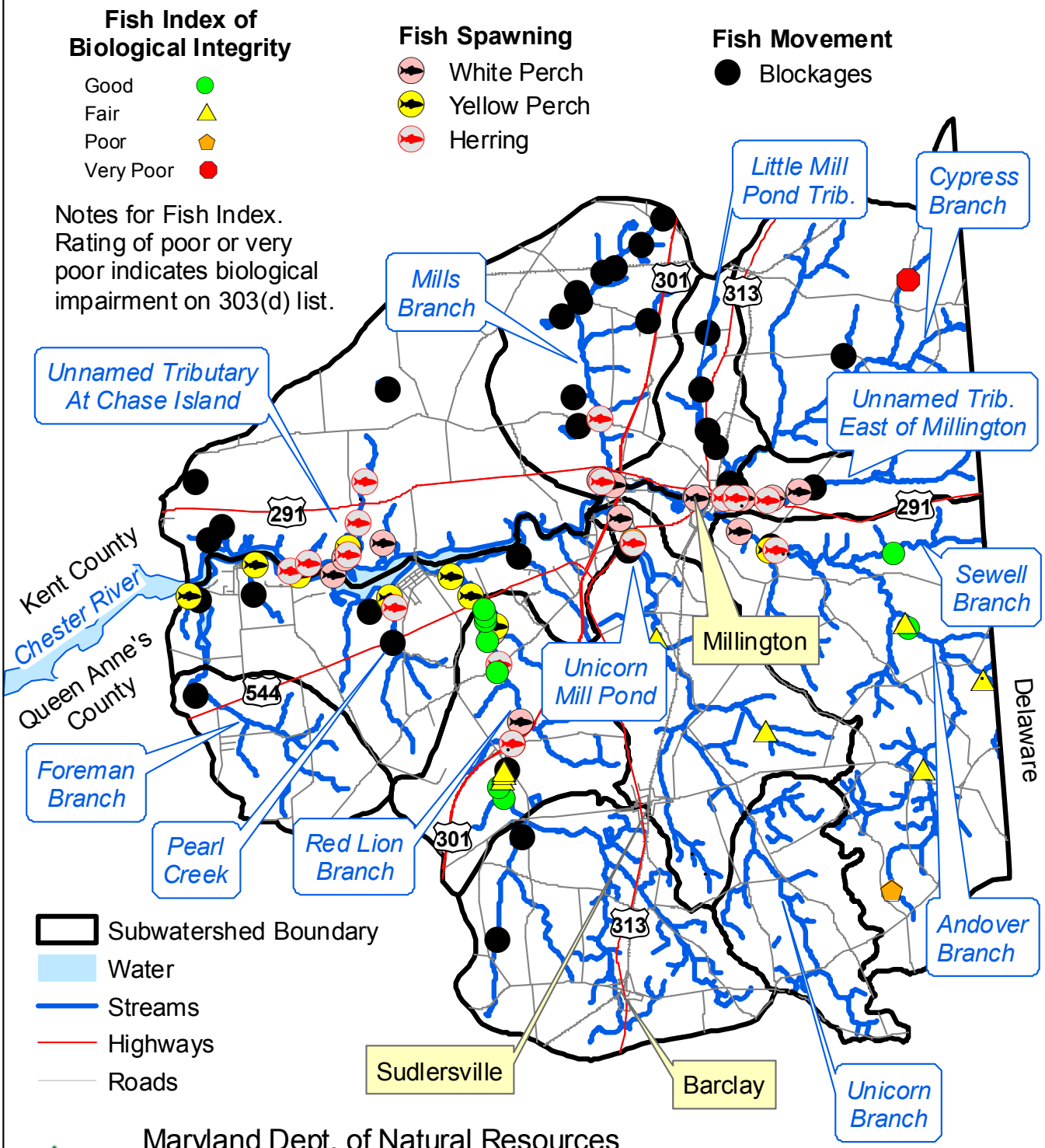


Maryland Dept. of Natural Resources
GIS: Watershed Services, LWAD March 2005
Streams, Land Use and Soil Data: MDP
Stream Buffer Planting Data: DNR Forest Service

0 0.5 1 2 3 4 Miles

1:150,000

Map 11 Fish Spawning, Blockages and MBSS Index
Upper Chester River WRAS



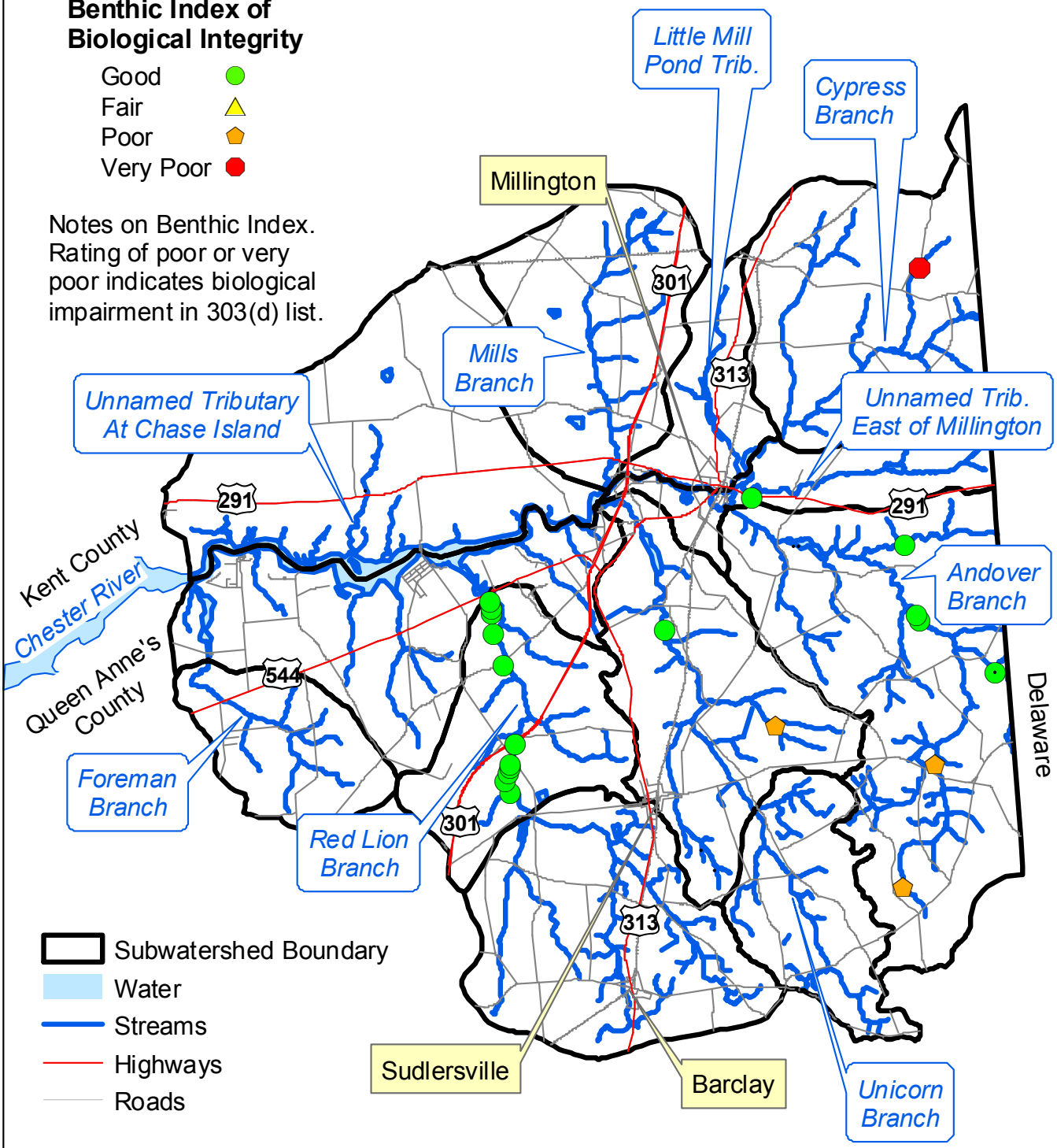
Maryland Dept. of Natural Resources

GIS: Watershed Services, LWAD March 2005
Index Data: DNR MBSS 1995
Spawning Data: DNR Fisheries Service
Blockages Data: DNR Fisheries Service

0 0.5 1 2 3 4 Miles

1:150,000

Map 12 Benthos - MBSS Index
Upper Chester River WRAS



Maryland Dept. of Natural Resources
GIS: Watershed Services, LWAD March 2005
Data: DNR MBSS 1995

0 0.5 1 2 3 4 Miles

1:150,000

Map 13 Sensitive Species
Upper Chester River WRAS

Ecologically Significant Areas encompass at least 22 sites.

Wetlands of Special State Concern encompass at least 54 sites covering nearly 490 acres.

Subwatershed Boundary

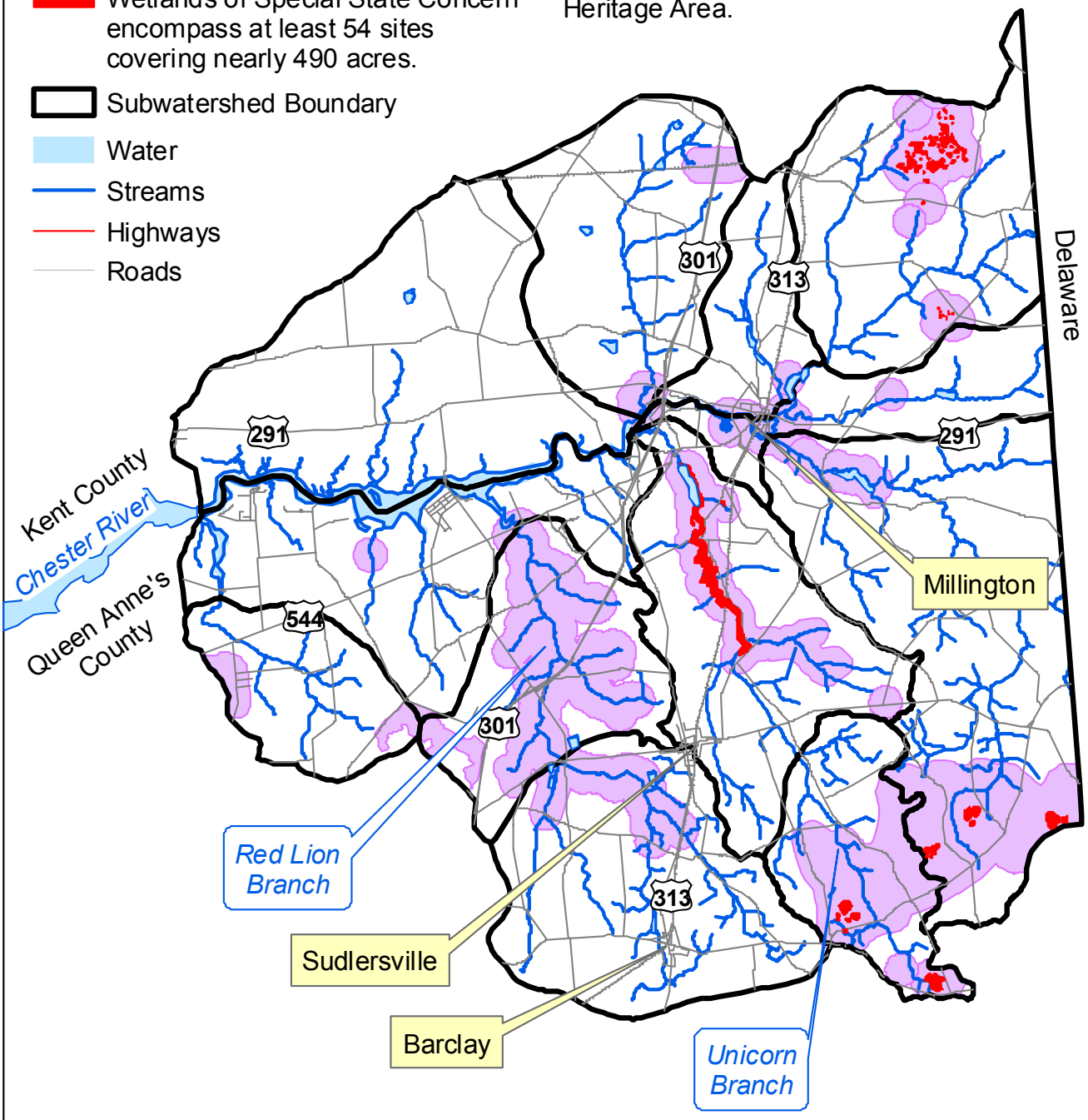
Water

Streams

Highways

Roads

NOTE: This watershed includes Ecologically Significant Areas and Wetlands of Special State Concern. It does not have a Natural Heritage Area.



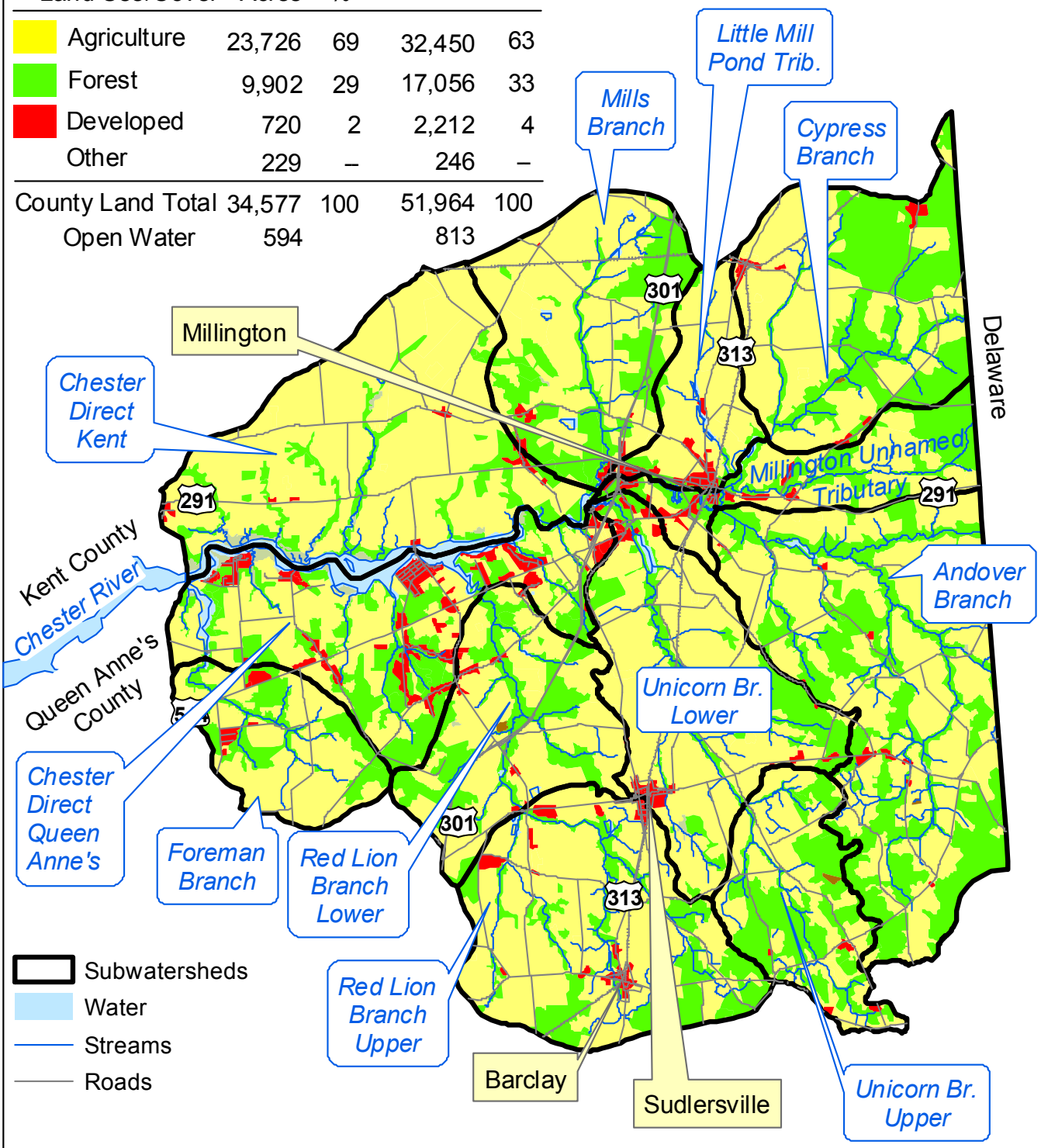
Maryland Dept. of Natural Resources
GIS: Watershed Services, LWAD March 2005
Sensitive Species Data: DNR June 2004

0 0.5 1 2 3 4 Miles

1:150,000

Map 14 Land Use, Upper Chester River WRAS

Land Use/Cover	Kent Acres	Kent %	Queen Anne's Acres	Queen Anne's %
Agriculture	23,726	69	32,450	63
Forest	9,902	29	17,056	33
Developed	720	2	2,212	4
Other	229	–	246	–
County Land Total	34,577	100	51,964	100
Open Water	594		813	



Maryland Dept. of Natural Resources
GIS: Watershed Services, LWAD March 2005
Data: MDP 2002

0 0.5 1 2 3 4 Miles
1:150,000

Map 15 Protected Land
Upper Chester River WRAS

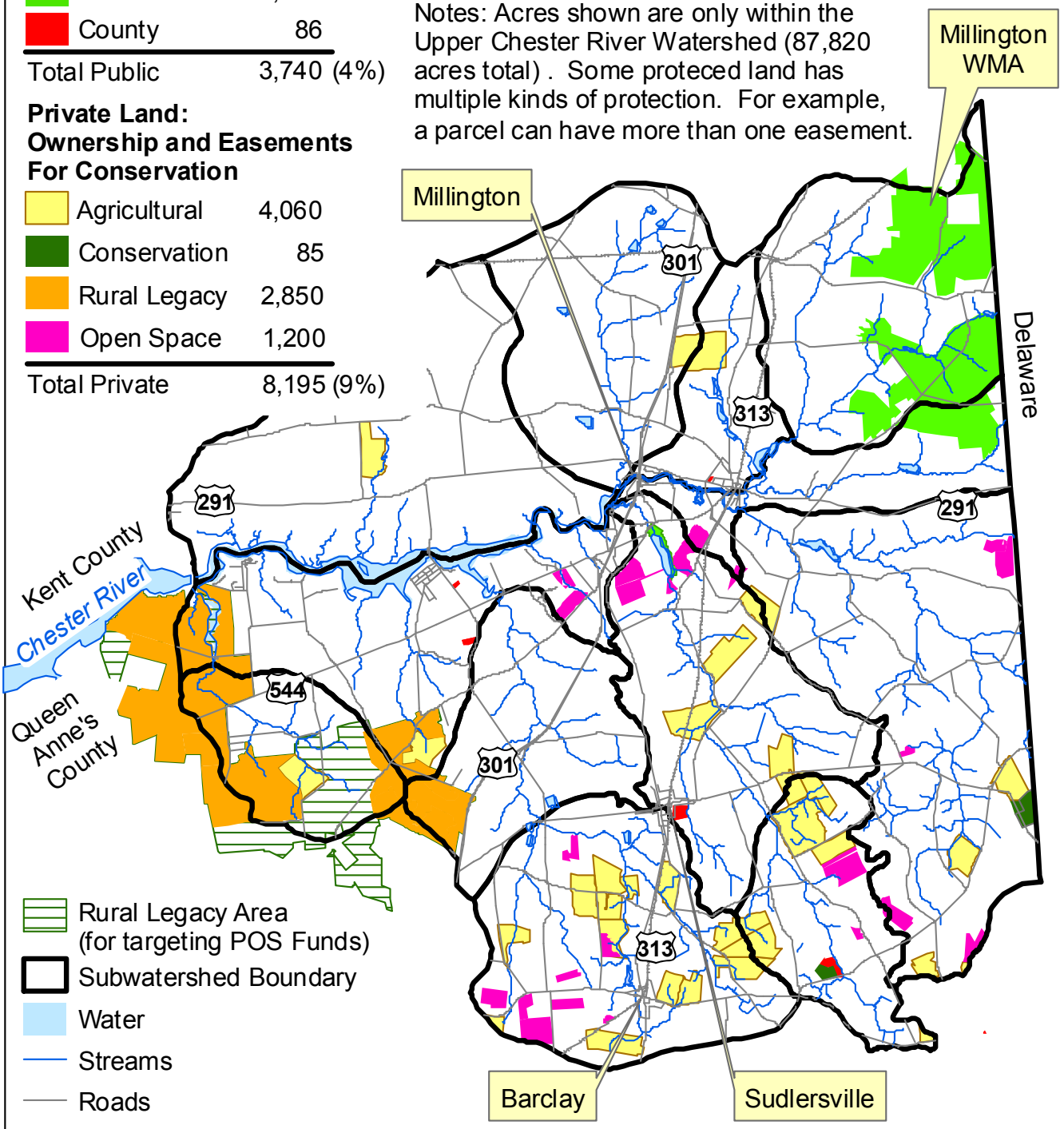
Public Land: Ownership For Conservation

	Acres
DNR Lands	3,654
County	86
Total Public	3,740 (4%)

Private Land: Ownership and Easements For Conservation

Agricultural	4,060
Conservation	85
Rural Legacy	2,850
Open Space	1,200
Total Private	8,195 (9%)

Notes: Acres shown are only within the Upper Chester River Watershed (87,820 acres total) . Some proteced land has multiple kinds of protection. For example, a parcel can have more than one easement.



Maryland Dept. of Natural Resources
GIS: Watershed Services, LWAD March 2005
Data: Queen Anne's County Planning & Zoning
State Agencies

0 0.5 1 2 3 4 Miles

1:150,000

Map 16 Impervious Area
Upper Chester River Subwatersheds

Subwatershed Average Percent Impervious

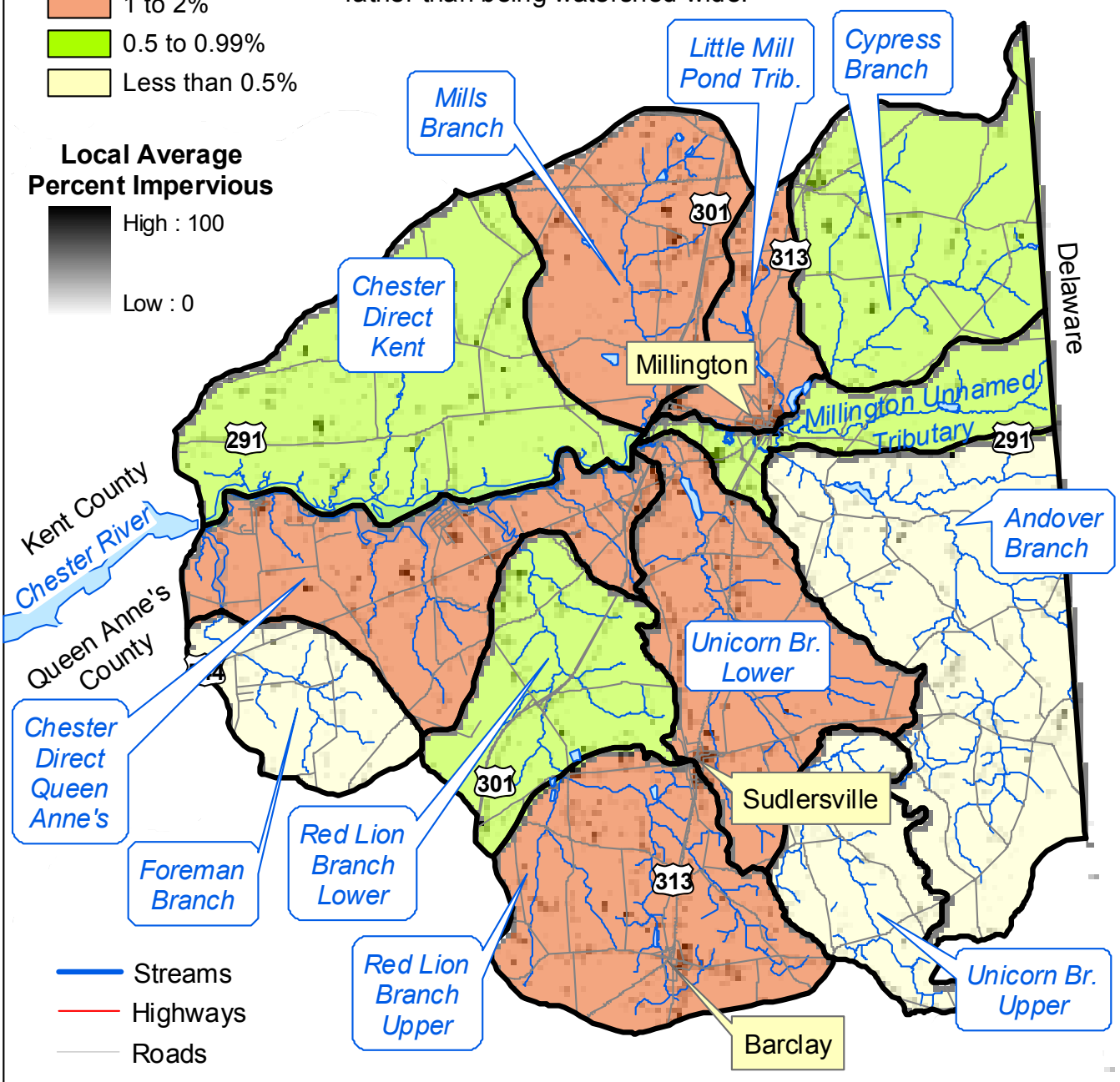
- 1 to 2%
- 0.5 to 0.99%
- Less than 0.5%

Local Average Percent Impervious

High : 100

Low : 0

Average percent impervious less than 2% suggests that significant impacts on habitat and water quality are limited to local areas rather than being watershed-wide.



Maryland Dept. of Natural Resources

GIS: Watershed Services LWAD March 2005
Impervious Area Data based on 1999-2001
land cover published by RESAC UOM 2002

0 0.5 1 2 3 4 Miles

1:150,000