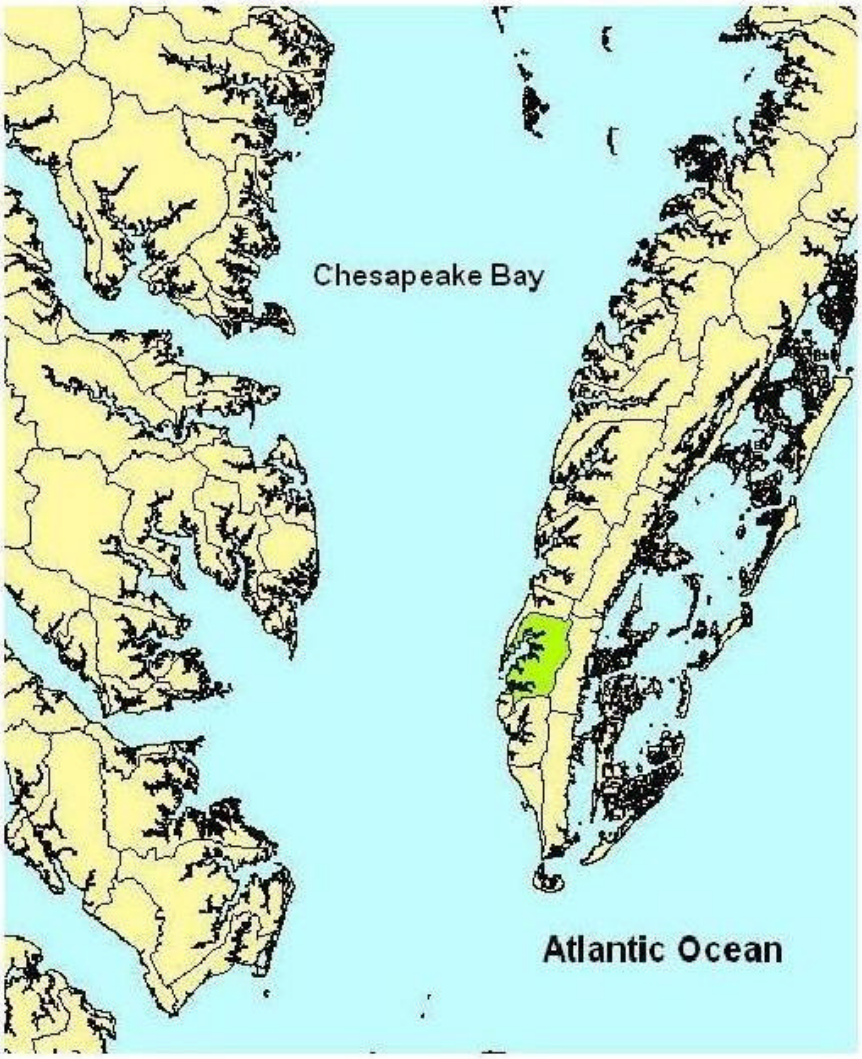
Total Maximum Daily Load (TMDL) Report for Shellfish Areas Listed Due to Bacterial Contamination

Cherrystone Inlet



DEQ
Virginia Department of Environmental Quality

VDH Virginia Department of Health
Protecting You and Your Environment

Chesapeake Bay: Cherrystone Inlet Watershed Total Maximum Daily Load (TMDL) Report for Shellfish Condemnation Areas Listed Due to Bacteria Contamination

Virginia Department of Environmental Quality

June 2007

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Total Maximum Daily Load Executive Summary

Total Maximum Daily Load Process

Management of water quality is a process intended to protect waters for a variety of uses. The first step in the process is the identification of desired uses for each water body. There are typically a number of physical, chemical and/or biological conditions that must exist in a water body to allow for a desired use to exist. In Virginia, most inshore tidal waters are identified as potential shellfish growing waters. In order to support shellfish propagation without risk to human consumers, shellfish waters must have very low levels of pathogenic organisms. Virginia, as most other states, uses fecal coliforms (FC) as an indicator of the potential presence of pathogenic organisms. To maintain the use of a water body for direct shellfish harvesting, the goal is to ensure the concentration of fecal coliforms entering the water body does not exceed a "safe" level. The safe level is set as the standard against which water quality monitoring samples are checked.

When water quality monitoring detects levels of fecal coliforms above allowable, "safe" levels, managers must identify the potential sources and plan to control them. The prescribed method for figuring out what must be controlled to attain the water quality standard is the calculation of a total maximum daily load (TMDL). The TMDL is the amount of fecal coliforms that may be introduced by each potential source without exceeding the water quality standard for fecal coliforms in shellfish growing waters.

The process of developing a shellfish water TMDL may be generalized in the following manner:

1. Water quality monitoring data are used to determine if the bacterial standard for shellfish have been violated;
2. Potential sources of fecal bacteria loading within the contributing watershed are identified;
3. The necessary reductions in fecal bacteria pollutant load to achieve the water quality standard are determined;
4. The TMDL study is presented to the public to garner comment;
5. An implementation strategy to reduce fecal bacteria loads is written into a plan and subsequently implemented;
6. Water quality monitoring data are used to determine if the bacterial standard is being met for shellfish waters.

Different approaches can be used to determine the sources of fecal pollution in a water body. Two distinctly different approaches are watershed modeling and bacterial source tracking (BST). Watershed modeling begins on the land, identifying potential sources based on information about conditions in the watershed (e.g. numbers of residents, estimated wildlife populations, estimated of livestock, etc.). BST begins in the water, identifying sources of fecal coliforms, specifically the dominant fecal coliform *Escherichia coli*, to shellfish waters based on either genetic or phenotypic characteristics of the coliforms. Virginia's Department of Environmental Quality has decided to utilize BST, and specifically to use a method called antibiotic resistance analysis (ARA). This method assumes that fecal bacteria found in four sources: humans, wildlife, livestock, and domestic animals will all differ in their reactions to antibiotics. Thus, when samples of fecal bacteria collected in the water quality monitoring program are exposed to specific antibiotics the pattern of responses allows

matching similarities to the response patterns of bacteria from known sources which have been accumulated in a "source library". Through this analysis investigators also estimate the relative proportion of the fecal bacteria derived from each of the four general source classes and assumes this proportion reflects the relative contribution from the watershed. The resulting estimates of the amount of fecal coliform pollution coming from each type of source can then be used to allocate reductions necessary to meet the water quality standard for shellfish growing waters. Identifying and agreeing on the means to achieve these reductions represent the TMDL implementation plan. Continued water quality monitoring will tell whether the efforts to control sources of fecal coliforms in the watershed have succeeded.

Fecal Coliform Impairment

This document details the development of bacterial TMDLs for the impairment in Cherrystone Inlet, Kings Creek watershed, a tributary to the Chesapeake Bay identified as shellfish Growing Area 88. This impairment was identified in the 1998 303(d) list as Cherrystone Inlet, Kings Creek (VAT-C15E-10) condemnation 88-139 located in Northampton County, Virginia. The VDH-DSS impairment identification nomenclature for this TMDL segment was changed in 2006 as shown in the January 2006 Shellfish Closure Notice. For the purposes of this TMDL report all impairments are presented with their 1998 nomenclature to ensure consistency with the October 14, 1998 303(d) list provided to the Environmental protection Agency pursuant to the consent order.

The applicable state standard specifies that the number of fecal coliform bacteria shall not exceed a maximum allowable level of geometric mean of 14 most probable number (3-tube MPN) per 100 milliliters (ml) and a 90th percentile geometric mean value of 49 MPN/100ml. (Virginia Water Quality Standard 9-VAC 25-260-5). In development of this TMDL, the 90th percentile 49 MPN/100 ml was used, since it represented the more stringent standard.

Sources of Fecal Coliform

Potential sources of fecal coliform consist primarily of non-point source contributions, as there are no permitted point source discharges that directly impact the identified impairments in the watershed. Non-point sources include wildlife; livestock; land application of bio-solids; recreational vessel discharges; failed, malfunctioning, or non-operational septic systems, and uncontrolled discharges (straight pipes conveying gray water from kitchen and laundry areas of private homes, etc.).

Water Quality Modeling

A tidal volumetric model was used for this TMDL study because the character of the water bodies to be modeled is relatively simple from a hydrologic perspective: for example, small in area and volume with a single, unrestricted connection to receiving waters. This approach uses the volume of the water body and adjusts for tidal flushing, freshwater inflow and bacterial decay in order to establish the existing and allocation conditions.

Determination of Existing Loadings

To assist in partitioning the loads from the diverse sources within the watershed, water quality samples of fecal coliform bacteria were collected for one year and evaluated using an antibiotic resistance analysis in a process called bacterial source tracking. These samples were compared to a reference library of fecal samples from known sources. The resulting data were used to assign portions of the load within the watershed to wildlife, humans, pets or livestock. The results of this analysis indicated that the primary source of fecal coliforms is wildlife with livestock as secondary contributors. The presence of a large signature attributable to one component is sufficient to establish potential directions for remediation under a future implementation plan.

Load Allocation Scenarios

The next step in the TMDL process was to determine the appropriate water quality standard to be applied. This was set as the 90th percentile standard because the data established that the 90th percentile required the greater reduction. Calculated results of the model for each segment were used to establish the existing load in the system. The load necessary to meet water quality standards was calculated in a similar fashion using the water quality standard criterion in place of the ambient water quality value. The difference between these two numbers represents the necessary level of reduction in each segment.

Finally the results of the BST developed for each segment were used to partition the load allocation that would meet water quality standards according to source. The results of the model, the BST source partitioning and the reductions necessary for each segment are shown below.

TMDL Summary for Bacteria Impairments of the Shellfish Growing Area 88 Watershed
Geometric Mean Analysis of Current Load and Estimated Load Reduction

Condemnation Area	Volume (m^3)	Ambient Fecal Coliform (MPN/100ml)	WQ Standard MPN/100ml	Current Load (MPN/day)	Allowable Load (MPN/day)	Required Reduction (%)
88-139 Cherrystone Inlet, Kings Creek (VAT-C15E-10)	**58320**	**45.1**	**14**	**2.63E+10**	**8.16E+09**	**69%**

TMDL Summary for Bacteria Impairments of Shellfish Growing Area 88 Watershed 90th
Percentile Analysis of Current Load and Estimated Load Reduction

Condemnation Area	Volume (m^3)	Ambient Fecal Coliform (MPN/100ml)	WQ Standard MPN/100ml	Current Load (MPN/day)	Allowable Load (MPN/day)	Required Reduction (%)
88-139 Cherrystone Inlet, Kings Creek (VAT-C15E-10)	**58320**	**325.5**	**49**	**1.90E+11**	**2.86E+10**	**85%**

Margin of Safety

In order to account for uncertainty in modeled output, a margin of safety (MOS) was incorporated into the TMDL development process by making very conservative choices. A margin of safety can be incorporated implicitly in the model through the use of conservative estimates of model parameters, or explicitly as an additional load reduction requirement. Individual errors in model inputs, such as data used for developing model parameters or data used for calibration, may affect the load allocations in a positive or a negative way. The purpose of the MOS is to avoid an overall bias toward load allocations that are too large for meeting the water quality target. An implicit MOS was used in the development of this TMDL through selection of a water quality standard providing a high level of protection, utilization of entire segment volumes for model calculations, averaging extreme high and low values to ensure that the more protective condition with the largest available data set was addressed and emphasizing watershed-based implementation measures.

Recommendations for TMDL Implementation

The goal of this TMDL was to develop an allocation plan that achieves water quality standards during the implementation phase. Virginia's 1997 Water Quality Monitoring, Information and Restoration Act states in section 62.1-44.19.7 that the "Board shall develop and implement a plan to achieve fully supporting status for impaired waters".

The TMDL developed for these impairments, provide allocation scenarios that will be a starting point for developing implementation strategies. Additional monitoring aimed at targeting the necessary reductions is critical to implementation development. Once established, continued monitoring will aid in tracking success toward meeting water quality milestones.

Public participation is critical to the implementation process. Reduction in non-point source loading is the crucial factor in addressing the problem. These sources cannot be addressed without public understanding of and support for the implementation process. Stakeholder input will be critical from the onset of the implementation process in order to develop an implementation plan that will be truly effective.

Public Participation

During development of the TMDL for Cherrystone Inlet, Kings Creek in Growing Area 88, public involvement was encouraged through a public participation process that included public meetings and stakeholder meetings.

The first public meeting was held on April 6, 2007. A basic description of the TMDL process and the agencies involved was presented and a discussion was held to regarding the source assessment input, bacterial source tracking, and model results.

Input from these meetings was utilized in the development of the TMDL and improved confidence in the allocation scenarios and TMDL process.

The second public meeting was held on April 24, 2007. The results of the TMDL study were presented and discussed. Public participation and involvement in the TMDL implementation planning process was solicited and encouraged.

1.0 Introduction

This document details the development of bacterial Total Maximum Daily Load (TMDL) for one segment in Cherrystone Inlet, Kings Creek in Growing Area 88 in Northampton County, Virginia. This water is listed as impaired on Virginia's 303(d) Total Maximum Daily Load Priority List. The TMDL is one step in a multi-step process that includes a high level of public participation in order to address water quality issues that can affect public health and the health of aquatic life.

1.1 Listing of Water Bodies under the Clean Water Act

Water quality standards are regulations based on federal or state law that set numeric or narrative limits on pollutants. Water quality monitoring is performed to measure these pollutants and determine if the measured levels are with the bounds of the limits set for the uses designated for the water body. The water bodies which have pollutant levels above the designated standards are considered impaired for the corresponding designated use (e.g. swimming, drinking, shellfish harvest, etc.). The impaired waterways are listed on the §303 (d) list reported to the Environmental Protection Agency. Those waters placed on the list require the development of a TMDL intended to eliminate the impairment and bring the water into compliance with the designated standards.

TMDLs represent the total pollutant loading that a water body can receive without violating water quality standards. The TMDL process establishes the allowable loading of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. By following the TMDL process, states can establish water quality based controls to reduce pollution from both point and non-point sources to restore and maintain the quality of their water resources (EPA, 1991).

Fecal coliform bacteria are the most common cause for the impairments in Virginia shellfish growing waters. This group of bacteria is considered an indicator of the presence of fecal contamination. The most common member of the fecal coliform groups is *Escherichia coli*. Fecal coliforms are associated with the fecal material derived from humans and warm-blooded animals. The presence of fecal coliform bacteria in aquatic environments is an indication that the water may have been contaminated by pathogens or disease-producing bacteria or viruses. Waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis, and hepatitis A. Filter-feeding shellfish can concentrate these pathogens which can be transmitted and cause disease when eaten uncooked. Therefore, the presence of elevated numbers of fecal coliform bacteria is an indicator that a potential health risk exists for individuals consuming raw shellfish. Fecal contamination can occur from point source inputs of domestic sewage or from nonpoint sources of human, (e.g., malfunctioning septic systems) or animal wastes.

Because the fecal coliform indicator does not provide information on the source or origin of fecal contamination, Agencies of the Commonwealth, including the Department of Environmental Quality (DEQ), the Virginia Department of Health – Division of Shellfish sanitation (VDH-DSS) and the Department of Conservation and Recreation (DCR) have worked together with state universities, the U.S. Geological Survey and the U.S. Environmental Protection Agency to develop methods to assess sources of fecal coliforms to assist in development of TMDLs in impaired shellfish waters.

As a group these methods are usually called bacterial or microbial source tracking (BST or MST). This study utilizes bacteria source tracking (BST) to determine the most probable sources of fecal coliform in the water. To assist with the analysis and development of the TMDLs for impaired shellfish waters, the Department of Environmental Quality contracted the Virginia Institute of Marine Science (VIMS).

1.2 Overview of the TMDL Development Process

A TMDL study for shellfish waters is the first part of a phased process aimed at restoring water quality. This study is designed to determine how much of the pollutant input needs to be reduced in order to achieve water quality standards. The second step in the process is the development of an implementation plan that identifies which specific control measures are necessary to achieve those reductions, their timing for implementation and at what cost. The implementation plan will also outline potential funding sources. The third step will be the actual implementation process. Implementation will typically occur in stages that allow a review of progress in reducing pollutant input, refine bacteria loading estimates based upon additional data and to make any identified changes to pollutant control measures.

The TMDL development process also must account for seasonal and annual variations in precipitation, flow, land use, and pollutant contributions. Such an approach ensures that TMDLs, when implemented, do not result in violations under a wide variety of scenarios that affect bacterial loading.

2.0 Applicable Water Quality Standard

Water quality standards are provisions of state or federal law which consist of a designated use or set of uses for the waters and water quality criteria based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.). According to Virginia Water Quality Standards (9 VAC 25-260-5), the term

"water quality standards means provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.)."

2.1 Designated Uses and Criteria

Generally, all tidal waters in Virginia are designated as shellfish waters. The identification of the applicable river reaches can be found in the river basin tables at 9 VAC 25-260-390 et seq. For a

shellfish supporting water body to be in compliance with Virginia bacterial standards, VADEQ specifies the following criteria (9 VAC 25-260-160):

"In all open ocean or estuarine waters capable of propagating shellfish or in specific areas where public or leased private shellfish beds are present, and including those waters on which condemnation or restriction classifications are established by the State Department of Health the following criteria for fecal coliform bacteria shall apply; The geometric mean fecal coliform value for a sampling station shall not exceed an MPN (most probable number) of 14 per 100 milliliters. The 90th percentile shall not exceed an MPN of 43 for a 5 tube, 3 dilution test or 49 for a 3 tube, 3 dilution test."

2.2 Classification of Virginia's Shellfish Growing Areas

The Virginia Department of Health, Division of Shellfish Sanitation (DSS) is responsible for classifying shellfish waters and protecting the health of bivalve shellfish consumers. The VDH- DSS follows the requirements of the National Shellfish Sanitation Program (NSSP), which is regulated by the U.S. Food and Drug Administration. The NSSP specifies the use of a shoreline survey as its primary tool for classifying shellfish growing waters. Fecal coliform concentrations in water samples collected in the immediate vicinity of the shellfish beds function to verify the findings of the shoreline survey and to define the border between approved and condemned (unapproved) waters. Much of the DSS effort is focused on locating fecal contamination, and in this manner minimizing the introduction of human pathogens to shellfish waters.

DSS designs and operates the shoreline survey to locate sources of pollution within the watersheds of shellfish growing areas. This is accomplished through a property-by-property inspection of the onsite sanitary waste disposal facilities of most properties on un-sewered sections of watersheds, and investigations of other sources of pollution such as wastewater treatment plants (WTP), marinas, livestock operations, landfills, etc. The information is compiled into a written report with a map showing the location of the sources of real or potential pollution found and sent to the various agencies that are responsible for regulating these concerns in the city or county. Once an onsite problem is identified, local health departments (LHDs), and/or other state and local agencies may play a role in the process of correcting the deficiencies.

The VDH-DSS collects monthly seawater samples at over 2,000 stations in the shellfish growing areas of Virginia. Though they continuously monitor sample data for unusual events, they formally evaluate shellfish growing areas on an annual basis. The annual review uses data from the most recent 30 samples (typically 30 months), collected randomly with respect to weather. The data are assessed to determine whether the water quality standards are met. If the water quality standards are exceeded, the shellfish area is closed for the harvest of shellfish that go directly to market. Those areas that marginally exceed the water quality standard and are closed for the direct marketing of shellfish are eligible for harvest of shellfish under permit from the Virginia Marine Resources Commission and VDH-DSS. The permit establishes controls that in part require shellfish be allowed to depurate for 15 days in clean growing areas or specially designed licensed on shore facilities. Shellfish in growing areas that may be highly polluted, such as those in the immediate vicinity of a wastewater treatment facility (prohibited waters), are not allowed to be moved to clean waters for self purification.

3.0 Watershed Characterization

The TMDL for Shellfish Growing Area 88 is comprised of Cherrystone Inlet, Kings Creek watershed listed as impaired in 1998. The impaired water is located entirely within Northampton County. The Growing Area 88 watershed is bounded on the north and west by Savage Neck Drive, on the east by State Route 13, and on the south by Townfield Drive. The location of the combined watershed is shown in Figure 3.0

The drainage area of Cherrystone Inlet, Kings Creek watershed is as 2921 acres or 4.6 mi^2. The watersheds have an estimated year round population according to the 2000 US Census of 435 for the entire growing area.

A map of the land use in each of these sub-watersheds is shown in Figure 3-1. In this watershed the dominant land use type is forest, grassland and agriculture. Estimations of the populations of livestock and wildlife, as well as numbers of septic systems within the watershed are shown in Table 3-1. Appendix B provides a description of data and list of data sources for Table 3.1.

Table 3.1 Estimated Animal Populations and Septic Systems Growing Area 88

Fecal Coliform Sources	Condemantion Area 88-139 Cherrystone Inlet, Kings Creek
Raccoon	112
Cattle	9
Duck	283
Deer	124
Geese	196
Septic	106
Sheep	1
Pig	6
Horse	3
Chicken	3
Dog	123

4.0 Water Quality Impairment and Bacterial Source Assessment

4.1 Water Quality Monitoring

The shellfish water quality monitoring network consists of a total of 30 stations for Shellfish Growing Area 88. Of these 30 monitoring stations 5 are located in the impaired segment in Kings Creek. This number may vary as the VDH-DSS adds and removes stations in order to provide necessary coverage to determine public health risks. The impaired shellfish waters, or condemnation

Figure 3.0

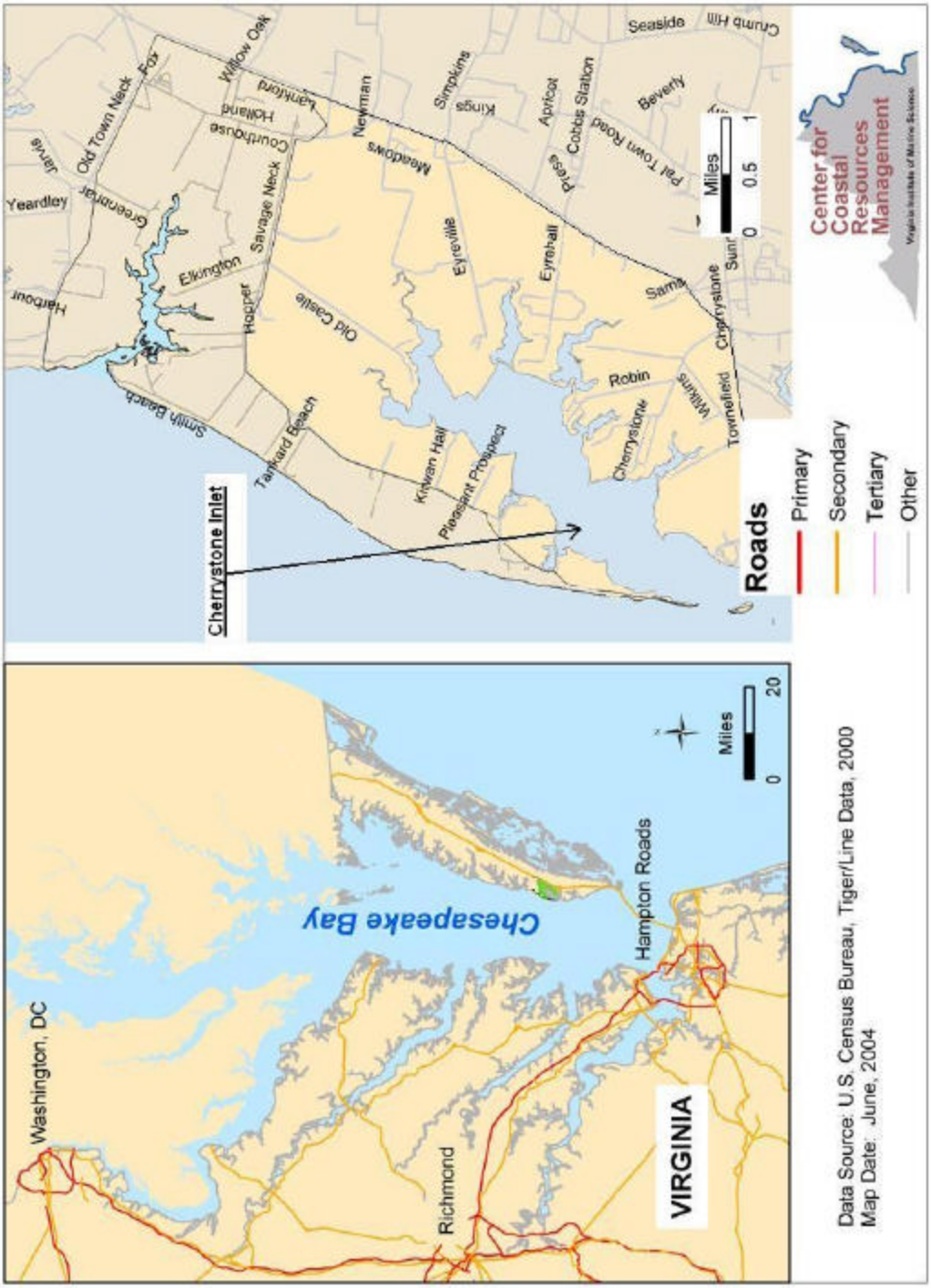
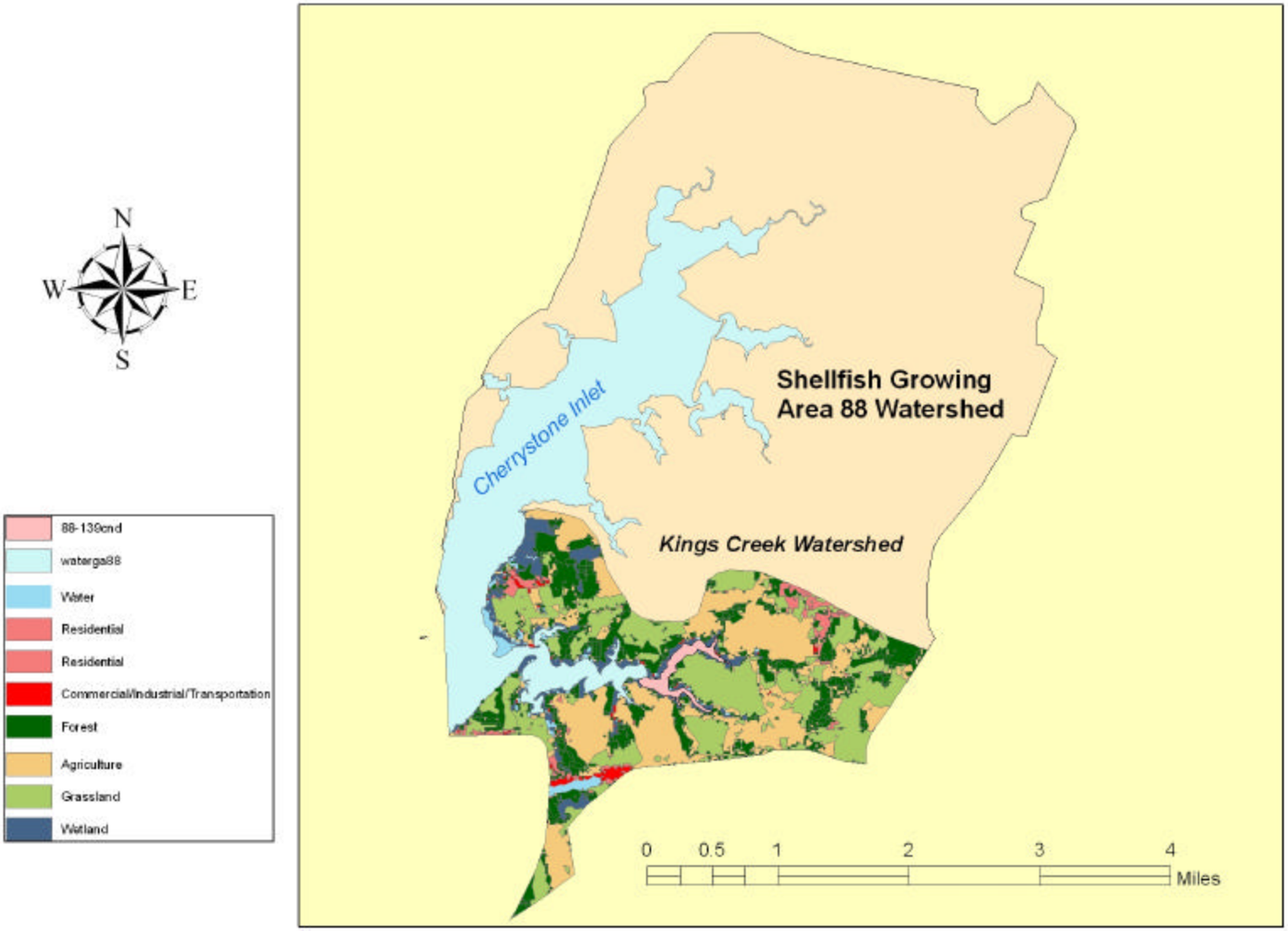

Washington, DC
Chesapeake Bay
Richmond
Hampton Roads
VIRGINIA
Miles
0
20
Data Source: U.S. Census Bureau, Tiger/Line Data, 2000
Map Date: June, 2004
Cherrystone Inlet
Roads
Primary
Secondary
Tertiary
Other
Miles
0
0.5
1
Center for Coastal Resources Management
Virginia Institute of Marine Science
Smith Beach
Tankard Beach
Old Castle
Kiwan Hall
Pleasant Prospect
Robin
Cherrystone
Townefield
Wilkins
Cherrystone
Sam
Sunset
Eyreville
Eyrehall
Meadows
Newman
Simpkins
Kings
Apricot
Cobbs Station
Pleasant
Pat Town Road
Beverly
Seaside
Crump Hill
Willow Oak
Fox
Old Town Neck
Lanhford
Holland
Courthouse
Savage Neck
Elkington
Hopper
Greenbriar
Yeardley
Harbour
Jarvis

Figure 3.1
Landuse in the Cherrystone Inlet, Kings Creek Watershed



areas, are shown in Figure 4.1. In these waters there are eight monitoring stations for the impaired segment for Cherrystone Inlet, Kings Creek. These stations are monitored by the VDH-DSS for fecal bacteria. The locations of the water quality monitoring stations are shown in Figure 4.2. At least one station in each of these watersheds was sampled for bacteria source tracking. These stations are also identified in Figure 4.2. This TMDL study examined bacterial monitoring data at these stations for a period of time from May of 2003 through December 2005. A summary of water quality data for the monitoring period preceding the TMDL study is shown in Table 4.1. Graphs depicting the geometric mean, 90th percentile, and ambient bacteria data are shown in Figures 4.3A through 4.3C. Data for those stations associated with a condemnation from 1998, as indicated by a condemnation number in Table 4.1 are used for the TMDLs in this study.

The closures in the growing areas are characterized based on all monitoring in the closed area. To facilitate an effective assignment of the appropriate level of protection for this system, the station with the highest water quality data was used to assess the existing load in each condemned area. This provides an increased margin of safety and provides a target that can be easily comprehended and uniformly implemented while retaining the necessary protection for the affected waters.

Table 3.2 Summary of Estimated Land Use in Acres by Type in the Impaired Watersheds of Growing Area 88

Land Use Type	Condemnation Area 88-139 Cherrystone Inlet, Kings Creek
Water	**62**
Residential	**88**
Commercial	**35**
Transitional	**0**
Forest	**645**
Grassland	**815**
Agriculture	**847**
Wetland	**194**

Figure 4.1
Location of Kings Creek Condemnation Area 88-139
within Cherrystone Inlet, Shellfish Growing Area 88

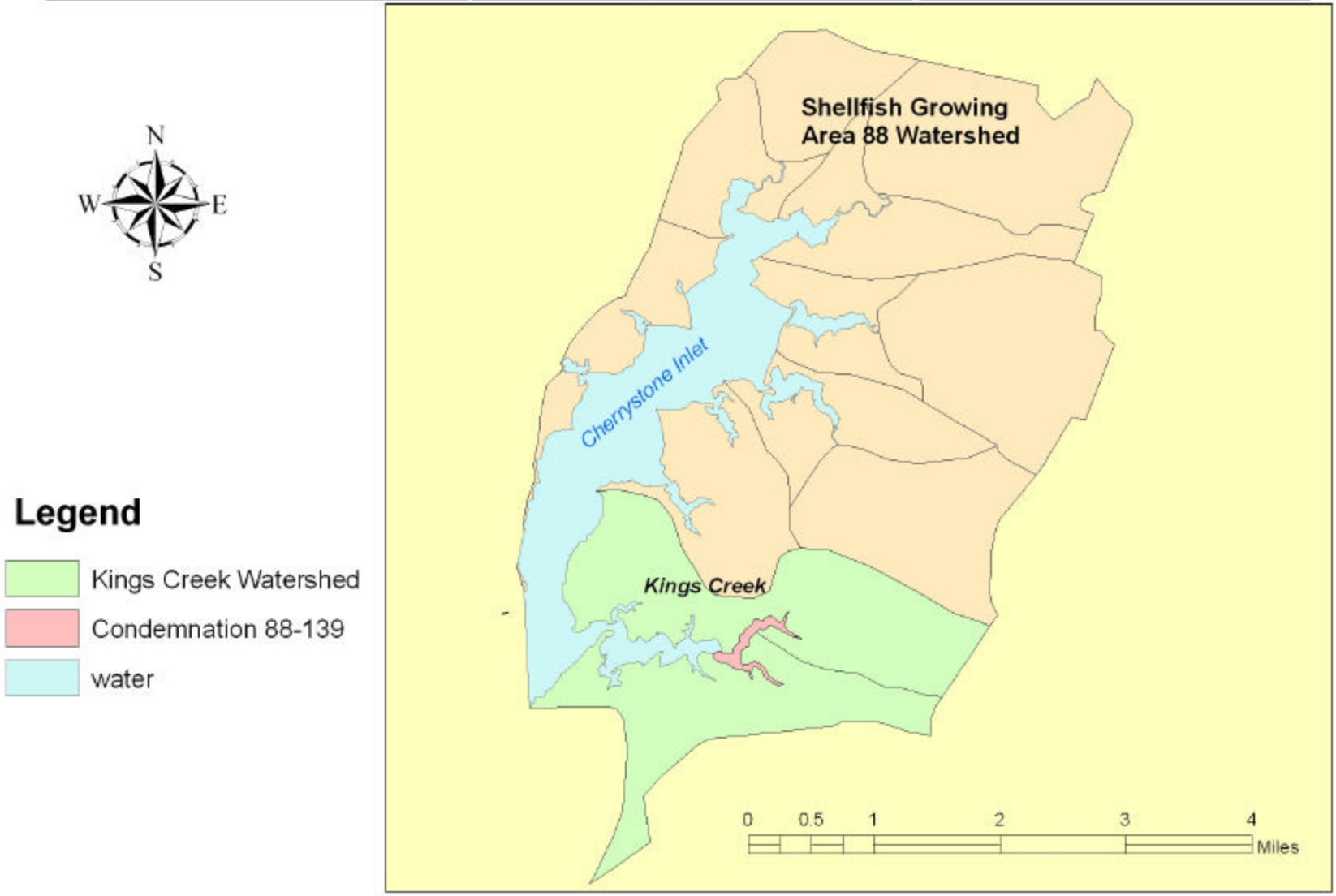


Figure 4.2
Location of Water Quality Monitoring and Bacteria Source Tracking Stations in Cherrystone Inlet Shellfish Growing Area 88

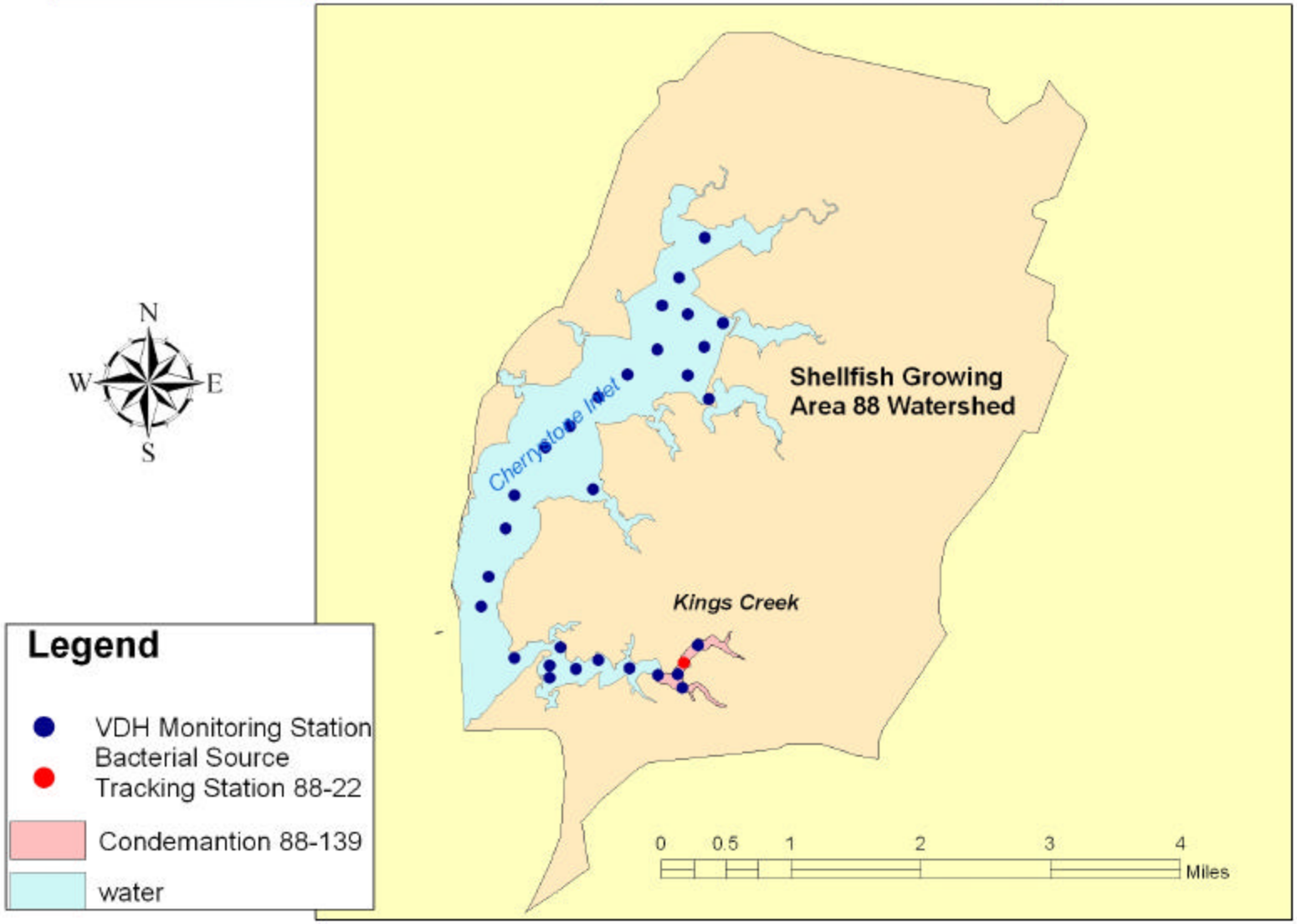


Table 4.1
Water Quality Data Summary: Growing Area 88, Cherrystone Inlet, Kings Creek

Station	Condemnation Area	Total Observations (1/month)	Geometric Mean MPN/100ml	Station Violates Geometric Standard: 14 MPN	90th Percentile MPN/100ml	Station Violates 90th Percentile Standard: 49 MPN
88-18		30	9.7	NO	40.5	NO
88-19	88-139	30	14.3	Yes	75.7	Yes
88-20	88-139	30	19.9	Yes	108.5	Yes
88-21	88-139	30	32.9	Yes	242.1	Yes
88-22	88-139	30	30.7	Yes	151.7	Yes
88-23	88-139	30	45.1	Yes	325.5	Yes

Figure 4.3A

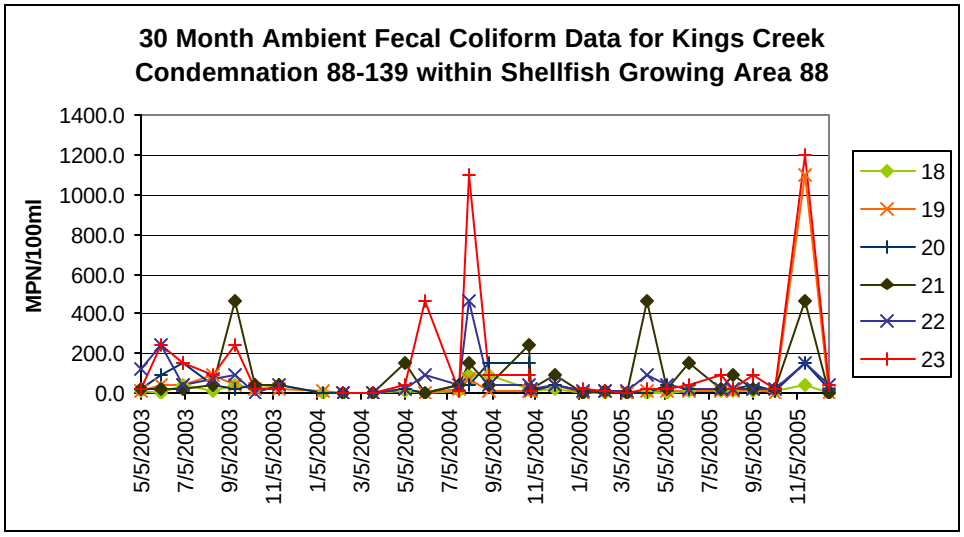


Figure 4.3B

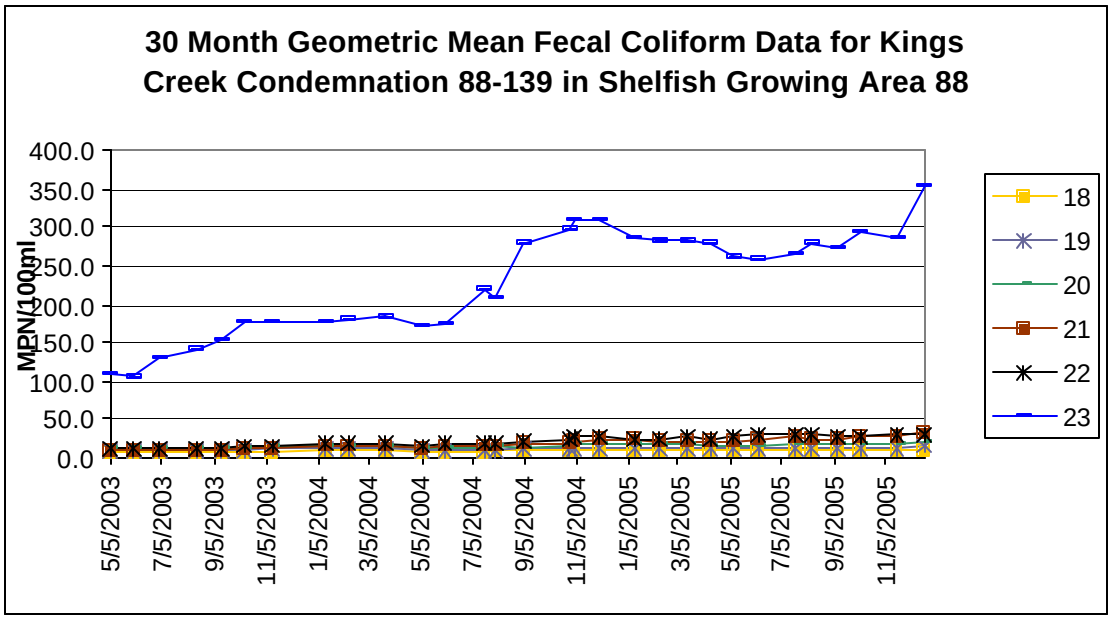
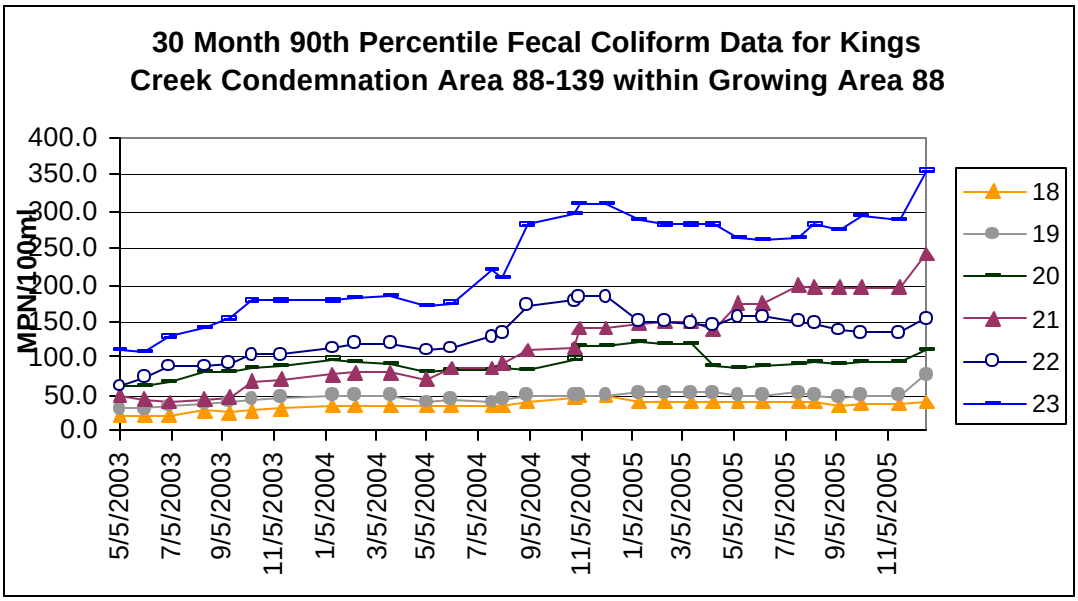


Figure 4.3C



4.2 Condemnation Areas

The impaired segment comprised of a portion of Cherrystone Inlet, Kings Creek in Growing Area 88 was listed as impaired on Virginia's 1998 303(d) water quality standard for fecal coliform bacteria in shellfish supporting waters. Detailed maps of the shellfish condemnation areas and their associated water quality stations

are available from the Virginia Department of health, Division of Shellfish Sanitation. A map of the condemnation areas is shown in Figure 4.0. Copies of the condemnation notices may be found in Appendix A.

4.3 Fecal Coliform Bacteria Source Assessment

The locations of shoreline deficiencies from the DSS shoreline survey are shown in Figure 4.4. A copy of the most recent sanitary shoreline survey may be found in Appendix A,

A. Point Source

There are no VPDES permitted wastewater treatment plant point source contributions of bacteria to the harvestable shellfish areas in the watershed.

B. Non-Point Source Contributions

Nonpoint sources of fecal coliform do not have one discharge point but may occur over the entire length of the receiving water. Fecal coliform bacteria deposited on the land surface can build up over time. During rain events, surface runoff transports water and sediment and discharges to the waterway. Sources of fecal coliform bacteria include grazing livestock, concentrated animal feeding operations, manure application and wildlife and pet excretion. Direct contribution to the waterway occurs when livestock or wildlife defecate into or immediately adjacent to receiving waters. Nonpoint source contributions from humans generally arise from failing septic systems and associated drain fields, moored or marina vessel discharges, storm water management facilities, pump station failures and ex-filtration from sewer systems. Contributions from wildlife, both mammalian and avian, are natural conditions and may represent a background level of bacterial loading. It is therefore likely that human loading is due to failures in septic waste treatment systems and/or potential pollution from recreational vessel discharges.

The shoreline survey is used as a tool to identify non-point source contribution problems and locations. Figure 4.4 shows the results of the DSS sanitary shoreline survey for June 29, 2006. A copy of the textual portion of this survey has been included as Appendix A. The survey identified 7 deficiencies. Four were on-site sewage deficiencies, none were related to boating, one was listed for potential pollution, one was an industrial site, and one were related to animal pollution. The number of deficiencies displayed on the map may not agree with the total because of the scale of the map and the possibility of multiple deficiencies at one location.

4.4 Bacterial Source Tracking

Bacterial Source tracking is used to identify sources of fecal contamination from human as well as domestic and wild animals. The BST method used in Virginia is based on the premise that *Escherichia coli (E. Coli)* found in human, domestic animal, and wild animals will have significantly different patterns of resistance to a variety of antibiotics. The Antibiotic Resistance Approach (ARA), uses fecal streptococcus or *E. coli* and patterns of antibiotic resistance for separation of sources of the bacterial contribution. The BST analysis used for this TMDL classified the bacteria into one of four source categories: human, pets, livestock, and wildlife. However, BST analysis is an experimental, not approved, technique that is under evaluation and the error involved in correctly assigning *E. coli* isolates to the appropriate fecal sources is unknown.

Figure 4.1 shows the TMDL study stations in each of the six impaired shellfish growing waters. There is one BST monitoring station for each of the impaired sub-watersheds. The data developed for the watershed shows the possible dominant bacteria contribution in Cherrystone Inlet, Kings Creek is indicated as a human component followed by pets and wildlife. Figure 4.5 shows the mean distribution by month for the source categories and the annual means are shown in Figures 4.6. The BST sampling period was October 2004 through September 2005. The target sampling interval was once monthly, if the graph does not show at least 11 months, that means that there were months for which data was not available, or no bacteria could be isolated. This data is shown in tabular form in Table 4.2.

5.0 TMDL Development

5.1 Simplified Modeling Approach (Tidal Volumetric Model):

Personnel from EPA, Virginia DEQ, Virginia Department of Conservation and Recreation (DCR), Maryland Department of the Environment (MDE), Virginia DSS, Virginia Institute of Marine Sciences (VIMS), United States Geological Survey, Virginia Polytechnic University, James Madison University, and Tetra Tech composed the shellfish TMDL workgroup and developed a procedure for

Table 4.2 Non-point Source Load Distribution using Annual Average BST Shellfish Growing Area 88

Condemnation Area	Wildlife	Human	Livestock	Pets
88-139 Kings Creek VAT-C15E-10	34%	14%	27%	27%

developing TMDLs using either a simplified approach to the development of the TMDL. The goal of the procedure is to use bacteriological source tracking (BST) data to determine the sources of fecal coliform violations and the load reductions needed to attain the applicable criteria.

5.2 The TMDL Calculation

To meet the water quality standards for both geometric mean and 90th percentile criteria, TMDLs for the impaired segments in the watershed are defined for the geometric mean load and the 90th percentile load. The TMDL for the geometric mean essentially represents the allowable average limit and the TMDL for the 90th percentile is the allowable upper limit.

A. Current Fecal Coliform Condition

The fecal coliform concentration in an embayment varies due to the changes in biological, hydrological and meteorological conditions. The current condition was determined based on the 30-sample geometric mean and 90th percentile of fecal coliform values of each condemned area. The period of record for the monitoring data used to determine the current condition is May 2003 to December 2005. The maximum values for geometric mean and 90th percentile were used to represent the current loads. Therefore, the current loads represent the worse case scenario.

Figure 4.4
Sanitary Shoreline Survey Results for Cherrystone Inlet, Shellfish Growing Area 88

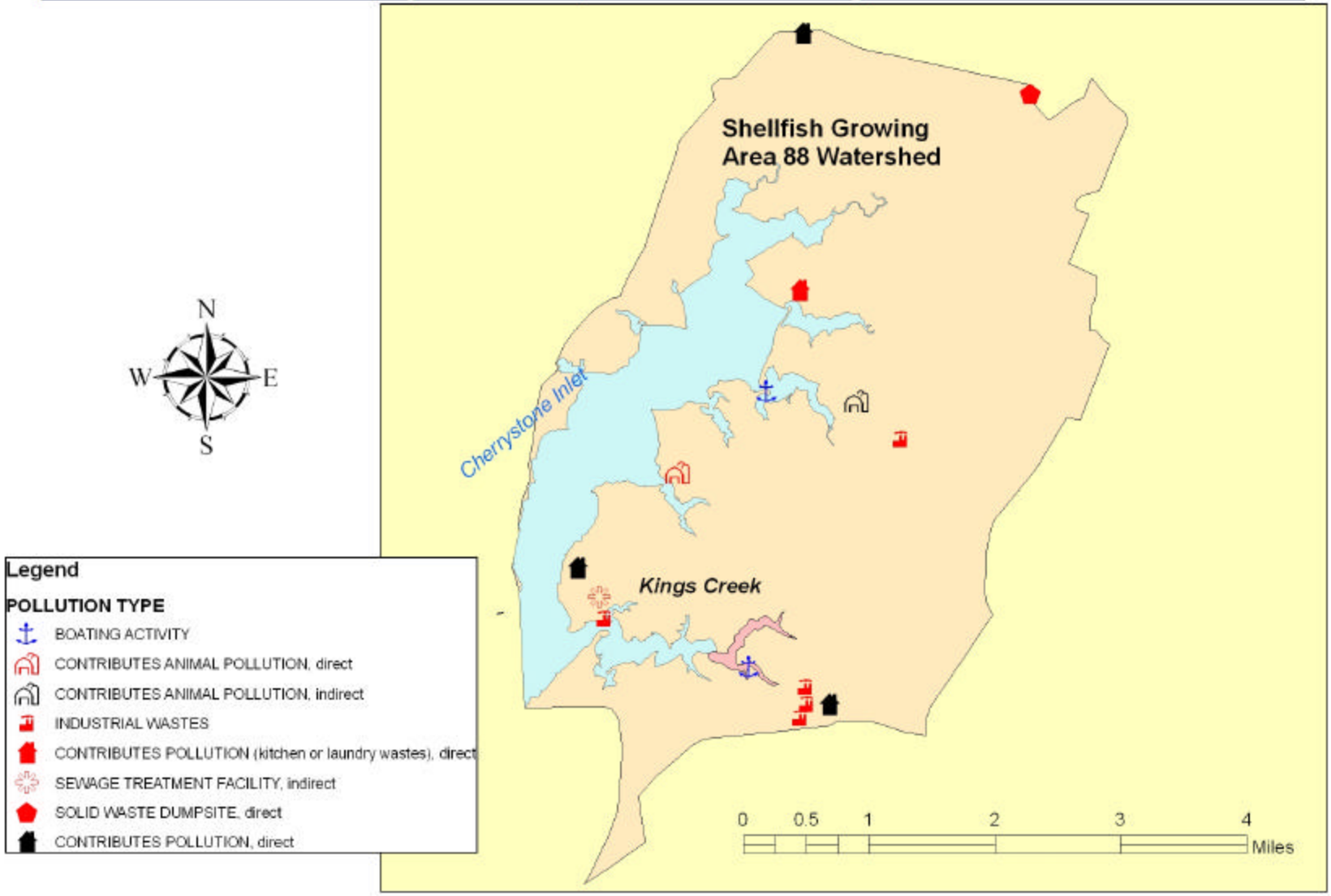


Figure 4.5A

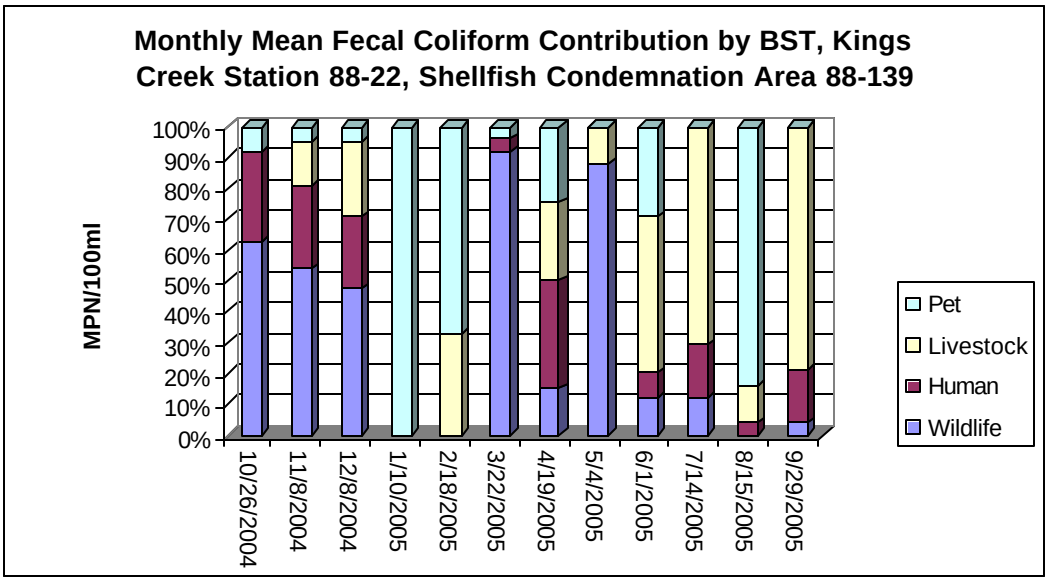
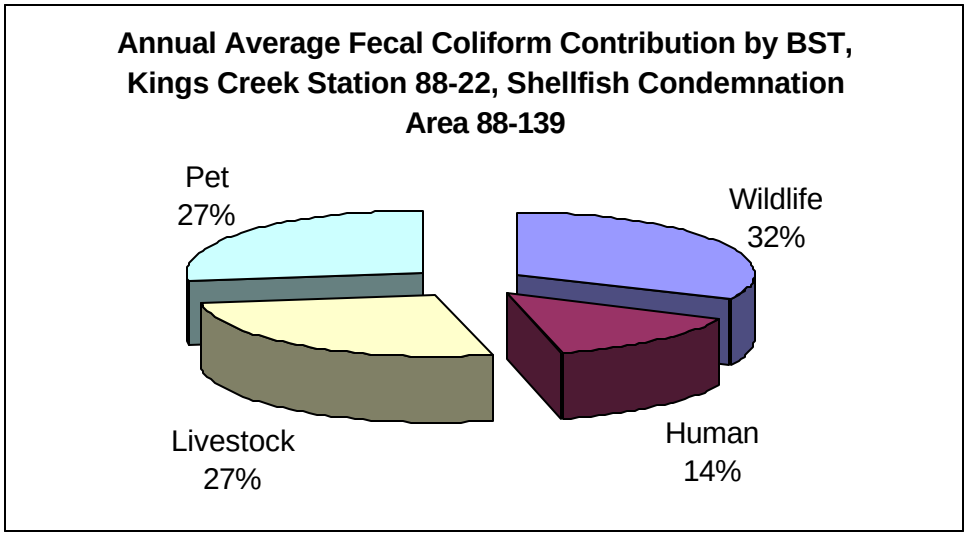


Figure 4.5B



B. Geometric Mean Analysis:

The current 30-sample geometric mean was used for the load estimation. The current load was estimated using a simple volumetric model. The allowable load was calculated using the water quality standard of 14 MPN/100ml. This value was also used as boundary condition for the calculation. The load reduction needed for the attainment of the water quality standard was determined by subtracting the allowable load from the current load. The process may be described by the word equation as follows. The calculated results are listed in Table 5-2.

The load reduction is estimated as follows:

Geometric Mean Value (X MPN/100ml) x (volume) = Existing Load

Criteria Value (14 MPN/100ml) x (volume) = Allowable Load

$$\textbf{Load Reduction} = \frac{\textbf{Current Load} - \textbf{Allowable Load}}{\textbf{Current Load}} \times 100\ \%$$

Table 5.1
Geometric Mean Analysis of Current Load and Estimated Load Reduction

Condemnation Area	Volume (m^3)	*Fecal Coliform (MPN/100ml)	WQ Standard MPN/100 ml	Current Load (MPN/day)	Allowable Load (MPN/day)	Required Reduction (%)
88-139 Kings Creek (VAT-C15E-10)	58320	45.1	14	2.63E+10	8.16E+09	69%

C. 90th Percentile Analysis

The current 30-sample 90th percentile concentration was used for load estimation. The current load was estimated using a simple volumetric model. The allowable load was calculated based on the water quality standard of 49 MPN/100ml. The calculated results are listed in Table 5-3.

The load reduction is estimated as follows:

$$\textbf{Load Reduction} = \frac{\textbf{Current Load} - \textbf{Allowable Load}}{\textbf{Current Load}} \times 100\ \%$$

Table 5.2
90th Percentile Analysis of Current Load and Estimated Load Reduction

Condemnation Area	Volume (m^3)	Fecal Coliform (MPN/100ml)	WQ Standard MPN/100ml	Current Load (MPN/day)	Allowable Load (MPN/day)	Required Reduction (%)
88-139 Kings Creek (VAT-C15E-10)	58320	325.5	49	1.90E+11	2.86E+10	85%

5.3 Load Allocation

A comparison of the reductions based on geometric mean load and on the 90th percentile load shows that the 90th percentile load is the critical condition for all impaired waters in Growing Area 88. This is consistent with water quality analysis. The 90th percentile criterion is most frequently exceeded. Therefore the 90th percentile loading is used to allocate source contributions and establish load reduction targets among the various contributing sources that will yield the necessary water quality improvements to attain the water quality standard in the creeks in Growing Area 88.
Based on source assessment of the watershed, the percent loading for each of the major source categories is estimated. These percentages are used to determine where load reductions are needed. The loadings for each source are determined by multiplying the total current and allowable loads by the representative percentage. The percent reduction needed to attain the water quality standard or criterion is allocated to each source category. This is shown in Table 5-4 and serves to fulfill the

Table 5.3 Reduction and Allocation Based Upon 90th Percentile Standard Criterion: Growing Area 88

Condemnation Area	Source	BST Allocation % of Total Load	Current Load MPN/ day	Load Allocation MPN/ day	Reduction Needed
Cherrystone Inlet, Kings Creek 88-139 (VAT-C15E-10)	Wildlife	32%	6.07E+10	2.86E+10	53%
	Human	14%	2.66E+10	0.00E+00	100%
	Livestock	27%	5.13E+10	0.00E+00	100%
	Pets	27%	5.13E+10	0.00E+00	100%
	Total	**100%**	**1.90E+11**	**2.86E+10**	**85%**

TMDL requirements by ensuring that the criterion is attained. The TMDL seeks to eliminate 100% of the human derived fecal component regardless of the allowable load determined through the load allocation process. Human derived fecal coliforms are a serious concern in the estuarine environment and discharge of untreated human waste is precluded by state and federal law. According to the preceding analysis, reduction of the controllable loads; human, livestock and pets, will result in achievement of the water quality standard for all condemned areas except for Barnes Creek and North Prong where reductions in wildlife populations are indicted as potentially being necessary to achieve water quality standards. Through an iterative implementation of actions to reduce the controllable loads, subsequent monitoring may indicate that further reductions are not necessary, or that revisions in implementation strategies may be appropriate. Continued violations may result in the process of Use Attainment Analysis, UAA, for the water body (see Chapter 6 for a discussion of UAA). The allocations presented demonstrate how the TMDLs could be implemented to achieve water quality standards; however, the state reserves the right to allocate differently, as long as consistency with the achievement of water quality standards is maintained.

5.3.1 Development of Waste load Allocations

There are no permitted point source discharges that affect the harvestable shellfish waters in the watershed. No waste load is considered in this TMDL.

5.4 Consideration of Critical Conditions and Seasonal Variation

EPA regulations at 40 CFR 130.7 (c) (1) requires TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the water body is protected during times when they are most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards. The current loading to the water body was determined using a long-term record of water quality monitoring (observation) data. The period of record for the data was June 2003 to December 2005.

A comparison of the geometric mean values and the 90th percentile values against the water quality criteria will determine which represents the more critical condition or higher percent reduction. If the geometric mean values dictate the higher reduction, this suggests that, on average, water sample counts are consistently high with limited variation around the mean. If the 90th percentile criterion requires a higher reduction, this suggests an occurrence of the high fecal coliform due to the variation of hydrological conditions. For this study, the 90th percentile criterion is the most critical condition. Thus, the final load reductions determined using the 90th percentile represents the most stringent conditions and it is the reductions based on these bacterial loadings that will yield attainment of the water quality standard. Seasonal variations involve changes in surface runoff, stream flow, and water quality as a result of hydrologic and climatologic patterns. Variations due to changes in the hydrologic cycle as well as temporal variability in fecal coliform sources, such as migrating duck and goose populations are accounted for by the use of the long-term data record to estimate the current load.

5.5. Margin of Safety

A Margin of Safety (MOS) is required as part of a TMDL in recognition of uncertainties in the understanding and simulation of water quality in natural systems. For example, knowledge is incomplete regarding the exact nature and magnitude of pollutant loads from various sources and the specific impacts of those pollutants on the chemical and biological quality of complex, natural water bodies. The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection. . Due to the very conservative assumptions made in this modeling effort the margin of safety is considered to be implicit in the load allocations the model establishes.

5.6 TMDL Summary

To meet the water quality standards for both geometric mean and 90th percentile criteria, TMDLs for Cherrystone Inlet, Kings Creek watershed in Growing Area 88 is defined for the geometric mean load and the 90th percentile load. The TMDLs are summarized in the Table 5.4 and 5.5.

Table 5.4 TMDL Summary for Four Closures in Shellfish Growing Area 88 (geometric mean)

Condemnation Area	Pollutant Identified	TMDL MPN/100ml	Waste Load Allocation MPN/day	Load Allocation MPN/day	Margin of Safety
88-139 Cherrystone Inlet, Kings Creek (VAT-C15E-10)	Fecal Coliform	8.16E+09	N/A	8.16E+09	Implicit

Table 5.5 TMDL Summary for Four Closures in Shellfish Growing Area 88 (90th percentile)

Condemnation Area	Pollutant Identified	TMDL MPN/100ml	Waste Load Allocation MPN/day	Load Allocation MPN/day	Margin of Safety
88-139 Cherrystone Inlet, Kings Creek (VAT-C15E-10)	Fecal Coliform	2.86E+10	N/A	2.86E+10	Implicit

6.0 TMDL Implementation

The goal of the TMDL program is to establish a three-step path that will lead to attainment of water quality standards. The first step in the process is to develop TMDLs that will result in meeting water quality standards. This report represents the culmination of that effort for the bacteria impairment in Cherrystone Inlet, Kings Creek watershed, Shellfish Growing Area 88. The second step is to develop a TMDL implementation plan. The final step is to implement the TMDL implementation plan, and to monitor water quality to determine if water quality standards are being attained.

Once a TMDL has been approved by EPA, measures must be taken to reduce pollution levels in the water body. These measures, which can include the use of better treatment technology and the installation of best management practices (BMPs), are implemented in an iterative process that is described along with specific BMPs in the implementation plan. The process for developing an implementation plan has been described in the recent "TMDL Implementation Plan Guidance Manual", published in July 2003 and available upon request from the DEQ and DCR TMDL project

staff or at http://www.deq.virginia.gov/tmdl/implans/ipguide.pdf. With successful completion of Implementation plans, Virginia will be well on the way to restoring impaired waters and enhancing the value of this important resource. Additionally, development of an approved implementation plan will improve a locality's chances for obtaining financial and technical assistance during implementation.

6.1 Staged Implementation

In general, Virginia intends for the required reductions to be implemented in an iterative process that first addresses those sources with the largest impact on water quality. For example, in agricultural areas of the watershed, the most promising management practice is livestock exclusion from water bodies. This has been shown to be very effective in lowering fecal coliform concentrations in water bodies, both by reducing the cattle deposits themselves and by providing additional riparian buffers Additionally, in both urban and rural areas, reducing the human fecal loading from failing septic systems should be a primary implementation focus because of its health implications. This component could be implemented through education on septic tank pump-outs as well as a septic system repair/replacement program and the use of alternative waste treatment systems. In urban areas, reducing the loading from leaking sewer lines could be accomplished through a sanitary sewer inspection and management program.

The iterative implementation of BMPs in the watershed has several benefits:

1. It enables tracking of water quality improvements following BMP implementation through follow-up monitoring;
2. It provides a measure of quality control, given the uncertainties inherent in computer simulation modeling;
3. It provides a mechanism for developing public support through periodic updates on BMP implementation and water quality improvements;
4. It helps ensure that the most cost effective practices are implemented first; and
5. It allows for the evaluation of the adequacy of the TMDL in achieving water quality standards.

Watershed stakeholders will have opportunity to participate in the development of the TMDL implementation plan. Specific goals for BMP implementation will be established as part of the implementation plan development.

6.2 Link to ongoing Restoration Efforts

Implementation of this TMDL will contribute to on-going water quality improvement efforts aimed at restoring water quality in the Chesapeake Bay. Other TMDLs have been developed for impaired shellfish waters in Northampton County for Nassawadox, Cherrystone Inlet, Kings, Old Plantation, and Cherrystone Inlet, Kings Creek watersheds. Reports for these TMDLS are available at the Department of Environmental Quality website http://www.deq.virginia.gov/tmdl/. A tributary strategy has been developed for the Virginia tributaries to the Chesapeake Bay. Up-to-date information on tributary strategy development can be found at http://www.snr.virginia.gov/Initiatives/TributaryStrategies.

6.3 Reasonable Assurance for Implementation

6.3.1 Follow-Up Monitoring

VDH-DSS will continue sampling at the established bacteriological monitoring stations in accordance with its shellfish monitoring program. VADEQ will continue to use data from these monitoring stations and related ambient monitoring stations to evaluate improvements in the bacterial community and the effectiveness of TMDL implementation in attainment of the general water quality standard.

6.3.2. Regulatory Framework

While section 303(d) of the Clean Water Act and current EPA regulations do not require the development of TMDL implementation plans as part of the TMDL process, they do require reasonable assurance that the load and waste load allocations can and will be implemented. Additionally, Virginia's 1997 Water Quality Monitoring, Information and Restoration Act (the "Act") directs the State Water Control Board to "develop and implement a plan to achieve fully supporting status for impaired waters" (Section 62.1-44.19.7). The Act also establishes that the implementation plan shall include the date of expected achievement of water quality objectives, measurable goals, corrective actions necessary and the associated costs, benefits and environmental impacts of addressing the impairments. EPA outlines the minimum elements of an approvable implementation plan in its 1999 "Guidance for Water Quality-Based Decisions: The TMDL Process." The listed elements include implementation actions/management measures, timelines, legal or regulatory controls, time required to attain water quality standards, monitoring plans and milestones for attaining water quality standards. Once developed, DEQ intends to incorporate the TMDL implementation plan into the appropriate Water Quality Management Plan (WQMP), in accordance with the Clean Water Act's Section 303(e). In response to a Memorandum of Understanding (MOU) between EPA and DEQ, DEQ also submitted a draft Continuous Planning Process to EPA in which DEQ commits to regularly updating the WQMPs. Thus, the WQMPs will be, among other things, the repository for all TMDLs and TMDL implementation plans developed within a river basin.

6.3.3. Implementation Funding Sources

One potential source of funding for TMDL implementation is Section 319 of the Clean Water Act. Section 319 funding is a major source of funds for Virginia's Non-point Source Management Program. Other funding sources for implementation include the U.S. Department of Agriculture's Conservation Reserve Enhancement and Environmental Quality Incentive Programs, the Virginia State Revolving Loan Program, and the Virginia Water Quality Improvement Fund. The TMDL Implementation Plan Guidance Manual contains additional information on funding sources, as well as government agencies that might support implementation efforts and suggestions for integrating TMDL implementation with other watershed planning efforts.

6.3.4 No Discharge Zones for Vessels

Many tributaries as well as the Chesapeake Bay are utilized by private and commercial vessels as routes of transportation and as areas of safe anchorage. In some tributaries large concentrations of these vessels may be present as vessels in transit and at anchor, vessels secured by moorings, or vessels

either resident or transient at marinas located in the watershed. While the discharge of untreated human sewage is illegal under the Clean Water Act and under Virginia law, discharges from Coast Guard approved Marine Sanitation Devices has remained. These devices are not able to adequately treat human waste discharged into small watersheds and embayments and results in an unabated discharge of viruses, nitrogen, phosphorus and oxygen demanding wastes. While use of MSD's may be appropriate for waters in open near coastal areas, other waters, particularly tributaries to the Chesapeake Bay may be adversely affected by such discharges. Sewage discharges from marine sanitation devices in small confined watersheds or anchorages where shellfish harvest or contact recreation use is the designated and actual use of these waters, can contaminate important shellfish resources and expose humans to inadequately treated human sewage. In such waters seeking a no-discharge designation may be the best means to preclude discharges of inadequately treated sewage from all vessels which may transit or seek shelter in the water body of concern. Such no-discharge designations currently exist in Smith Mountain Lake and are applicable to other inland lakes and rivers and has been approved by Virginia and submitted to the U.S. Environmental Protection Agency for Lynnhaven, Broad, and Linkhorn Bays, tributaries to the Chesapeake Bay. In this watershed holding tanks and pump out facilities must be used and the discharge of treated human waste from vessels is prohibited. Procedures for establishing such NDZ's and the state and federal regulations regarding vessel discharges can be found in the Appendix.

6.3.5 Addressing Wildlife Contributions

In some waters for which TMDLs have been developed, water quality modeling indicates that even after removal of all of the sources of bacteria (other than wildlife), the stream will not attain standards under all flow regimes at all times. **However, neither the Commonwealth of Virginia, nor EPA is proposing the elimination of wildlife to allow for the attainment of water quality standards.** This is obviously an impractical and wholly undesirable action. While managing over-populations of wildlife remains as an option to local stakeholders, the reduction of wildlife or changing a natural background condition is not the intended goal of a TMDL.

Based on the above, EPA and Virginia have developed a TMDL strategy to address the wildlife issue. The first step in this strategy is to develop a reduction goal. The pollutant reductions for the interim goal are applied only to controllable, anthropogenic sources identified in the TMDL, setting aside any control strategies for wildlife. During the first implementation phase all controllable sources would be reduced to the maximum extent practicable using the staged approach outlined above. Following completion of the first phase, DEQ would re-assess water quality in the stream to determine if the water quality standard is attained. This effort will also evaluate if the technical assumptions were correct. If water quality standards are not being met, a UAA may be initiated to reflect the presence of naturally high bacteria levels due to uncontrollable sources. In some cases, the effort may never have to go to the second phase because the water quality standard exceedances attributed to wildlife may be very small and fall within the margin of error.

If water quality standards are not being met, a special study called a Use Attainability Analysis (UAA) may be initiated to reflect the presence of naturally high bacteria levels due to uncontrollable sources. The outcomes of the UAA may lead to the determination that the designated use(s) of the waters may need to be changed to reflect the attainable use(s). To remove a designated use, the state must demonstrate 1) that the use is not an existing use, 2) that downstream uses are protected, and 3) that the source of bacterial contamination is natural and uncontrollable by effluent limitations and by

implementing cost-effective and reasonable best management practices for non-point source control (9 VAC 25-260-10). All site-specific criteria or designated use changes must be adopted as amendments to the water quality standards regulations. Watershed stakeholders and EPA will be able to provide comment during this process. Additional information can be obtained at http://www.deq.virginia.gov/wqs/WQS03AUG.pdf

7.0. Public Participation

During development of the TMDL for Cherrystone Inlet, Kings Creek in Growing Area 88, public involvement was encouraged through a public participation process that included public meetings and stakeholder meetings.

The first public meeting was held on February 6, 2007. A basic description of the TMDL process and the agencies involved was presented and a discussion was held to regarding the source assessment input, bacterial source tracking, and model results. This meeting was followed by development of the final draft TMDL and a review by the stakeholders. Input from these meetings was utilized in the development of the TMDL and improved confidence in the allocation scenarios and TMDL process.

The second public meeting where the TMDL load allocations were presented was held on April 24, 2007. Public involvement in the TMDL implementation planning process was solicited and encouraged.

8.0 Glossary

303(d). A section of the Clean Water Act of 1972 requiring states to identify and list water bodies that do not meet the states' water quality standards.
Allocations. That portion of receiving water's loading capacity attributed to one of its existing or future pollution sources (nonpoint or point) or to natural background sources. (A wasteload allocation [WLA] is that portion of the loading capacity allocated to an existing or future point source, and a load allocation [LA] is that portion allocated to an existing or future nonpoint source or to natural background levels. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading.)
Ambient water quality. Natural concentration of water quality constituents prior to mixing of either point or nonpoint source load of contaminants. Reference ambient concentration is used to indicate the concentration of a chemical that will not cause adverse impact on human health.
Anthropogenic. Pertains to the [environmental] influence of human activities.
Bacteria. Single-celled microorganisms. Bacteria of the coliform group are considered the primary indicators of fecal contamination and are often used to assess water quality.
Bacterial source tracking (BST). A collection of scientific methods used to track sources of fecal contamination.
Best management practices (BMPs). Methods, measures, or practices determined to be reasonable and cost-effective means for a landowner to meet certain, generally non-point source, pollution control needs. BMPs include structural and nonstructural controls and operation and maintenance procedures.
Clean Water Act (CWA). The Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972), Public Law 92-500, as amended by Public Law 96-483 and Public Law 97-117, 33 U.S.C. 1251 et seq. The Clean Water Act (CWA) contains a number of provisions to restore and maintain the quality of the nation's water resources. One of these provisions is section 303(d), which establishes the TMDL program.
Concentration. Amount of a substance or material in a given unit volume of solution; usually measured in milligrams per liter (mg/L) or parts per million (ppm).
Contamination. The act of polluting or making impure; any indication of chemical, sediment, or biological impurities.
Cost-share program. A program that allocates project funds to pay a percentage of the cost of constructing or implementing a best management practice. The remainder of the costs is paid by the producer(s).
Critical condition. The critical condition can be thought of as the "worst case" scenario of environmental conditions in the water body in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence.
Designated uses. Those uses specified in water quality standards for each water body or segment whether or not they are being attained.
Domestic wastewater. Also called sanitary wastewater, consists of wastewater discharged from residences and from commercial, institutional, and similar facilities.
Drainage basin. A part of a land area enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into a receiving water. Also referred to as a watershed, river basin, or hydrologic unit.

Existing use. Use actually attained in the water body on or after November 28, 1975, whether or not it is included in the water quality standards (40 CFR 131.3).
Fecal Coliform. Indicator organisms (organisms indicating presence of pathogens) associated with the digestive tract.
Geometric mean. A measure of the central tendency of a data set that minimizes the effects of extreme values.
GIS. Geographic Information System. A system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth. (Dueker and Kjerne, 1989)
Infiltration capacity. The capacity of a soil to allow water to infiltrate into or through it during a storm.
Interflow. Runoff that travels just below the surface of the soil.
Loading, Load, Loading rate. The total amount of material (pollutants) entering the system from one or multiple sources; measured as a rate in weight per unit time.
Load allocation (LA). The portion of a receiving waters loading capacity attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and nonpoint source loads should be distinguished (40 CFR 130.2(g)).
Loading capacity (LC). The greatest amount of loading a water body can receive without violating water quality standards.
Margin of safety (MOS). A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water body (CWA section 303(d)(1)©). The MOS is normally incorporated into the conservative assumptions used to develop TMDLs (generally within the calculations or models) and approved by EPA either individually or in state/EPA agreements. If the MOS needs to be larger than that which is allowed through the conservative assumptions, additional MOS can be added as a separate component of the TMDL (in this case, quantitatively, a TMDL = LC = WLA + LA + MOS).
Mean. The sum of the values in a data set divided by the number of values in the data set.
Monitoring. Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.
Narrative criteria. Non-quantitative guidelines that describe the desired water quality goals.
Nonpoint source. Pollution that originates from multiple sources over a relatively large area. Nonpoint sources can be divided into source activities related to either land or water use including failing septic tanks, improper animal-keeping practices, forest practices, and urban and rural runoff.
Numeric targets. A measurable value determined for the pollutant of concern, which, if achieved, is expected to result in the attainment of water quality standards in the listed water body.
Point source. Pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving water water body or river.
Pollutant. Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water. (CWA section 502(6)).

Pollution. Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, biological, chemical, and radiological integrity of water.

Privately owned treatment works. Any device or system that is (a) used to treat wastes from any facility whose operator is not the operator of the treatment works and (b) not a publicly owned treatment works.

Public comment period. The time allowed for the public to express its views and concerns regarding action by EPA or states (e.g., a Federal Register notice of a proposed rule-making, a public notice of a draft permit, or a Notice of Intent to Deny).

Publicly owned treatment works (POTW). Any device or system used in the treatment (including recycling and reclamation) of municipal sewage or industrial wastes of a liquid nature that is owned by a state or municipality. This definition includes sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment.

Raw sewage. Untreated municipal sewage.

Receiving waters. Creeks, streams, rivers, lakes, estuaries, ground-water formations, or other bodies of water into which surface water and/or treated or untreated waste are discharged, either naturally or in man-made systems.

Riparian areas. Areas bordering streams, lakes, rivers, and other watercourses. These areas have high water tables and support plants that require saturated soils during all or part of the year. Riparian areas include both wetland and upland zones.

Riparian zone. The border or banks of a stream. Although this term is sometimes used interchangeably with floodplain, the riparian zone is generally regarded as relatively narrow compared to a floodplain. The duration of flooding is generally much shorter, and the timing less predictable, in a riparian zone than in a river floodplain.

Runoff. That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into receiving waters.

Septic system. An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a drain field or subsurface absorption system consisting of a series of percolation lines for the disposal of the liquid effluent. Solids (sludge) that remain after decomposition by bacteria in the tank must be pumped out periodically.

Sewer. A channel or conduit that carries wastewater and storm water runoff from the source to a treatment plant or receiving stream. Sanitary sewers carry household, industrial, and commercial waste. Storm sewers carry runoff from rain or snow. Combined sewers handle both.

Slope. The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25 or 1 on 25, indicating one unit vertical rise in 25 units of horizontal distance, or in a decimal fraction (0.04), degrees (2 degrees 18 minutes), or percent (4 percent).

Stakeholder. Any person with a vested interest in the TMDL development.

Surface area. The area of the surface of a water body; best measured by planimetry or the use of a geographic information system.

Surface runoff. Precipitation, snowmelt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants.

Surface water. All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors directly influenced by surface water.

Topography. The physical features of a geographic surface area including relative elevations and the positions of natural and man-made features.

Total Maximum Daily Load (TMDL). The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources and natural background, plus a margin of safety (MOS). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard.

VADEQ. Virginia Department of Environmental Quality.

VDH. Virginia Department of Health.

Virginia Pollutant Discharge Elimination System (NPDES). The national program for issuing, modifying, revoking and re-issuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act.

Wasteload allocation (WLA). The portion of a receiving waters' loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2(h)).

Wastewater. Usually refers to effluent from a sewage treatment plant. See also **Domestic wastewater**.

Wastewater treatment. Chemical, biological, and mechanical procedures applied to an industrial or municipal discharge or to any other sources of contaminated water to remove, reduce, or neutralize contaminants.

Water quality. The biological, chemical, and physical conditions of a water body. It is a measure of a waterbody's ability to support beneficial uses.

Water quality criteria. Levels of water quality expected to render a body of water suitable for its designated use, composed of numeric and narrative criteria. Numeric criteria are scientifically derived ambient concentrations developed by EPA or states for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.

Water quality standard. Law or regulation that consists of the beneficial designated use or uses of a water body, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular water body, and an antidegradation statement.

Watershed. A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

WQIA. Water Quality Improvement Act.

9.0 Citations

MapTech, Inc. December 2005. Bacterial Source Tracking Analysis to Support Virginia's TMDLs: Shellfish Stations.

US EPA Shellfish Workshop Document (2002).

VA DEQ 1998 303(d) List of Impaired Waters.

10.0 Appendices

Appendix A **Growing Area 88 Sanitary Survey and Condemnation Notices**

Appendix B **Supporting Documentation and Watershed Assessment**

Appendix C **Guidance Memo No. 04-2022 Procedures for Establishing Boating No Discharge Zones**

Appendix D **Code of Virginia §62.1-194.1 Obstructing or contaminating state waters.**

Appendix A: Growing Area 88: 1) Shoreline Sanitary Survey

CHERRYSTONE INLET, KINGS CREEK
Growing Area # 088
Northampton County
Shoreline Sanitary Survey
Date: 29 June 2006

Survey Period: May 11, 2006 – June 23, 2006
Total Number of Properties Surveyed: 371
Surveyed By: S.E. Naylor

SECTION A: GENERAL

This survey area extends from Reference Point 87 on state Route 630 (extended) to Reference Point 88 at Wescoat Point, including the Chesapeake Bay shoreline between these points, The Gulf, and all of its tributaries.

The topography of the area is relatively low. Elevations rise from 5' along the Chesapeake Bay shoreline to a maximum of 35' along the eastern boundary of the watershed. The population is mostly sparse except for the moderate concentrations around James Crossroads, Eastville, and the seasonal development at Smith Beach. The economy is based mainly on agriculture, seafood harvesting, and the county government complex at Eastville.
Meteorological data indicated that the area received a total rainfall of 7.56" for the survey period. A monthly breakdown is as follows.

May 11- 31 1.76"
June 1- 23 5.8"

Copies of Bacteriological, Hydrographic, and Shellfish Closure data are available at the area office for review. Copies of the current condemnation notices and maps are available via the Internet at http://www.vdh.virginia.gov/oehs/shellfish/.

This report lists only those properties which have a sanitary deficiency or have other environmental significance. ***"DIRECT"*** indicates that the significant activity or deficiency has a direct impact on shellfish waters. Individual field forms with full information on properties listed in this report are on file in the Richmond Office of the Division of Shellfish Sanitation and are available for reference until superseded by a subsequent resurvey of the area. Data in the report is also made available to local health departments and other agencies to address items that may be out of compliance with their regulatory programs.

SECTION B: SEWAGE POLLUTION SOURCES

SEWAGE TREATMENT FACILITIES
-None-

ON-SITE SEWAGE DEFICIENCIES

1. CONTRIBUTES POLLUTION – 15466 James Circle, Eastville 23347. Dwelling - offwhite metal siding house trailer. No contact. Effluent erupting from septic tank onto ground surface. Sanitary Notice issued 5-18-06 to field #13.

3. CONTRIBUTES POLLUTION – 15595 James Circle, Eastville 23347. Dwelling - white aluminum siding 1 story with enclosed porch. 2 persons. Effluent erupting from septic tank onto ground surface. Sanitary Notice issued 5-18-06 to field #23.

4. CONTRIBUTES POLLUTION – 5338 Old Town Neck Drive, Eastville 23347. Dwelling - white aluminum siding 1 story with black shutters. 2 persons. Effluent erupting from septic tank onto ground surface. Sanitary Notice issued 5-19-06 to field #38.

7. CONTRIBUTES POLLUTION (Kitchen or Laundry Wastes) – 16234 Smith Beach Road, Eastville 23347. Dwelling - cream vinyl siding 2 story with red trim. No contact. Laundry waste water discharging from 4" white PVC pipe on side of house to ground surface. Sanitary Notice issued 6-22-06 to field #341.

POTENTIAL POLLUTION

2. 15494 James Circle, Eastville 23347. Dwelling - off-white aluminum siding house trailer with blue shutters. 1 person. Occupant states septic tank will erupt to ground surface after extreme rain events. No evidence of discharge at time of inspection.

SECTION C: NON-SEWAGE WASTE SITES

INDUSTRIAL WASTES

6. ***DIRECT*** – Occupant: Bagwell Enterprises, 15568 Smith Beach Road, Eastville 23347. Owner: Yvonne Bagwell, P.O. Box 508, Eastville. Business- shellstock shipping facility (VA-918SS). 14 employees. Washdown wastes and floor drains discharge to Cherrystone Inlet, Kings Creek. Has a March 5, 1992 letter from the Department of Environmental Quality, Water Regional Office for discharge.

SOLID WASTE DUMPSITES
-None-

SECTION D: BOATING ACTIVITY

MARINAS
-None-

OTHER PLACES WHERE BOATS ARE MOORED
-None-

UNDER SURVEILLANCE
-None-

SECTION E: CONTRIBUTES ANIMAL POLLUTION

5. 5350 Willow Oak Road, Eastville 23347. Dwelling - white wood siding 2 story with black shutters and red horse stables. 1 person. Present at time of survey were 5 horses in a fenced pasture. Manure is composted and spread in flower gardens.

SUMMARY
Area # 087
Cherrystone Inlet, Kings Creek
29 June 2006

SECTION B: SEWAGE POLLUTION SOURCES

1. SEWAGE TREATMENT FACILITIES
0 – DIRECT – None
0 – INDIRECT – None
0 – B.1. TOTAL

2. ON-SITE SEWAGE DEFICIENCES
Correction of deficiencies in this section is the responsibility of the local health department.
0 – CONTRIBUTES POLLUTION, DIRECT – None
3 – CONTRIBUTES POLLUTION, INDIRECT - # 1, 3, 4
0 – CP (Kitchen or Laundry Wastes), DIRECT – None
1 – CP (Kitchen or Laundry Wastes), INDIRECT - # 7
0 – NO FACILITIES, DIRECT – None
0 – NO FACILITIES, INDIRECT – None
4 – B.2. TOTAL

3. POTENTIAL POLLUTION
Periodic surveillance of these properties will be maintained to determine any status change.

1 – POTENTIAL POLLUTION - # 2

SECTION C: NON-SEWAGE WASTE SITES

1. INDUSTRIAL WASTE SITES
1 – DIRECT – # 6
0 – INDIRECT – None
1 – C.1. TOTAL

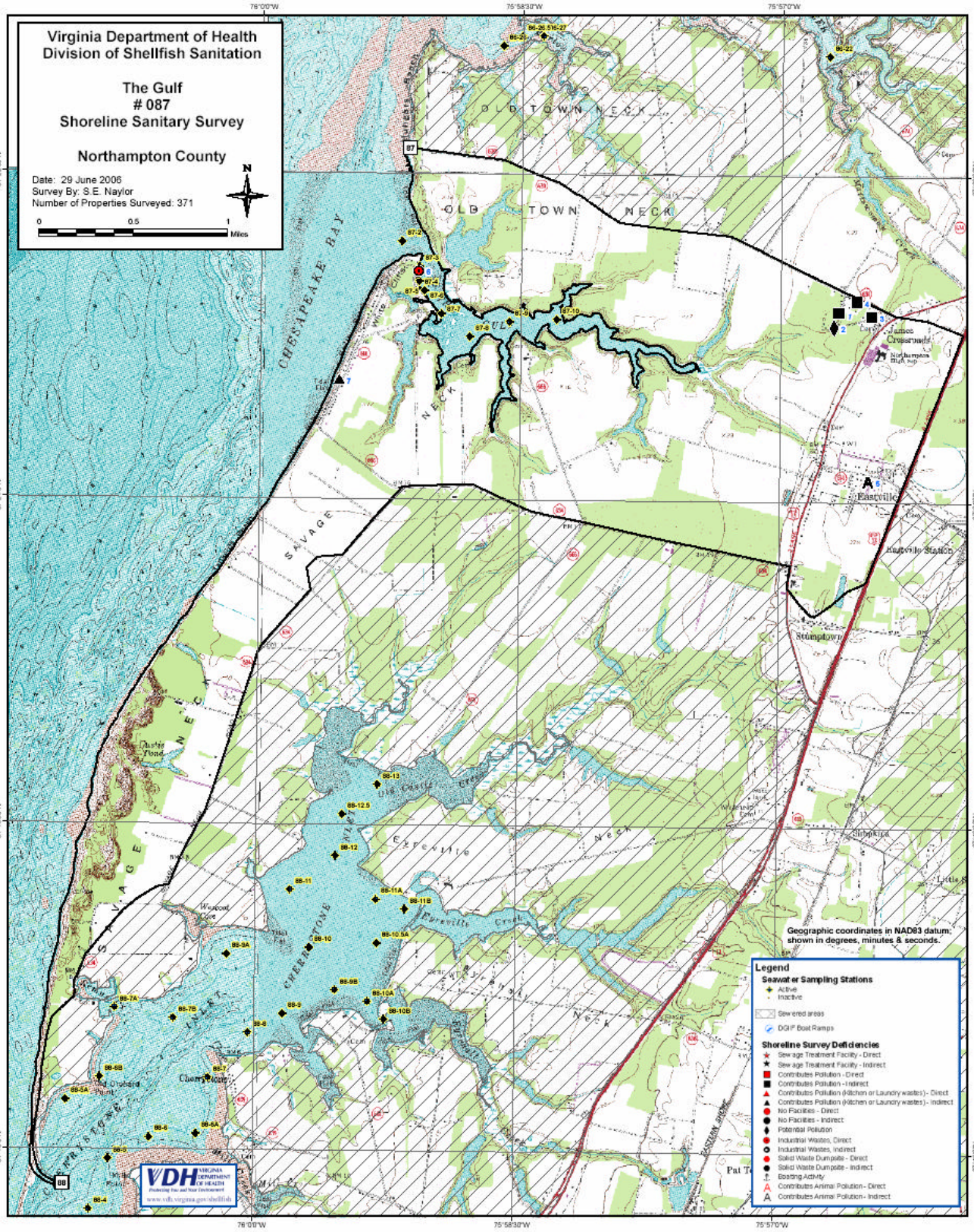
2. SOLID WASTE DUMPSITES
0 – DIRECT – None
0 – INDIRECT – None
0 – C.2. TOTAL

SECTION D: BOATING ACTIVITY

0 – MARINAS – None
0 – OTHER PLACES WHERE BOATS ARE MOORED – None
0 – UNDER SURVIELLANCE – None
0 – D. TOTAL

SECTION E: CONTIBUTES ANIMAL POLLUTION

0 – DIRECT – None
1 – INDIRECT - # 5
1 – E. TOTAL


Virginia Department of Health
Division of Shellfish Sanitation
The Gulf
087
Shoreline Sanitary Survey
Northampton County
Date: 29 June 2006
Survey By: S.E. Naylor
Number of Properties Surveyed: 371
N
0
0.5
1
Miles
OLD TOWN NECK
CHESAPEAKE BAY
SAVAGE NECK
CHERRYSTONE INLET
Eastville
Stumptown
Geographic coordinates in NAD83 datum; shown in degrees, minutes & seconds.
Legend
Seawater Sampling Stations
Active
Inactive
Sewered areas
DGIF Boat Ramps
Shoreline Survey Deficiencies
Sewage Treatment Facility - Direct
Sewage Treatment Facility - Indirect
Contributes Pollution - Direct
Contributes Pollution - Indirect
Contributes Pollution (Kitchen or Laundry wastes) - Direct
Contributes Pollution (Kitchen or Laundry wastes) - Indirect
No Facilities - Direct
No Facilities - Indirect
Potential Pollution
Industrial Wastes, Direct
Industrial Wastes, Indirect
Solid Waste Dumpsite - Direct
Solid Waste Dumpsite - Indirect
Boating Activity
Contributes Animal Pollution - Direct
Contributes Animal Pollution - Indirect
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REGISTRAR OF REGULATIONS

06 JUL 24 AM 11:02

COMMONWEALTH of VIRGINIA

Department of Health
DIVISION OF SHELLFISH SANITATION
109 Governor Street, Room 614-B
Richmond, VA 23219

Ph: 804-864-7487
Fax: 804-864-7481

NOTICE AND DESCRIPTION OF SHELLFISH AREA CONDEMNATION NUMBER 088-139, CHERRYSTONE INLET

EFFECTIVE 4 AUGUST 2006

Pursuant to Title 28.2, Chapter 8, §§28.2-803 through 28.2-808, §32.1-20, and §9-6.14:4.1, B.16 of the *Code of Virginia.*

1. The "Notice and Description of Shellfish Area Condemnation Number 088-139, Cherrystone Inlet," effective 9 March 2005, is cancelled effective 4 August 2006.

2. Condemned Shellfish Area Number 088-139, shown as Section A, is established effective 4 August 2006. It shall be unlawful for any person, firm, or corporation to take shellfish from this area, for any purpose, except by permit granted by the Marine Resources Commission, as provided in Section 28.2-810 of the *Code of Virginia.* The boundaries of this area are shown on the map titled "Cherrystone Inlet, Condemned Shellfish Area Number 088-139, 4 August 2006" which is part of this notice.

3. Seasonally Condemned Shellfish Area Number 088-139, shown as Section M1, is hereby established, effective 4 August 2006, and shall remain in force annually thereafter for the period beginning the first day of April through the last day of October until rescinded. It is unlawful for any person, firm or corporation to take shellfish from this area during such period for any purpose, except by permit granted by the Marine Resources Commission, as provided in §28.2-810 of the *Code of Virginia.* The boundaries of this area are shown on the map titled "Cherrystone Inlet, Condemned Shellfish Area Number 088-139, 4 August 2006" which is part of this notice.

4. The Department of Health will receive, consider and respond to petitions by any interested person at any time with respect to reconsideration or revision of this order.

BOUNDARIES OF CONDEMNED AREA NUMBER 088-139

A. The condemned area shall include that portion of Kings Creek and its tributaries lying upstream of a line drawn between latitude/longitude map coordinate (37°16'46.9", -75°59'38.1") and map coordinate (37°16'45.7",-75°59'42.5").

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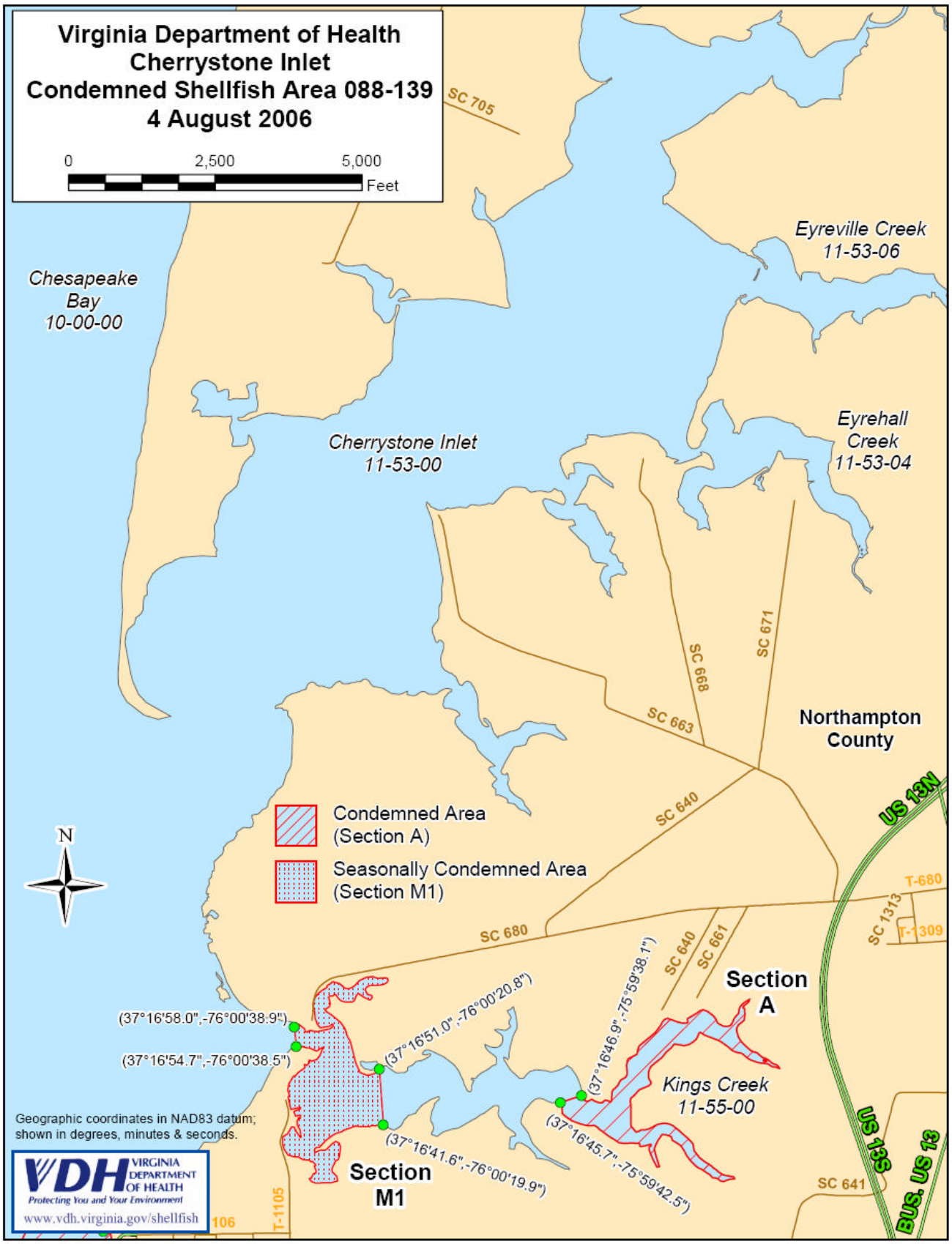
M1. The condemned area shall include all of that portion of Kings Creek and its tributaries lying upstream of a line drawn between latitude/longitude map coordinate (37°16'58.0", -76°00'38.9") and map coordinate (37°16'54.7",-76°00'38.5"); and downstream of a line drawn between map coordinate (37°16'51.0",-76°00'20.8") and map coordinate (37°16'41.6",-76°00'19.9").

Recommended by: _____
for Director, Division of Shellfish Sanitation

Ordered by: _____ 07/21/2006
State Health Commissioner Date


Virginia Department of Health
Cherrystone Inlet
Condemned Shellfish Area 088-139
4 August 2006
0
2,500
5,000
Feet
Chesapeake Bay 10-00-00
Cherrystone Inlet 11-53-00
Eyreville Creek 11-53-06
Eyrehall Creek 11-53-04
Kings Creek 11-55-00
Northampton County
SC 705
SC 668
SC 671
SC 663
SC 640
SC 680
SC 661
SC 1313
T-680
T-1309
SC 641
T-1105
106
US 13N
US 13S
BUS. US 13
N
Condemned Area (Section A)
Seasonally Condemned Area (Section M1)
Section A
Section M1
(37°16'58.0",-76°00'38.9")
(37°16'54.7",-76°00'38.5")
(37°16'51.0",-76°00'20.8")
(37°16'41.6",-76°00'19.9")
(37°16'46.9",-75°59'38.1")
(37°16'45.7",-75°59'42.5")
Geographic coordinates in NAD83 datum; shown in degrees, minutes & seconds.
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Appendix B: Supporting Documentation and Watershed Assessment

1. **Fecal Production Literature Review**
2. **Geographic Information System Data: Sources and Process**
3. **Watershed Source Assessment**

B-1. Fecal Production Literature Review

	Concentration in feces		Fecal coliform production rate		Comments
	FC/g	Ref.	FC/day (seasonal)	Ref.	
Cat	7.9E+06	1	5.0E+09	4	
Dog	2.3E+07	1	5.0E+09	4	
Chicken	1.3E+06	1	1.9E+08	4	
Chicken			2.4E+08	9	
Cow	2.3E+05	1	1.1E+11	4	average of dairy and beef
Beef cattle			5.4E+09	9	
Deer	1.0E+02	6	2.5E+04	6	assume 250 g/day
Deer	?		5.0E+08	9	best prof. judgement
Duck			4.5E+09	4	average of 3 sources
Duck	3.3E+07	1	1.1E+10	9	
Canada Geese			4.9E+10	4	
Canada Geese	3.6E+04	3	9.0E+06	3	
Canada Geese	1.5E+04	8	3.8E+06	8	assume 250 g/day (3)
Horse			4.2E+08	4	
Pig	3.3E+06	1	5.5E+09	4	
Pig			8.9E+09	9	
Sea Gull	3.7E+08	8	3.7E+09	8	assume 10 g/day
Sea gull			1.9E+09	5	mean of four species
Rabbit	2.0E+01	2	?		
Raccoon	1.0E+09	6	1.0E+11	6	assume 100 g/day
Sheep	1.6E+07	1	1.5E+10	4	
Sheep			1.8E+10	9	
Turkey	2.9E+05	1	1.1E+08	4	
Turkey			1.3E+08	9	
Rodent	1.6E+05	1	?		
Muskrat	3.4E+05	6	3.4E+07	6	
Human	1.3E+07	1	2.0E+09	4	
Septage	4.0E+05	7	1.0E+09	7	assume 70/gal/day/person

1. Geldreich, E. and E. A. Kenner. 1969. Concepts of fecal streptococci in stream pollution. J. Wat. Pollut. Control Fed. 41:R336-R352.
2. Geldreich, E., E. C. Best, B. A. Kenner, and D. J. Van Donsel. 1968. The bacteriological aspects of stormwater pollution. J. Wat. Pollut. Control Fed. 40:1861-1872.
3. Hussong, D., J. M. Damare, R. J. Limpert, W. J. L. Sladen, R. M. Weiner, and R. R. Colwell. 1979. Microbial impact of Canada geese (Branta canadensis) and whistling swans.
4. U.S. Environmental Protection Agency. 2001. Protocol for Developing Pathogen TMDLs. EPA 841-R-00-002. Office of Water (4503F), United States Environmental Protection Agency, Washington, DC. 132 pp.
5. Gould, D. J. and M. R. Fletcher. 1978. Gull droppings and their effects on water quality. Wat. Res. 12:665-672.
6. Kator, H. and M. W. Rhodes. 1996. Identification of pollutant sources contributing to degraded sanitary water quality in Taskinas Creek National Estuarine Research Reserve, Virginia. Special Report in Applied Marine Science and Ocean Engineering No. 336, The College of William and Mary, VIMS/School of Marine Science.
7. Kator, H., and M. W. Rhodes. 1991. Evaluation of Bacteroides fragilis bacteriophage, a candidate human-specific indicator of fecal contamination for shellfish-growing waters. A final report prepared under NOAA Cooperative Agreement NA90AA-H-FD234. Prepared and submitted to NOAA, Southeast Fisheries Science Center, Charleston Laboratory, Charleston, SC. 98 pp.
8. Alderisio, K. A. and N. DeLuca. 1999. Seasonal enumeration of fecal coliform bacteria from the feces of ring-billed gulls (Larus delawarensis) and Canada geese (Branta canadensis). Appl. Environ. Microbiol. 65:5628-5630.
9. TMDL report attributed to Metcalf and Eddy 1991 (Potomac Headwaters of West VA).

B-3 Geographic Information System Data: Sources and Process

A geographic information system is a powerful computer software package that can store large amounts of spatially referenced data and associated tabular information. The data layers produced by a GIS can be used for many different tasks, such as generating maps, analyzing results, and modeling processes. Below is a table that lists the data layers that were developed for the watershed and hydrodynamic models.

Table B-2 GIS Data Elements and Sources

Data Element	Source	Date
Watershed boundary	Division of Shellfish Sanitation, VA Department of Health	Various dates
Subwatershed boundary	Center for Coastal Resources Management	2003
Land use	National Land Cover Data set (NLCD), US Geological Survey	1999
Elevation	Digital Elevation Models and Digital Raster Graphs, US Geological Survey	Various dates
Soils	SSURGO and STATSGO, National Resource Conservation Service	Various dates
Stream network	National Hydrography Dataset	1999
Precipitation, temperature, solar radiation, and evapotranspiration	Chesapeake Bay Program, Phase V	2002
Stream flow data	Gauging stations, US Geological Survey	Various dates
Shoreline Sanitary Survey deficiencies	Division of Shellfish Sanitation, VA Department of Health	Various dates
Wastewater treatment plants	VA Department of Environmental Quality	Various dates
Sewers	Division of Shellfish Sanitation, VA Department of Health	Various dates
Dog population	US Census Bureau American Veterinary Association	2000 2002
Domestic livestock	National Agricultural Statistics Service, USDA	1997/2001
Wildlife	Virginia Department of Game and Inland Fisheries, US Fish and Wildlife Service	2004 2004
Septic tanks (from human population)	Division of Shellfish Sanitation, VA Department of Health US Census Bureau	Various dates 2000
Water quality monitoring stations	Division of Shellfish Sanitation, VA Department of Health	Various dates
Water quality segments	Center for Coastal Resources Management	2003
Tidal prism segments	Department of Physical Sciences, VIMS	2003
Water body volumes	Bathymetry from Hydrographic Surveys, National Ocean Service, NOAA	Various dates
Condemnation zones	Division of Shellfish Sanitation, VA Department of Health	Various dates
Tidal data	NOAA tide tables	2004

A. GIS Data Description and Process

Watershed boundary determined by VDH, DSS. There are 105 watersheds in Virginia.

Subwatershed boundaries were delineated based on elevation, using digital 7.5 minute USGS topographic maps. There are 1836 subwatersheds.

The original land use has 15 categories that were combined into 3 categories:
urban (high and low density residential and commercial);
undeveloped (forest and wetlands); and
agriculture (pasture and crops).

Descriptions of Shoreline Sanitary Survey deficiencies are found in each report. Contact DSS for more information. Digital data layer generated by CCRM from hardcopy reports.

Wastewater treatment plant locations were obtained from DEQ and digital data layer was generated by CCRM. Design flow, measured flow, and fecal coliform discharges were obtained from DEQ.

Sewers data layer was digitized from Shoreline Sanitary Surveys by CCRM.

Dog numbers were obtained using the American Vet Associations equation of #households * 0.58.
See website for additional information—
http://www.avma.org/membshp/marketstats/formulas.asp#households1.
Database was generated by CCRM.

Domestic livestock includes cows, pigs, sheep, chickens, turkeys, and horses. Database was generated by CCRM.

Wildlife includes ducks and geese, deer, and raccoons. Animals were chosen based on availability of fecal coliform production rates and population estimates. Database was generated by CCRM.
Ducks and geese–US FWS, DGIF
Deer–DGIF
Raccoons–DGIF

Human input was based on DSS sanitary survey deficiencies and US Census Bureau population data (number of households).

Water quality monitoring data are collected, on average, once per month. Digital data layer of locations was generated by DSS. Water quality data was mathematically processed and input into a database for model use.

Water bodies were divided into segments based on the location of the monitoring stations (midway between stations). If a segment contained >1 station, the FC values were averaged. If a segment contained 0 stations, the value from the closest station(s) was assigned to it. Digital data layer of segments was generated by CCRM. FC loadings in the water were obtained by multiplying FC concentrations by segment volume.

Bathymetry data were used to generate a depth grid that was used to estimate volumes for each water quality segment and tidal prism segment.

The 1998 303d report was used to set the list of condemnation zones that require TMDLs. The digital data layer was generated by CCRM from hardcopy closure reports supplied by DSS.

B. Population Numbers

The process used to generate population numbers used for the nonpoint source contribution analysis part of the watershed model for the four source categories: human, livestock, pets and wildlife is described for each below.

Human:

The number of people contributing fecal coliform from failing septic tanks were developed in two ways and then compared to determine a final value.

1) Deficiencies (septic failures) from the DSS shoreline surveys were counted for each watershed and multiplied by 3 (average number of people per household).
2) Numbers of households in each watershed were determined from US Census Bureau data. The numbers of households were multiplied by 3 (average number of people per household) to get the total number of people and then multiplied by a septic failure rate* to get number of people contributing fecal coliform from failing septic tanks.

*The septic failure rate was estimated by dividing the number of deficiencies in the watershed by the total households in the watershed. The average septic failure rate was 12% and this was used as the default unless the DSS data indicated that septic failure was higher.

Livestock:

US Census Bureau data was used to calculate the livestock values. The numbers for each type of livestock (cattle, pigs, sheep, chickens (big and small), and horses) were reported by county. Each type of livestock was assigned to the land use(s) it lives on, or contributes to by the application of manure, as follows:

Cattle	cropland and pastureland
Pigs	cropland
Sheep	pastureland
Chickens	cropland
Horses	pastureland

GIS was used to overlay data layers for several steps:

1) The county boundaries and the land uses to get the area of each land use in each county. The number of animals was divided by the area of each land use for the county to get an animal density for each county.
2) The subwatershed boundaries and the land uses to get the area of each land use in each subwatershed.
3) The county boundaries and the subwatershed boundaries to get the area of each county in each subwatershed. If a subwatershed straddled more than one county, the areal proportion of each county in the subwatershed was used to determine the number of animals in the subwatershed.

Using MS Access, for each type of livestock, the animal density by county was multiplied by the area of each land use by county in each subwatershed to get the number of animals in each subwatershed. If more than one county was present in a subwatershed, the previous step was done for each county in the subwatershed, then summed for a total number of animals in the subwatershed. The number of animals in each subwatershed was summed to get the total number of animals in each watershed.

Pets:

The dog population was calculated using a formula for estimating the number of pets using national percentages, reported by the American Veterinary Association:

dogs = # of households * 0.58.

US Census Bureau data provided the number of households by county. The number of dogs per county was divided by the area of the county to get a dog density per county. GIS was used to overlay the subwatershed boundaries with the county boundaries to get the area of each county in a subwatershed. If a subwatershed straddled more than one county, the areal proportion of each county in the subwatershed was calculated. Using MS Access, the area of each county in the subwatershed was multiplied by the dog density per county to get the number of dogs per subwatershed. If more than one county was present in a subwatershed, the previous step was done for each county in the subwatershed, then summed for a total number of dogs in the subwatershed. The number of dogs in each subwatershed was summed to get the total number of dogs in each watershed.

Wildlife:

Deer—

The number of deer were calculated using information supplied by DGIF, consisting of an average deer index by county and the formula:

#deer/mi^2 of deer habitat = (-0.64 + (7.74 * average deer index)).

Deer habitat consists of forests, wetlands, and agricultural lands (crop and pasture). GIS was used to overlay data layers for the following steps:

1) The county boundaries and the subwatershed boundaries to get the area of each county in each subwatershed. If a subwatershed straddled more than one county, the areal proportion of each county in the subwatershed was calculated.
2) The subwatershed boundaries and the deer habitat to get the area of deer habitat in each subwatershed.

Using MS Access, number of deer in each subwatershed were calculated by multiplying the #deer/mi^2 of deer habitat times the area of deer habitat. If more than one county was present in a subwatershed, the previous step was done for each county in the subwatershed, then summed for a total number of deer in the subwatershed. The number of deer in each subwatershed was summed to get the total number of deer in each watershed.

Ducks and Geese—

The data for ducks and geese were divided into summer (April through September) and winter (October through March).

Summer

The summer numbers were obtained from the Breeding Bird Population Survey (US Fish and Wildlife Service) and consisted of bird densities (ducks and geese) for 3 regions: the southside of the James River, the rest of the tidal areas, and the salt marshes in both areas. The number of ducks and geese in the salt marshes were distributed into the other 2 regions based on the areal proportion of salt marshes in them using the National Wetland Inventory data and GIS.

Winter

The winter numbers were obtained from the Mid-Winter Waterfowl Survey (US Fish and Wildlife Service) and consisted of population numbers for ducks and geese in several different areas in the tidal region of Virginia. MS Access was used to calculate the total number of ducks and geese in each area and then these numbers were grouped to match the 2 final regions (Southside and the rest of tidal Virginia) for the summer waterfowl populations. Winter populations were an order of magnitude larger than summer populations.

Data from DGIF showed the spatial distribution of ducks and geese for 1993 and 1994. Using this information and GIS a 250m buffer on each side of the shoreline was generated and contained 80% of the birds. Wider buffers did not incorporate significantly more birds, since they were located too far inland. GIS was used to overlay the buffer and the watershed boundaries to calculate the area of buffer in each watershed. To distribute this information into each subwatershed, GIS was used to calculate the length of shoreline in each subwatershed and the total length of shoreline in the watershed. Dividing the length of shoreline in each subwatershed by the total length of shoreline gives a ratio that was multiplied by the area of the watershed to get an estimate of the area of buffer in each subwatershed. MS Excel was used to multiply the area of buffer in each subwatershed times the total numbers of ducks and geese to get the numbers of ducks and geese in each subwatershed. These numbers were summed to get the total number of ducks and geese in each watershed. To get annual populations, the totals then were divided by 2, since they represent only 6 months of habitation (this reduction underestimates the total annual input from ducks and geese, but is the easiest conservative method to use since the model does not have a way to incorporate the seasonal differences).

Raccoons—

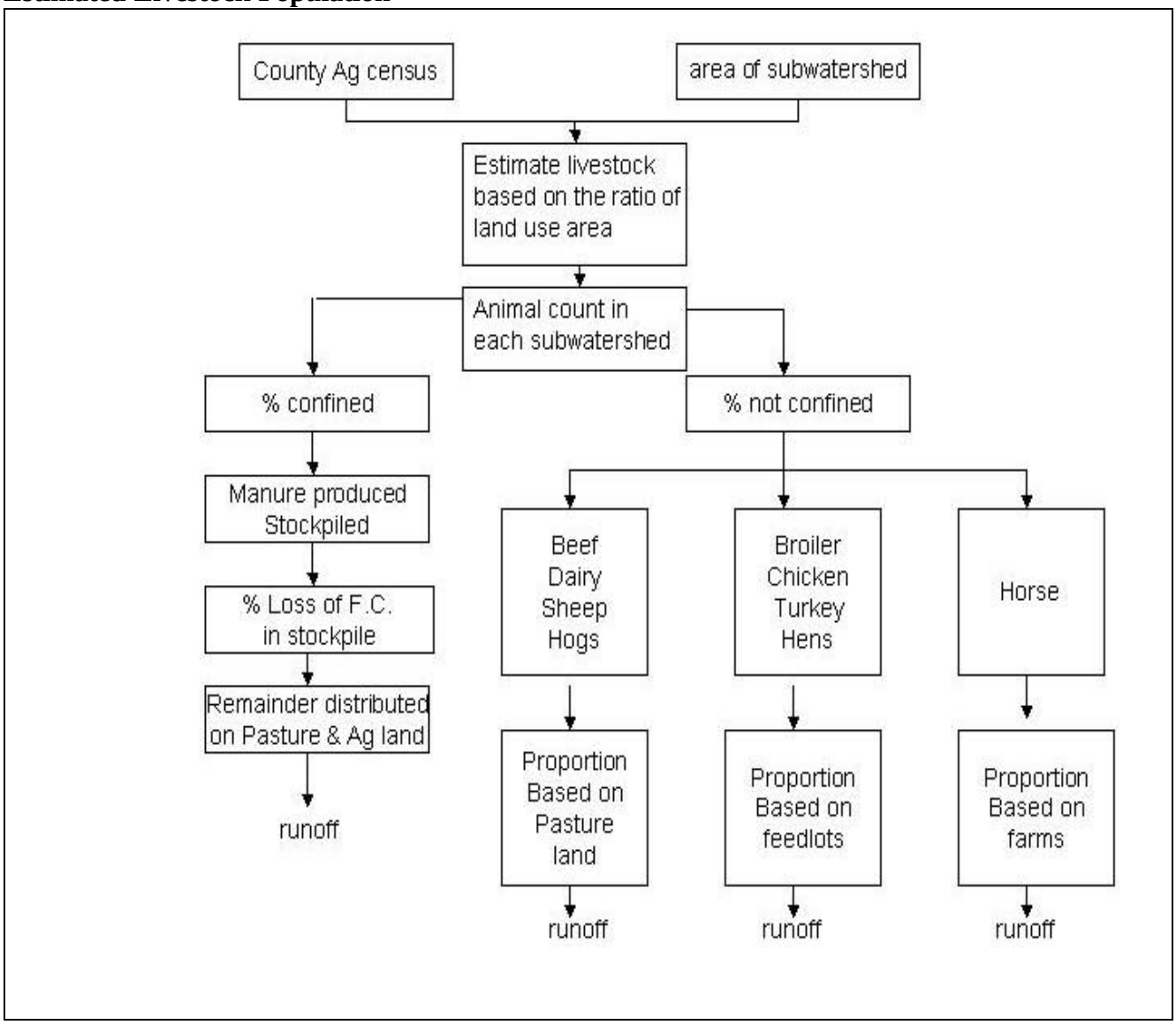
Estimates for raccoon densities were supplied by DGIF for 3 habitats—wetlands (including freshwater and saltwater, forested and herbaceous), along streams, and upland forests. GIS was used to generate a 600ft buffer around the wetlands and streams, and then to overlay this buffer layer with the subwatershed boundaries to get the area of the buffer in each subwatershed. GIS was used to overlay the forest layer with the subwatershed boundaries to get the area of forest in each subwatershed. MS Access was used to multiply the raccoon densities for each habitat times the area of each habitat in each subwatershed to get the number of raccoons in each habitat in each subwatershed. The number of raccoons in each subwatershed was summed to get the total number of raccoons in each watershed.

B-4. Watershed Source Assessment

The watershed assessment calculates fecal coliform loads by source based on geographic information system data. A geographic information system is a powerful computer software package that can store large amounts of spatially referenced data and associated tabular information. The data layers produced by a GIS can be used for many different tasks, such as generating maps, analyzing results, and modeling processes. The watershed model requires a quantitative assessment of human sewage sources (i. e., malfunctioning septic systems) and animal (livestock, pets and wildlife) fecal sources distributed within each watershed.

The fecal coliform contribution from livestock is through the manure spreading processes and direct deposition during grazing. This contribution was initially estimated based on land use data and the livestock census data. In the model, manure was applied to both cropland and pasture land depending on the grazing period. Figure B-1 shows a diagram of the procedure for estimating the total number of livestock in the watershed and fecal coliform production. A description of the process used to determine the source population values for wildlife, pets and human used in the calculation of percent loading is found in Appendix B.

FIGURE B-1 Diagram to Illustrate Procedure Used to Estimate Fecal Coliform Production from Estimated Livestock Population



Appendix C

Code of Virginia §62.1-194.1 Obstructing or contaminating state waters.

Code of Virginia §62.1-194.1

§62.1-194.1. Obstructing or contaminating state waters.

Except as otherwise permitted by law, it shall be unlawful for any person to dump, place or put, or cause to be dumped, placed or put into, upon the banks of or into the channels of any state waters any object or substance, noxious or otherwise, which may reasonably be expected to endanger, obstruct, impede, contaminate or substantially impair the lawful use or enjoyment of such waters and their environs by others. Any person who violates any provision of this law shall be guilty of a misdemeanor and upon conviction be punished by a fine of not less than $100 nor more than $500 or by confinement in jail not more than twelve months or both such fine and imprisonment. Each day that any of said materials or substances so dumped, placed or put, or caused to be dumped, placed or put into, upon the banks of or into the channels of, said streams shall constitute a separate offense and be punished as such. In addition to the foregoing penalties for violation of this law, the judge of the circuit court of the county or corporation court of the city wherein any such violation occurs, whether there be a criminal conviction therefor or not shall, upon a bill in equity, filed by the attorney for the Commonwealth of such county or by any person whose property is damaged or whose property is threatened with damage from any such violation, award an injunction enjoining any violation of this law by any person found by the court in such suit to have violated this law or causing the same to be violated, when made a party defendant to such suit. (1968, c. 659.)

APPENDIX D

Guidance Memo No. 04-2022 Procedures for Establishing Boating No Discharge Zones

M E M O R A N D U M
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF WATER QUALITY PROGRAMS

P.O. Box 10009 Richmond, VA 23240-0009

SUBJECT: Guidance Memo No. 04-2022
Procedures for Establishing Boating No Discharge Zones

TO: Regional Directors

FROM: Ellen Gilinsky, Ph.D., Director

DATE: November 29, 2004

COPIES: Rick Weeks, Jon Van Soestbergen and Cindy Berndt

Summary:

The purpose of this guidance is to provide a procedure for handling public or internal requests for the establishment of boating No Discharge Zones, and for establishing the No Discharge Zones in accordance with federal regulation 40 CFR Part 140 (2004) and state regulation 9 VAC 25-71 (2004).

Electronic Copy:

An electronic copy of this guidance in PDF format is available for staff internally on DEQNET and for the general public on DEQ's website at: http://www.deq.virginia.gov/water/.

Contact information:

Please contact Mike Gregory, Office of Water Permit Support, (804) 698-4065 or mbgregory@deq.virginia.gov if you have any questions about this guidance.

Disclaimer:

This document is provided as guidance and, as such, sets forth standard operating procedures for the agency. However, it does not mandate any particular method nor does it prohibit any particular method for the analysis of data, establishment of a wasteload allocation, or establishment of a permit limit. If alternative proposals are made, such proposals should be reviewed and accepted or denied based on their technical adequacy and compliance with appropriate laws and regulations.

PROCEDURE FOR DEQ REVIEW OF SECTION 312
NO DISCHARGE ZONE DESIGNATION REQUESTS

Background

Section 312 of the Clean Water Act and EPA regulations at 40 CFR Part 140 address sewage discharges from boats. The federal regulations control these discharges by requiring boats with installed toilets to have treatment units called Marine Sanitation Devices or "MSDs". Type I and Type II MSDs consist of two levels of treat and discharge units, while Type III MSDs are holding tanks that do not discharge and must be pumped out at pump out facilities. Pump out facilities are usually located at marinas and are regulated by the Virginia Department of Health. Most recreational boats with installed toilets have the holding tanks. Discharging raw sewage from boats, from holding tanks or portable toilets for example, is not directly addressed by federal regulations, but state law prohibits it and this is now clarified in our state regulation 9 VAC 25-71.

Federal law prohibits a state from adopting regulations regarding MSDs that are more stringent than federal regulations, but it allows a state to petition EPA for designation of No Discharge Zones (NDZs), where all sewage discharges, treated or untreated, are banned. The process is for the state to demonstrate that the particular water body requires special protection and that there are adequate pump out facilities in the area, since boat sewage wastes in NDZs would have to be held until pumped out. EPA does not have a specific application but has developed informational documents and a loosely structured process for applying for NDZ designation. Any citizen can initiate the process but the final request must be signed by the governor or chief environmental officer of the state.

Note that since untreated sewage discharges from boats are illegal, the only difference in a NDZ with respect to the law is that boats with treat and discharge units (MSD Type I or II) cannot use them. Since most boats on the water have holding tanks anyway, this is not a significant difference. It might be considered, however, that the public outreach and increased law enforcement efforts in NDZs provide for more protection of the waters with regard to previously undetected illegal discharges. Another consideration is that in areas where there is a considerable amount of commercial boat traffic there are more likely to be boats operating with treat and discharge type units (e.g., tug boats in the Chesapeake Bay).

As of the date of this guidance Smith Mountain Lake is the only designated NDZ in the state. This resulted from a bill that was passed by the General Assembly directing the State Water Control Board to petition EPA for NDZ designation. The designation was received and a new boating regulation, 9 VAC 25-71, was adopted that provides for NDZ identification and enforcement. Since the Smith Mountain Lake NDZ designation inquiries have been received from various groups in the Chesapeake Bay watershed wishing to pursue NDZ designation for other water bodies of concern. In order to handle these requests consistently and in accordance with State Water Control Law at Section 62.1-44.33 the following procedure should be followed.

Procedure

The procedure for designating Section 312 Boating No Discharge Zones will be as follows.

1. When an interested party, local government or state agency proposes No Discharge Zone (NDZ) designation for a waterbody within the state it should submit a proposal including the following information to the Director of the DEQ Division of Water Quality Programs. The Division of Water Quality Programs will develop this information for DEQ initiated proposals:

A. Name and contact information for the person or group making the request.
B. Name and location of the waterbody.
C. Exact boundaries of the area to be designated, using latitude and longitude of boundaries, any bordering landmarks or delineating features (e.g., bridges or mean low water elevations) or other means of identifying the area.
D. A map of the area to be designated.
E. Reason why designation is being sought, i.e., why the water body requires greater environmental protection, including:

(1) Nature of the waterbody (estuary, river, lake, etc.) and a description of its features (e.g., heavily populated area, major port or boating area, pristine bay with little surrounding development, enclosed embayment, deep mountain lake);
(2) any unique features or qualities (including high quality waters) or environmental importance (e.g. shellfish waters) that necessitate stronger resource protection;
(3) information on contact recreational use (e.g., swimming);
(4) any specific water quality problems existing, including 303(d) listing and TMDL status if applicable.

Note that greater environmental protection might be considered necessary to maintain the status of a high quality resource or to improve the status of a low quality one.

F. Indication if the waterbody is:

(1) in an established sanctuary, national or state park, wilderness area, recreation area or if the waterbody is used by endangered or threatened species;
(2) a public water supply.

G. A statement or rough estimate of the availability of boat sewage holding tank pumpouts in the area (more exact information will be developed for the EPA application).
H. A statement or rough estimate of the amount of boat traffic in the waterbody and the type of boat traffic, recreational or commercial (more exact information will be developed for the EPA application).
I. Indication, if available, of any public support or interest for or against the NDZ designation.
J. Information on any local enforcement capability (e.g., police boats).
K. Information on any local public outreach capability (provision of signs, pamphlets or other public awareness efforts).

2. DEQ will review the proposal and obtain more information if necessary.

3. If DEQ decides it is not appropriate to proceed, it will indicate why and what options are available to the individual or group if they wish to continue (e.g., approach the State Water Control Board or petition EPA directly).

4. If DEQ decides to proceed with the proposal it will set up a public meeting and provide public notice by publication in a paper local to the waterbody and by such other means as deemed necessary, notifying the public of the intent to designate the waters and what that means, and providing public meeting information. A 30-day public notice period will follow.

5. After the public meeting and upon completion of the public notice period a review of public comments will be summarized and DEQ staff will present the proposal for NDZ and the summary of public comments to the State Water Control Board with a recommendation on pursuing the NDZ designation from EPA. Disapproval would mean that the individual or group wishing the designation would have to pursue it directly from EPA, obtaining the governor's signature without DEQ endorsement.

6. If the State Water Control Board approves pursuing the designation, DEQ will assist the individual or group in preparing an application to EPA and will coordinate with the Virginia Department of Health, the Department of Game and Inland Fisheries and the Virginia Marine Resources Commission (62.1-44.33 requires consultation with these agencies in formulating boating regulations) as well as with EPA Region III.

7. Once the application is prepared and the draft reviewed by EPA (EPA will indicate if it is sufficient for approval prior to formal submittal), DEQ will route the application through to the Executive Office for signature by the Secretary of Natural Resources and transmittal to EPA.

8. EPA will publish the proposal in the federal register.

9. Upon final publication in the federal register, the new NDZ will be established at the federal level.

10. DEQ will amend 9 VAC 25-71 by adding the new NDZ to the list of state designated NDZs, and will present it to the State Water Control Board as final exempt (required to conform to federal law).

11. Publication of the 9 VAC 25-71 amendment will be made in the Virginia Register and the final 30-day notice period will follow, after which the new NDZ is established at the state level.

12. Public awareness and enforcement efforts can begin.