UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Decision Rationale
Total Maximum Daily Loads
Recreation Use (Bacteria) Impairment in the Dan River, Blackberry Creek, Byrds Branch, Double Creek Fall Creek, Leatherwood Creek, Marrowbone Creek, North Fork Mayo River, South Fork Mayo River, Smith River Sandy Creek, and Sandy River Watersheds, located in portions of Carroll, Floyd, Franklin, Halifax, Henry Mecklenburg, Patrick, and Pittsylvania Counties, Virginia

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Jon M. Capacasa, Director
Water Protection Division

Date: 12/8/2008

TMDL Review Checklist

State: Virginia
Date of Submittal: April 30, 2008
303(d) Segments: See Table 1 below
Date of EPA Action:
Pollutant: *E. coli*
EPA Reviewer: Helene Drago
State Document: Bacteria TMDL Development for the Dan River, Blackberry Creek, Byrds Branch, Double Creek, Fall Creek, Leatherwood Creek, Marrowbone Creek, North Fork Mayo River, South Fork Mayo River, Smith River, Sandy Creek and Sandy River Watersheds- revised September 2008.

Review Element	**Adequate Yes/No**	**Recommendations/Comments**
Submittal Letter	Yes	Dated April 30, 2008
Identification of Waterbody	Yes	See Attached Table 1
Consent Decree Water	Yes	See Attached Table 1
Pollutant of Concern and Sources	Yes	*E. coli* Source Assessment discussed in Section 3.5
Impairment	Yes	Bacteria – Recreation Use
Final TMDL	Yes	Chapter 5 and See Table 1
Daily Loads	Yes	Chapter 5 and See Table 1
Load Allocations	Yes	Chapter 5
Wasteload Allocations	Yes	Chapter 5
Margin of Safety	Yes	Implicit – p. 5-1
Seasonal Variations	Yes	p. 2-7
Critical Conditions	Yes	p. 2-1
Reasonable Assurances: through NPDES permits or if WLAs depend on LAs	Yes	Chapter 6
Public Participation	Yes	p. 7-1
Technical Analysis/ Supporting Documentation	Yes	Appendices A through E
Other Comments	No	

Table 1. Identification of Waters and their Daily TMDLs for *E. coli* in cfu/day

Watershed	Consent Decree Water	WLA (Point Sources)	LA (Nonpoint Sources)	MOS (Margin of Safety)	TMDL
Dan River (VAC-L60R-01, includes VAC-L62, VAC-L64R and VAC- L73R)	Yes, for segments VAC-L62, VAC-L64R, and VAC-L73R	5.33E+11	2.74E+12	Implicit	3.27E+12
Blackberry Creek (VAW-L52R-02)	Yes	1.84E+08	4.01E+10	Implicit	4.03E+10
Byrds Branch (VAC-L62R-04)	No	1.43E+07	4.74E+09	Implicit	4.75E+09
Double Creek (VAC-L62R-03)	No	2.07E+08	4.47E+10	Implicit	4.49E+10
Fall Creek (VAC-L61R-01)	No	2.48E+08	1.00E+11	Implicit	1.01E+11
Leatherwood Creek (VAW-L56R-01)	Yes	9.55E+08	1.10E+11	Implicit	1.11E+11
Marrowbone Creek (VAW-L55R-01)	Yes	3.32E+08	6.76E+10	Implicit	6.79E+10
North Fork Mayo River (VAW-L46R-01)	No	6.68E+08	3.33E+11	Implicit	3.34E+11
Sandy Creek (VAC-L59R-01)	No	1.43E+07	8.68E+10	Implicit	8.68E+10
Sandy River (VAC-L58R-01)	Yes	2.97E+08	5.56E+11	Implicit	5.56E+11
Smith River (VAW-L54R-01)	No	2.86E+11	1.38E+11	Implicit	4.24E+11
Smith River (VAW-L53R-01)	No	2.45E+09	4.89E+11	Implicit	4.92E+11
South Fork Mayo River (VAW-L45R-01)	No	1.40E+09	3.35E+11	Implicit	3.37E+11

Supporting Document for Approving Virginia's Bacteria TMDLs
Addressing Recreational Use Impairments
October 2008

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those waterbodies identified as impaired by a state where technology based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a Margin of Safety (MOS) that may be discharged to a water quality limited waterbody.

This document will support the U.S. Environmental Protection Agency's (EPA) rationale for approving the TMDLs for the recreation use (bacteria) impairments in watersheds within the Commonwealth of Virginia. EPA's rationale is based on the determination that the TMDLs meet the following seven regulatory conditions pursuant to 40 CFR Part 130.

1. The TMDL is designed to implement applicable water quality standards.
2. The TMDL includes a total allowable load as well as individual wasteload allocations (WLAs) and load allocations (LAs).
3. The TMDL considers the impacts of background pollutant contributions.
4. The TMDL considers critical environmental conditions.
5. The TMDL considers seasonal environmental variations.
6. The TMDL includes a MOS.
7. The TMDL has been subject to public participation.

In addition, the TMDLs considered reasonable assurance that the TMDL allocations assigned to nonpoint sources can be reasonably met.

II. Determination of Sources of Existing Loadings

To assist in partitioning the loads from the diverse sources within the watershed, water quality samples of *E. coli* collected over long periods (one year or more) are evaluated using an antibiotic resistance analysis in a process called Bacterial Source Tracking (BST). The BST method used in Virginia is based on the premise that *E. coli* sources due to humans, domestic animals, 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 bacterial sources. These samples are compared to a reference library of fecal samples from known sources. The resulting data is used to assign portions of the load within the watershed to wildlife, humans, pets or livestock. The identification of a major source of bacteria loads helps to establish potential directions for remediation under a future implementation plan.

III. Discussion of Possible TMDL Models used to Address the Recreational Use Impairment

Numerical models have been widely used for TMDL development. It is a common practice to use a linked watershed model, such as the Hydrologic Simulation Program – Fortran (HSPF), and a receiving water model, to simulate bacteria concentration in the receiving water and develop the TMDL through long term simulation. Once the relationship is developed, management options for reducing pollutant loadings to streams can be assessed. Besides using a complex numerical model, the Monte Carlo simulation, log-normal probability modeling, and the load duration curve (LDC) method can be used for TMDL development.

- For simpler systems a water quality model with a steady State distribution of sources can be applied. Assuming the bacteria is fully mixed horizontally and vertically, the *E. coli* concentration can be expressed as:

$$C = \frac{L}{k}(1 - e^{-\frac{k}{u}x})$$

where C is the concentration (count/m^3); k is the first order decay rate (1/day), $k=k_0\theta^{T-20}$ (k_0 is the decay constant, θ=1.07, and T is the temperature); L is the diffuse source loading (count/m^3/day); x is the distance measured from the upstream to downstream; and u is the cross-section mean velocity (m/day), which equals to Q/A (Q is the instream flow and A is the cross-sectional area).

To estimate the unit loading, L, a daily flow Q is required. A United States Geological Survey (USGS) gauge station either on the waterbody or in a neighboring comparable watershed is used. The Loading Simulation Program C^{++} (LSPC) model can be used to simulate daily flow over several years. The model will be calibrated against data gathered from USGS gauge stations. The LSPC model outputs can be used to estimate the flow in the waterbody. The velocity can be estimated based on the Manning's equation to account for the change of cross-section as flow changes, so that the bacteria concentration for each measurement date could be simulated. The inverse Bayesian parameter estimation approach, together with the simulated flows, observed *E. coli* concentrations, temperatures and *E. coli* standards are used to calculate the allocated and existing loadings based on the methodology of using duration curves under different flow and temperature conditions.

- The HSPF water quality model is another model that can be used to simulate fecal coliform existing conditions, and to perform fecal bacteria TMDL allocations. The HSPF model is a continuous simulation model that can account for nonpoint source (NPS) pollutants in runoff, as well as pollutants entering the flow channel from point sources. In establishing the existing and allocation conditions, seasonal variations in hydrology, climatic conditions, and watershed activities can be explicitly accounted for in the model. The use of HSPF allows for consideration of seasonal aspects of precipitation patterns within the watershed. Existing conditions are adjusted until the water quality standards are attained. The model is set up to estimate loads of fecal coliform, and then the model output was converted to concentrations of *E. coli.*

IV. Discussion of Regulatory Conditions

EPA reviews each TMDL to determine if Virginia provided sufficient information to meet all of the seven basic requirements for establishing TMDLs for water bodies with recreational use (bacteria) impairment. Additionally, EPA determines if Virginia provided reasonable assurance that the TMDLs can be met. Below are basic conditions in each of Virginia's TMDLs meant to restore a waterbody's recreational use.

1) The TMDL is designed to meet the applicable water quality standards.

According to Virginia Water Quality Standards (9 VAC 25-260-10), "All State waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them, wildlife, and the production of edible and marketable natural resources, e.g., fish and shellfish."

EPA has recommended that all states adopt an *E. coli* standard for freshwater and *enterococci* standards for saltwaters and transition zones, as there is a stronger correlation between the concentration of these organisms and the incidence of gastrointestinal illness than there is with fecal coliform. *E. coli* and *enterococci* are both bacteriological organisms that can be found in the intestinal tract of warm-blooded animals and are subsets of the fecal coliform and fecal streptococcus groups, respectively. Virginia adopted and published revised bacteria criteria on June 17, 2002, which became effective on January 15, 2003. As of that date, the *E. coli* standard described below applies to all freshwater streams in Virginia. Additionally, prior to June 30, 2008, the interim fecal coliform standard must be applied at any sampling station that has fewer than 12 samples of *E. coli*.

The Virginia Department of Environmental Quality (VA DEQ) specifies the following criteria for primary contact recreational uses for a nonshellfish waterbody:

- Interim Fecal Coliform Standard: Fecal coliform bacteria shall not exceed a geometric mean of 200 fecal coliform bacteria per 100 ml of water for two or more samples over a calendar month, nor shall more than 10 percent of the total samples taken during any calendar month exceed 400 fecal coliform bacteria per 100 ml of water.

- *Escherichia coli* Standard: *E. coli* bacteria concentrations for freshwater shall not exceed a geometric mean of 126 counts per 100 ml for two or more samples taken during any calendar month, and shall not exceed a single sample maximum of 235 counts per 100 ml.

VA DEQ specifies the following criteria for recreational uses for waterbodies located in saltwater or in a transition zone:

- *Enterococci* bacteria shall not exceed a geometric mean of 35 counts/100 ml of water for two or more samples over a calendar month, or shall not exceed the single sample maximum of 104 counts/100 ml of water.

During any assessment period, if more than 10 percent of a station's samples exceed the applicable standard, the stream segment associated with that station is classified as impaired; and a TMDL must be developed and implemented to bring the station into compliance with the water quality standard.

2) The TMDL includes a total allowable load as well as individual wasteload allocations and load allocations.

Total Allowable Loads

The objective of the bacteria TMDL is to determine what reductions in bacteria loadings from point and nonpoint sources are required to meet state water quality standards. The TMDL considers all significant sources contributing bacteria to the impaired streams. The sources can be separated into nonpoint and point sources. The different sources in the TMDL are defined in the following equation:

TMDL = WLAs + LAs + MOS

Where:

WLA = wasteload allocation
LA = load allocation
MOS = margin of safety

Wasteload Allocations

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR §122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR §130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Load Allocations

According to Federal regulations at 40 CFR §130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and NPS loads should be distinguished.

3) The TMDLs consider the impacts of background pollution.

Virginia considers background pollutant contributions in the TMDL development process by quantifying the fecal coliform loads from wildlife sources.

4) The TMDLs consider critical environmental conditions.

According to EPA's regulation 40 CFR §130.7(c)(1), TMDLs are required 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 is protected during times when it is 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. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst case" scenario condition. For example, stream analysis often uses a low flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.

Generally, in establishing the existing and allocation conditions for waterbodies, seasonal variations in hydrology, climatic conditions, and watershed activities are explicitly accounted for in the model. Frequently, both wet weather and dry weather conditions are identified as the critical condition. For example, under dry weather conditions, the direct deposition load from cattle may dominate. Under wet weather conditions, the nonpoint source loads from low-density residential and pasture areas may dominate. When the TMDLs are developed using a continuous simulation model, results will apply to both high and low flow conditions.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow and loadings as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods.

In establishing the existing and allocation conditions for watersheds, seasonal variations in hydrology, climatic conditions, and watershed activities are explicitly accounted for in the model.

6) The TMDLs include a Margin of Safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL.

7) The TMDL has been subject to public participation.

Virginia generally seeks public participation at every stage of TMDL development in order to receive input from stakeholders and to apprise the stakeholders of the progress made. Virginia frequently conducts technical advisory committee (TAC) meetings and always conducts two public meetings within the watershed.

IV. Discussion of Reasonable Assurance

WLAs will be implemented through the NPDES permit process. According to 40 CFR §122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the State and approved by EPA. Furthermore, EPA has authority to object to the issuance of an NPDES permit that is inconsistent with WLAs established for that point source. When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on the assumption that nonpoint source load reductions will occur, EPA's guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures will achieve load reductions in order for the TMDL to be approvable.

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.

For the implementation of the WLA component of the TMDL, the Commonwealth intends to utilize the NPDES program, which typically includes consideration of the Water Quality Monitoring, Information, and Restoration Act (WQMIRA) requirements during the permitting process. Requirements of the permit process should not be duplicated in the TMDL process, and with the exception of stormwater related permits, permitted sources are not usually addressed during the development of a TMDL implementation plan.

Virginia's DEQ and Department of Conservation and Recreation (DCR) coordinate separate state permitting programs that regulate the management of pollutants carried by stormwater runoff. DEQ regulates stormwater discharges associated with industrial activities through its NPDES program, while DCR regulates stormwater discharges from construction sites, and from municipal separate storm sewer systems (MS4s) through the Virginia Stormwater Management Program (VSMP). For MS4 permits, the Commonwealth expects the permittee to specifically address the TMDL wasteload allocations for stormwater through the iterative implementation of programmatic Best Management Practices (BMPs). BMP effectiveness would be determined through permittee implementation of an individual control strategy that includes a monitoring program that is sufficient to determine its BMP effectiveness.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program. Additional 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.

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. In both urban and rural areas, reducing the human bacteria loading from straight pipe discharges and failing septic systems will be a primary implementation focus because of their health implications. These components could be implemented through education on septic tank pump-outs, a septic system installation/repair/replacement program, and hookup to the existing Wastewater Treatment Plant (WWTP).

In urban areas, reducing the human bacteria loading from leaking sewer lines could be accomplished through a sanitary sewer inspection and management program. Other BMPs that might be appropriate for controlling urban wash-off from parking lots and roads, and that could be readily implemented, may include more restrictive ordinances to reduce fecal loads from pets, improved garbage collection and control, and improved street cleaning.

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

a. To enable tracking of water quality improvements following BMP implementation through follow-up stream monitoring;
b. To provide a measure of quality control, given the uncertainties inherent in computer simulation modeling;
c. To provide a mechanism for developing public support through periodic updates on BMP implementation and water quality improvements;
d. To help to ensure that the most cost effective practices are implemented first; and
e. To allow for the evaluation of the adequacy of the TMDL in achieving water quality standards.

Watershed stakeholders will have the 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.