Decision Rationale

Total Maximum Daily Load of
Fecal Coliform for Maggodee Creek[1]

I. Introduction

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the Total Maximum Daily Load (TMDL) of Fecal Coliform for Maggodee Creek submitted for final Agency review on March 27, 2001 Our rationale is based on the TMDL submittal document to determine if the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1. The TMDLs are designed to implement applicable water quality standards.
2. The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.
3. The TMDLs consider the impacts of background pollutant contributions.
4. The TMDLs consider critical environmental conditions.
5. The TMDLs consider seasonal environmental variations.
6. The TMDLs include a margin of safety.
7. The TMDLs have been subject to public participation.
8. There is reasonable assurance that the TMDLs can be met.

II. Background

The impaired segment of Maggodee Creek is 21.13 miles in length with a 29,187-acre watershed. The impaired reach begins at the confluence of the North and South Fork of Maggodee Creek culminating at its confluence with the Blackwater River. Forest is the major land use and makes up roughly 62% of the 29,187 acre watershed.

In response to Section 303 (d) of the Clean Water Act (CWA), the Virginia Department of Environmental Quality (VADEQ) listed 21.13 miles of Maggodee Creek as being impaired by elevated levels of fecal coliform on Virginia's 1998 Section 303 (d) list. Maggodee

[1]This typewritten version of the decision rationale was created after the close of the administrative record on April 27, 2001. It contains a transcription of hand written grammatical changes that were made to the document prior to the close of the record on April 27, 2001. The original document, with the hand written modifications, will be filed within the administrative record.

Creek was listed for violations of Virginia's fecal coliform bacteria standard for primary contact. Fecal coliform is a bacterium which can be found within the intestinal tract of all warm-blooded animals. Therefore, fecal coliform can be found in the fecal wastes of these animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

Maggodee Creek, identified as watershed VAW-L09R, was given a high priority for TMDL development. Section 303 (d) of the Clean Water Act and its implementing regulations require a TMDL to be developed for those waterbodies identified as impaired by the State where technology-based and other controls will not provide for the attainment of Water Quality Standards. The TMDL submitted by Virginia is designed to determine the acceptable load of fecal coliform which can be delivered to Maggodee Creek, as demonstrated by the Hydrologic Simulation Program Fortran (HSPF)[2], in order to ensure that the water quality standard is attained and maintained. HSPF is considered an appropriate model to analyze this watershed because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions.

EPA has been encouraging the States to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation has been drawn between the concentrations of e-coli (and enterococci) and the incidence of gastrointestinal illness. The Commonwealth is pursuing changing the standard from fecal coliform to e-coli.

Virginia designates all of its waters for primary contact, therefore all waters must meet the current fecal coliform standard for primary contact. Virginia's standard applies to all flows. Through the development of this and other similar TMDLs, it was discovered that natural conditions (wildlife contributions to the streams) were causing or contributing to violations of the standard during low flows. Based on the model, fecal coliform loading from wildlife alone caused violations of the standard. Thus many of Virginia's TMDLs have called for some reduction in the amount of wildlife contributions to the stream. EPA believes that a significant reduction in wildlife is not practical or desirable and will not be necessary due to the implementation discussion below.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. The first phase of the implementation will reduce all sources of fecal coliform to the stream other than wildlife. In phase 2, which can occur concurrently to phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. During phase 2, the Commonwealth has indicated that it will evaluate the following items in relation to the standard: 1) The possibility of placing a minimum flow requirement on the bacteriological standard will be considered. As a result, the standard may not apply to flows below the minimum (possibly 7Q10). This application of the standard is applied in many States.

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[2]Bicknell, B.R., J.C. Imhoff, J.L. Little, and R.C. Johanson. 1993. Hydrologic Simulation Program-FORTRAN (HSPF): User's Manual for release 10.0. EPA 600/3-84-066. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

2) The Commonwealth may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of that UAA, it is possible that these streams could be designated primary contact infrequent bathing. 3) The Commonwealth will also investigate incorporating a natural background condition for the bacteriological indicator.

After the completion of phase 1 of the implementation plan the Commonwealth will conduct monitoring to determine if the wildlife reductions are actually necessary, as the violation rate associated with the wildlife loading may be smaller than the percent error of the model. In phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted. However, if standards are still not being attained after the implementation of phases 1 and 2 further work and reductions will be warranted.

During the development of this TMDL, it was discovered that the model consistently under-represented the concentration of fecal coliform in these river segments. The model used for this TMDL duplicated the assumptions and loadings that were used for TMDL development in the four Upper Blackwater River segments (North Fork of the Blackwater, South Fork of the Blackwater, the Upper Blackwater, and the Middle Fork of the Blackwater). As the assumptions made in the previous TMDLs resulted in a model that accurately reflected the concentrations of fecal coliform in the upper watershed, it was felt that a change in the loadings would question the integrity of both studies. An unknown mechanism may be contributing to the elevated fecal coliform concentrations detected in this segment.

One possible mechanism for this discrepancy would be the resuspension of sediments. As documented in the report, fecal coliform concentrations in the sediment often far exceed the concentrations detected in the water column. An agent (cattle in-stream or other mechanism) causing a resuspension of these sediments may cause an elevation in fecal coliform concentrations. The model developed for this TMDL used a factor value based on the likelihood that cattle in-stream were causing the resuspension of fecal coliform in the sediment. The factor value was determined by dividing the stream access area by the sum of the pasture area and the stream width. [3]

The HSPF model is a comprehensive modeling system for simulation of watershed hydrology, point and nonpoint source loadings, and receiving water quality for conventional pollutants and toxicants[4]. More specifically HSPF uses precipitation data for continuous and storm event simulation to determine total fecal loading to Maggodee Creek from urban areas, forest, good pasture, poor pasture, cropland, farmstead, loafing areas, and livestock access areas. The total land loading of fecal coliform is the result of the application of manure, direct deposition from cattle and wildlife (geese, deer, etc.) to the land, fecal coliform production from

[3]MapTech, 2001. Fecal Coliform TMDL (Total Maximum Daily Load) Development for Maggodee Creek, Virginia. Addendum B.

[4] CH2MHILL, 2000. Fecal Coliform TMDL Development for Cedar, Hall, Byers, and Hutton Creeks Virginia.

pets, fecal coliform from septic systems, and the application of biosolids.

The TMDL analysis allocates the application/deposition of fecal coliform to land-based and in-stream sources. For land-based sources, the HSPF model accounts for the buildup and washoff of pollutants from these areas. Buildup (accumulation) refers to the complex spectrum of dry-weather processes that deposit or remove pollutants between storms[5]. Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the HSPF model to determine the amount of fecal coliform from land based sources which is reaching the stream. Point sources and wastes deposited directly to the stream were treated as direct deposits. These wastes do not need a transport mechanism to allow them to reach the stream. The allocation plan calls for the reduction in fecal coliform wastes delivered by cattle in-stream, wildlife in-stream, and straight pipes.

Table #1 summarizes the specific elements of the TMDL at the watershed outlet.

Segment	Parameter	TMDL	WLA (cfu/yr)	LA (cfu/yr)	MOS(cfu/yr)[1]
Maggodee Creek	Fecal Coliform	1.86E+15	8.28E+10	1.86E+15	4.39E+12

1 Virginia includes an explicit MOS by identifying the TMDL target as achieving the total fecal coliform water quality concentration of 190 cfu/100ml as opposed to the WQS of 200 cfu/ml. This can be viewed explicitly as a 5% MOS.

EPA believes it is important to recognize the conceptual difference between waste load allocation (WLA) values, load allocation (LA) values for sources modeled as being directly deposited to the stream segment, and LA values for flux sources of fecal coliform to land use categories. WLA values and LA values for direct sources represent the amount of fecal coliform which is actually deposited into the stream segment. However, LA values for flux sources represent the amount of fecal coliform deposited to the land. The actual amount of fecal coliform which reaches the stream segment will be significantly less than the amount of fecal coliform deposited to the land. The HSPF model, which considers landscape processes which affect fecal coliform runoff from land uses, determines the amount of fecal coliform which reaches the stream segment. The LA in Table #1 is the amount of colony forming units reaching the stream outlet from nonpoint sources annually.

The United States Fish and Wildlife Service (USFWS) has been provided with a copy of this TMDL. A formal response from the USFWS has not been received.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all eight basic requirements for establishing a fecal coliform TMDL for Maggodee Creek. EPA is therefore approving this TMDL. Our approval is outlined according to the regulatory requirements listed below.

[5]Supra, footnote #4.

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

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (directly deposited to the Creek) have caused violations of the water quality standards and designated uses on Maggodee Creek. The water quality criterion for fecal coliform is a geometric mean 200 cfu (colony forming units)/100ml or an instantaneous standard of no more than 1,000 cfu/100ml. Two or more samples over a 30 day period are required for the geometric mean standard. Therefore, most violations of the State's water quality standard are due to violations of the instantaneous standard.

The HSPF model is being used to determine the fecal coliform deposition rates to the land as well as loadings to the stream from point and other direct deposit sources necessary to support the fecal coliform water quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of fecal coliform to Maggodee Creek will ensure that the criterion is attained.

Fecal coliform production rates within the watershed are attained from a wide array of sources on the farm practices in the area (land application rates of manure), the amount and concentration of farm animals, point sources in the watershed, animal access to the stream, wildlife in the watershed, wildlife fecal production rates, land uses, weather, stream geometry, etc. This information is used in the development of the model.

The hydrology component of the model for all the Blackwater TMDLs was developed on United States Geologic Survey (USGS) gage #02056900 on the Blackwater River. The percent error of the simulated flow versus observed flow was within the acceptable limit of 10% and the calibration was deemed acceptable. The model was calibrated to USGS gage #02056900 data from October 01, 1994 through September 30, 1998. The model was then validated, applied to a different time period to determine if it still accurately reflected observed conditions, to USGS gage #02056900 data from January 01, 1991 to September 30, 1994 and October 01, 1980 to September 30, 1981. The validation run was also deemed acceptable with an error of 12.6%.

A regression analysis was performed on instantaneous flow measurements at the USGS gage to flow measurements made at the watershed outlet by VADEQ. This was done to transform the USGS flow to the outlet of the impaired water, thus creating a continuous flow record. Water quality sampling was used to determine an average ratio of flow at the VADEQ monitoring stations to the watershed outlet. This process was then conducted for the simulated flow measurements. These ratios were then evaluated to determine the accuracy of the model on a finer (subwatershed) scale.

The water quality calibration was conducted using data from January 1, 1993 to December 31, 1995.[6] Parameters such as the fecal coliform concentration in interflow, the intensity of rainfall that will cause 90% of the pollutant to be washed off, decay rate, and the

[6]MapTech, 2001.Fecal Coliform TMDL (Total Maximum Daily Load) Development for Maggodee Creek, Virginia.

maximum accumulation of a pollutant on the land surface were changed to create a better correspondence between observed and simulated conditions. The decay rate is used to simulate how settlement and die-off affect the in-stream loading. The first order decay rate influences the land-based and in-stream loading.

EPA believes that using HSPF to model and allocate fecal coliform will ensure that the designated uses and water quality standards will be attained and maintained for Maggodee Creek.

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

Total Allowable Loads

Virginia indicates that the total allowable loading of fecal coliform is the sum of the loads allocated to land based, precipitation driven nonpoint source areas (good pasture, poor pasture, cropland, forest, urban, farmstead, loafing lots, and livestock access), directly deposited nonpoint sources of fecal coliform (cattle in-stream, wildlife in-stream, straight pipes, and lateral flow), and point sources. Activities such as the application of manure, fertilizer, and the direct deposition of wastes from grazing animals are considered fluxes to the land use categories. The actual value for the total fecal load can be found in Table #1 of this document. The total allowable load is calculated on an annual basis due to the nature of HSPF model.

Waste Load Allocations

Boones Mill Wastewater Treatment Plant (WWTP) is the only point source discharging to the impaired segment of Maggodee Creek. Boones Mill WWTP has an effluent limit of 200cfu/100 ml. The treatment plant is required to chlorinate its effluent. Therefore, the actual end of pipe concentrations are much lower than the permitted concentrations. The plant was modeled in the allocation scenario as discharging its permitted concentration (200 cfu/100 ml) at its design flow capacity (0.3 million gallons per day).

EPA regulations require that an approvable TMDL include individual Waste Load Allocations (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 NPDES permit that is inconsistent with the WLAs established for that point source.

Table #2 - Waste Load Allocations for the Impaired Segment of Maggodee Creek

Facility	Permit Number	Existing Load	Allocated Load
Boones Mill WWTP	VA0067245	8.27E+10	8.27E+10

Load Allocations

According to federal regulations at 40 CFR 130.2 (g), load allocations 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 nonpoint source loads should be distinguished.

VADEQ recognizes the significant loading of fecal coliform from cattle in-stream, straight pipes, wildlife in-stream, and failed septic systems (lateral flow). These sources are not dependent on a transport mechanism to reach a surface waterbody and therefore can impact water quality during low and high flow events. As stated above a factor value was incorporated into the loading. This factor value was an attempt to address an unknown mechanism that increased the observed fecal coliform concentrations. The model developed for this TMDL used a factor value based on the likelihood that cattle in-stream were causing the resuspension of fecal coliform in the sediment. Table #3 illustrates the load allocation for the land application of fecal coliform, the loading to each land use. The load that reaches the stream from each land use will be significantly smaller than the amount of fecal coliform deposited to the land (quantities listed in the table).

Table #3 - Load allocation for the land application of fecal coliform

Source	Existing Load(cfu/yr)	Allocated Load(cfu/yr)	Percent Reduction
Good Pasture	1.69E+15	1.69E+15	0%
Poor Pasture	5.89E+15	5.89E+15	0%
Cropland	1.92E+16	1.92E+16	0%
Forest	1.20E+15	1.20E+15	0%
Urban	1.09E+15	1.09E+15	0%
Farmstead	4.47+E13	4.47+E13	0%
Livestock Access[1]	1.31E+14	4.36E+14	-233%
Loafing Lot	1.86E+15	1.86E+15	0%
Straight Pipes	6.44E+13	0.00	100%
Lateral Flow	3.09E+09	3.09E+09	0%
Wildlife In-Stream	2.54E+13	3.80E+12	85%
Cattle In-Stream	1.28E+15	0.00	100%

1 Livestock access areas are areas where cattle currently have access to the stream. After the implementation of this TMDL, these areas will no longer provide the cattle with access to the stream. The increase in loading to this area is a result of the Cattle In-Stream load being applied to this land segment.
This table documents the allowable loading to each land use, significantly smaller amount of fecal colifrom will actually be reaching the stream.

3) The TMDL considers the impacts of background pollution.

A background concentration was set for all land segments by adding 10% of the total wildlife load to each land segment.

4) The TMDL considers critical environmental conditions.

EPA regulations at 40 CFR 130.7 (c)(1) require 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 Maggodee Creek 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[7]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of

[7]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

occurrence but when modeled to insure that water quality standards will be met for the remainder of conditions. 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.

The sources of bacteria for these stream segments were a mixture of dry and wet weather driven sources. Therefore, the critical condition for Maggodee Creek was represented as a typical hydrologic year. However, the most stringent reductions were needed to insure that water quality standards were met during extreme low flows. It should be noted that low flow events occurred more often than wet weather events and therefore it was essential that the standard be maintained during these periods. Runoff events occurred less than 8% of the time, based on rainfall analysis from 1994-1999. Therefore, if the geometric mean of fecal coliform concentrations during non-runoff event periods is 100 cfu/100 ml, then the geometric mean of fecal coliform concentrations during runoff events could be as much as 4 orders of magnitude greater and the Commonwealth's water quality standard (30-day, geometric mean < 200 cfu/100ml) would still be met[8].

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flow normally occurs during the early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods. Consistent with our discussion regarding critical conditions, the HSPF model and TMDL analysis will effectively consider seasonal environmental variations.

The model also accounted for seasonal variations in fecal coliform loading. Fecal coliform loads changed for many of the sources depending on the time of the year. For example, cattle spent more time in the stream in the summer and animals were confined for longer periods of time in the winter. Therefore, the loading from cattle in-stream was greatest in the summer when there were more cattle in the stream for longer periods of time. This loading was further enhanced by the low flows encountered during the summer months.

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. Margins of safety may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the wasteload allocation, load allocation, or TMDL.

Virginia includes an explicit margin of safety by establishing the TMDL target water quality concentration for fecal coliform at 190 cfu/ 100mL, which is more stringent than

[8] Supra, footnote #3.

Virginia's water quality standard of 200 cfu/100 ml. This would be considered an explicit 5% margin of safety.

7) The TMDLs have been subject to public participation.

Seven meetings were held to discuss the TMDL and TMDL process. There was one semi-public meeting, three public meetings associated with TMDL development on the upper four Blackwater segments, two public meetings on the Lower Blackwater and Maggodee Creek, and a public meeting for a select group of farmers. Two one-hour programs and the February 16, 2000 meeting were televised for additional outreach. All of the public meetings were advertised in the *Virginia Register*.

8) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. 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 issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the Clean Water Act, commonly referred to as the Nonpoint Source Program. Additionally, Virginia's Unified Watershed Assessment, an element of the Clean Water Action Plan, could provide assistance in implementing this TMDL.