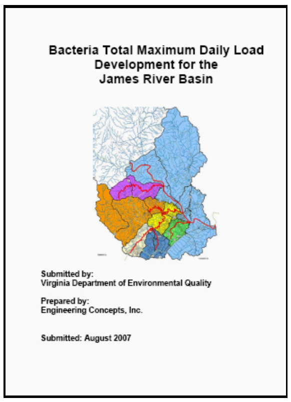
Amendment to the TMDL document, titled *Bacteria Total Maximum Daily Load Development for the James River Basin* (Submitted to VADEQ August 2007)

1. INTRODUCTION

In addressing provisions of the Clean Water Act and agreements with the United States Environmental Protection Agency, Virginia's Department of Environmental Quality initiated the TMDL development process for seven bacteria impaired segments in the area of Lynchburg, Virginia.



James River	*from Holcomb Rock Dam to Archer Creek*
Ivy Creek	*from Cheese Creek to Blackwater Creek*
Fishing Creek	*from its headwaters to the James River*
Blackwater Creek	*from Tomahawk and Burton Creeks to the James River*
Tomahawk Creek	*from its headwaters to Burton Creek*
Burton Creek	*from its headwaters to Tomahawk Creek*
Judith Creek	*from its headwaters to the James River*

The resulting TMDL document was submitted to VADEQ in August 2007, and was titled *Bacteria Total Maximum Daily Load Development for the James River Basin*. In progressing toward implementation planning for the impaired waters, two issues were identified that required attention – specifically, the bacteria standard used for setting allocations in the original TMDL and the land area modeled for the TMDL. With regard to the bacteria standard used for setting allocations, the proper standard was applied at the time of TMDL development, however, the standard has since been changed. While the original TMDL is protective of the new standard, the loading reduction scenarios needed to be re-visited in light of the new standard. Regarding the land area modeled during development of the TMDL, the description of the impaired segment of the James River indicates that it continues to the confluence of Archer Creek. The watershed for this segment includes Beaver Creek, a significant tributary to the James River, which has a fecal-bacteria impairment and required a TMDL. However, this area was not modeled during TMDL development. This amendment seeks to address these two issues.

The TMDL for Beaver Creek has now been completed. This area has been incorporated into the existing TMDL model for the impaired waters described above and the bacteria loads have been re-allocated using the current standard. This document addresses the portions of the original document that have changed. The original modeling description and calibration details remain unaffected. Modeling of the additional watershed area considered in this amendment (*i.e.*, Beaver Creek) can be found in the document titled *Fecal Bacteria Total Maximum Daily Load Development for Beaver Creek in Campbell County, Virginia*, submitted to VADEQ in March 2010. This amendment specifically addresses changes to the fecal bacteria standard, and the revised allocation of loads in the seven impaired segments described above, resulting from incorporation of the new standard and bacteria input to the James River from the Beaver Creek watershed.

2. APLICABLE WATER QUALITY STANDARDS AND TMDL ENDPOINT

Virginia adopted its current *E. coli* and *enterococci* standard in January 2003, and it was updated in 2009. The criteria which were used in developing the bacteria TMDLs in this study are outlined in Section 9 VAC 25-260-170 (Bacteria; other recreational waters) and read as follows:

> *A. The following bacteria criteria (colony forming units (cfu)/100mL) shall apply to protect primary contact recreational uses in surface waters, except waters identified in subsection B of this section:*
>
> *E. coli bacteria shall not exceed a monthly geometric mean of 126 cfu/100mL in freshwater. Enterococci bacteria shall not exceed a monthly geometric mean of 35 cfu/100mL in transition and saltwater.*
>
> 1. *See 9VAC25-260-140 C for boundary delineations for freshwater, transition and saltwater.*
> 2. *Geometric means shall be calculated using all data collected during any calendar month with a minimum of four weekly samples.*
> 3. *If there [are] insufficient data to calculate monthly geometric means in freshwater, no more than 10% of the total samples in the assessment period shall exceed 235 E. coli cfu/100mL.*
> 4. *If there [are] insufficient data to calculate monthly geometric means in transition and saltwater, no more than 10% of the total samples in the assessment period shall exceed enterococci 104 cfu/100mL.*

5. *For beach advisories or closures, a single sample maximum of 235 E. coli cfu/100mL in freshwater and a single sample maximum of 104 enterococci cfu/100mL in saltwater and transition zones shall apply.*

B. The following bacteria criteria per 100mL (cfu/100mL) of water shall apply to protect secondary contact recreational uses in surface waters:

E. coli bacteria shall not exceed a monthly geometric mean of 630 cfu/100mL in freshwater. Enterococci bacteria shall not exceed a monthly geometric mean of 175 cfu/100mL in transition and saltwater.

1. *See 9VAC25-260-140 C for boundary delineations for freshwater, transition and saltwater.*
2. *Geometric means shall be calculated using all data collected during any calendar month with a minimum of four weekly samples.*
3. *If there [are] insufficient data to calculate monthly geometric means in freshwater, no more than 10% of the total samples in the assessment period shall exceed 1,173 E. coli cfu/100mL.*
4. *If there [are] insufficient data to calculate monthly geometric means in transition and saltwater, no more than 10% of the total samples in the assessment period shall exceed enterococci 519 cfu/100mL.*
5. *Where the existing water quality for bacteria is below the geometric mean criteria in a water body designated for secondary contact in subdivision 6 of this subsection that higher water quality will be maintained in accordance with 9VAC25-260-30 A 2.*

2.1 Selection of a TMDL Endpoint

The first step in developing a TMDL is the establishment of in-stream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. In-stream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load reductions specified in the TMDL. For the bacteria impairments in this study, the applicable endpoints and associated target values can be determined directly from the Virginia water quality regulations. In order to remove a waterbody from a state's list of impaired waters, the Clean Water Act requires compliance with that state's water quality standard.

Since modeling provided simulated output of *E. coli* concentrations at 1-hour intervals, assessment of TMDLs was made using the geometric mean standard of 126 cfu/100 ml.

Therefore, the in-stream *E. coli* target for the TMDLs in this study was a monthly geometric mean not exceeding 126 cfu/100 ml.

3. ALLOCATION

Four permits that were not included in the original TMDL have been added to the model. A brief description of the permits is provided in Table 1.

Table 1. VPDES permitted point sources added to the study.

Permit	Receiving Stream(s)	Facility Description	Permitted for Fecal Bacteria Control
VA0061042	Opossum Creek (James River Impairment)	Bennies Mobile Home Park Sewage Treatment Plant (0.035 MGD)	Yes
VA0082546	Harris Creek, UT (James River Impairment)	Amherst Co Service Authority Westbriar Subdivision (0.015 MGD)	Yes
VA0027618	Harris Creek (James River Impairment)	US Department of Labor-Rescare Incorporated (0.04 MGD)	Yes
VAR040118	Burton Creek	Central Virginia Community College MS4 (~ 45 acres)	Yes

Allocation scenarios were modeled using the HSPF model. Scenarios were created by reducing direct and land-based bacteria until the water quality standards were attained. Pollutant concentrations were modeled over the entire duration of a representative modeling period and pollutant loads were adjusted until the standard was met. The development of the allocation scenario was an iterative process that required numerous runs with each followed by an assessment of source reduction against the calendar month geometric-mean standard of 126 cfu/100 ml.

Allocation scenarios were run sequentially, beginning with headwater impairments, and then continuing with downstream impairments until all impairments were allocated to 0% exceedances of the applicable standard. Table 2 shows the resulting allocation scenarios. All scenarios were run with 100% reduction of loads from illicit discharges (*i.e.*, straight pipes). The watersheds were all sensitive to reductions in "direct" loads, that is, loads that are delivered directly and persistently to the stream, without dependency on runoff events.

Bacteria loads in runoff from agricultural and urban/residential lands were given equal reductions. Initially, the same reductions were applied to Combined Sewer Overflow (CSO) loads in the upstream watersheds (*i.e.*, Ivy, Fishing, and Blackwater Creeks). However, these reductions were increased to 100%, upon discussion with local stakeholders, as these loads are considered to be more readily controllable (likely through separation) than the CSO loads in the James River. Three scenarios are presented for the James River Impairment. The first shows that a 92% reduction in the CSO loads, in combination with the indicated upstream reductions, would address the impairment, without additional reductions from land loads. The second shows that with 100% reduction of other anthropogenic loads, a 59% reduction of the CSO loads is still needed, in combination with the indicated upstream reductions. The third scenario was the selected scenario for the TMDL and represents equal (75%) reductions from agricultural lands, urban/residential lands, and CSOs.

Table 2. Allocation scenarios for achieving fecal bacteria standards in impaired drainages of the James River near Lynchburg, VA.

	% Reduction in Fecal Bacteria Loading From Existing Conditions						
	Wildlife Direct	**Wildlife Land Based**	**Livestock Direct**	**Agricultural Land Based**	**Human Direct**	**Human and Pet Land Based**	**CSOs[2]**
Impaired Segment[1]		*Forest & Wetland*		*Cropland, Pasture*	*Straight Pipes*	*Urban & Residential*	
Beaver Creek	0	0	99	99	100	64	--
Judith Creek	0	0	99	0	100	0	--
Ivy Creek	0	0	99	87	100	87	100
Tomahawk Creek	0	0	99	87	100	87	--
Burton Creek	0	0	100	87	100	87	--
Fishing Creek	0	0	72[3]	67[3]	100	67	100
Blackwater Creek	0	0	92	87	100	87	100
James River (CSO focus)	0	0	0	0	100	0	92
James River (non-CSO focus)	0	0	100	100	100	100	59
James River	0	0	83	75	100	75	75

[1] Final TMDL Scenarios are indicated by shading.
[2] The City of Lynchburg is currently updating their Combined Sewer Overflow (CSO) LTCP, one element of which is improving the model used to estimate CSO loads. Improvements to the estimates of CSO loads may impact the resulting TMDL allocations.
[3] Although the original TMDL called for reductions to direct livestock and agricultural sources within Fishing Creek, it has subsequently been determined, through stakeholder input, that there is a drastically reduced population of livestock within the Fishing Creek impairment watershed, therefore no agricultural BMPs are required.

Table 3 shows the average annual TMDL, which gives the average amount of bacteria that can be present in the stream in a given year, and still meet existing water quality standards. These values are output from the HSPF model and incorporate in-stream die-off and other hydrological and environmental processes involved during runoff and stream routing techniques within the HSPF model framework. To account for future growth of urban and residential human populations, one percent of the final TMDL was set aside for future growth in the WLA portion.

Starting in 2007, the USEPA has mandated that TMDL studies include a daily load as well as the average annual load previously shown. The approach to developing a daily maximum load was similar to the USEPA approved approach to developing load duration bacterial TMDLs. The daily average in-stream loads for the study area are shown in Table 4.

The City of Lynchburg is currently updating their CSO Long-Term Control Plan (LTCP), one element of which is improving the model used to estimate CSO loads. Improvements in the estimates of CSO loads may impact the resulting TMDL allocations. The TMDL load will not change, as this load is modeled based on meeting the in-stream standard, however, the allocation of loads among sources may change. Table 5 presents a sensitivity analysis for reductions required of the CSO load as a result of changes in the existing load, based on improvements in the CSO model.

Table 3. Final average annual in-stream E. coli bacterial loads (cfu/year) modeled after TMDL allocation in the study area impairments.

Impairment	WLA	LA	MOS	TMDL
Beaver Creek	**3.26E+11**	**2.97E+13**	Implicit	**3.00E+13**
VA0062031 [1]	*2.61E+10*			
Future Load [2]	*3.00E+11*			
Judith Creek	**5.60E+12**	**7.83E+12**		**1.34E+13**
VA0091162 [1]	*2.61E+10*			
VAR040008 (MS4-Lynchburg) VAR040015 (MS4-VDOT) [3]	*5.44E+12*			
Future Load [2]	*1.34E+11*			
Ivy Creek	**4.44E+12**	**4.44E+13**		**4.88E+13**
VAR040008 (MS4-Lynchburg) VAR040015 (MS4-VDOT) [3]	*3.96E+12*			
VA0024970 (CSO) [5]	*0*			
Future Load [2]	*4.88E+11*			
Tomahawk Creek	**6.06E+12**	**6.44E+12**		**1.25E+13**
VAR040008 (MS4-Lynchburg) VAR040015 (MS4-VDOT) [3]	*3.94E+12*			
Future Load [2]	*1.25E+11*			
Burton Creek	**4.64E+12**	**6.54E+12**		**1.12E+13**
VAR040008 (MS4-Lynchburg) VAR040015 (MS4-VDOT) [3]	*4.27E+12*			
VAR040118 [3]	*2.6E+11*			
Future Load [2]	*1.12E+11*			
Fishing Creek	**2.93E+12**	**9.34E+12**		**1.23E+13**
VAR040008 (MS4-Lynchburg) VAR040015 (MS4-VDOT) [3]	*2.81E+12*			
VA0024970 (CSO) [5]	*0*			
Future Load [2]	*1.23E+11*			
Blackwater Creek	**3.28E+13**	**1.62E+14**		**1.95E+14**
VAR040008 (MS4-Lynchburg) VAR040015 (MS4-VDOT) [3]	*3.09E+13*			
VA0024970 (CSO) [5]	*0*			
Future Load [2]	*1.95E+12*			
James River	**2.69E+15**	**1.45E+14**		**2.84E+15**
VA0063657 [1]	*2.59E+09*			
VA0024970 [1]	*3.83E+13*			
VA0024970 (CSO) [4,5]	*2.14E+15*			
VA0062031 [1]	*3.00E+11*			
VA0061042 [1]	*3.81E+10*			
VA0082546 [1]	*1.63E+09*			
VAR040008 (MS4-Lynchburg) VAR040015 (MS4-VDOT) [3]	*3.63E+14*			
Future Load [2]	*1.53E+14*			

1 Any issued permit will include bacteria effluent limits in accordance with applicable permit guidance and will ensure that the discharge meets the applicable numeric water quality criteria for bacteria at the end-of-pipe.

2 The WLA reflects an allocation for potential future permits issued for bacteria control.

3 For MS4/VSMP permits, the permittee may address the TMDL WLAs for stormwater through the iterative implementation of programmatic BMPs. Each of the Lynchburg MS4 loads has been aggregated with a portion of the adjacent VDOT MS4 load, due to the continuity of the system.

4 When portions of the City's Combined Sewer System are separated, WLA(s) will need to be transferred from the VPDES permit to the municipal separate storm sewer system (MS4) for the separated CSS area.

5 The WLA associated with the combined sewer system will be addressed through the performance standards for the facilities in the approved Long Term Control Plan (LTCP). If Water Quality Standards are attained earlier than expected, or are not attained after the completion of CSO LTCP, as determined by post-construction monitoring, changes to the LTCP may be required.

Table 4. Final average daily in-stream E. coli bacterial loads (cfu/day) modeled after TMDL allocation in the study area impairments.

Impairment	WLA	LA	MOS	TMDL[2]
Beaver Creek	**8.93E+08**	**5.64E+11**	Implicit	**5.65E+11**
VA0062031 [1]	*7.15E+07*			
Future Load [3]	*8.22E+08*			
Judith Creek	**1.53E+10**	**4.62E+11**		**4.78E+11**
VA0091162 [1]	*7.15E+07*			
VAR040008 (MS4-Lynchburg) } [4] VAR040015 (MS4-VDOT)	*1.49E+10*			
Future Load [3]	*3.67E+08*			
Ivy Creek	**1.22E+10**	**1.47E+12**		**1.48E+12**
VAR040008 (MS4-Lynchburg) } [4] VAR040015 (MS4-VDOT)	*1.08E+10*			
VA0024970 (CSO) [6]	*0*			
Future Load [3]	*1.34E+09*			
Tomahawk Creek	**1.66E+10**	**4.67E+11**		**4.83E+11**
VAR040008 (MS4-Lynchburg) } [4] VAR040015 (MS4-VDOT)	*1.08E+10*			
Future Load [3]	*3.42E+08*			
Burton Creek	**1.27E+10**	**7.03E+11**		**7.15E+11**
VAR040008 (MS4-Lynchburg) } [4] VAR040015 (MS4-VDOT)	*1.17E+10*			
VAR040118 [4]	*7.12E+08*			
Future Load [3]	*3.07E+08*			
Fishing Creek	**8.03E+09**	**5.04E+11**		**5.12E+11**
VAR040008 (MS4-Lynchburg) } [4] VAR040015 (MS4-VDOT)	*7.70E+09*			
VA0024970 (CSO) [6]	*0*			
Future Load [3]	*3.37E+08*			
Blackwater Creek	**8.99E+10**	**3.27E+12**		**3.36E+12**
VAR040008 (MS4-Lynchburg) } [4] VAR040015 (MS4-VDOT)	*8.47E+10*			
VA0024970 (CSO) [6]	*0*			
Future Load [3]	*5.34E+09*			
James River	**7.383E+12**	**1.67E+14**		**1.74E+14**
VA0063657 [1]	*7.10E+06*			
VA0024970 [1]	*1.05E+11*			
VA0024970 (CSO) [5, 6]	5.86E+12			
VA0062031 [1]	*8.22E+08*			
VA0061042 [1]	*1.04E+08*			
VA0082546 [1]	*4.47E+06*			
VAR040008 (MS4-Lynchburg) } [4] VAR040015 (MS4-VDOT)	*9.95E+11*			
Future Load [3]	*4.19E+11*			

[1] Any issued permit will include bacteria effluent limits in accordance with applicable permit guidance and will ensure that the discharge meets the applicable numeric water quality criteria for bacteria at the end-of-pipe.

[2] The TMDL is presented for the 99th percentile daily flow condition at the numeric water quality criterion of 235 cfu/100ml. The TMDL is variable depending on flow conditions. The appropriate numeric water quality criterion will be used to assess progress toward TMDL goals.

[3] The WLA reflects an allocation for potential future permits issued for bacteria control.

[4] For MS4/VSMP permits, the permittee may address the TMDL WLAs for stormwater through the iterative implementation of programmatic BMPs. Each of the Lynchburg MS4 loads has been aggregated with a portion of the adjacent VDOT MS4 load, due to the continuity of the system.

[5] When portions of the City's Combined Sewer System are separated, WLA(s) will need to be transferred from the VPDES permit to the municipal separate storm sewer system (MS4) for the separated CSS area.

[6] The WLA associated with the combined sewer system will be addressed through the performance standards for the facilities in the approved Long Term Control Plan (LTCP). If Water Quality Standards are attained earlier than expected, or are not attained after the completion of CSO LTCP, as determined by post-construction monitoring, changes to the LTCP may be required.

Table 5. Impact of improved CSO load model on reductions required from CSOs.

Correction to CSO Load	Load Reduction Needed from CSOs
-15%	70.6%
-10%	72.2%
-5%	73.7%
0%	75.0%
5%	76.2%
10%	77.3%
15%	78.3%