A Total Maximum Daily Load Analysis for Recreational Uses of the Titicus River Sub-Regional Basin

FINAL

This document has been established pursuant to the requirements of Section 303(d)of the Federal Clean Water Act

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TABLE OF CONTENTS

TABLES

APPENDICES

INTRODUCTION

The Total Maximum Daily Load (TMDL) analysis is a management tool used to restore impaired waters by establishing the maximum amount of a pollutant that a waterbody can receive without adverse impacts to fish, wildlife, recreation, or other public uses. A TMDL takes into account pollutant loadings from point sources, nonpoint sources, background levels and incorporates a margin of safety. The completed analysis provides guidance for responsible parties to use as a framework for developing an implementation plan to reduce pollutants in impaired waters.

A Total Maximum Daily Load (TMDL) analysis was completed for indicator bacteria in the Titicus River Sub-Regional Basin (Figure 1 of Appendix A). This waterbody is included on the most recent *List of Connecticut Waterbodies Not Meeting Water Quality Standards* (Chapter 3 of the *2010 State of Connecticut Integrated Water Quality Report*[1]) due to exceedences of the indicator bacteria criteria contained within the State *Water Quality Standards*[2] (WQS). Under section 303(d) of the Federal Clean Water Act (CWA), States are required to develop TMDLs for waters impacted by pollutants that are included on their Impaired Waters Lists, and for which technology-based controls are insufficient to achieve water quality standards.

In general, the TMDL represents the maximum loading that a waterbody can receive without exceeding the water quality criteria, which have been adopted into the WQS for that parameter. Federal regulations specify that TMDL loadings may be expressed as a mass per time, toxicity, or other appropriate measure[3]. In this TMDL, loadings are expressed as the average percent reduction from current loadings that must be achieved to meet water quality standards. The U.S. Environmental Protection Agency's (EPA) most recent guidance recommends that all TMDLs and associated load allocations and wasteload allocations be expressed in terms of daily time increments[4]. The percent reduction TMDL for the Titicus River Regional Basin is applicable each and every day until recreational use goals are attained. Federal regulations require that the TMDL analysis identify the portion of the total loading which is allocated to point source discharges (termed the Wasteload Allocation or WLA) and the portion attributed to nonpoint sources (termed the Load Allocation or LA), which contribute that pollutant to the waterbody. In addition, TMDLs must include a Margin of Safety (MOS) to account for uncertainty in establishing the relationship between pollutant loadings and water quality. Seasonal variability in the relationship between pollutant loadings and WQS attainment is also considered in TMDL analysis.

The Titicus River Sub-Regional Basin is located within the Town of Ridgefield. Ridgefield has designated urban areas, as defined by the U.S. Census Bureau[5] and is required to comply with the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 permit) (see Appendix E) issued by the Connecticut Department of Energy and Environmental Protection (DEEP). This general permit is applicable to municipalities that are identified in Appendix A of the MS4 permit, that contain designated urban areas and discharge stormwater via a separate storm sewer system to surface waters of the State. The permit requires municipalities to develop a Stormwater Management Plan (SMP) to reduce the discharge of pollutants, as well as to protect water quality. The MS4 permit is discussed further in the "TMDL Implementation Guidance" section of this document. Additional information

regarding stormwater management and the MS4 permit can be obtained on DEEP's website (see Appendix E).

TMDLs that have been established by states are submitted to the EPA Regional Office for review. The EPA can either approve the TMDL or disapprove the TMDL and act in lieu of the State. TMDL analyses for indicator bacteria in the Titicus River Sub-Regional Basin are provided herein. As required in a TMDL analysis, load allocations are determined, a margin of safety is included, and seasonal variation is considered. This document also includes recommendations for TMDL implementation as well as a water quality monitoring plan.

PRIORITY RANKING

Within the Integrated Water Quality Report (Table 3-8)[1], DEEP indentifies water body segments for which TMDLs are expected to be prepared in the near term. Waters are prioritized for TMDL development based on a variety of reasons such as threats to human health, the potential for a TMDL analysis to result in improved water quality, coordinating with or providing support to regulatory programs designed to improve water quality and comments received during the public review of the proposed 303(d) list. Changes may be made from this list based on data availability, the need to revise priorities to address additional water quality concerns or staff and other resource constraints.

Table 1. The impairment status and TMDL development priority for the Titicus River Sub-Regional Basin based on the *State of Connecticut Integrated Water Quality Report*[1]**.**

Waterbody Name	Waterbody Segment	Waterbody Segment Description	303(d) Listed	Impairment Use / Cause	Priority
Titicus River Sub-Regional Basin (Ridgefield)	CT8104-00-01	From New York state border (in large marsh along north side of North Salem Road (Route 116)), US to headwaters (at unnamed marsh, US of Old West Mountain Road crossing), Ridgefield. (Segment includes several ponds and marshes)	Yes	Recreation / *Escherichia coli*	2011

DESCRIPTION OF THE WATERBODY

See "Site Specific Information" in Appendix B.

POLLUTANT OF CONCERN AND POLLUTANT SOURCES

Potential sources of indicator bacteria include point and nonpoint sources, such as stormwater runoff, agriculture, sanitary sewer overflows (collection system failures), illicit discharges and inappropriate discharges to the waterbody. Potential sources that have been tentatively identified based on land-use (Figure 3 of Appendix A) and site survey work for each of the waterbodies are presented in Table 2 below. However, the list of potential sources is general in nature and is not

comprehensive. There may be other sources not listed here which contribute to the observed water quality impairment. More detailed evaluation of sources is expected to become available as activities are conducted to implement this TMDL.

Table 2. Potential sources of bacteria for the Titicus River Sub-Regional Watershed.

Waterbody Name	Nonpoint Sources	Point Sources
Titicus River Sub-Regional Basin	Failed Septic Systems, Unspecified Urban stormwater, Source unknown	Regulated stormwater runoff, illicit connections to storm sewers, Animal waste, other unknown sources

There are no municipal Wastewater Treatment Plants in the Titicus Sub-regional Basin. The Town of Ridgefield is required to comply with the MS4 General Permit (Figure 2 of Appendix A), however no facilities are registered in the Industrial, or Commercial Stormwater General Permit programs. There is one site currently registered in the construction General Permit Program. No monitoring is required for compliance with this program. There are 5 permits issued by DEEP in the Titicus sub-regional Basin, one stormwater construction general permit, two underground storage tanks, a registered discharge to the ground and one lake discharge for pesticide application (Table 3). The Underground Injection (UI) permit registered to Scotland Elementary School is the only permitted facility that may be considered a potential source of bacteria in the watershed. This permit requires the town to monitor for fecal coliform quarterly. Data is available for this site for 2009 and 2010. In 2009 this discharge location was reported as dry. In 2010 the fecal coliform amount was reported as non detectable.

Table 3. Permits issued by DEEP in the Titicus River Sub-Regional Basin.

Registrant	NPDES ID	Discharges to	Type of Permit
Town of Ridgefield	GSM000041	Titicus River Basin	Municipal Stormwater General Permit
Francis Cleaners Inc	UST(118-7166)	Titicus River	Underground Storage Tank
Scotland Elementary School	UI0000380 UST(118-9448)	Titicus River	Underground Injection Underground Storage Tank
Mamanasco Lake	AQUA-2010-202	Titicus River Basin	Aquatics Permit for Pesticide application
Harrison Property	GSN001745	Titicus River	Stormwater Construction General Permit

An aerial view of the watershed shows the northern area has a large golf course, a large horse farm, and many lakes and large homes throughout the watershed. There are at least 4 schools

with ball fields and large amounts of impervious cover. A review of 6 *E. coli* samples collected by the Town of Ridgefield within the watershed as part of their MS4 annual monitoring requirement between 2007-2010 indicated that bacteria levels ranged from 135 to >2,419 col/100mls.

APPLICABLE SURFACE WATER QUALITY STANDARDS

Connecticut's WQS establish criteria for bacterial indicators of sanitary water quality that are based on protecting recreational uses such as swimming (both designated and non-designated swimming areas), kayaking, wading, water skiing, fishing, boating, aesthetic enjoyment and others. Indicator bacteria criteria are used as general indicators of sanitary quality based on the results of EPA research conducted in areas with known human fecal material contamination[6]. The EPA established a statistical correlation between levels of indicator bacteria and human illness rates, and set forth guidance for States to establish numerical criteria for indicator bacteria organisms so that recreational use of the water can occur with minimal health risks. However, it should be noted that the correlation between indicator bacteria densities and human illness rates varies greatly between sites and the presence of indicator bacteria does not necessarily indicate that human fecal material is present since indicator bacteria occur in all warm-blooded animals.

The applicable water quality criteria for indicator bacteria to the Titicus River Sub-Regional Regional Basin are presented in Table 4. These criteria are applicable to all recreational uses established for these waters. However, it should be noted that the water quality classification and criteria should not be considered as a certification of quality by the State or an approval to engage in certain activities such as swimming. Full body contact should be avoided immediately downstream of wastewater treatment plants, in areas known to have high levels *E. coli*, and during times when *E. coli* levels are expected to be particularly high, such as during and following storm events. The general recreational criteria listed in the WQS for "all other recreational uses" are applicable throughout the watershed since there are no designated or non-designated swimming areas located in segments covered by the TMDL.

Table 4. Applicable indicator bacteria criteria for the subject waterbodies.

Waterbody Name	Waterbody Segment ID	Class	Bacterial Indicator	Criteria
Titicus River Sub-Regional Basin (Ridgefield)	CT8104-00_01	AA	*Escherichia coli* (*E. Coli*)	Geometric mean less than 126 col/100ml Single sample maximum 576 col/100ml

NUMERIC WATER QUALITY TARGET

TMDL calculations were performed consistent with the analytical procedures presented in the guidelines for *Development of TMDLs for Indicator Bacteria in Contact Recreation Areas Using*

the Cumulative Frequency Distribution Function Method[7] included in Appendix D. All data used in the analysis and the results of all calculations are presented in Appendix B. In addition, Appendix B contains a summary of the TMDL analyses for the waterbody. The results are summarized in Table 5.

Table 5. Summary of TMDL analysis.

Waterbody Name	Waterbody Segment Description	Waterbody Segment	Monitoring Site	Average Percent Reduction to Meet Water Quality Standards			
				TMDL	WLA	LA	MOS
Titicus River Sub-Regional Basin (Ridgefield)	From New York state border (in large marsh along north side of North Salem Road (Route 116)), US to headwaters (at unnamed marsh, US of Old West Mountain Road crossing), Ridgefield. (Segment includes several ponds and marshes).	CT8104-00_01	926	61	71	54	Implicit

MARGIN OF SAFETY

TMDL analyses are required to include a margin of safety (MOS) to account for uncertainties regarding the relationship between load and waste load allocations, and water quality. The MOS may be either explicit or implicit in the analysis.

The analytical approach used to calculate the TMDLs incorporates an implicit MOS. Sampling results that indicate quality better than necessary to achieve consistency with the criteria are assigned a percent reduction of "zero" instead of a negative percent reduction. This creates an excess capacity that is averaged as a zero value thereby contributing to the implicit MOS. The indicator bacteria criteria used in this TMDL analysis were developed exclusively from data derived from studies conducted by EPA at high use designated public bathing areas with known human fecal contamination[6]. Therefore, the criteria provide an additional level of protection when applied to waters not used as designated swimming areas or contaminated by human fecal material. As a result, achieving the criteria results in an "implicit MOS". Additional explanation concerning the implicit MOS incorporated into the analysis is provided in Appendix D.

SEASONAL ANALYSIS

Previous investigations by DEEP into seasonal trends of indicator bacteria densities in surface waters indicate that the summer months typically exhibit the highest densities of any season[8]. This phenomenon is likely due to the enhanced ability of indicator bacteria to survive in surface waters and sediment when ambient temperatures more closely approximate those of warm-blooded animals, from which the bacteria originate. In addition, resident wildlife populations are

likely to be more active during the warmer months and more migratory species are present during the summer. These factors combine to make the summer, recreational period representative of "worst-case" conditions. Achieving consistency with the TMDLs through the summer months will result in achieving full support of recreational uses throughout the remainder of the year.

TMDL IMPLEMENTATION GUIDANCE

There are two major approaches to identifying and implementing changes within a watershed to address water quality impairments and incorporate the recommendations of the TMDL: management of stormwater under the stormwater permitting program and development of watershed based plans. The percent reductions established in this TMDL can be achieved by implementing control actions where technically and economically feasible that are designed to reduce *E. coli* loading from nonpoint sources (Load Allocation) and point sources (Waste Load Allocation).

DEEP advocates that a watershed based plan for the Titicus River Basin be developed to implement the TMDL. The following guidance offers suggestions regarding BMP implementation, however the goal is to allow responsible parties flexibility in developing a TMDL implementation plan. DEEP supports an adaptive and iterative management approach where reasonable controls are implemented and water quality is monitored in order to evaluate for achievement of the TMDL goals and modification of controls as necessary.

The TMDLs establish a benchmark to measure the effectiveness of BMP implementation. Achievement of the TMDL is directly linked to incorporation of the provisions of the MS4 permit by municipalities, as well as the implementation of other BMPs to address nonpoint sources. Improper disposal of pet waste and waste from wildlife are potential nonpoint sources of bacteria in the Basin. Information on nuisance wildlife control and pet waste disposal can be found on DEEP's website (see Appendix E). It is expected that as progress is made implementing BMPs, bacteria levels will decrease and the water quality criteria for recreational use will be achieved and maintained. For additional information on Source Control and Pollution Prevention please refer to Chapter 5 of DEEP's Stormwater Manual (see Appendix E). Some point source discharges may be easier to control through identification and regulation, however some sources such as wildlife living in stormdrains or birds nesting under bridges could prove more difficult to control.

DEEP encourages the use of Low Impact Development (LID) techniques as a management measure that may address a variety of nonpoint source issues. LID is a site design strategy intended to maintain or replicate predevelopment hydrology through the use of small-scale controls integrated throughout the site to manage stormwater runoff as close to its source as possible. Infiltration of stormwater through LID helps to remove sediments, nutrients, heavy metals, and other types of pollutants from runoff. Examples of these recommendations can be found in Connecticut's approved watershed based plans (see Appendix E).

It is important to note that the TMDLs are applicable to the entire watershed because they are a measurement of compounded impacts at a single point. As such, corrective actions must be undertaken at the source(s) throughout the watershed whether it is a tributary or illicit discharge pipe, in order to achieve the required percent reductions. Also, the approach to TMDL implementation is anticipated to be on a watershed wide scale, which will require that all sources within the regional basin that are contributing to the in-stream impairment be addressed. Action may be taken by State and Local government, business, academia, volunteer citizens groups, and individuals to promote effective watershed management.

Stormwater Permits

Potential point sources to Titicus River and its tributaries include regulated and unregulated stormwater. Control actions for regulated stormwater include those specified in the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 Permit). Under this permit, municipalities are required to implement minimum control measures in their Stormwater Management Plan (SMP) to reduce the discharge of pollutants, protect water quality, and satisfy the appropriate water quality requirements of the Clean Water Act. The six minimum control measures are:

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control (>1 acre)
- Post-construction Runoff Control
- Pollution Prevention/Good Housekeeping

The minimum control measures include a number of Best Management Practices (BMP) for which an implementation schedule must be developed and submitted to DEEP as Part B Registration. Under the MS4 permit, all minimum control measures must be implemented by January 8, 2009. Each regulated municipality must identify, implement, and assess the effectiveness of measures utilized to comply with SMP requirements. Information regarding Connecticut's MS4 permit can be found on DEEP's website (see Appendix E). In addition, the EPA has developed fact sheets, which provide an overview of the Phase II final rule and MS4 permit, and provide detail regarding the minimum control measures, as well as optional BMPs not required in Connecticut's MS4 permit. The fact sheets can be found on the EPA's website (see Appendix E). Some of the information includes guidance for the development and implementation of Stormwater Management Plans, as well as guidance for establishing measurable goals for BMP implementation.

Upon approval of a TMDL by EPA, Section 6(k) of the MS4 Permit requires the municipality to review its SMP to determine if its stormwater discharges contribute the pollutant(s) for which the TMDL had been designated. If the municipality contributes a pollutant(s) in excess of the designated TMDL allocation, the municipality must modify its SMP to implement the TMDL within four months of TMDL approval by EPA. For the discharges to the TMDL waterbody(ies), the municipality must assess the six minimum measures of its SMP and modify the plan to implement additional necessary controls for each appropriate measure. Particular

focus should be placed on the following plan components: public education program, illicit discharge detection and elimination, stormwater structures cleaning, priority for the repair, upgrade, or retrofit of storm sewer structures.

Watershed Based Plans

One approach to TMDL implementation would be to develop a watershed based plan for the Titicus River Sub-Regional Basin. A watershed based plan formulated at the local level will most efficiently make use of local resources by assigning tasks to responsible parties and serving as an agreed roadmap to reducing bacteria levels in the Basin. DEEP encourages all local stakeholders to continue their efforts by working together to formulate a watershed based plan to implement the TMDL.

Watershed Based Plans funded under the Clean Water Act Section 319 grant program require incorporation of EPA's 9 Planning Elements (see Appendix E). Identification of impairments, load reduction, management measures, technical and financial assistance, public information and education, schedule, milestones, performance and monitoring. The Watershed Based Plan should include a flexible schedule and future implementation of management measures recommended to reduce nonpoint source pollution within the watershed. In some cases, implementation efforts included in the Section 319 funded Watershed Based Plan and the TMDL may be scheduled and coordinated together.

Members of DEEP's Watershed Management Program will continue to provide technical and educational assistance to the local municipalities and other stakeholders, as well as identify potential funding sources, when available, for implementation of the TMDL and monitoring plan. Please see Appendix E for a link to contact information for involved DEEP staff .

WATER QUALITY MONITORING PLAN

A comprehensive water quality monitoring program is necessary to guide TMDL implementation efforts and should be designed, at a minimum, to accomplish two major objectives; source detection and tracking water quality improvements. Monitoring is needed to identify specific sources of bacterial loading which will, in turn, direct BMP implementation efforts. As changes are made within the watershed and BMPs applied, additional monitoring is needed to quantify progress in achieving TMDL established goals.

Water quality monitoring can be incorporated into any implementation activity, however, it is explicitly required under the MS4 permit. Stormwater monitoring is required under Section 6(h)(1)(A) of the MS4 Permit which specifies the following monitoring requirement:

> *"Stormwater monitoring shall be conducted by the Regulated Small MS4 annually starting in 2004. At least two outfalls apiece shall be monitored from areas of primarily industrial development, commercial development and residential development, respectively, for a total of six (6) outfalls monitored. Each monitored outfall shall be selected based on an evaluation by the MS4 that the drainage area of such outfall is representative of the overall nature of its respective land use type."*

This type of monitoring may be referred to as event monitoring because it is scheduled to coincide with a stormwater runoff event. Event monitoring can present numerous logistical difficulties for municipalities and may not be the most efficient way to measure progress in achieving water quality standards. This is particularly true for streams draining urbanized watersheds where many sources contribute to excursions above water quality criteria.

However, a comprehensive water quality monitoring program is necessary to guide TMDL implementation efforts. Therefore, the monitoring program should be designed to accomplish two objectives; source detection to identify specific sources of bacterial loading and direct BMP implementation efforts with fixed station monitoring to quantify progress in achieving TMDL established goals. In order to customize their monitoring plan to better identify TMDL pollutant sources and track the effectiveness of TMDL pollutant reduction measures, the municipality may request written approval from DEEP for an alternative monitoring program as allowed by Section 6(h)(1)(B) of the permit:

> *"The municipality may submit a request to the Commissioner in writing for implementation of an alternate sampling plan of equivalent or greater scope. The Commissioner will approve or deny such a request in writing."*

DEEP advises municipalities with discharges that contribute pollutant(s) for which a TMDL(s) has been designated to request approval for an alternative monitoring program to address both source detection and track the effectiveness of TMDL pollutant reduction measures. Source detection monitoring may include visual inspection of storm sewer outfalls under dry weather conditions, event sampling of individual storm sewer outfalls, and monitoring of ambient in-stream conditions at closely spaced intervals to identify "hot spots" for more detailed investigations leading to specific sources of high bacteria loads. Such monitoring may be performed by municipal staff, citizen volunteers, or contracted to an environmental consulting firm. Further guidance for an alternative municipal monitoring is attached as Appendix C.

Progress in achieving TMDL established goals through BMP implementation may be most effectively gauged through implementing a fixed station ambient monitoring program. DEEP strongly recommends that routine monitoring be performed at the same sites used to generate the data to perform the TMDL calculations. Sampling should be scheduled at regularly spaced intervals during the recreational season (May 1- Sept 30). In this way the data set at the end of each season will include ambient values for both "wet" and "dry" conditions in relative proportion to the number of "wet" and "dry" days that occurred during that period. As additional data is generated over time it will be possible to repeat the TMDL calculations and compare the percent reductions needed under "dry" and "wet" conditions to the percent reductions needed at the time of TMDL adoption.

All pollutant parameters must be analyzed using methods prescribed in the Code of Federal Regulations[9]. Electronic submission of data to DEEP is highly encouraged. Results of monitoring that indicate unusually high levels of contamination or potentially illegal activities should be forwarded to the appropriate municipal or State agency for follow-up investigation and

enforcement. Consistent with the requirements of the MS4 permit, the following parameters should be included in any monitoring program:

pH (SU)
Hardness (mg/l)
Conductivity (umos)
Oil and grease (mg/l)
Chemical Oxygen Demand (mg/l)
Turbidity (NTU)
Total Suspended Solids (mg/l)
Total Phosphorous (mg/l)
Ammonia (mg/l)
Total Kjeldahl Nitrogen (mg/l)
Nitrate plus Nitrite Nitrogen (mg/l)
E. coli (col/100ml)
Precipitation (in)

DEEP is committed to providing technical assistance in monitoring program design and establishing procedures for electronic data submission.

REASONABLE ASSURANCE

The MS4 Permit is a legally enforceable document that provides reasonable assurance that the municipalities will take steps towards achieving the target TMDL and reducing point sources of stormwater containing bacteria. If portions of a watershed are not subject to the Connecticut's MS4 Permit Program, DEEP has the authority to include those additional municipally-owned or municipally-operated Small MS4s located outside an Urbanized Area as may be designated by the Commissioner.

In addition, DEEP continues to work with watershed stakeholders to draft Watershed Based Management Plans (WBMPs) under the CWA 319 program (see Appendix E). As part of these WBMPs, watershed stakeholders are required to investigate impairments and promote the implementation of nonpoint source pollution best management practices and stormwater management practices in the watershed. DEEP approves CWA 319 Watershed Based Plans, including those that address management measures to reduce bacteria and source mitigation in order to support the TMDLs. WBMPs include watershed-wide and place-based recommendations aimed at reducing nonpoint sources of pollution, including bacteria. These recommended WBMP projects may be eligible for CWA 319 funding, as long as such projects are not used for permit compliance.

PROVISIONS FOR REVISING THE TMDL

DEEP reserves the authority to modify the TMDL as needed to account for new information made available during the implementation of the TMDL. Modification of the TMDL will only be made following an opportunity for public participation and will be subject to the review and approval of the EPA. New information, which will be generated during TMDL implementation, includes monitoring data, new or revised State or Federal regulations adopted pursuant to Section 303(d) of the Clean Water Act, and the publication by EPA of national or regional guidance relevant to the implementation of the TMDL program. DEEP will propose modifications to the TMDL analyses only in the event that a review of the new information indicates that such a modification is warranted and is consistent with the anti-degradation provisions in Connecticut Water Quality Standards. The subject waterbodies of this TMDL analysis will continue to be included on the *List of Connecticut Waterbodies Not Meeting Water Quality Standards* until monitoring data confirms that recreation use is fully supported.

PUBLIC PARTICIPATION

This TMDL document will be public noticed for review and comment by the general public. It is expected that open forums will continue as implementation of the TMDL occurs.

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REFERENCES

1 – Connecticut Department of Environmental Protection, 2010. Table 3-2: List of Connecticut Water bodies Not Meeting Water Quality Standards. In: *Integrated Water Quality Report to Congress. Bureau of Water Protection and Land Reuse*, 79 Elm Street, Hartford, CT 06106-5127.

2 - Connecticut Department of Environmental Protection, 2011 *Connecticut Water Quality Standards*. Bureau of Water Management, 79 Elm Street, Hartford, CT.

3 - Code of Federal Regulations, Title 40, CFR, section 130.2(i).

4 – United States Environmental Protection Agency. November 15, 2006 memorandum. *Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No.05-5015, (April 25, 2006) and Implications for NPDES Permits*.

5 - U.S. Census Bureau, March 2002. www.census.gov/geo/www/ua/ua_2k.html.

6 - United States Environmental Protection Agency, 1986. *Ambient Water Quality Criteria for Bacteria -1986.* EPA 440/5-84-002.

7 - Connecticut Department of Environmental Protection, 2005. *Development of Total Maximum Daily Loads (TMDLs) for Indicator Bacteria in Contact Recreation Areas Using the Cumulative Distribution Function Method*. Bureau of Water Management, 79 Elm Street, Hartford, CT.

8 - Connecticut Department of Environmental Protection, 2002. *Water Quality Summary Report for Sasco Brook, Mill River, Rooster River, Fairfield County Connecticut*. November 2002. Bureau of Water Management, 79 Elm Street, Hartford, CT.

9 - Code of Federal Regulations, Title 40, CFR, Part 136.

Appendix A. Regional Basin Maps

Figure 1: Titicus River Regional Basin Location Map

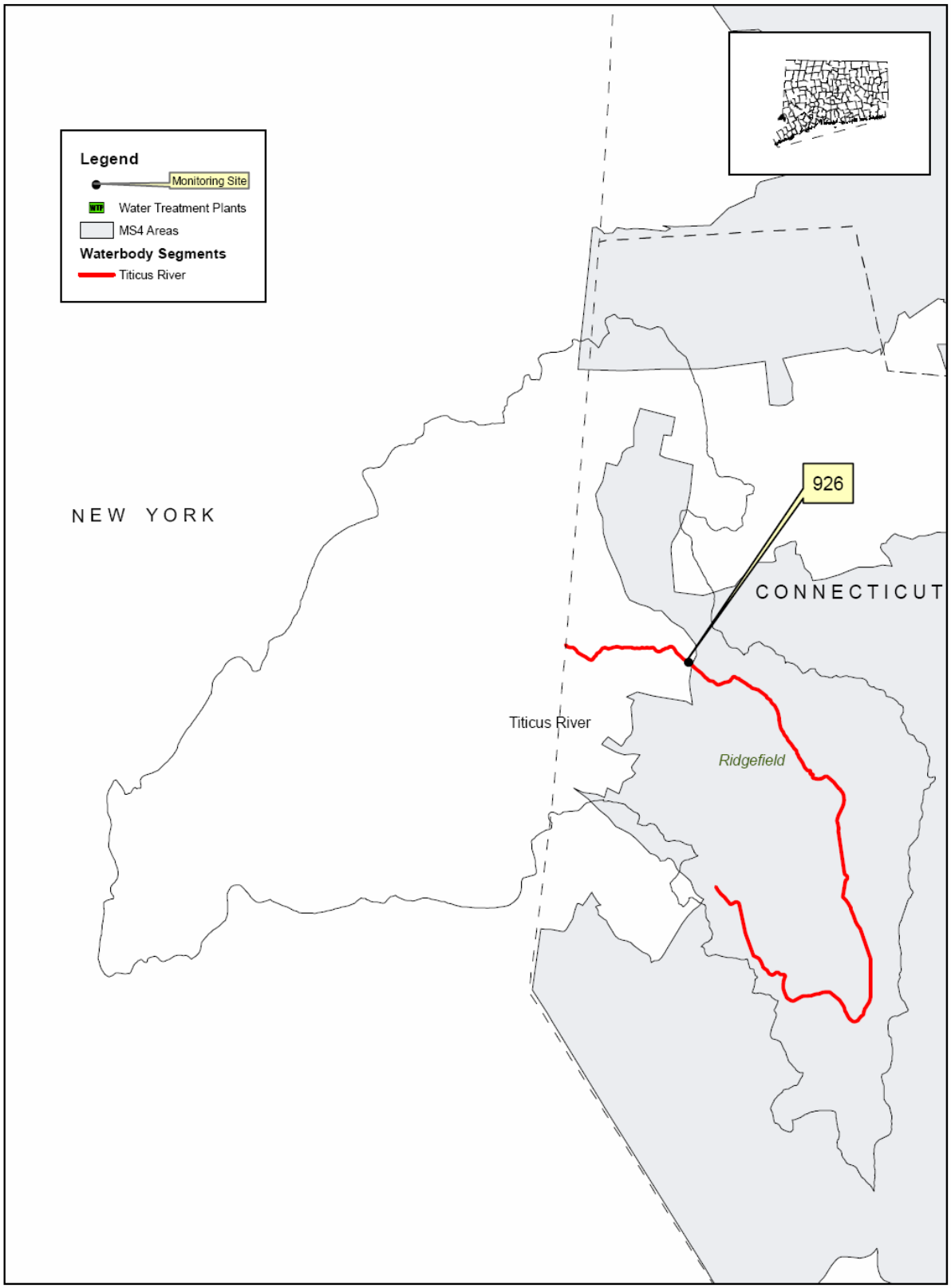


Figure 2: Titicus River Regional Basin Designated MS4 Map

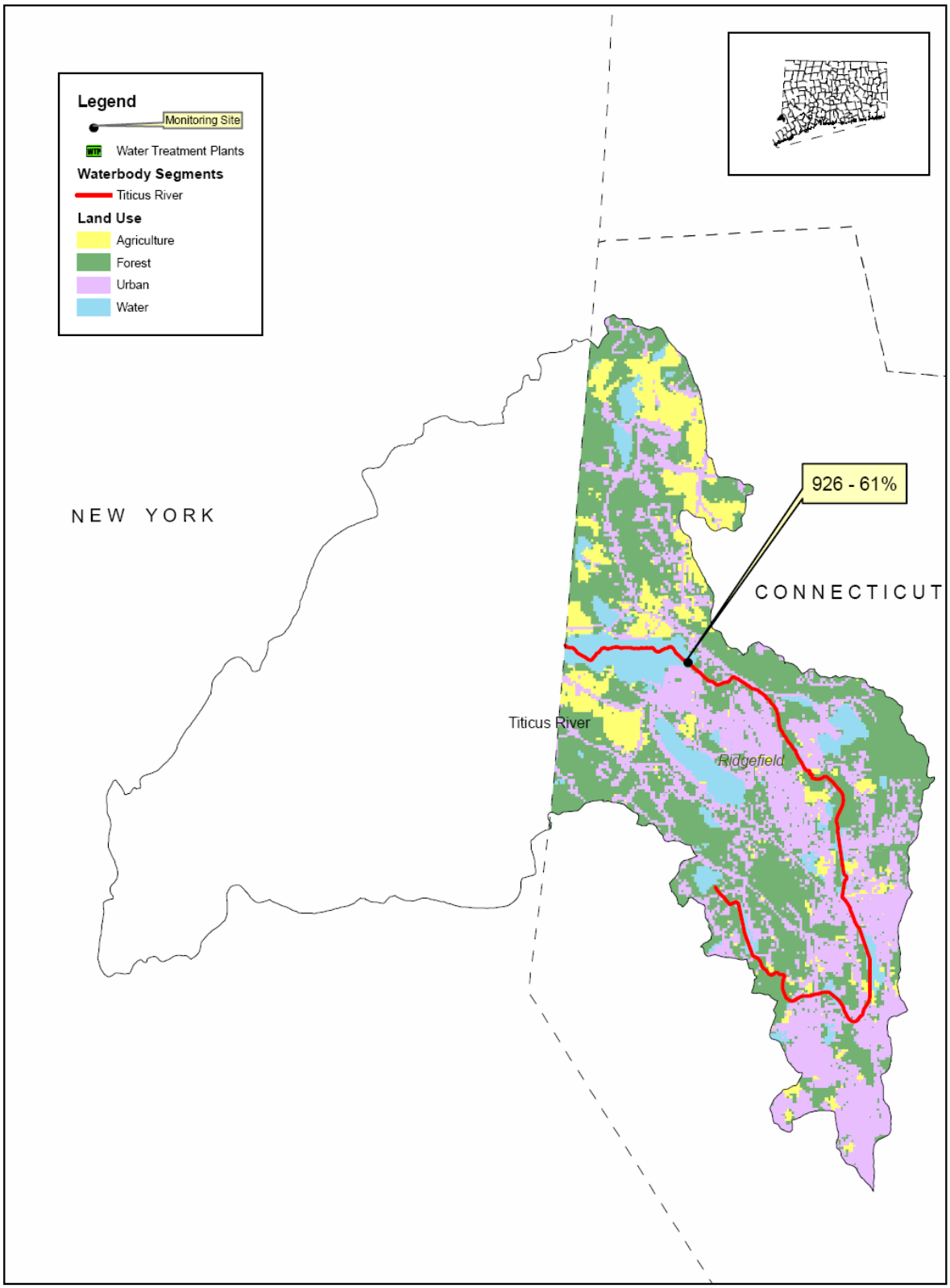


Figure 3: Titicus River Regional Basin Land Use and TMDL % Reduction Map

Appendix B. Site Specific Information and TMDL Calculations

Titicus River Sub-Regional Basin
Waterbody Specific Information

Impaired Waterbody
Waterbody Name: Titicus River Sub-Regional Basin
Waterbody Segment IDs: CT8104-00_01
Waterbody Description: From New York state border (in large marsh along north side of North Salem Road (Route 116)), US to headwaters (at unnamed marsh, US of Old West Mountain Road crossing), Ridgefield. (Segment includes several ponds and marshes).
Waterbody Segment Size: 6.34 linear miles

Impairment Description:
Designated Use Impairment: Recreation
Surface Water Classification: AA

Watershed Description:
Total Drainage Basin Area: 5148.27 acres
Subregional Basin Name & Code: Titicus River Sub-Regional Basin, 8104
Regional Basin: Croton Main Stem
Major Basin: Hudson Major Basin
Watershed Towns: Ridgefield
MS4 applicable? Yes
Applicable Season: Recreation Season (May 1 to September 30)
Sub-Regional Basin Land Use*:

Land Cover Category	Percent Composition
Agriculture	12% (600 acres)
Forest	45% (2339 acres)
Urban	33% (1702 acres)
Water	10% (507 acres)

*Data Source: 2002 Land Cover, CLEAR - Center for Land Use Education and Research.

Titicus River

CT8104-00_01

Data Used in the Analysis

Monitoring Site: 926, Behind track at Ridgefied High School

Date	Precip.(in)[1]			Condition[2]	E. coli	Rank	Proportion	Criteria	%
	24h	48h	96h	(WET/DRY)	(col./100 ml)			Value	Reduction
6/6/2007	0.00	0.00	0.71	DRY	240	18.5	0.5139	130	46
6/12/2007	0.04	0.20	0.25	DRY	320	22.5	0.6250	169	47
6/27/2007	0.09	0.09	0.09	DRY	230	15.0	0.4167	104	55
7/5/2007	0.14	1.00	1.00	**WET**	1800	32.5	0.9028	416	77
7/5/2007	0.14	1.00	1.00	**WET**	1800	32.5	0.9028	416	77
7/10/2007	0.00	0.00	0.01	DRY	63	1.0	0.0278	22	66
7/17/2007	0.00	0.00	0.11	DRY	230	15.0	0.4167	104	55
7/25/2007	0.00	0.00	1.20	DRY	250	20.0	0.5556	143	43
8/2/2007	0.00	0.00	0.00	DRY	320	22.5	0.6250	169	47
8/9/2007	0.01	0.74	0.74	**WET**	1200	30.5	0.8472	324	73
8/30/2007	0.00	0.00	0.00	DRY	260	21.0	0.5833	153	41
9/6/2007	0.00	0.00	0.00	DRY	86	4.5	0.1250	44	49
9/6/2007	0.00	0.00	0.00	DRY	200	11.5	0.3194	82	59
9/13/2007	0.00	0.00	0.06	DRY	440	25.0	0.6944	201	54
5/22/2008	0.12	0.24	0.50	**WET**	74	2.0	0.0556	29	61
6/5/2008	0.00	0.32	0.32	**WET**	220	12.5	0.3472	88	60
6/5/2008	0.00	0.32	0.32	**WET**	3400	34.0	0.9444	547	84
6/9/2008	0.00	0.05	0.42	DRY	240	18.5	0.5139	130	46
6/19/2008	0.00	0.11	1.62	DRY	1200	30.5	0.8472	324	73
6/26/2008	0.00	0.00	0.45	DRY	220	12.5	0.3472	88	60
7/8/2008	0.00	0.00	1.35	DRY	190	8.0	0.2222	62	67
7/23/2008	0.86	0.86	1.18	**WET**	800	28.0	0.7778	255	68
7/31/2008	0.12	0.45	0.45	**WET**	4400	35.0	0.9722	576	87
8/4/2008	0.00	0.00	0.39	DRY	360	24.0	0.6667	187	48
8/14/2008	0.46	0.46	1.09	**WET**	190	8.0	0.2222	62	67
9/9/2008	0.97	0.97	6.19	**WET**	5500	36.0	1.0000	576	90
6/11/2009	0.34	0.35	1.09	**WET**	600	26.0	0.7222	217	64
6/11/2009	0.34	0.35	1.09	**WET**	620	27.0	0.7500	235	62
6/17/2009	0.01	0.01	0.99	DRY	230	15.0	0.4167	104	55
7/2/2009	0.13	0.27	0.41	**WET**	180	7.0	0.1944	57	68
7/9/2009	0.00	0.01	0.38	DRY	230	14.0	0.3889	97	58
7/16/2009	0.32	0.32	0.32	**WET**	840	29.0	0.8056	279	67
7/23/2009	0.23	0.24	1.09	**WET**	200	11.5	0.3194	82	59
8/6/2009	0.00	0.07	0.09	DRY	75	3.0	0.0833	35	53
8/12/2009	0.02	0.02	0.23	DRY	150	6.0	0.1667	52	66
8/19/2009	0.00	0.00	0.03	DRY	86	4.5	0.1250	44	49

Statistics

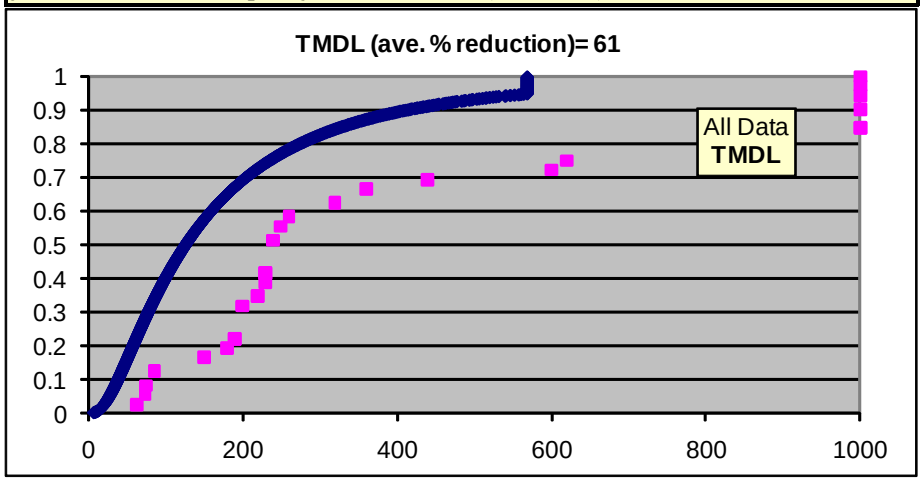
# Samples DRY	**21**
# Samples WET	**15**
# Samples Total	**36**
Geomean	**357**
Log std deviation	**0.4952**

Avg % Reduction

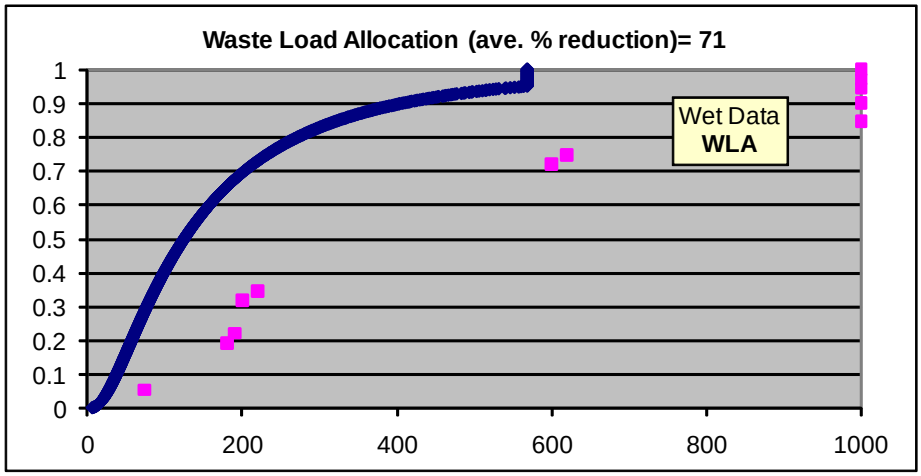
Wet (WLA)	**71**
Dry (LA)	**54**
Total (TMDL)	**61**

Precipitation data provided by NOAA and Weather underground, E.coli data provided by DEEP. **WET** Condition defined as greater than 0.1" precipitation in 24 hours or 0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

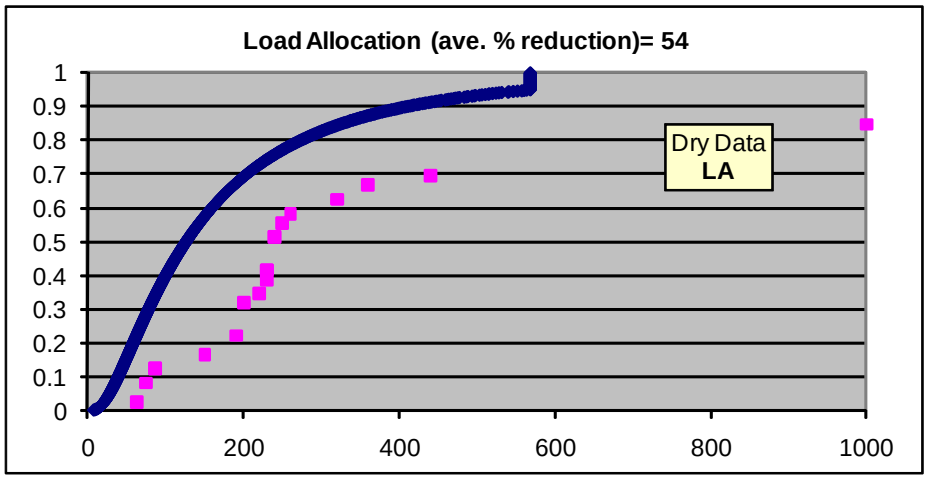
Criteria Curve for Monitoring Site 926
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Titicus River Sub-Regional Basin
TMDL Summary

The TMDL analysis for the Titicus River Sub-Regional Basin was conducted at one representative site, Station 926. This site is influenced by sources of bacteria active under both wet weather and dry weather conditions. Generally, percent reductions for wet weather conditions were found to be slightly higher than dry weather conditions. Reductions in the Waste Load Allocation (WLA) can be achieved through the detection and elimination of illicit discharges to the storm sewers and the upgrade of failed sanitary infrastructure. The WLA also includes regulated stormwater and can be further reduced by the installation of engineered controls to minimize the surge of stormwater to the river, promote groundwater recharge, and improve water quality will also reduce inputs of bacteria to the river. Since illicit discharges and failed sanitary collection systems may also be active at some sites during dry conditions, it is likely that corrective actions aimed at eliminating these sources will also reduce the Load Allocation (LA). Other contributors to the LA include domestic animal waste, wildlife, and stormwater input as sheet flow.

Station 926 in the Titicus Sub-Regional Basin, Ridgefield, Connecticut. Map available at www.Bing.com .

Appendix C. Municipal Stormwater alternative monitoring guidance

Guidance for Implementing Bacteria-based TMDLs within DEEP's Stormwater Permitting Program

DEEP investigates impaired waterbodies to determine the major causes of impairment. This information is expressed as Total Maximum Daily Load (TMDL). TMDLs provide the framework for restoring impaired waters by establishing the maximum amount of a pollutant that a waterbody can take in without adverse impact to fish, wildlife, recreation, or other public uses. If a TMDL includes requirements for control of stormwater discharges it is the responsibility of the municipalities within the watershed to implement the recommendations of the TMDL (typically bacteria reduction). Management of stormwater quality within the municipality is governed by the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 General Permit).

The MS4 General Permit is required for any municipality with urbanized areas that initiates, creates, originates or maintains any discharge of stormwater from a storm sewer system to waters of the state. The MS4 permit requires towns to design a Stormwater Management Plan (SMP) to reduce the discharge of pollutants in stormwater to improve water quality. The plan must address the following 6 minimum measures.

1. Public Education and Outreach.
2. Public Involvement/Participation.
3. Illicit discharge detection and elimination.
4. Construction site stormwater runoff control.
5. Post-construction stormwater management in the new development and redevelopment.
6. Pollution prevention/good housekeeping for municipal operations.

Section 6(k) of the MS4 General Permit requires a municipality to modify their Stormwater Management Plan to implement the TMDL within 4 months of TMDL approval by EPA if stormwater within the municipality contributes pollutant(s) in excess of the allocation established within the TMDL. For the discharges to the TMDL waterbody(ies), the municipality must assess the six minimum measures of its plan and modify the plan to implement additional, necessary controls for each appropriate measure. Particular focus should be placed on the following plan components: public education program, illicit discharge detection and elimination, stormwater structures cleaning, priority for the repair, upgrade, or retrofit of storm sewer structures. The goal of the modifications is to establish a program to improve water quality consistent with the requirements of the TMDL. Modifications to the Stormwater Management Plan in response to TMDL development should be submitted to the Stormwater Program of DEEP for review and approval.

Also required under the MS4 General Permit is annual stormwater monitoring. The permit provides a general framework for monitoring stormwater quality within a municipality. At minimum, stormwater from six sample locations are to be collected annually: two outfalls from commercial areas, two from industrial areas, and two from residential areas. These six

sample locations are point source discharges that drain areas with distinct characteristics. Each stormwater sample is tested for 12 parameters using methods prescribed in Title 40, CFR, Part 136.

pH (SU)	Total Suspended Solids (mg/l)
Hardness (mg/l)	Total Phosphorous (mg/l)
Conductivity (umos)	Ammonia (mg/l)
Oil and grease (mg/l)	Total Kjeldahl Nitrogen (mg/l)
Chemical Oxygen Demand (mg/l)	Nitrate plus Nitrite Nitrogen (mg/l)
Turbidity (NTU)	E. coli (col/100ml)

However, DEEP encourages municipalities affected by the establishment of a TMDL to develop an alternative stormwater monitoring plan to assess progress in meeting the goals of the TMDL. Alternate monitoring programs are established in accordance with Section 6(h)(1)(B) of the MS4 permit which allows towns to submit written requests to the Commissioner for the review and approval of alternate stormwater monitoring plans of equivalent or greater scope. This gives towns freedom to develop a plan that better assesses the stormwater quality in their watershed. The monitoring program should be designed to accomplish two objectives; source detection to identify specific sources of bacterial loading and direct BMP implementation efforts with fixed station monitoring to quantify progress in achieving TMDL established goals. Monitoring may be performed by municipal staff, citizen volunteers, or contracted to an environmental consulting firm. In order to secure DEEP approval, the program must include sampling to address both objectives (source detection and progress quantification). Source detection monitoring may include such activities as visual inspection of storm sewer outfalls under dry weather conditions, event sampling of individual storm sewer outfalls, and monitoring of ambient (in-stream) conditions at closely spaced intervals to identify "hot spots" for more detailed investigations leading to specific sources of high bacteria loads.

DEEP strongly recommends that stream monitoring be performed at the same locations DEEP sampled during TMDL development. Samples should also be collected at other key locations within the watershed, such as above and below potential contributing sources or areas slated for BMP implementation. Since watershed borders and TMDLs do not follow town borders there is a possibility DEEP did not sample locations in your town. If this is the case collecting a sample where the waterbody enters your town and another where the waterbody leaves your town maybe helpful to determine how stormwater from your town influences water quality. In all cases, sampling should be scheduled at regularly spaced intervals during the recreational season. In this way, the data set at the end of each season will include ambient values for both "wet" and "dry" conditions.

Appendix D. Cumulative Frequency Distribution Function Method

DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS (TMDLs) FOR INDICATOR BACTERIA IN CONTACT RECREATION AREAS USING THE CUMULATIVE FREQUENCY DISTRIBUTION FUNCTION METHOD

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Mary E. Becker, Environmental Analyst
CT Department of Environmental Protection
Total Maximum Daily Load Program

Last revised: November 8, 2005

OVERVIEW OF APPROACH

The analytical methodology presented in this document provides a defensible scientific and technical basis for establishing TMDLs to address recreational use impairments in surface waters. Representative ambient water quality monitoring data for a minimum of 21 sampling dates during the recreational season (May 1 – September 30) is required for the analysis. The reduction in bacteria density from current levels needed to achieve consistency with the criteria is quantified by calculating the difference between the cumulative relative frequency of the sample data set and the criteria adopted by Connecticut to support recreational use. Connecticut's adopted water quality criteria for indicator bacteria (*Escherichia coli*) are represented by a statistical distribution of the geometric mean 126 and log standard deviation 0.4 for purposes of the TMDL calculations.

TMDLs developed using this approach are expressed as the average percentage reduction from current conditions required to achieve consistency with criteria. The procedure partitions the TMDL into wet weather allocation and dry weather allocation components by quantifying the contribution of ambient monitoring data collected during periods of high stormwater influence and minimal stormwater influence to the current condition. The partition is used to determine the effect of high stormwater influence on the contribution of sources to the waterbody. TMDLs developed using this analytical approach provide an ambient monitoring benchmark ideally suited for quantifying progress in achieving water quality goals as a result of TMDL implementation.

APPLICABILITY

The methodology is intended solely for use in developing TMDLs for waters that are identified as impaired on the *List of Connecticut Water Bodies Not Meeting Water Quality Standards* [1]. It is expected that implementation of these TMDLs will be accomplished through implementing the provisions of the Small Municipal Separate Storm Sewer System general permit (MS4 permit) [2] in designated urban areas, as well as through measures that address non-point sources. The method as described here is not intended for use as an assessment tool for purposes of identifying use attainment status relative to listing or delisting of waterbody segments pursuant to Section 303(d) of the federal Clean Water Act. Assessment of use support is performed in accordance with the Department's guidance document, *Connecticut Consolidated Assessment and Listing Methodology (CT-CALM)* [3].

BACKGROUND

TMDLs are established by the State in accordance with the requirements established in the federal Clean Water Act. Section 303(d) of the Act requires the State to perform an assessment of waters within the State relative to their ability to support designated uses including recreational use. The procedure used by the Department to assess use attainment is described in the guidance document, *CT-CALM* [3]. The list of waterbody segments in Connecticut that do not currently support recreational use is updated to incorporate the most recent monitoring information by the Department every two years. As a result of this process, waterbodies may be added to or deleted from the list of impaired waters in accordance with the *CT-CALM* guidance. Once complete, the list is submitted to the Regional office of the federal EPA for approval. Section 303(d) of the Act requires the State to establish TMDLs for each pollutant contributing to the impairment of each waterbody segment identified on the list.

WATER QUALITY CRITERIA FOR INDICATOR BACTERIA

Connecticut's adopted water quality criteria for the indicator bacteria *Escherichia coli (E.coli)* in the CT Water Quality Standards [4] include a geometric mean and upper confidence limit (i.e. single sample maximum), which are based on three recreational use categories. The categories include designated swimming, non-designated swimming, and all other recreational uses. 'Designated swimming' includes areas that have been designated by State or Local authorities. 'Non-designated swimming' includes waters suitable for swimming but have not been designated by State or Local authorities, as well as water that support recreational activities where full body contact is likely, such as tubing or water skiing. 'All other recreational uses' include waters that support recreational activities where full body contact is infrequent, such as fishing, boating, kayaking, and wading. The recreational uses and applicable criteria are provided in the following table.

Recreational Use Category	Indicator Bacteria	Geometric Mean	Single Sample Maximum Upper Confidence Limit
Designated Swimming	*E.coli*	126col/100mls	235col/100mls 75th Percentile
Non-designated Swimming			410col/100mls 90th Percentile
All Other Recreational Uses			576col/100mls 95th Percentile

Table 1. Applicable indicator bacteria (*E.coli*) water quality criteria for recreational uses

The indicator bacteria, *E. coli*, is not pathogenic, rather its presence in water is an indicator of contamination with fecal material that may also contribute pathogenic organisms. Connecticut's criteria are based on federal guidance [5]. In this guidance, the basis for the criteria and the relationship between the geometric mean criterion and the single sample maximum criterion is explained in detail.

The geometric mean criterion was derived by EPA scientists from epidemiological studies at beaches where the incidence of swimming related health effects (gastrointestinal illness rate) could be correlated with indicator bacteria densities. EPA's recommended criteria reflect an average illness rate of 8 illnesses per 1000 swimmers exposed. This condition was predicted to exist based on studies cited in the federal guidance when the steady-state geometric mean density of *E. coli* was 126 col/100ml. The distribution of individual sample results around the geometric mean is such that approximately half of all individual samples are expected to exceed the geometric mean and half will be below the geometric mean.

EPA also derived a single sample maximum criterion from this same database to support decisions by public health officials regarding the closure of beaches when an elevated risk of illness exists. Because approximately half of all individual sample results for a beach where the risk of illness is considered "acceptable" are expected to exceed the geometric mean criteria of 126 col/100ml, an upper boundary to the range of individual sample results was statistically derived that will be exceeded at frequencies less than 50% based on the variability of sample data. The mean log standard deviation for *E. coli* densities at the freshwater beach sites studied by EPA was 0.4. The single sample maximum criterion of 235 col/100mls, 410 col/100mls, and 576 col/100mls adopted by Connecticut represents the 75^{th}, 90^{th}, and 95^{th} percentile upper confidence limit, respectively, for a statistical distribution of data with a geometric mean of 126 and a log standard deviation of 0.4 as recommended by EPA [5].

Consistent with the State's disinfection policy (Water Quality Standard #23), the critical period for application of the indicator bacteria criteria is the recreational season, defined as May 1 through September 30. For waters that do not receive point discharges of treated sewage subject to the disinfection policy, a review of ambient monitoring data contained in the State's Ambient Monitoring Database [6] confirms that bacteria densities are typically highest during the summer months. Consistency with criteria during the summer is indicative of consistency at all times of the year. Lower densities reported during other portions of the year are most likely a result of several environmental factors including more rapid die-off of enteric bacteria in colder temperatures and reduced loadings from wildlife and domestic animal populations. Further, human exposure to potentially contaminated water is greatly reduced during the colder months, particularly exposure that results from immersion in the water since cold temperatures discourage participation in recreational activities that typically involve immersion.

Connecticut's adopted criteria are based on federal guidance and reflect an idealized distribution of bacteria monitoring data for sites studied by EPA that can be represented by statistical distribution with a geometric mean of 126 col/100ml and a log standard deviation of 0.4. The criteria can therefore be expressed as a cumulative frequency distribution or "criteria curve" as shown in figures 1a through1c for each of the specified recreational uses in Connecticut's bacteria criteria.

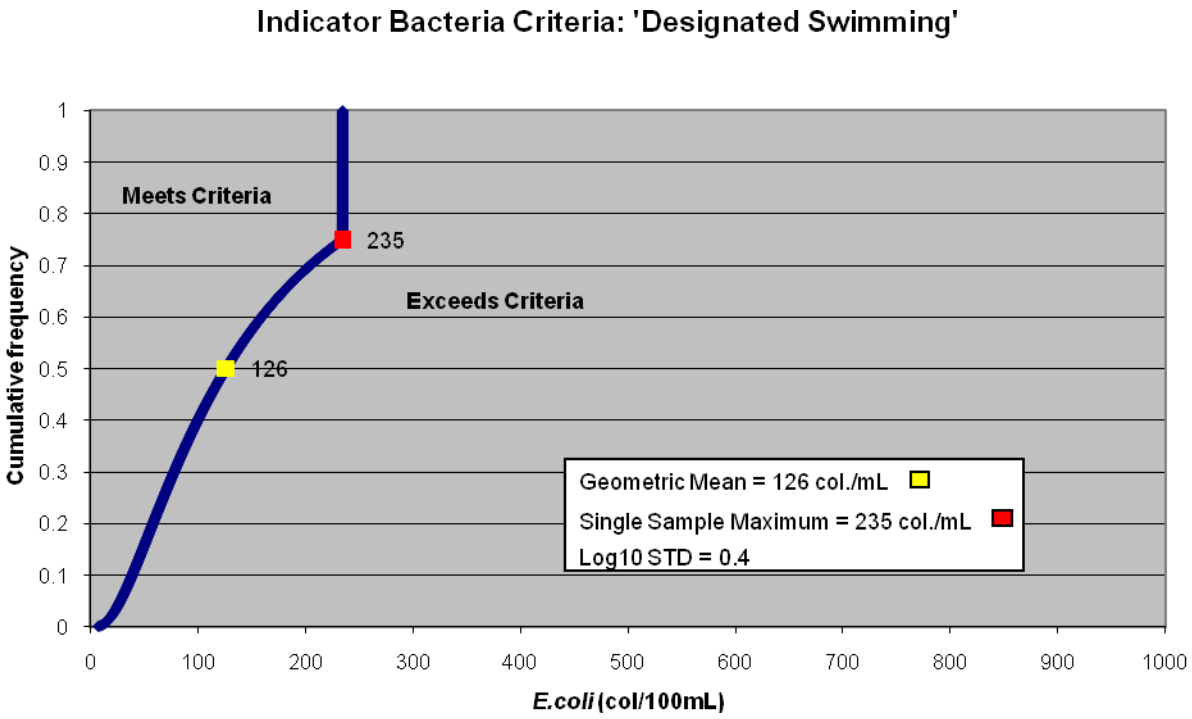

Figure 1a. Cumulative Relative Frequency Distribution representing water quality to support designated swimming use.

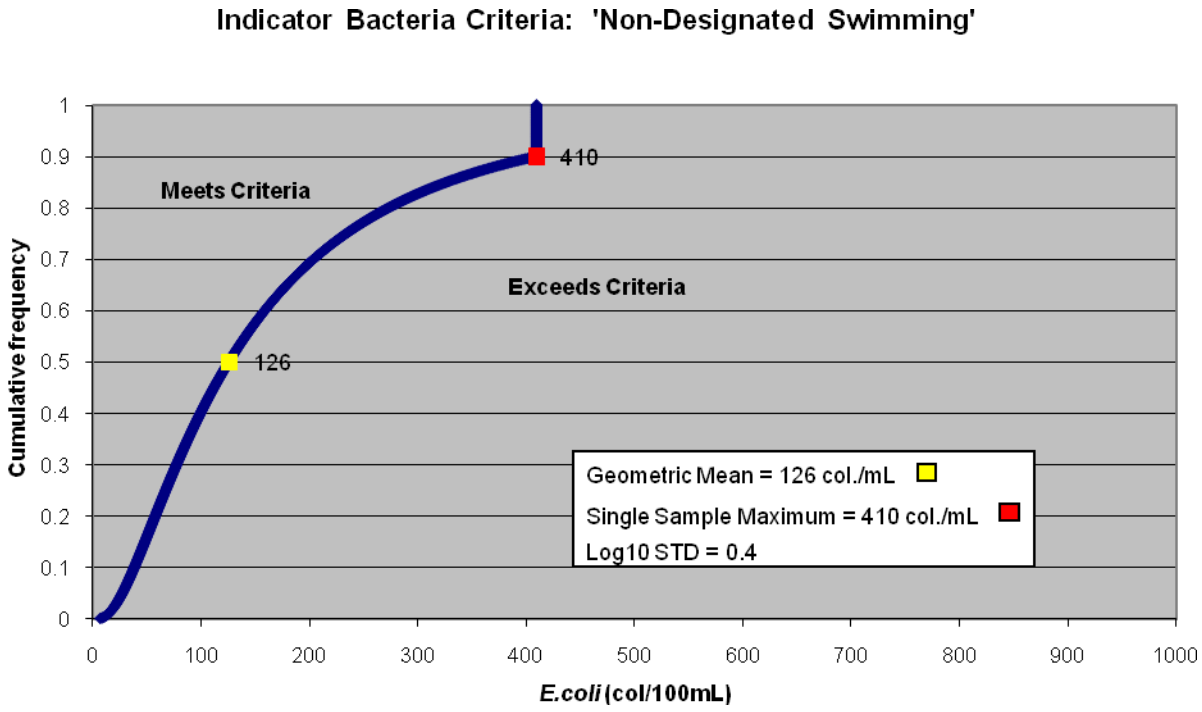

Figure 1b. Cumulative Relative Frequency Distribution representing water quality to support non-designated swimming use.

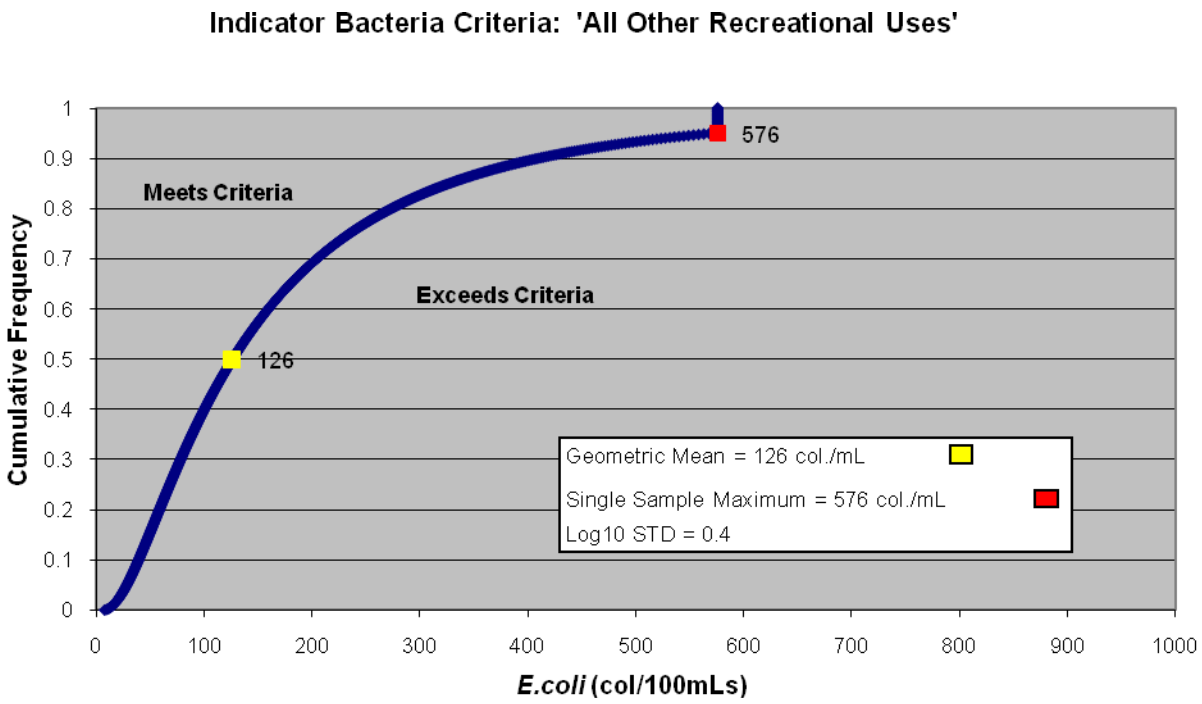

Figure 1c. Cumulative Relative Frequency Distribution representing water quality criteria to support all other recreational uses.

TMDL

As with the cumulative relative frequency curves representing the criteria shown in Figure 1a through 1c, a cumulative relative frequency curve can be prepared using site-specific sample data to represent current conditions at the TMDL monitoring site. The TMDL for the monitored segment is derived by quantifying the difference between these two distributions as shown conceptually in Figures 2a through 2c. This is accomplished by calculating the reduction required at representative points on the sample data cumulative frequency distribution curve and then averaging the reduction needed across the entire range of sampling data. This procedure allows the contribution of each individual sampling result to be considered when estimating the percent reduction needed to meet a criterion that is expressed as a geometric mean.

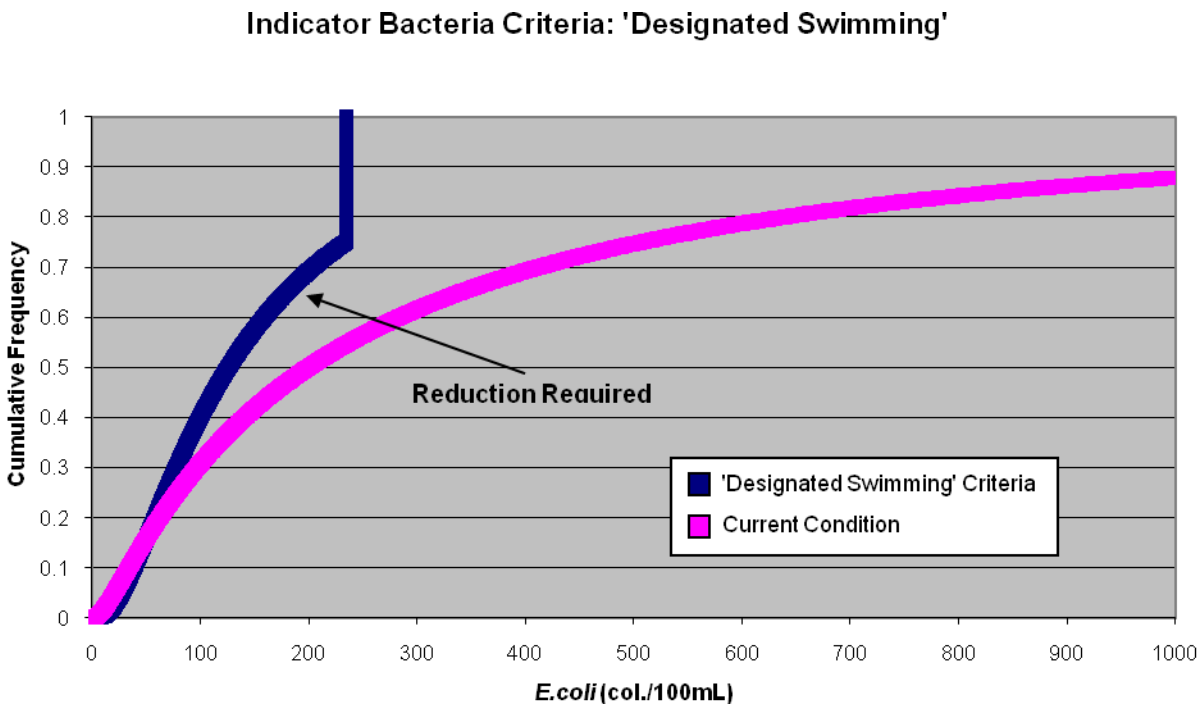

Figure 2a. Reduction indicator bacteria density needed from current condition to meet 'designated swimming' criteria based on cumulative relative frequency distribution.

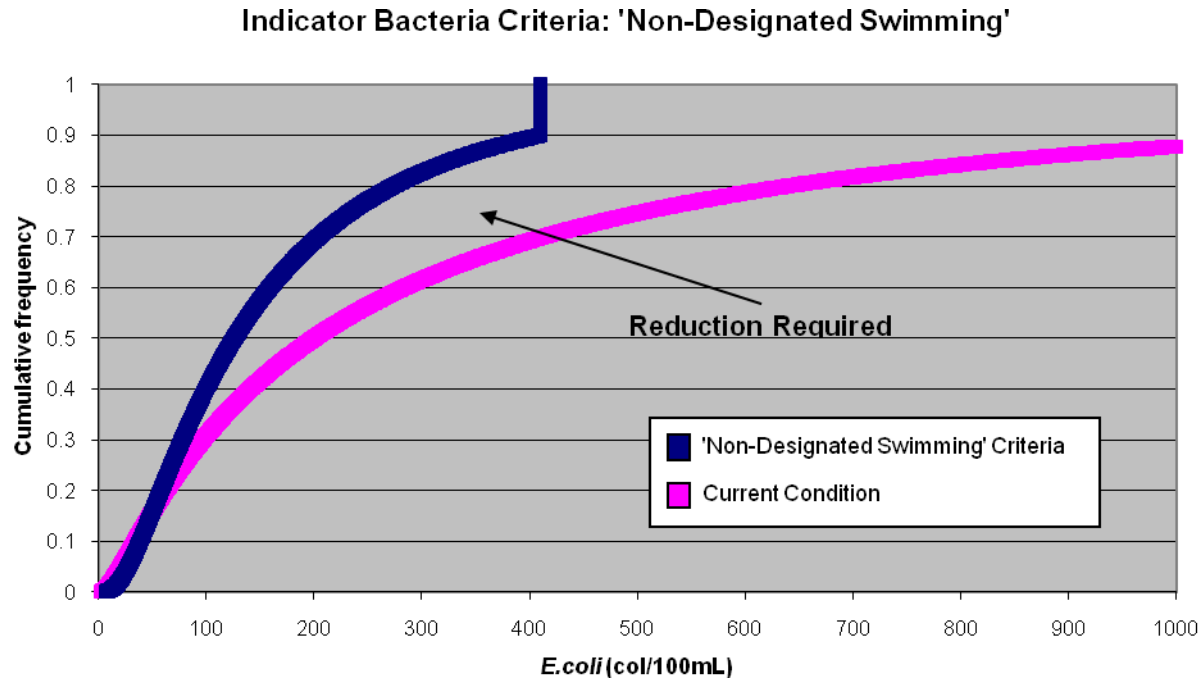

Figure 2b. Reduction indicator bacteria density needed from current condition to meet 'non-designated swimming' criteria based on cumulative relative frequency distribution.

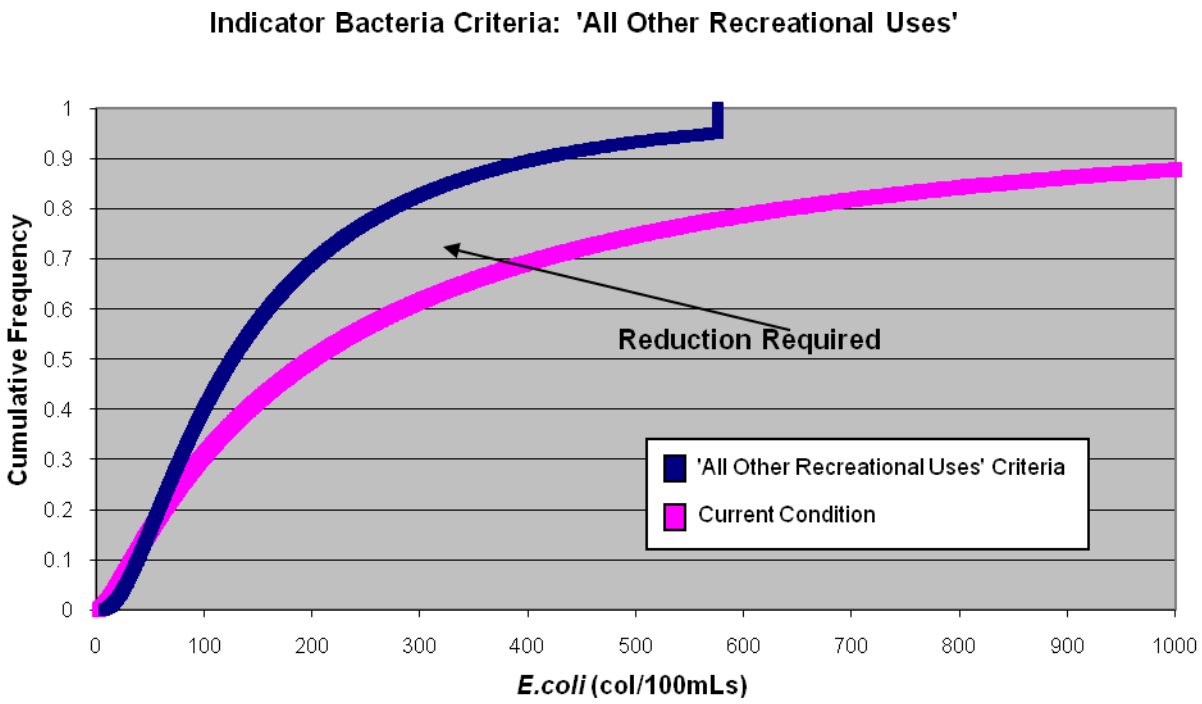

Figure 2c. Reduction indicator bacteria density needed from current condition to meet 'all other recreational uses' criteria based on cumulative relative frequency distribution.

TMDL ALLOCATIONS

Federal regulations require that the TMDL analysis identify the portion of the total loading which is allocated to point source discharges and the portion attributed to non-point sources, which contribute that pollutant to the waterbody. Stormwater runoff is considered a point source subject to regulation under the NPDES permitting program in designated urbanized areas. Designated urban areas, as defined by the US Census Bureau [7], are required to comply with the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 permit). The general permit is applicable to municipalities that contain designated urban areas (or MS4 communities) and discharge stormwater via a separate storm sewer system to surface waters of the State. TMDLs for indicator bacteria in waters draining urbanized areas must therefore be partitioned into a WLA to accommodate point source stormwater loadings of indicator bacteria and a LA to accommodate non-point loadings from unregulated sources. One common characteristic of urbanized areas is the high percentage of impervious surface. Much of the impervious surface is directly connected to nearby surface waters through stormwater drainage systems. As a result, runoff is rapid following rain events and flow in urban streams is typically dominated by stormwater runoff during these periods. Monitoring results for samples collected under these conditions are strongly influenced by stormwater quality. During dry conditions, urban streams contain little stormwater since urban watersheds drain quickly and baseflows are reduced due to lower infiltration rates and reduced recharge of groundwater. At baseflow, urban stream water quality is dominated by non-point sources of indicator bacteria since stormwater outfalls are inactive.

A WLA for stormwater discharges is not warranted in non-designated urbanized areas and in waterbody segments where there are no stormwater outfalls. As such, sources of bacteria in these waterbodies segments are attributed solely to nonpoint sources. However, wet weather and dry weather percent reductions are partitioned in the LA analysis to demonstrate the effect of stormwater events on the contribution of nonpoint sources of bacteria to the waterbody.

The relative contribution of indicator bacteria loadings occurring during periods of high or low stormwater influence to the geometric mean indicator density is estimated by calculating separate averages of the reduction needed to achieve consistency with criteria under "wet" and "dry" conditions. In urbanized areas, the reduction needed under "wet" conditions is assigned to the WLA and the reduction needed under "dry" conditions is assigned to the LA. In non-designated urbanized areas, the LA is comprised of "wet" and "dry" conditions, which are partitioned into separate reduction goals. Separate reduction goals are established for baseflow and stormwater dominated periods that can assist local communities in selection of best management practices to improve water quality. The technique also facilitates the use of ambient stream monitoring data to track future progress in meeting water quality goals.

The sources contributing to the WLA and LA can be further subdivided depending on knowledge of sources present in the watershed (Table 2). Some existing sources such as dry weather flows from stormwater collections systems, illicit discharges to stormwater systems, and combined sewer overflows are allocated "100 percent reduction" since the management goal for these sources is elimination. Permitted discharges of treated and disinfected domestic wastewater (sewage treatment plants) are allocated "zero percent reduction" since disinfection required by the NPDES permit is sufficient to reduce indicator bacteria levels to below levels of concern. Natural sources such as wildlife are also allocated a "zero percent reduction" since the management goal is to foster a sustainable natural habitat and stream corridor to the extent practicable. Management measures to control nuisance populations of some wildlife species that can result in elevated indicator bacteria densities such as Canadian geese however should be considered in developing an overall watershed management plan. The management goal for point sources in designated swimming areas is elimination when the source is determined to be the main contributor of bacteria to the swimming area. This is consistent with the United States Environmental Protection Agency's (EPA) advisory for swimmers to avoid areas with discharge pipes [8] and a recent study indicating an increased potential for health risk to people swimming in areas near storm drains [9].

Source	Critical Conditions	Assigned To
On-Site Septic	Baseflow (DRY)	LA
Domestic Animal	Baseflow (DRY)	LA
Natural (Wildlife)	Baseflow (DRY)	LA
Wastewater Treatment Plants	Baseflow (DRY)	WLA
Regulated Urban Runoff/Storm Sewers	Wet Weather Flow (WET)	WLA
Dry Weather Overflow	Baseflow (DRY)	None
Illicit Discharges	Baseflow (DRY)	None
Combined Sewer Overflow	Wet Weather Flow (WET)	None

Table 2: Establishing WLA and LA Pollutant Sources

MARGIN OF SAFETY

Federal regulations require that all TMDL analyses include either an implicit or explicit margin of safety (MOS). The analytical approach described here incorporates an implicit MOS. Factors contributing to the MOS include assigning a percent reduction of "zero" to sampling results that indicate quality better than necessary to achieve consistency with the criteria. The increase in loadings on those dates that could be assimilated by the stream without exceeding criteria is not quantified (as a negative percent reduction) and averaged with the load reductions needed on other sampling dates. Rather, this excess capacity is averaged as a zero value thereby contributing to the implicit MOS.

The means of implementing the TMDL also contributes to the MOS. The loading reductions specified in the TMDL for regulated stormwater discharges and nonpoint sources must be sufficient to achieve water quality standards since confirmation that these reductions have been achieved will be based on ambient monitoring data documenting that water quality standards are met. Further, achieving compliance with the requirements of the MS4 permit includes elimination of high loading sources such as illicit discharges and dry weather overflows from storm sewer systems. Eliminating loads from these sources, as opposed to allocating a percent reduction equal to that given other sources, contributes to the implicit MOS. Further assurance that implementing the TMDL will meet water quality standards is provided by the iterative implementation required for compliance with the MS4 permit. This approach mandates that additional management efforts must be implemented until ambient monitoring data confirms that standards are met.

Many of the best management practices that are implemented to address either wet or dry weather sources will have some degree of effectiveness in reducing loads under all conditions. For example, the TMDL allocates all the percent reduction needed to meet standards under wet weather conditions to the WLA. However, reductions resulting from best management practices implemented to reduce dry weather loads (LA) will provide some benefit during wet weather conditions as well. These reductions also contribute to the implicit MOS.

DATA REQUIREMENTS

Ambient monitoring data for a minimum of 21 sampling dates during the recreational season (May 1 – September 30) is required. Data collected at other times during the year are excluded from the analysis. In addition to data on indicator bacteria density, precipitation data for each sampling date and the week prior to the sampling is necessary. Sampling dates should be selected to insure that representative data is available for both wet and dry conditions. This may be accomplished most easily by selecting sampling dates without prior knowledge of the meteorological conditions likely to be encountered on that date.

Data must reflect current conditions in the TMDL segment. The monitoring location where data is collected must therefore be sited in an area that can be considered representative of water quality throughout the TMDL segment. Data obtained under unusual circumstances may be excluded from the analysis provided the reason for excluding that data is provided in the TMDL. Potential reasons for excluding data may include such things as evidence that a spill, upset in

wastewater treatment, or sewer line breakage occurred that resulted in a short-term excursion from normal conditions. Data that represent conditions during an extreme storm event that resulted in widespread failure of wastewater treatment or stormwater best management practices may also be excluded. However, data for periods following typical rainfall events must be retained. Reasons for excluding any data must be provided in the TMDL Analysis.

All data must be less than five years old. If circumstances in any watershed suggest that conditions have changed during the most recent five-year period, the analysis may be restricted to more recent data in order to be representative of the current status provided the minimum data requirements are met.

Assurance of acceptable data quality must be provided. Typically, all data should be collected and results analyzed and reported pursuant to an EPA approved Quality Assurance Project Plan (QAPP). Data collected in the absence of a QAPP may be acceptable provided there is evidence that confirms acceptable data quality.

ANALYTICAL PROCEDURE – TMDL

1.

The *E. coli* monitoring data is ranked from lowest to highest. In the event of ties, monitoring results are assigned consecutive ranks in chronological order of sampling date. The sample proportion (*p*) is calculated for each monitoring result by dividing the assigned rank (*r*) for each sample by the total number of sample results (*n*):

$$p = r / n$$

2.

Next, a single sample criteria reference value is calculated for each monitoring result according to the specified recreational use (designated swimming, non-designated swimming, or all other) in a waterbody segment from the statistical distribution used to represent the criteria following the procedure described in steps **3 - 6** below:

3.

Designated Swimming	**Non-Designated Swimming**	**All Other Recreational Uses**
If the sample proportion is ≥ 0.75, the single sample criteria reference value is equivalent to the single sample criterion adopted into the Water Quality Standards (235 col/100ml)	If the sample proportion is ≥ 0.90, the single sample criteria reference value is equivalent to the single sample criterion adopted into the Water Quality Standards (410 col/100ml)	If the sample proportion is ≥ 0.95, the single sample criteria reference value is equivalent to the single sample criterion adopted into the Water Quality Standards (576 col/100ml)

4.

Designated Swimming	Non-Designated Swimming	All Other Recreational Uses
If the sample proportion is less than 0.75, and greater than 0.50, the single sample criteria reference value is calculated as:	If the sample proportion is less than 0.90, and greater than 0.50, the single sample criteria reference value is calculated as:	If the sample proportion is less than 0.95, and greater than 0.50, the single sample criteria reference value is calculated as:

$$\textit{criteria reference value} = \text{antilog}_{10}\,[\log_{10} 126 \text{ col/100ml} + (F * 0.4)]$$

N.B. 126 col/100ml is the geometric mean indicator bacteria criterion adopted into Connecticut's Water Quality Standards, *F* is a factor determined from areas under the normal probability curve for a probability level equivalent to the sample proportion, 0.4 is the $\log_{10}$ standard deviation used by EPA in deriving the national guidance criteria recommendations (Table 4).

5.

Designated Swimming	Non-Designated Swimming	All Other Recreational Uses
If the sample proportion is equal to 0.50, the single sample reference criteria value is equal to the geometric mean criterion adopted into the Water Quality Standards (126 col/100 ml)		

6.

Designated Swimming	Non-Designated Swimming	All Other Recreational Uses
If the sample proportion is less than 0.50, the single sample reference criteria value is calculated as:		

$$\textit{criteria reference value} = \text{antilog}_{10}\,[\log_{10} 126 \text{ col/100ml} - (F * 0.4)]$$

7. The percent reduction necessary to achieve consistency with the criteria is then calculated following the procedure described in steps **8 - 9** below:

8. If the monitoring result is less than the single sample reference criteria value, the percent reduction is zero.

9. If the monitoring result exceeds the single sample criteria reference value, the percent reduction necessary to meet criteria on that sampling date is calculated as:

$$\textit{percent reduction} = [(\textit{monitoring result} - \textit{criteria reference value})/\textit{monitoring result}]*100$$

10. The TMDL, expressed as the average percent reduction to meet criteria, is then calculated as the arithmetic average of the percent reduction calculated for each sampling date.

ANALYTICAL PROCEDURE – WET AND DRY WEATHER EVENTS

Precipitation data is reviewed and each sampling date is designated as a "dry" or "wet" sampling event. Although a site-specific protocol may be specified in an individual TMDL analysis, "wet" conditions are typically defined as greater than 0.1 inches precipitation in 24 hours or 0.25 inches precipitation in 48 hours, or 2.0 inches precipitation in 96 hours.

In designated urbanized areas the average percent reduction for all sampling events used to derive the TMDL that are designated as "wet" is computed and established as the WLA. The average percent reduction for all sampling events used to derive the TMDL that are designated as "dry" is computed and established as the LA.

In areas that do not have point sources, the average percent reduction for all sampling events used to derive the TMDL that are designated "wet" is computed as the wet weather LA, and the average percent reduction for all sampling events used to derive the TMDL that are designated as "dry" is computed as the dry weather LA.

ANALYTICAL PROCEDURE – SPREADSHEET MODEL

An Excel$^{(tm)}$ spreadsheet has been developed that performs all calculations necessary to derive a TMDL using this procedure. Copies of the spreadsheet in electronic form may be obtained from DEEP by contacting Mary Becker at (860) 424-3262 or by email at mary.becker@ct.gov.

REFERENCES

1. 2004 List of Connecticut Water Bodies Not Meeting Water Quality Standards, Connecticut Department of Environmental Protection, Adopted April 28, 2004, approved June 24, 2004.

2. General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems. Connecticut Department of Environmental Protection. Issued January 9, 2004.

3. Connecticut Consolidated Assessment and Listing Methodology for 305(b) and 303(d) Reporting. Connecticut Department of Environmental Protection, April 2004.

4. Water Quality Standards. Connecticut Department of Environmental Protection. Effective December 17, 2002.

5. Ambient Water Quality Criteria for Bacteria – 1986. U.S. Environmental Protection Agency, Office of Water, January 1986. (EPA440/5-84-002).

6. Water Quality Database. Connecticut Department of Environmental Protection, Monitoring and Assessment Program.

7. U.S. Census Bureau, March 2002. www.census.gov/geo/www/ua/ua_2k.html

8. Environmental Protection Agency, 2004. http://www.epa.gov/beaches/.

9. Haile, RW et al, 1999. *The Health Effects of Swimming in Ocean Water Contaminated by Storm Drain Runoff***.** Epidemiology. 10 (4) 355-363.

Appendix E. Links to web sites mentioned in this document

Stormwater Program information -MS4, Industrial, Construction and Commercial general permits: www.ct.gov/dep/stormwater

EPA's Stormwater website: http://cfpub.epa.gov/npdes/stormwater/swphases.cfm

Nuisance wildlife www.ct.gov/dep/enconpolice listed under featured links

Pet waste disposal:
http://www.ct.gov/Dep/cwp/view.asp?a=2708&q=457360&depNav_GID=1763

DEEP Water Quality Manual-Source Control & Pollution Prevention including Nuisance Wildlife & Pet waste:
http://www.ct.gov/dep/lib/dep/water_regulating_and_discharges/stormwater/manual/Chapter_5.pdf .

Staff list: Watershed Management Program:
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325624&depNav_GID=1654

List of approved stormwater management plans:
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=379296&depNav_GID=1654

The nine planning elements in an EPA approved Watershed Based Plan:
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=335504&depNav_GID=1654

CWA 319 program:
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325588&depNav_GID=1654