A Total Maximum Daily Load Analysis for Allen Brook Pond, Allen Brook, Gay City Pond, and Schreeder Pond

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

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INTRODUCTION

A Total Maximum Daily Load (TMDL) analysis was completed for indicator bacteria in Allen Brook Pond (CT5207-02-1-L1_01) in Wallingford and North Haven, Gay City Pond (CT4707-00-2-L2_01) in Hebron and Bolton, and Schreeder Pond (CT5105-00-2-L1_01) in Killingworth. After review of indicator bacteria sources to the ponds, a TMDL was also prepared for segment CT5207-02_02 of Allen Brook in Wallingford, which is a tributary to Allen Brook Pond and was found to carry high levels of indicator bacteria to the Pond. Allen Brook Pond, Gay City Pond, and Schreeder Pond are designated swimming areas in Wharton Brook State Park, Gay City State Park, and Chatfield Hollow State Park, respectively (Figures 1-3). Both Allen Brook Pond and segment CT5207-02_02 of Allen Brook are included on the 2004 *List of Connecticut Waterbodies Not Meeting Water Quality Standards* [1] (2004 *List*) due to exceedences of the indicator bacteria criteria contained within the State *Water Quality Standards* (WQS) [2], as well as a number of beach closures at Allen Brook Pond. Gay City Pond and Schreeder Pond were not included on the 2004 *List*. However, beach closure information since the preparation of the 2004 *List* indicates that an impairment to swimming uses exists due to elevated levels of indicator bacteria. As such, these waterbodies will be included on the *2006 List of Connecticut Waterbodies Not Meeting Water Quality Standards*. A small segment of Allen Brook at the outlet of Allen Brook Pond (CT5207-02_01) was also not included on the 2004 *List*, however was included in the TMDL because recent data indicated exceedences of indicator bacteria criteria and will be included on the *2006 List of Connecticut Waterbodies Not Meeting Water Quality Standards*.

Under section 303(d) of the Federal Clean Water Act (CWA), States are required to develop TMDLs for waters impaired by pollutants that are included on the *List of Connecticut Waterbodies Not Meeting Water Quality Standards* for which technology-based controls are insufficient to achieve water quality standards. Please refer to the 2004 *List* for more information on impaired waterbodies throughout the State, and the *2004 Water Quality Report to Congress* [3] for information regarding all assessed waterbodies in the State. 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. In this TMDL, loadings are expressed as the average percent reduction from current loadings that must be achieved to meet water quality standards. 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 the TMDL analyses.

Allen Brook Pond receives stormwater discharges from the municipalities of North Haven and Wallingford at its inlet, as well as via Allen Brook. Within these municipalities are designated urban areas, as defined by the US Census Bureau [4]. Such municipalities 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. The permit requires municipalities to develop a program aimed at reducing the discharge of pollutants, as well as to protect water quality. The permit includes a provision requiring towns to focus their stormwater plans on waterbodies for which TMDLs have been developed. Such a program must include the following six control measures: public education and outreach; public participation; illicit discharge detection and elimination; construction stormwater management (greater than 1 acre); post-construction stormwater management; and pollution prevention and good housekeeping. Specific requirements have been developed within each of these control measures. Additional information regarding the general permit can be obtained on the Department of Environmental Protection (DEP) website at http://www.dep.state.ct.us/wtr/stormwater/ms4index.htm. Although Gay City Pond is located in a designated MS4 community, the pond does not receive stormwater discharges. Because of this, the MS4 Permit is not applicable to Gay City Pond. The MS4 Permit is also not applicable to Schreeder Pond, because it is not located in an MS4 community.

TMDLs that have been established by States are submitted to the Regional Office of the Federal Environmental Protection Agency (EPA) for review. The EPA can either approve the TMDL or disapprove the TMDL and act in lieu of the State. TMDLs provide a scientific basis for developing and implementing a Water Quality Management Plan (Plan), which describes the control measures necessary to achieve acceptable water quality conditions. Therefore, Plans derived from TMDLs typically include an implementation schedule and a description of ongoing monitoring activities to confirm that the TMDL will be effectively implemented and that WQS are achieved and maintained. Public participation during development of the TMDL analysis and subsequent preparation of the Plans is vital to the success of resolving water quality impairments.

TMDL analyses for indicator bacteria in Allen Brook Pond, Allen Brook, Gay City Pond, and Schreeder Pond are provided herein. As required in a TMDL analysis, load allocations have been determined, a margin of safety has been included, and seasonal variation has been considered. This document also includes recommendations for a water quality monitoring plan, as well as a discussion of TMDL Implementation.

PRIORITY RANKING

Bacteria impaired waterbodies in designated swimming areas are considered high priorities for TMDL development. Beach closure information for Allen Brook Pond, Gay City Pond and Schreeder Pond indicated bacteria impairments in the subject waterbodies. Beach closures are determined through the Connecticut State Public Beach Monitoring Program [5,6]. Allen Brook, a tributary to Allen Brook Pond, was ranked a T on the 2004 *List* indicating that the waterbody was under study and may lead to TMDL development if warranted by the study results. As such, it was determined that elevated levels of bacteria in the Pond during storm events correlate with elevated levels of bacteria in the Pond and the subsequent closure of the beach to swimming. This finding prompted development of a TMDL for Allen Brook simultaneous with the one for Allen Brook Pond. The impairment status of subject waterbodies is provided in the following table.

Table 1. The status of impairment for each of the subject waterbodies.

Waterbody Name Segment ID	Waterbody Segment Description	Impaired Use Cause
Allen Brook Pond CT5207-02-1-L1_01	Wharton Brook State Park. Impoundment off Allen Brook, near mouth and confluence with Wharton Brook; Wallingford/North Haven boundary.	Recreation Indicator Bacteria
Allen Brook CT5207-02_01	From mouth at confluence with Wharton Brook (east of Route 5, south of exit 13 on/off ramp, I91), US to Allen Brook Pond outlet dam, Wallingford.	Recreation Indicator Bacteria
Allen Brook CT5207-02_02	From inlet to Allen Brook Pond (south of exit 13 on/off ramp, I91), Wallingford/North Haven town borders, US to headwaters (under I91, and then parallel along east side, stays to west side of RailRoad track), Wallingford.	Recreation Indicator Bacteria
Gay City Pond CT4707-00-2-L2_01	Gay City State Park. Impoundment off Blackledge River; Bolton/Hebron boundary.	Recreation Indicator Bacteria
Schreeder Pond CT5105-00-2-L1_01	Chatfield Hollow State Park. Impoundment off Chatfield Hollow Brook; Killingworth.	Recreation Indicator Bacteria

DESCRIPTION OF THE WATERBODIES

See "Site Specific Information" in Appendix A

POLLUTANT OF CONCERN AND POLLUTANT SOURCES

Potential nonpoint sources of indicator bacteria to the subject waterbodies include wildlife, pet waste, horse/pet farms, surface water base flow, non-discharging toilets, and unknown sources. Point sources to Allen Brook and Allen Brook Pond include regulated storm water discharges and illicit discharges from the Towns of North Haven and Wallingford. Potential sources that have been tentatively identified, based on land use (Figures 4-6), for each of the waterbodies are presented in Table 2.

Table 2. Potential sources of bacteria for each of the subject waterbodies.

Waterbody Name	Nonpoint Sources	Point Sources
Allen Brook Pond	Wildlife, Pet Waste, Surface Water Base Flow (Allen Brook)	Regulated Storm Sewer/Urban Runoff from Allen Brook and Pipe at Inlet
Allen Brook	Wildlife, Horse/Pet Farms, Pet Waste, Unknown Sources	Regulated Storm Sewer/Urban Runoff, Illicit Discharges
Gay City Pond	Wildlife, Pet Waste	None
Schreeder Pond	Wildlife, Pet Waste, Non-Discharging Toilets	None

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 (a distinction is made between designated and non-designated), 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 [7] conducted in areas with known human fecal material contamination. 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 for Allen Brook Pond, Allen Brook, Gay City Pond, and Schreeder Pond are presented in Table 3. The criteria for Allen Brook is applicable to all recreational uses established for this waterbody. There are no designated or non-designated swimming areas located in this waterbody segment. The criteria for Allen Brook Pond, Gay City Pond, and Schreeder Pond have been established for designated swimming uses and are applicable to these waterbodies.

Table 3. Applicable indicator bacteria criteria for the subject waterbodies.

Waterbody	Class	Bacterial Indicator	Criteria
Allen Brook Pond	A	*Escherichia coli* (*E. coli*)	Geometric Mean less than 126/100ml Single Sample Maximum 235/100ml
Gay City Pond	A		
Schreeder Pond	A		
Allen Brook	A	*Escherichia coli* (*E. coli*)	Geometric Mean less than 126/100ml Single Sample Maximum 576/100ml

NUMERIC WATER QUALITY TARGET

TMDL calculations were performed consistent with the analytical procedures presented in the guidelines for the development of indicator bacteria TMDLs (Guidelines) [8]. The Guidelines are applicable to recreational uses established in the WQS [2]. The recreational uses addressed in the TMDLs include both all other uses and designated freshwater swimming uses. All data used in the analysis and the results of all calculations are presented in Appendix A. The results are summarized in Table 4 below.

Table 4. Summary of TMDL analysis.

Waterbody Segment ID	Waterbody Segment Description	Monitoring Site	Average Percent (%) Reduction to Meet Water Quality Standards				
			TMDL	WLA	LA		MOS
					Wet	Dry	
Allen Brook Pond CT5207-02-1-L1_01	Wharton Brook State Park. Impoundment off Allen Brook, near mouth and confluence with Wharton Brook; Wallingford/North Haven boundary.	WBK-1	23	25**	21**	3	Implicit
		WBK-2	22	22**	21**	3	Implicit
Allen Brook* CT5207-02_01	From mouth at confluence with Wharton Brook (east of Route 5, south of exit 13 on/off ramp, I91), US to Allen Brook Pond outlet dam, Wallingford.	WBKOUT	22	22	21	3	Implicit
Allen Brook CT5207-02_02	From inlet to Allen Brook Pond (south of exit 13 on/off ramp, I91), Wallingford/North Haven town borders, US to headwaters (under I91, and then parallel along east side, stays to west side of RailRoad track), Wallingford.	AB-1	68	73	-	64	Implicit
Gay City Pond CT4707-00-2-L2_01	Gay City State Park. Impoundment off Blackledge River; Bolton/Hebron boundary.	GYC-1	18	-	28	12	Implicit
		GYC-2	13	-	21	8	Implicit
Schreeder Pond CT5105-00-2-L1_01	Chatfield Hollow State Park. Impoundment off Chatfield Hollow Brook; Killingworth.	CHH-1	5	-	18	0	Implicit
		CHH-2	5	-	18	0	Implicit

* Current data is unavailable to conduct a TMDL analysis for Allen Brook segment CT5207-02_01. However, this small segment (0.05 linear mile) is located immediately downstream of the Allen Brook Pond Monitoring Site WBK-2, therefore it is reasonable to presume that the same percent reduction applies.

** The total wet weather percent reduction for the Allen Brook Pond monitoring sites (46% and 43%) were subdivided into a waste load allocation (WLA) and wet weather load allocation (LA). This was done to identify the average percent reduction attributed to point source regulated stormwater (i.e. WLA), as well as nonpoint sources active under wet weather condition (i.e. wet weather LA). The wet weather LA for the Allen Brook Pond sites were calculated by averaging the wet weather LAs for the Gay City and Schreeder Pond sites. The average wet weather LA was used because all three ponds experience similar wet weather nonpoint sources. The WLA for the Allen Brook Pond sites were calculated by subtracting the average wet weather LA from the total wet weather percent reduction (**See Below**).

Calculated Allen Brook Pond Total Wet Weather Percent Reductions: **WBK-1 = 46%**
WBK-2 = 43%

Average Wet Weather LA for Gay City Pond and Schreeder Pond: **Avg. Wet LA = 21%**

WLA for Allen Brook Pond (Total Wet Weather Percent Reduction – Average Wet Weather LA):
WBK-1 (46% - 21%) = 25%
WBK-2 (43% - 21%) = 22%

As demonstrated in Table 4, TMDLs are separated into WLA to account for point sources and LA to account for nonpoint sources. For Gay City Pond and Schreeder Pond, the LA is partitioned into wet weather and dry weather percent reductions to demonstrate the effect of stormwater events as nonpoint sources of bacteria in the ponds. A WLA for Gay City Pond and Schreeder Pond is not warranted because there are no regulated stormwater discharges or other point source discharges in the ponds. Therefore, the sources of *E.coli* are attributed exclusively to nonpoint sources active under both wet and dry weather conditions. Separate reduction goals are established for baseflow and stormwater dominated periods to assist managers of designated swimming areas with the selection of best management practices (BMPs) to improve water quality and prevent beach closures.

Wet weather and dry weather allocations were also partitioned for Allen Brook Pond, however the total wet weather percent reduction was further subdivided into a wet weather load allocation (LA) and waste load allocation (WLA) to account for point source regulated stormwater, as well as the effect of stormwater events on nonpoint sources. Allen Brook Pond receives point source regulated stormwater discharges from a pipe near the inlet of the Pond and via stormwater flow from Allen Brook segment CT5207-02_02. 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. However, inspection of the stormwater pipe indicated that the discharge was minimal and only occurred during periods of extensive storm events. Implementation of stormwater BMPs will likely result in reductions of bacteria densities from the pipe discharge, as well as Allen Brook. A wet weather LA is not applicable to Allen Brook segment CT5207-02_02 because the contribution of indicator bacteria during wet weather events is attributed to regulated stormwater discharges (WLA).

MARGIN OF SAFETY

TMDL analyses are required to include a margin of safety (MOS) to account for uncertainties regarding the relationship between load and wasteload 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. In addition, 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 [7]. Therefore, the criteria provide an additional level of protection when applied to waters not contaminated by human fecal material. Also, because the criteria were developed using data from swimming areas, the criteria provide an additional level of protection when applied to water not designated for high use bathing, as is such in Allen Brook. As such, achievement of the TMDL results in an "implicit MOS". Additional explanation concerning the implicit MOS incorporated into the TMDL analysis is provided in the Guidelines [8] included as Appendix B.

SEASONAL ANALYSIS

The TMDLs presented in this document are applicable during the typical recreation (summer) season from May 1 to September 30. Previous investigations by the DEP into seasonal trends of indicator bacteria densities in surface waters impacted solely by nonpoint sources indicates that the summer months typically exhibit the highest densities of any season [9]. This phenomena 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 during the summer months will result in achieving full support of recreational uses throughout the year.

TMDL IMPLEMENTATION

The percent reductions established in this TMDL can be achieved by implementing control actions that are designed to reduce *E. coli* loading from sources to the waterbodies. These actions may be taken by State and Local government, academia, volunteer citizens groups, and individuals to promote effective watershed management. Suggestions regarding best management practice (BMP) implementation are provided in the following section, however the goal is to allow the responsible parties flexibility to implement the most effective solutions to reduce *E.coli* loading. The DEP 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 goal and modification of controls as necessary.

It should be noted that DEP and the CT Department of Public Works funded a study to address water quality issues in Allen Brook Pond. The study identified and evaluated potential options to reduce bacteria including BMPs for the park and municipalities, flow augmentation options, swimming area screening, and dredging options. Recommendations and conclusions from section 5 of the '*Wharton Brook State Park Water Quality Study Report*' [10] are included as Appendix C.

Point sources to Allen Brook and Allen Brook Pond include regulated stormwater. Control actions for regulated stormwater include 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 Plans 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
- 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 the DEP as Part B Registration. Under the MS4 permit, all minimum control measures must be implemented by January 8, 2009. Information regarding Connecticut's MS4 permit can be found on the DEP's website at http://www.dep.state.ct.us/pao/download.htm#MS4GP. In addition, the EPA has developed fact sheets, which provide an overview of EPA's stormwater program 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 at: http://cfpub.epa.gov/npdes/stormwater/swphases.cfm. 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.

Section 6(K) of the MS4 Permit requires the municipality to modify their Stormwater Management Plan to implement the TMDL (achieve reductions) within four months of TMDL approval by EPA. It is recommended that municipalities focus their revised Stormwater Management Plans on the TMDL waterbodies for Section 6(a)(1)(A)(i) - implement public education program, Section 6(a)(3)(A)(i, ii, iii) and 6(a)(3)(A)(i, ii, iii, iv) - illicit discharge detection, Section 6(a)(6)(A)(iv) - stormwater structures cleaning, and Section 6(a)(6)(A)(v) - prioritize stormwater structures for repair or upgrade, of the MS4 permit.

Nonpoint sources of *E.coli* to Allen Brook Pond, Gay City Pond, and Schreeder Pond include wildlife, pet waste, non-discharging toilets, and surface water base flow. The contribution of nonpoint sources of bacteria varies under wet and dry weather conditions. Wet weather percent reductions are significantly higher than dry weather percent reductions for all three ponds. This indicates that the greatest impact to the waterbodies is delivery of bacteria from nonpoint sources through stormwater runoff to the swimming areas. Therefore, BMPs should focus on the management of nonpoint sources during wet weather. It is likely that BMPs for the management of nonpoint sources during wet weather will result in percent reductions during dry weather as well.

BMPs for the management of nonpoint sources include riparian buffer strips (zone), nuisance wildlife control and pet waste management. Natural vegetation surrounding the ponds, other than the beach area, should be allowed to grow freely in order to act as a barrier to solids and other potential sources of bacteria during storm events. Wildlife is not allocated a percent reduction because the TMDL management goal is to foster a sustainable natural habitat. However, BMPs may be implemented to control some wildlife species that can result in elevated indicator bacteria densities, such as resident populations of Canadian geese. Nuisance wildlife information can be found on the DEP's website at http://www.dep.state.ct.us/burnatr/wildlife/problem.htm. High bacteria densities in all three waterbodies are likely augmented by pet waste found in and around the beach area. Pet waste can collect in surface runoff that channels as sheet flow to the swimming areas during wet weather events. The DEP State Parks Department pet policy currently does not allow pets on the beach. However, pets are allowed on park grounds surrounding the beach. The pet policy should be enforced and modified to include proper pet waste management at the parks where these beaches are located. Signs regarding the cleanup of pet waste should be prominently posted throughout the park and ideally disposal receptacles provided. Non-discharging toilets that deposit directly into a pit in the ground may potentially contribute to bacteria densities through groundwater leaching into nearby waterbodies, particularly in areas that are sloped towards the water. While it is unknown whether or not these toilets contribute significant levels of bacteria to the water, BMPs may include precautionary measures such as frequent cleaning or prioritization for replacement with self-contained systems. The contribution of bacteria from surface water base flow in Allen Brook Pond is addressed through percent reductions in Allen Brook. As progress is made implementing BMPs, the "percent reduction" needed to meet criteria will decrease.

WATER QUALITY MONITORING PLAN

The DEP currently samples two sites in Allen Brook Pond, Gay City Pond, and Schreeder Pond weekly during the summer bathing season (approximately May 31 through September 1) as part of the State Beach Monitoring Program (Program). Sampling is expected to continue under this Program. Details of the monitoring procedure are outlined in the *Guidelines for Monitoring Bathing Waters and Closure Protocol* [5] and the *Quality Assurance Project Plan (QAPP) for Indicator Bacteria Monitoring at Public Bathing Beaches* [6]. Water quality monitoring under the Program is sufficient to evaluate TMDL implementation efforts.

Under the MS4 Permit, MS4 communities in Allen Brook and Allen Brook Pond include the following additional monitoring requirements:

> *"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."*
>
> Section 6(h)(A) MS4 Permit

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, the municipality may request written approval from the DEP for an alternative monitoring program:

> *"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.*
>
> Section 6(h)(B) MS4 Permit

The DEP encourages municipalities faced with implementing a TMDL to request approval for an alternative monitoring program. Monitoring may be performed by municipal staff, citizen volunteers, or contracted to an environmental consulting firm. 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.

Progress in achieving TMDL established goals through BMP implementation may be most effectively gauged through implementing a fixed station ambient monitoring program. DEP strongly recommends that routine monitoring be performed at the same sites used to generate the data used to perform the TMDL calculations. 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 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 Title 40, CFR, Part 136 (1990). Electronic submission of data to DEP 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)

DEP will continue to explore ways to provide funding support for monitoring efforts linked to TMDL implementation or other activities that exceed the minimum requirements of the MS4 permit. DEP is also committed to providing technical assistance in monitoring program design and establishing procedures for electronic data submission.

RESONABLE ASSURANCE

The bathing areas in Allen Brook Pond, Gay City Pond, and Schreeder Pond are located in State Parks, which are overseen and operated by the DEP Bureau of Outdoor Recreation. The Bureau of Outdoor Recreation is committed to protecting Connecticut's natural resources to ensure continued recreational opportunities. This provides reasonable assurance that future efforts by the Bureau of Outdoor Recreation will be aimed towards the prevention of beach closures through achievement of the TMDL goals, and subsequently sustained use of the swimming areas.

In addition, the MS4 Permit is a legally enforceable document that will provide reasonable assurance of regulated stormwater discharge management in Allen Brook and Allen Brook Pond.

PROVISIONS FOR REVISING THE TMDL

The DEP 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 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. The DEP will propose modifications to the TMDL analysis 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 recreational uses are fully supported.

PUBLIC PARTICIPATION

The Allen Brook Pond, Allen Brook, Gay City Pond and Schreeder Pond TMDL document was noticed for public comment in the Hartford Courant on September 1, 2006. In addition, the public notice was posted at State Park kiosks near each pond and several interested parties were notified by mail of the comment period. As of the end of the public review period (October 6, 2006), no comment letters were received by the DEP.

REFERENCES

(1) Connecticut Department of Environmental Protection, 2004. *List of Connecticut Water bodies Not Meeting Water Quality Standards*. Bureau of Water Management, 79 Elm Street, Hartford, CT 06106-5127.

(2) Connecticut Department of Environmental Protection, 2002. *Connecticut Water Quality Standards*. Bureau of Water Management, 79 Elm Street, Hartford, CT 06106-5127.

(3) Connecticut Departmen of Environmental Protection, 2004. *Water Quality Report to Congress*. Bureau of Water Management, 79 Elm Street, Hartford, CT 06106-5127.

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

(5) Connecticut Department of Environmental Protection and Connecticut Department of Public Health, 2003. *State of Connecticut Guidelines for Monitoring Bathing Waters and Closure Protoco*l. Bureau of Water Management, 79 Elm Street, Hartford, CT 06106-5127.

(6) Connecticut Department of Environmental Protection and Connecticut Department of Public Health, 2003. *Quality Assurance Project Plan for Indicator Bacteria Monitoring at Public Bathing Beaches*. Bureau of Water Management, 79 Elm Street, Hartford, CT 06106-5127.

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

(8) Connecticut Department of Environmental Protection, 2005. *Development of Total Maximum Daily Loads for Indicator Bacteria in Recreation Areas Using the Cumulative Distribution Function Method*. Bureau of Water Mangement, 79 Elm Street, Hartford, CT 06106-5127. (Included as Appendix B)

(9) Connecticut Department of Environmental Protection, 1991. *A Survey of Connecticut Streams and Rivers – Central Coastal and Western Coastal Drainages*. Bureau of Recreation, 79 Elm Street, Hartford, CT 06106-5127.

(10) Diversified Technology Consultants, 2003. *Wharton Brook State Park Water Quality Study Report*. DTC Project No.: 00-409-101. (Included as Appendix C)

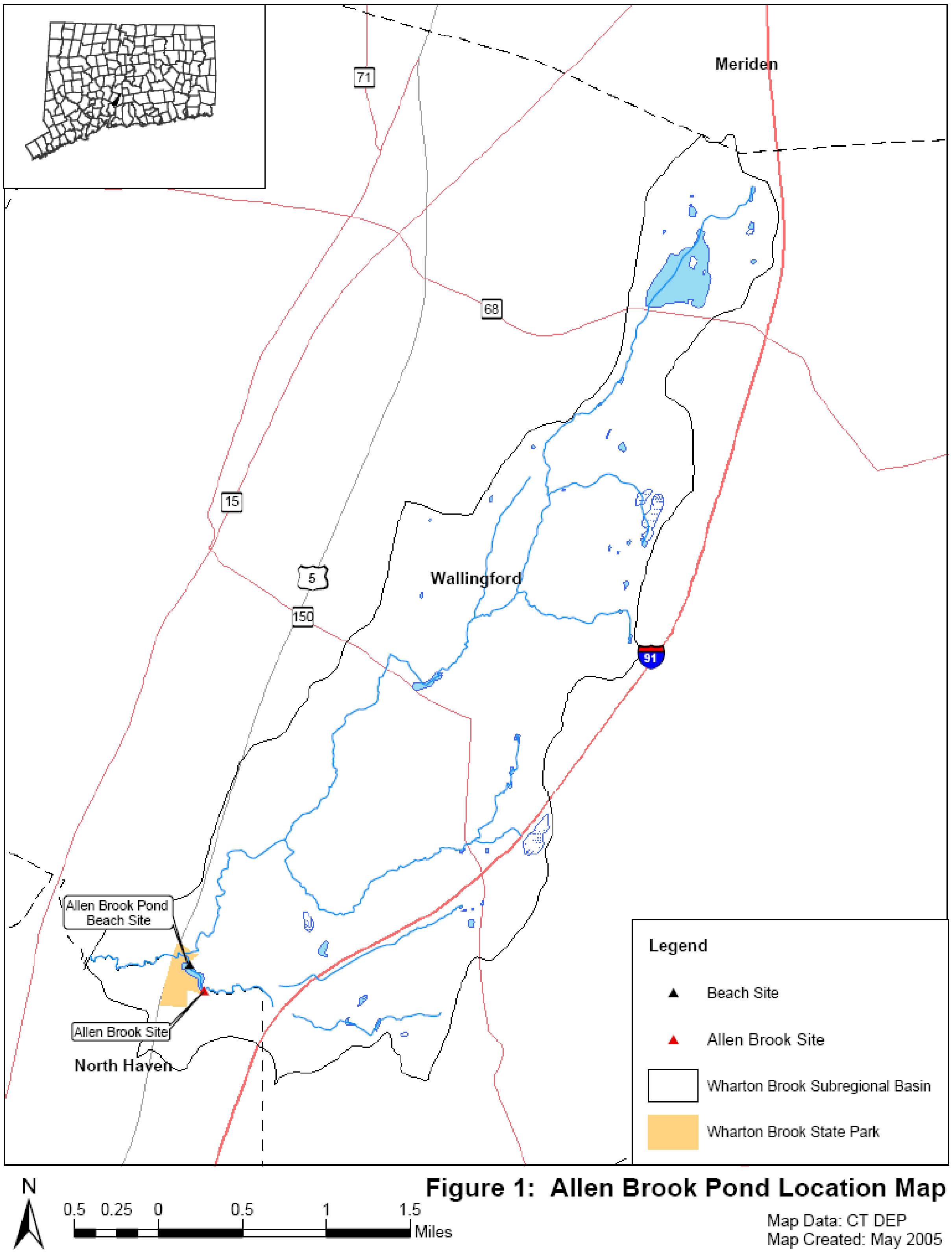


Figure 1: Allen Brook Pond Location Map

Map Data: CT DEP
Map Created: May 2005

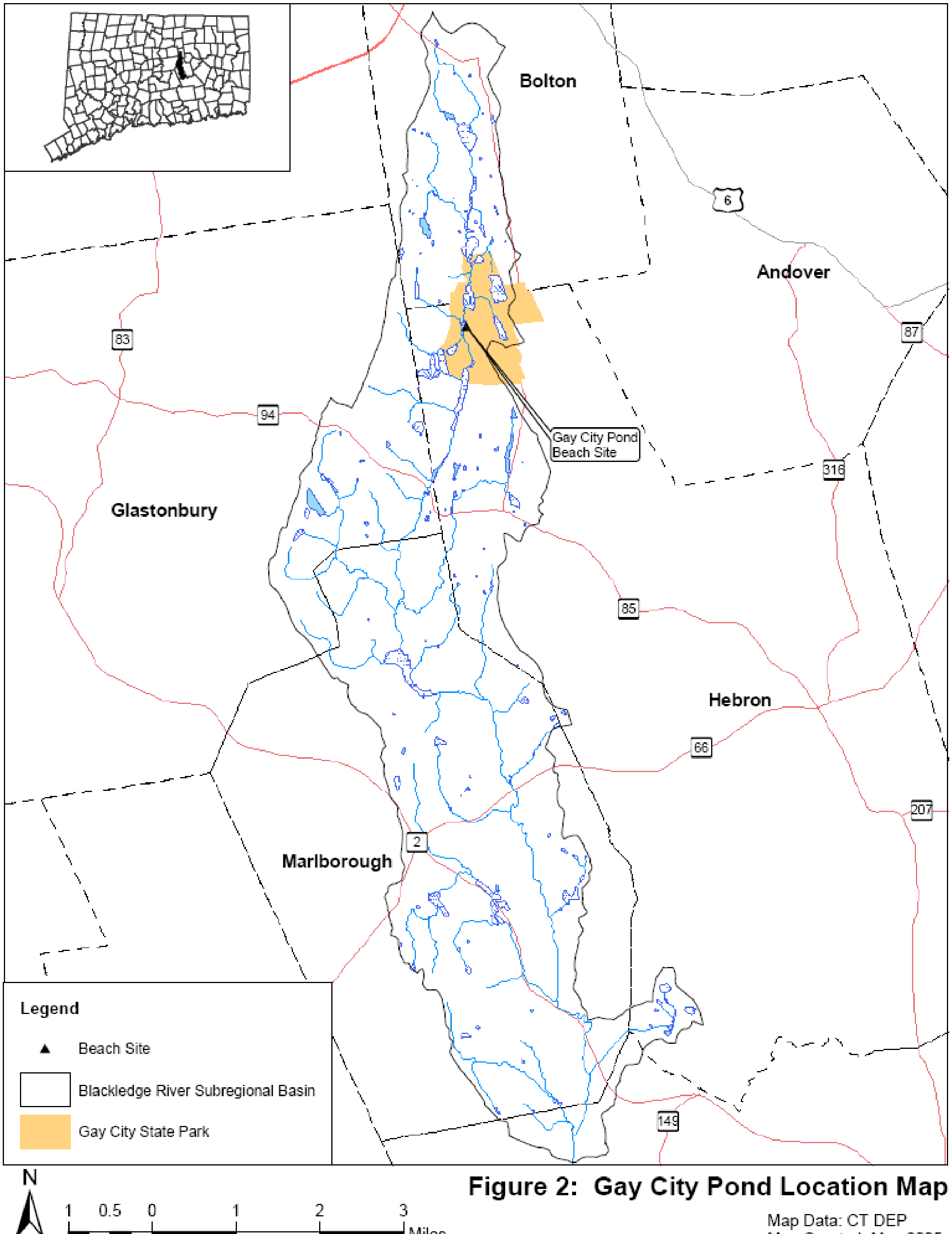


Figure 2: Gay City Pond Location Map

Map Data: CT DEP
Map Created: May 2005

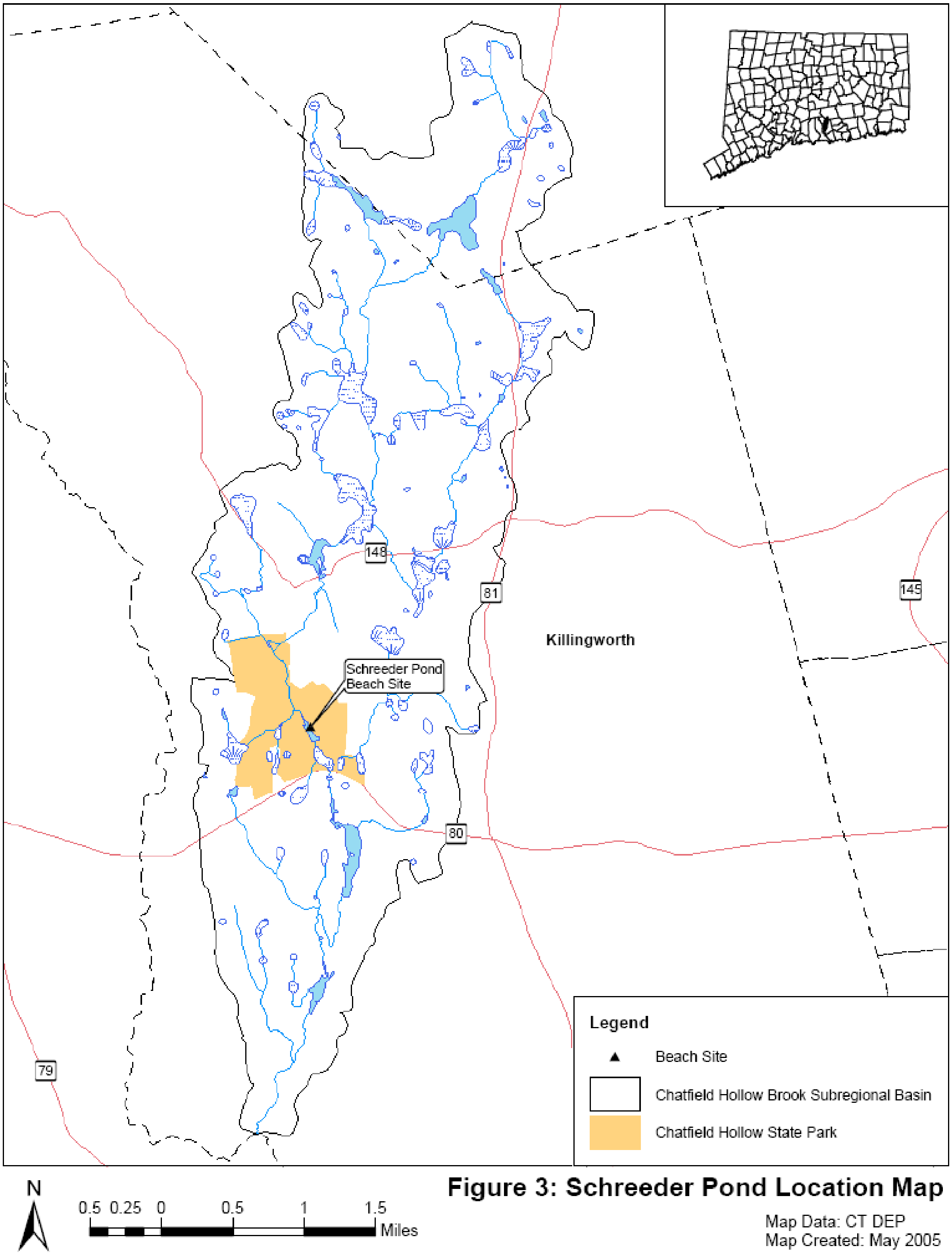


Figure 3: Schreeder Pond Location Map

Map Data: CT DEP
Map Created: May 2005

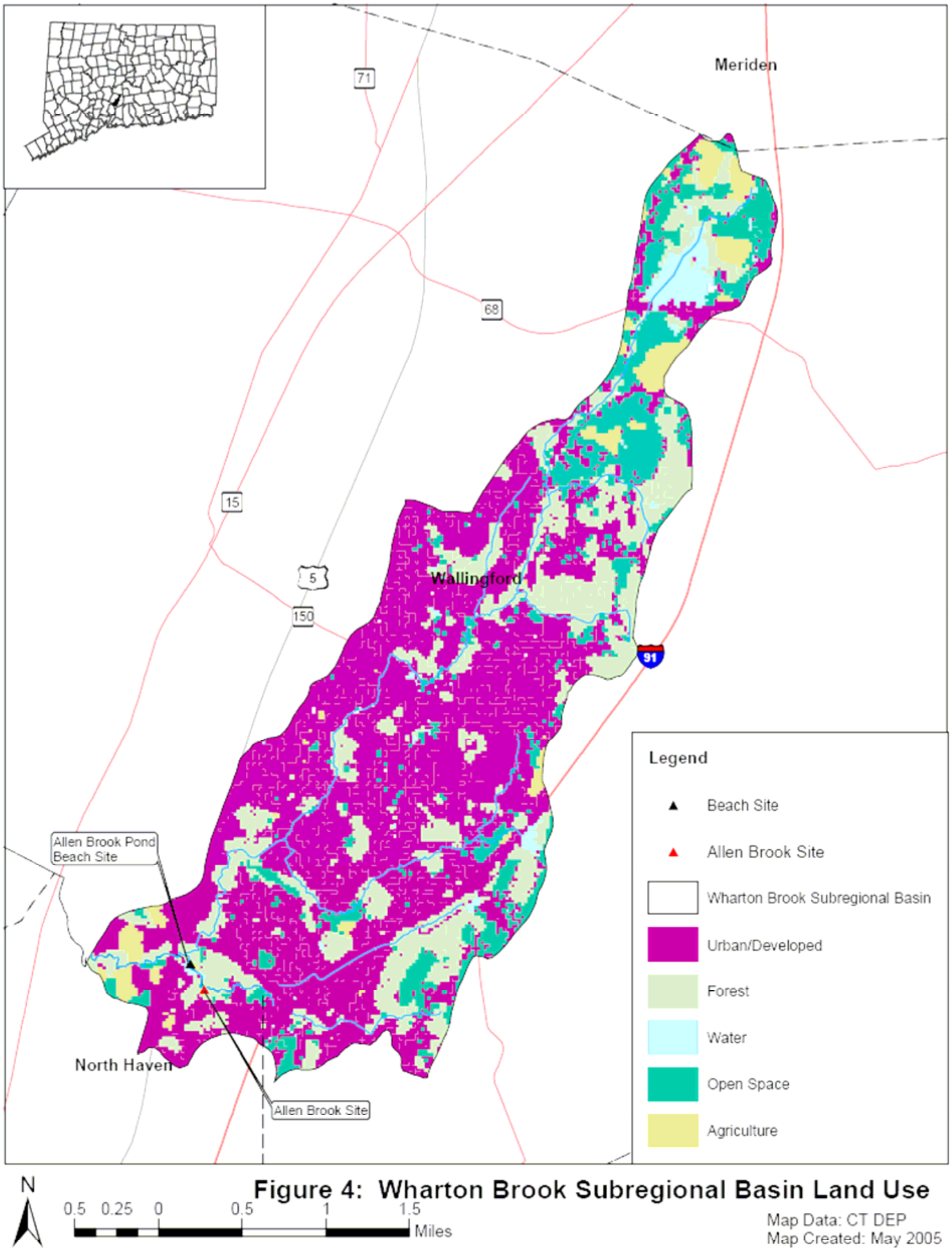


Figure 4: Wharton Brook Subregional Basin Land Use

Map Data: CT DEP
Map Created: May 2005

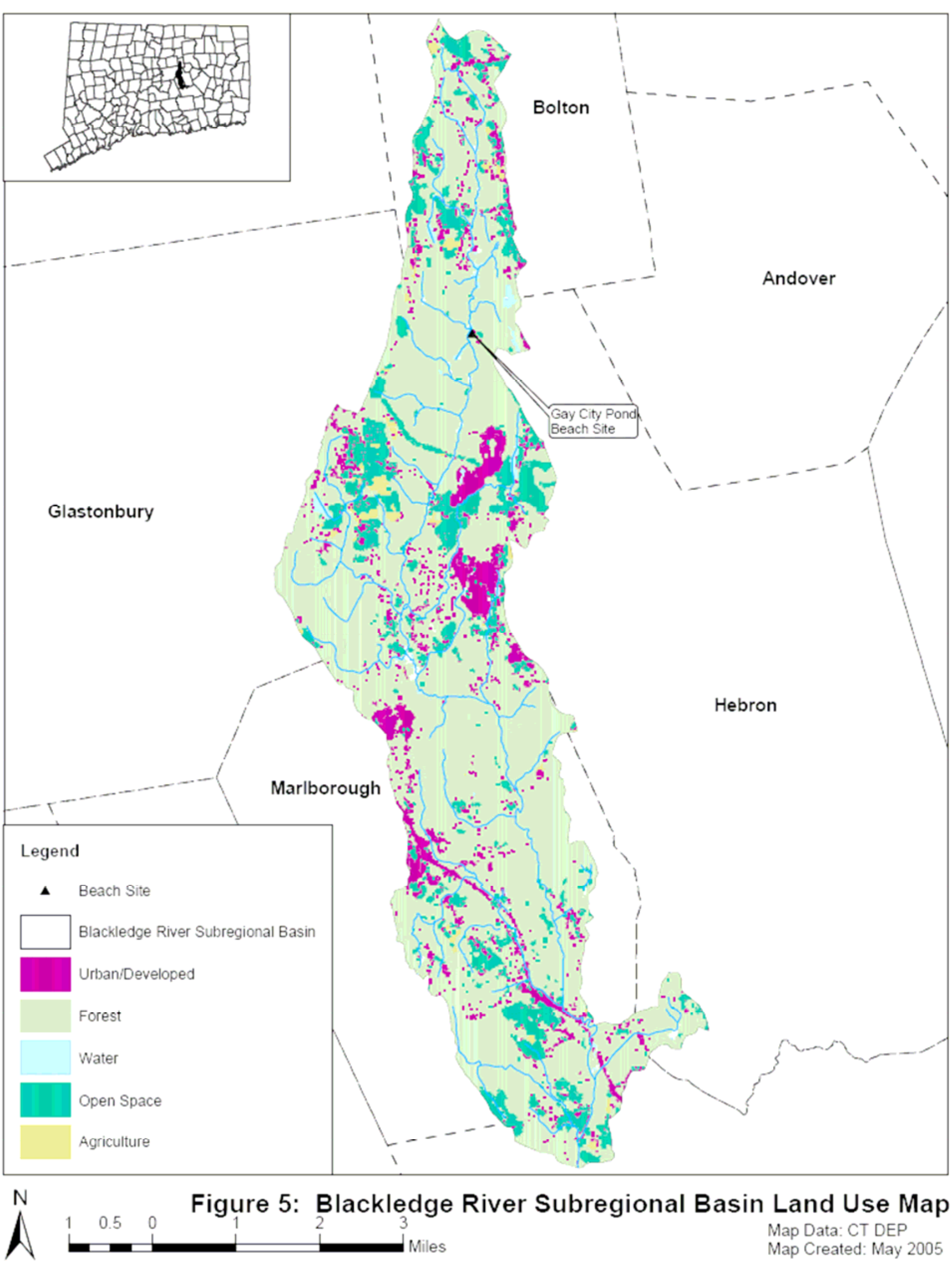


Figure 5: Blackledge River Subregional Basin Land Use Map

Map Data: CT DEP
Map Created: May 2005

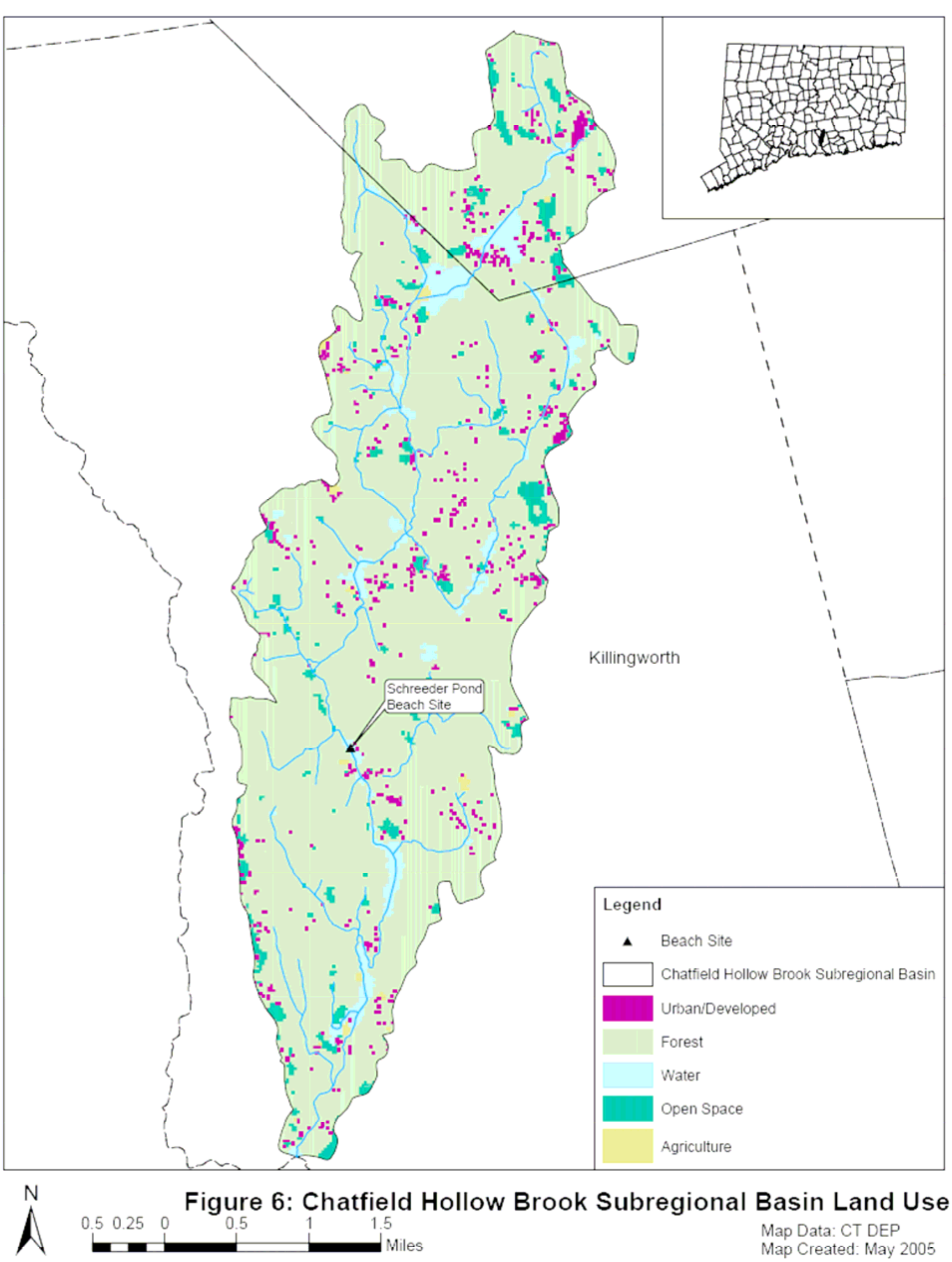


Figure 6: Chatfield Hollow Brook Subregional Basin Land Use

Map Data: CT DEP
Map Created: May 2005

Appendix A

Appendix A-1
Allen Brook Pond, Allen Brook
Waterbody Specific Information

Impaired Waterbody
Waterbody Name (Segment ID): Allen Brook Pond (CT5207-02-1-L1_01), Allen Brook (CT5707-02_01, CT5707-02_02)

Waterbody Segment Description:
Allen Brook Pond (CT5207-02-1-L1_01) - Wharton Brook State Park. Impoundment off Allen Brook, near mouth and confluence with Wharton Brook; Wallingford/North Haven boundary.
Allen Brook (CT5707-02_01) - From mouth at confluence with Wharton Brook (east of Route 5, south of exit 13 on/off ramp, I91), US to Allen Brook Pond outlet dam, Wallingford.
Allen Brook (CT5707-02_02) - From inlet to Allen Brook Pond (south of exit 13 on/off ramp, I91), Wallingford/North Haven town borders, US to headwaters (under I91, and then parallel along east side, stays to west side of RailRoad track), Wallingford.

Impairment Description:
Designated Use Impairment: Contact Recreation
Surface Water Classification: Class A

Watershed Description:
Total Drainage Basin Area: 1.285 square miles
Subregional Basin Name & Code: Wharton Brook, 5207
Regional Basin: Quinnipiac
Major Basin: South Central Coastal Basin
Watershed Towns: Wallingford, North Haven
MS4 applicable? Wallingford (Yes), North Haven (Yes),
Applicable Season: Recreation Season (May 1 to September 30)
Subregional Basin Landuse:

Land Use Category	Percent Composition
Forested	21.43%
Urban/Developed	59.50%
Open Space	12.89%
Water/Wetland	2.24%
Agriculture	3.94%

Data Source: Connecticut Land Use Land Cover Data Layer LANDSTAT (1995) Thematic Mapper Satellite Imagery.

Allen Brook Pond

Data Used in the Analysis

Monitoring Site: WBK-1, At Left Side of Beach in Wharton Brook S.P.

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/23/00	0.62	0.68	0.88	**WET**	87	62.5	0.5896	155	0
5/30/00	0.00	0.00	0.00	DRY	20	27.5	0.2594	70	0
6/5/00	0.14	0.16	0.16	**WET**	75	59.0	0.5566	144	0
6/8/00	0.00	0.00	2.32	**WET**	1415	88.0	0.8302	235	83
6/12/00	0.14	3.09	3.09	**WET**	2000	97.5	0.9198	235	88
6/14/00	0.02	0.14	3.23	**WET**	530	79.0	0.7453	231	56
6/16/00	0.00	0.02	0.16	DRY	148.5	68.0	0.6415	176	0
6/19/00	0.00	0.60	0.60	**WET**	99	64.5	0.6085	162	0
6/21/00	0.05	0.05	0.65	DRY	64	55.5	0.5236	133	0
6/26/00	0.09	0.09	0.09	DRY	10	12.0	0.1132	41	0
7/5/00	0.00	0.54	0.65	**WET**	780	82.0	0.7736	235	70
7/7/00	0.00	0.00	0.54	DRY	10	12.0	0.1132	41	0
7/10/00	0.00	0.05	0.05	DRY	10	12.0	0.1132	41	0
7/17/00	0.00	0.00	2.81	**WET**	2000	97.5	0.9198	235	88
7/19/00	0.15	0.15	0.15	**WET**	160	70.0	0.6604	184	0
7/24/00	0.00	0.00	0.03	DRY	10	12.0	0.1132	41	0
7/28/00	0.00	0.29	2.27	**WET**	500	78.0	0.7358	225	55
7/31/00	0.05	1.61	1.61	**WET**	2000	97.5	0.9198	235	88
8/2/00	0.14	0.19	1.80	**WET**	950	84.0	0.7925	235	75
8/4/00	0.00	0.28	0.47	**WET**	220	73.0	0.6887	198	10
8/7/00	0.00	0.78	0.78	**WET**	2000	97.5	0.9198	235	88
8/9/00	0.78	0.78	1.56	**WET**	1700	89.5	0.8443	235	86
8/14/00	0.26	1.12	1.52	**WET**	2000	97.5	0.9198	235	88
8/16/00	0.03	0.12	1.24	DRY	120	66.0	0.6226	168	0
8/21/00	0.00	0.00	0.16	DRY	25.5	33.0	0.3113	80	0
8/28/00	0.00	0.00	0.00	DRY	10	12.0	0.1132	41	0
5/20/02	0.00	0.00	1.46	DRY	360	77.0	0.7264	219	39
5/22/02	0.00	0.00	0.00	DRY	150	69.0	0.6509	180	0
5/28/02	0.22	0.22	0.22	**WET**	99	64.5	0.6085	162	0
6/3/02	0.00	0.00	0.85	DRY	87	62.5	0.5896	155	0
6/10/02	0.00	0.00	0.20	DRY	31	36.5	0.3443	87	0
6/17/02	0.62	0.62	1.32	**WET**	1200	87.0	0.8208	235	80
6/19/02	0.00	0.00	0.62	DRY	20.5	32.0	0.3019	78	0
6/24/02	0.00	0.00	0.00	DRY	31	36.5	0.3443	87	0
7/1/02	0.00	0.00	0.00	DRY	10	12.0	0.1132	41	0
7/8/02	0.00	0.00	0.00	DRY	10	12.0	0.1132	41	0
7/10/02	0.00	0.29	0.29	**WET**	84	61.0	0.5755	150	0
7/15/02	0.00	0.00	0.00	DRY	20	27.5	0.2594	70	0
7/22/02	0.00	0.00	0.22	DRY	64	55.5	0.5236	133	0
7/24/02	0.00	0.80	0.80	**WET**	1700	89.5	0.8443	235	86
7/29/02	0.00	0.00	0.00	DRY	20	27.5	0.2594	70	0
7/31/02	0.00	0.00	0.00	DRY	10	12.0	0.1132	41	0
8/5/02	0.00	0.00	1.25	DRY	31	36.5	0.3443	87	0
8/7/02	0.00	0.00	0.00	DRY	41	41.5	0.3915	98	0
8/12/02	0.00	0.00	0.00	DRY	20	27.5	0.2594	70	0
8/19/02	0.12	0.12	0.14	**WET**	10	12.0	0.1132	41	0
8/19/02	0.12	0.12	0.14	**WET**	10	12.0	0.1132	41	0
8/26/02	0.00	0.00	0.18	DRY	10	12.0	0.1132	41	0
5/19/03	0.00	0.00	0.00	DRY	10	12.0	0.1132	41	0
5/27/03	0.15	2.55	2.76	**WET**	2000	97.5	0.9198	235	88
5/29/03	0.00	0.01	2.56	**WET**	890	83.0	0.7830	235	74
6/2/03	0.00	0.33	1.54	**WET**	2000	97.5	0.9198	235	88
6/4/03	1.63	2.01	2.34	**WET**	140	67.0	0.6321	172	0
6/9/03	0.00	0.01	0.54	DRY	290	76.0	0.7170	214	26
6/11/03	0.34	0.34	0.35	**WET**	53	51.5	0.4858	122	0
6/16/03	0.00	0.00	1.08	DRY	190	72.0	0.6792	193	0
6/23/03	0.03	0.56	1.28	**WET**	2000	97.5	0.9198	235	88
6/25/03	0.00	0.00	0.56	DRY	64	55.5	0.5236	133	0
6/30/03	0.00	0.00	0.00	DRY	53	51.5	0.4858	122	0
7/1/03	0.00	0.00	0.00	DRY	41	41.5	0.3915	98	0

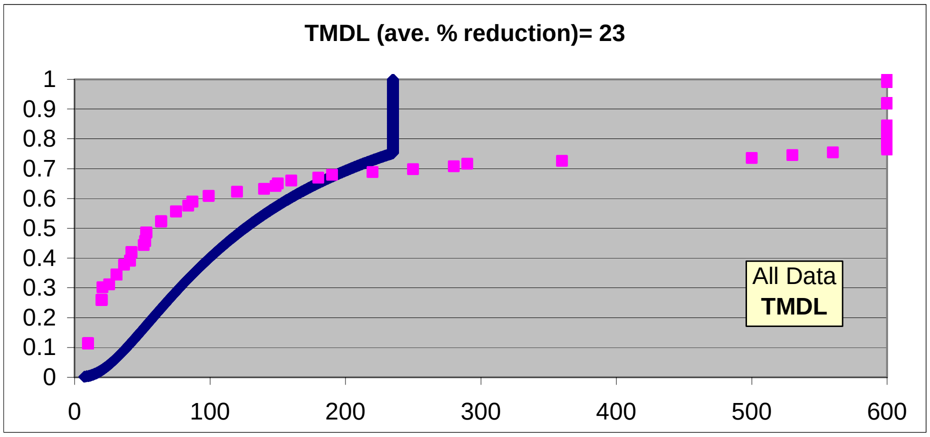
Statistics

# Samples DRY	**56**
# Samples WET	**50**
# Samples Total	**106**
Geomean	**97**
Log std deviation	**0.8367**
Avg % Reduction	
Wet Weather Reduction	**46**
Dry Weather Reduction	**3**
Total (TMDL)	**23**

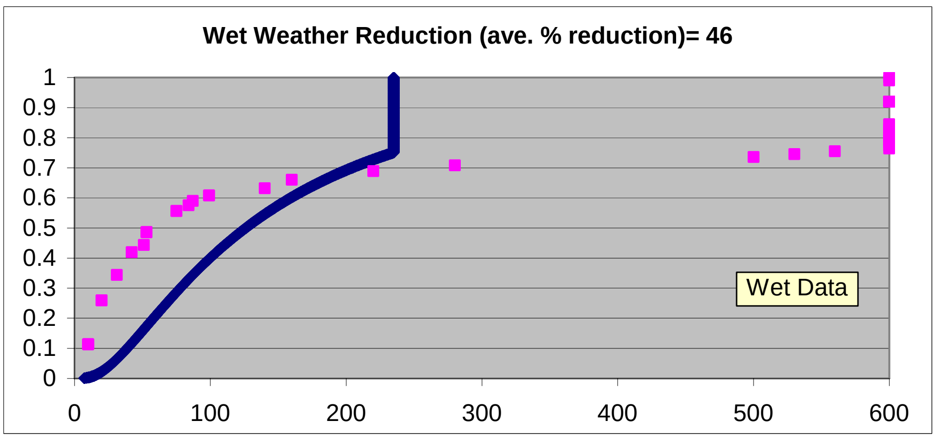
7/7/03	0.11	0.11	0.11	**WET**	20	27.5	0.2594	70	0
7/14/03	0.00	0.00	0.01	DRY	10	12.0	0.1132	41	0
7/16/03	0.32	0.32	0.32	**WET**	10	12.0	0.1132	41	0
7/21/03	0.16	0.16	0.18	**WET**	31	36.5	0.3443	87	0
7/28/03	0.06	0.07	0.07	DRY	31	36.5	0.3443	87	0
7/30/03	0.00	0.00	0.07	DRY	52	48.5	0.4575	114	0
8/4/03	1.10	1.35	2.96	**WET**	700	81.0	0.7642	235	66
8/6/03	0.00	0.70	2.05	**WET**	2000	97.5	0.9198	235	88
8/7/03	1.43	1.43	3.23	**WET**	2000	97.5	0.9198	235	88
8/11/03	0.02	0.38	0.94	**WET**	2000	97.5	0.9198	235	88
8/18/03	0.01	0.46	1.22	**WET**	560	80.0	0.7547	235	58
8/20/03	0.00	0.00	0.46	DRY	42	44.5	0.4198	105	0
8/25/03	0.00	0.00	0.00	DRY	10	12.0	0.1132	41	0
8/28/03	0.00	0.00	0.00	DRY	20	27.5	0.2594	70	0
9/12/03	0.00	0.00	0.00	DRY	10	12.0	0.1132	41	0
9/24/03	0.03	1.40	1.41	**WET**	4600	106.0	1.0000	235	95
5/24/04	0.04	0.68	0.68	**WET**	2000	97.5	0.9198	235	88
5/27/04	0.04	0.44	0.49	**WET**	53	51.5	0.4858	122	0
6/1/04	0.03	0.58	0.58	**WET**	42	44.5	0.4198	105	0
6/3/04	0.00	0.30	0.88	**WET**	280	75.0	0.7075	208	26
6/7/04	0.00	0.06	0.06	DRY	10	12.0	0.1132	41	0
6/14/04	0.07	0.07	0.07	DRY	10	12.0	0.1132	41	0
6/17/04	0.09	0.09	0.16	DRY	10	12.0	0.1132	41	0
6/21/04	0.00	0.00	0.08	DRY	10	12.0	0.1132	41	0
6/28/04	0.22	0.22	0.23	**WET**	53	51.5	0.4858	122	0
6/30/04	0.00	0.00	0.22	DRY	20	27.5	0.2594	70	0
7/6/04	0.00	0.86	1.64	**WET**	1000	85.0	0.8019	235	77
7/8/04	0.00	0.07	0.93	DRY	36.5	40.0	0.3774	94	0
7/12/04	0.50	0.50	0.50	**WET**	20	27.5	0.2594	70	0
7/13/04	0.02	0.52	0.52	**WET**	51	47.0	0.4434	111	0
7/19/04	0.00	0.15	0.43	DRY	31	36.5	0.3443	87	0
7/26/04	0.00	0.00	0.46	DRY	42	44.5	0.4198	105	0
7/29/04	0.00	0.05	0.91	DRY	52	48.5	0.4575	114	0
8/2/04	0.00	0.35	0.35	**WET**	2000	97.5	0.9198	235	88
8/4/04	0.94	0.94	1.29	**WET**	75	59.0	0.5566	144	0
8/9/04	0.00	0.00	0.00	DRY	10	12.0	0.1132	41	0
8/12/04	0.02	0.24	0.24	DRY	42	44.5	0.4198	105	0
8/16/04	0.58	0.67	1.86	**WET**	1100	86.0	0.8113	235	79
8/18/04	0.00	0.00	0.67	DRY	250	74.0	0.6981	203	19
8/19/04	0.04	0.04	0.62	DRY	75	59.0	0.5566	144	0
8/23/04	0.00	0.00	1.44	DRY	2000	97.5	0.9198	235	88
8/25/04	0.00	0.00	0.00	DRY	64	55.5	0.5236	133	0
8/26/04	0.00	0.00	0.00	DRY	180	71.0	0.6698	189	0
8/30/04	0.08	0.08	0.08	DRY	10	12.0	0.1132	41	0
9/7/04	0.34	0.36	0.40	**WET**	10	12.0	0.1132	41	0
9/21/04	0.00	0.00	2.18	**WET**	2900	105.0	0.9906	235	92

Precipitation and E. coli data provided by the Town of Wallingford and CT DEP, respectively.**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. Duplicate samples were averaged.

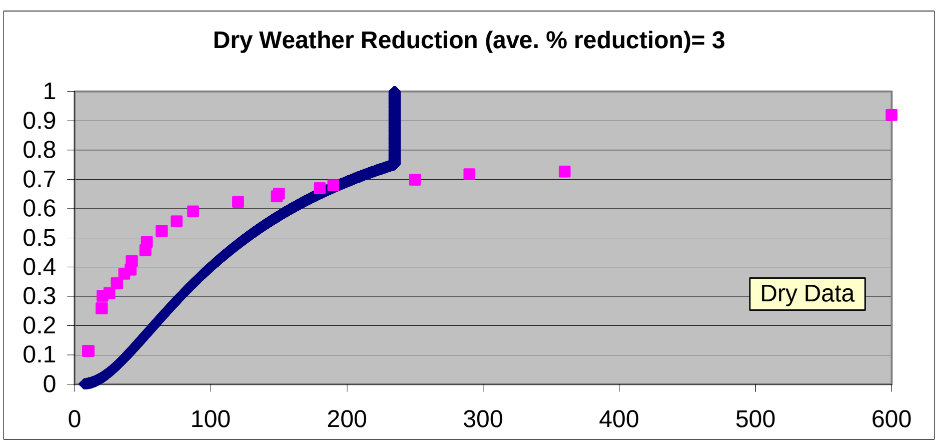
Allen Brook Pond Criteria Curve for Monitoring Site WBK-1
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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



Wet Weather Reduction needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Dry Weather Reduction needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Allen Brook Pond

Data Used in the Analysis

Monitoring Site: WBK-2, At Right Side of Beach in Wharton Brook S.P.

Date	Precip.(in)[1]			Condition[2]	E. coli	Rank	Proportion	Criteria	%
	24h	48h	96h	(WET/DRY)	(col./100 ml)			Value	Reduction
5/23/00	0.62	0.68	0.88	**WET**	20	36.0	0.3396	86	0
5/30/00	0.00	0.00	0.00	DRY	10	16.0	0.1509	49	0
6/5/00	0.14	0.16	0.16	**WET**	140	66.5	0.6274	170	0
6/8/00	0.00	0.00	2.32	**WET**	1100	88.0	0.8302	235	79
6/12/00	0.14	3.09	3.09	**WET**	2000	99.0	0.9340	235	88
6/14/00	0.02	0.14	3.23	**WET**	320	78.0	0.7358	225	30
6/16/00	0.00	0.02	0.16	DRY	150	69.5	0.6557	182	0
6/19/00	0.00	0.60	0.60	**WET**	150	69.5	0.6557	182	0
6/21/00	0.05	0.05	0.65	DRY	10	16.0	0.1509	49	0
6/26/00	0.09	0.09	0.09	DRY	31	43.5	0.4104	102	0
7/5/00	0.00	0.54	0.65	**WET**	1400	93.0	0.8774	235	83
7/7/00	0.00	0.00	0.54	DRY	10	16.0	0.1509	49	0
7/10/00	0.00	0.05	0.05	DRY	31	43.5	0.4104	102	0
7/17/00	0.00	0.00	2.81	**WET**	2000	99.0	0.9340	235	88
7/19/00	0.15	0.15	0.15	**WET**	225	74.0	0.6981	203	10
7/24/00	0.00	0.00	0.03	DRY	20	36.0	0.3396	86	0
7/28/00	0.00	0.29	2.27	**WET**	430	79.0	0.7453	231	46
7/31/00	0.05	1.61	1.61	**WET**	2000	99.0	0.9340	235	88
8/2/00	0.14	0.19	1.80	**WET**	620	82.5	0.7783	235	62
8/4/00	0.00	0.28	0.47	**WET**	150	69.5	0.6557	182	0
8/7/00	0.00	0.78	0.78	**WET**	2000	99.0	0.9340	235	88
8/9/00	0.78	0.78	1.56	**WET**	290	76.0	0.7170	214	26
8/14/00	0.26	1.12	1.52	**WET**	2000	99.0	0.9340	235	88
8/16/00	0.03	0.12	1.24	DRY	99	60.0	0.5660	147	0
8/21/00	0.00	0.00	0.16	DRY	10	16.0	0.1509	49	0
8/28/00	0.00	0.00	0.00	DRY	10	16.0	0.1509	49	0
5/20/02	0.00	0.00	1.46	DRY	530	80.0	0.7547	235	56
5/22/02	0.00	0.00	0.00	DRY	130	64.5	0.6085	162	0
5/28/02	0.22	0.22	0.22	**WET**	53	50.5	0.4764	119	0
6/3/02	0.00	0.00	0.85	DRY	87	58.0	0.5472	141	0
6/10/02	0.00	0.00	0.20	DRY	99	60.0	0.5660	147	0
6/17/02	0.62	0.62	1.32	**WET**	1000	87.0	0.8208	235	77
6/19/02	0.00	0.00	0.62	DRY	42	48.5	0.4575	114	0
6/24/02	0.00	0.00	0.00	DRY	10	16.0	0.1509	49	0
7/1/02	0.00	0.00	0.00	DRY	10	16.0	0.1509	49	0
7/8/02	0.00	0.00	0.00	DRY	10	16.0	0.1509	49	0
7/10/02	0.00	0.29	0.29	**WET**	120	63.0	0.5943	157	0
7/15/02	0.00	0.00	0.00	DRY	31	43.5	0.4104	102	0
7/22/02	0.00	0.00	0.22	DRY	10	16.0	0.1509	49	0
7/24/02	0.00	0.80	0.80	**WET**	820	85.0	0.8019	235	71
7/29/02	0.00	0.00	0.00	DRY	31	43.5	0.4104	102	0
7/31/02	0.00	0.00	0.00	DRY	10	16.0	0.1509	49	0
8/5/02	0.00	0.00	1.25	DRY	42	48.5	0.4575	114	0
8/7/02	0.00	0.00	0.00	DRY	10	16.0	0.1509	49	0
8/12/02	0.00	0.00	0.00	DRY	10	16.0	0.1509	49	0
8/19/02	0.12	0.12	0.14	**WET**	10	16.0	0.1509	49	0
8/19/02	0.12	0.12	0.14	**WET**	20	36.0	0.3396	86	0
8/26/02	0.00	0.00	0.18	DRY	10	16.0	0.1509	49	0
5/19/03	0.00	0.00	0.00	DRY	10	16.0	0.1509	49	0
5/27/03	0.15	2.55	2.76	**WET**	2000	99.0	0.9340	235	88
5/29/03	0.00	0.01	2.56	**WET**	890	86.0	0.8113	235	74
6/2/03	0.00	0.33	1.54	**WET**	1300	90.5	0.8538	235	82
6/4/03	1.63	2.01	2.34	**WET**	150	69.5	0.6557	182	0
6/9/03	0.00	0.01	0.54	DRY	310	77.0	0.7264	219	29
6/11/03	0.34	0.34	0.35	**WET**	64	53.0	0.5000	126	0
6/16/03	0.00	0.00	1.08	DRY	160	72.0	0.6792	193	0
6/23/03	0.03	0.56	1.28	**WET**	1300	90.5	0.8538	235	82
6/25/03	0.00	0.00	0.56	DRY	210	73.0	0.6887	198	6
6/30/03	0.00	0.00	0.00	DRY	20	36.0	0.3396	86	0
7/1/03	0.00	0.00	0.00	DRY	110	62.0	0.5849	154	0

Statistics

# Samples DRY	**56**
# Samples WET	**50**
# Samples Total	**106**
Geomean	**85**
Log std deviation	**0.8505**

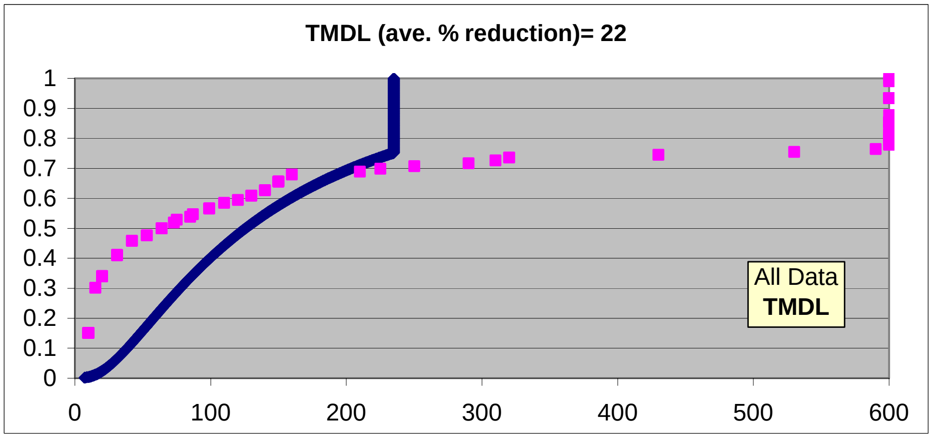
Avg % Reduction

Wet Weather Reduction	**43**
Dry Weather Reduction	**3**
Total (TMDL)	**22**

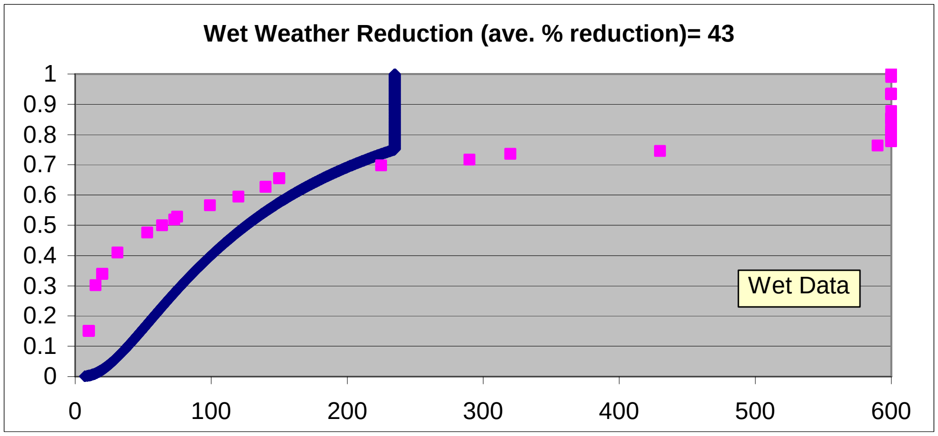
7/7/03	0.11	0.11	0.11	**WET**	20	36.0	0.3396	86	0
7/14/03	0.00	0.00	0.01	DRY	10	16.0	0.1509	49	0
7/16/03	0.32	0.32	0.32	**WET**	15	32.0	0.3019	78	0
7/21/03	0.16	0.16	0.18	**WET**	31	43.5	0.4104	102	0
7/28/03	0.06	0.07	0.07	DRY	64	53.0	0.5000	126	0
7/30/03	0.00	0.00	0.07	DRY	31	43.5	0.4104	102	0
8/4/03	1.10	1.35	2.96	**WET**	620	82.5	0.7783	235	62
8/6/03	0.00	0.70	2.05	**WET**	2000	99.0	0.9340	235	88
8/7/03	1.43	1.43	3.23	**WET**	2000	99.0	0.9340	235	88
8/11/03	0.02	0.38	0.94	**WET**	2000	99.0	0.9340	235	88
8/18/03	0.01	0.46	1.22	**WET**	590	81.0	0.7642	235	60
8/20/03	0.00	0.00	0.46	DRY	10	16.0	0.1509	49	0
8/25/03	0.00	0.00	0.00	DRY	10	16.0	0.1509	49	0
8/28/03	0.00	0.00	0.00	DRY	20	36.0	0.3396	86	0
9/12/03	0.00	0.00	0.00	DRY	10	16.0	0.1509	49	0
9/24/03	0.03	1.40	1.41	**WET**	4900	106.0	1.0000	235	95
5/24/04	0.04	0.68	0.68	**WET**	2000	99.0	0.9340	235	88
5/27/04	0.04	0.44	0.49	**WET**	140	66.5	0.6274	170	0
6/1/04	0.03	0.58	0.58	**WET**	75	56.0	0.5283	135	0
6/3/04	0.00	0.30	0.88	**WET**	10	16.0	0.1509	49	0
6/7/04	0.00	0.06	0.06	DRY	10	16.0	0.1509	49	0
6/14/04	0.07	0.07	0.07	DRY	20	36.0	0.3396	86	0
6/17/04	0.09	0.09	0.16	DRY	10	16.0	0.1509	49	0
6/21/04	0.00	0.00	0.08	DRY	10	16.0	0.1509	49	0
6/28/04	0.22	0.22	0.23	**WET**	10	16.0	0.1509	49	0
6/30/04	0.00	0.00	0.22	DRY	10	16.0	0.1509	49	0
7/6/04	0.00	0.86	1.64	**WET**	780	84.0	0.7925	235	70
7/8/04	0.00	0.07	0.93	DRY	10	16.0	0.1509	49	0
7/12/04	0.50	0.50	0.50	**WET**	10	16.0	0.1509	49	0
7/13/04	0.02	0.52	0.52	**WET**	73	55.0	0.5189	132	0
7/19/04	0.00	0.15	0.43	DRY	10	16.0	0.1509	49	0
7/26/04	0.00	0.00	0.46	DRY	10	16.0	0.1509	49	0
7/29/04	0.00	0.05	0.91	DRY	130	64.5	0.6085	162	0
8/2/04	0.00	0.35	0.35	**WET**	2000	99.0	0.9340	235	88
8/4/04	0.94	0.94	1.29	**WET**	99	60.0	0.5660	147	0
8/9/04	0.00	0.00	0.00	DRY	64	53.0	0.5000	126	0
8/12/04	0.02	0.24	0.24	DRY	31	43.5	0.4104	102	0
8/16/04	0.58	0.67	1.86	**WET**	1300	90.5	0.8538	235	82
8/18/04	0.00	0.00	0.67	DRY	250	75.0	0.7075	208	17
8/19/04	0.04	0.04	0.62	DRY	53	50.5	0.4764	119	0
8/23/04	0.00	0.00	1.44	DRY	1300	90.5	0.8538	235	82
8/25/04	0.00	0.00	0.00	DRY	31	43.5	0.4104	102	0
8/26/04	0.00	0.00	0.00	DRY	85	57.0	0.5377	137	0
8/30/04	0.08	0.08	0.08	DRY	10	16.0	0.1509	49	0
9/7/04	0.34	0.36	0.40	**WET**	10	16.0	0.1509	49	0
9/21/04	0.00	0.00	2.18	**WET**	3100	105.0	0.9906	235	92

Precipitation and E. coli data provided by the Town of Wallingford and CT DEP, respectively.**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. Duplicate samples were averaged.

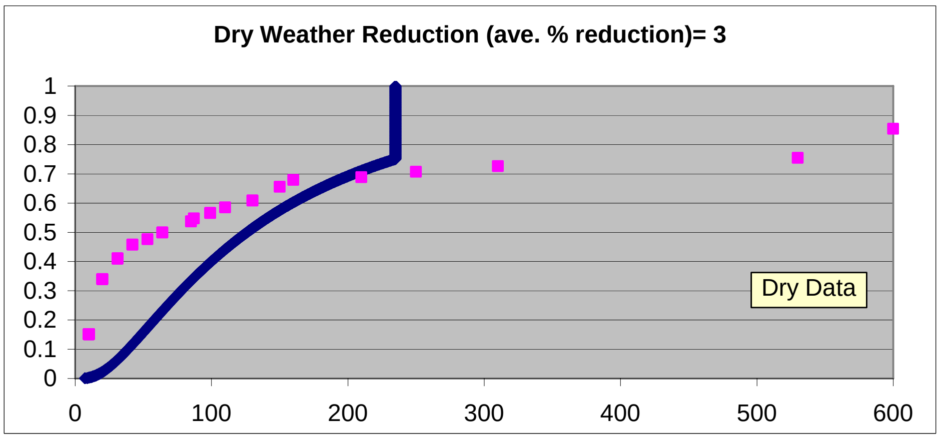
Allen Brook Pond Criteria Curve for Monitoring Site WBK-2
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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



Wet Weather Reduction needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Dry Weather Reduction needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Allen Brook

Data Used in the Analysis

Monitoring Site: AB-1 (798), At Inlet of Allen Brook Pond in Wharton Brook S.P

Date	Precip.(in)[1]			Condition[2]	E. coli	Rank	Proportion	Criteria Value	% Reduction
	24h	48h	96h	(WET/DRY)	(col./100 ml)				
7/10/2002	0.00	0.29	0.29	**WET**	1200	19.0	0.9048	421	65
7/24/2002	0.00	0.80	0.80	**WET**	2950	21.0	1.0000	576	80
7/31/2002	0.00	0.00	0.00	DRY	540	13.0	0.6190	167	69
8/7/2002	0.00	0.00	0.00	DRY	440	8.0	0.3810	95	78
8/19/2002	0.12	0.12	0.14	**WET**	470	10.0	0.4762	119	75
7/1/2003	0.00	0.00	0.00	DRY	680	16.0	0.7619	243	64
7/16/2003	0.32	0.32	0.32	**WET**	670	15.0	0.7143	212	68
7/30/2003	0.00	0.00	0.07	DRY	15	1.0	0.0476	27	0
8/13/2003	0.00	0.01	0.39	DRY	570	14.0	0.6667	187	67
8/28/2003	0.00	0.00	0.00	DRY	420	6.5	0.3095	80	81
9/12/2003	0.00	0.00	0.00	DRY	52	2.0	0.0952	38	27
9/24/2003	0.00	0.00	0.00	DRY	480	11.0	0.5238	133	72
6/3/2004	0.00	0.30	0.88	**WET**	740	17.0	0.8095	282	62
6/17/2004	0.09	0.09	0.16	DRY	460	9.0	0.4286	107	77
6/30/2004	0.00	0.00	0.22	DRY	280	3.5	0.1667	52	82
7/13/2004	0.02	0.52	0.52	**WET**	2300	20.0	0.9524	576	75
7/29/2004	0.00	0.05	0.91	DRY	850	18.0	0.8571	337	60
8/12/2004	0.02	0.24	0.24	DRY	330	5.0	0.2381	65	80
8/26/2004	0.00	0.00	0.00	DRY	520	12.0	0.5714	149	71
9/7/2004	0.34	0.36	0.40	**WET**	280	3.5	0.1667	52	82
9/21/2004	0.00	0.00	2.18	**WET**	420	6.5	0.3095	80	81

Statistics

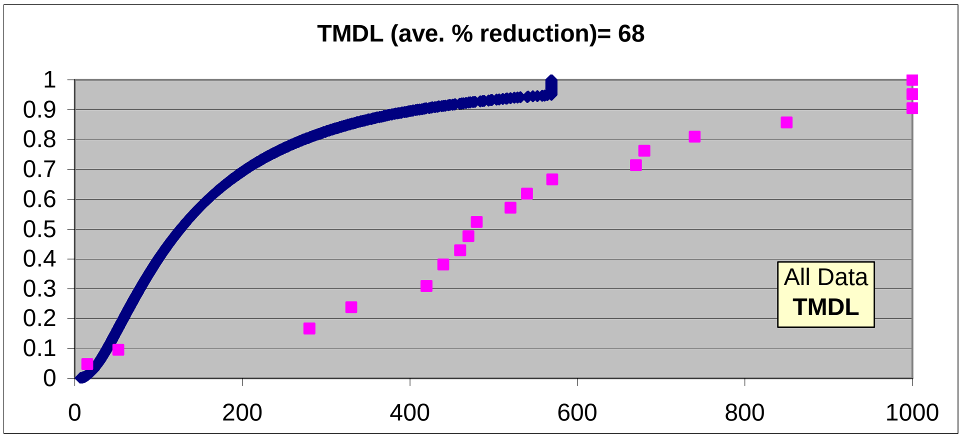
# Samples DRY	**13**
# Samples WET	**8**
# Samples Total	**21**
Geomean	**453**
Log std deviation	**0.4859**

Avg % Reduction

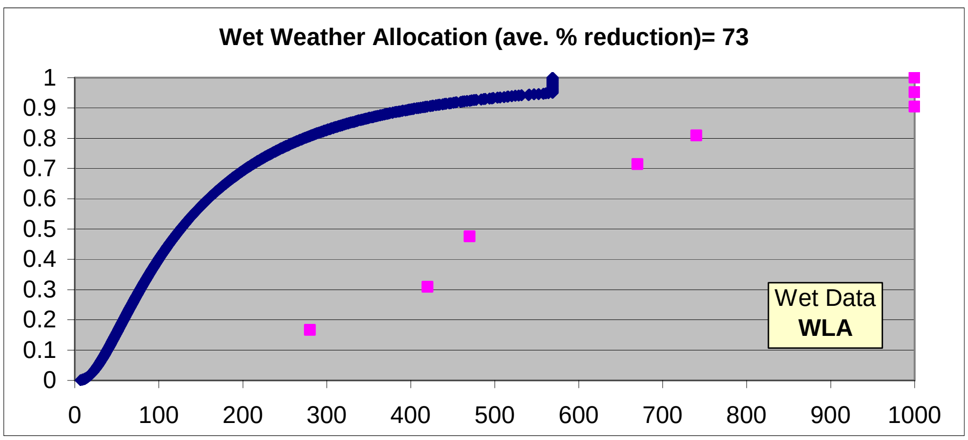
Wet (WLA)	**73**
Dry (LA)	**64**
Total (TMDL)	**68**

Precipitation and E. coli data provided by the Town of Wallingford and CT DEP, respectively.**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. Duplicate samples were averaged.

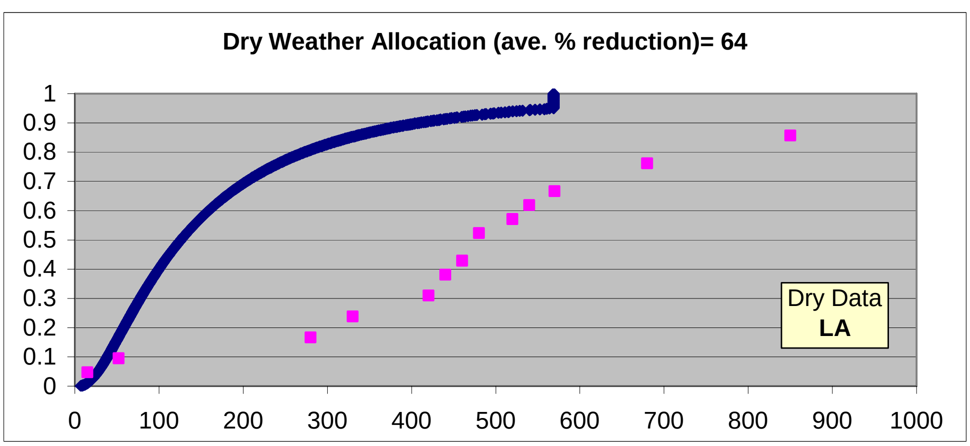
Allen Brook Criteria Curve for Monitoring Site AB-1 (798)
y axis = cumulative frequency; x axis = E.coli (col/100mL)



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



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



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

Appendix A-1
Allen Brook Pond
TMDL Summary

The TMDL analysis for Allen Brook and Allen Brook Pond was conducted at three sites, which are representative of three waterbody segments (CT5707-02_01, CT5707-02_02, CT5207-02-1-L1_01). The analysis indicates that the Pond is primarily influenced by sources of bacteria during wet weather conditions. The Waste Load Allocation (WLA) is applicable to a regulated stormwater discharge to the Pond. However, it is important to note that another contributor of *E.coli* to the Pond is surface water base flow and stormwater flow from Allen Brook. This source of *E.coli* to the Pond is addressed by allocating percent reductions to both point and nonpoint sources of *E.coli* to Allen Brook. Reduction in WLA to Allen Brook can be achieved through the detection and elimination illicit discharges to the storm sewers, as well as, installation of engineered controls to reduce the surge of stormwater to the Brook, promote groundwater recharge, and improve water quality. Nonpoint sources to the Pond, such as wildlife, pet waste, and surface water base flow from Allen Brook may contribute to the Load Allocation. There is no percent reduction for wildlife, except for nuisance wildlife. However, it should be noted that nuisance wildlife, including resident Canadian geese, have not been observed to be a major contributor of bacteria to Allen Brook Pond. It is likely that stormwater runoff transports bacteria to the Pond from pet waste found along the perimeter of the Pond particularly in areas where natural vegetation is limited. Natural vegetation should be allowed to grow freely around the Pond, other than the beach area, in order to create a riparian buffer area that acts as a barrier to solids and other potential sources of bacteria during storm events. It is also important to note that monitoring data indicates that during dry weather conditions higher bacteria levels are typically found at the inlet to Allen Brook Pond in Allen Brook than at the monitoring sites in the Pond during dry weather. This indicates that Allen Brook Pond acts as a settling basin for bacteria associated with particulate material. This material may be resuspended during storm events and contribute to the elevated levels of bacteria responsible for beach closures.

Appendix A-2
Gay City Pond
Waterbody Specific Information

Impaired Waterbody
Waterbody Name: Gay City Pond
Segment ID: CT4707-00-2-L2_01
Waterbody Segment Description: Gay City State Park. Impoundment off Blackledge River; Bolton/Hebron boundary.

Impairment Description:
Designated Use Impairment: Contact Recreation
Surface Water Classification: Class A

Watershed Description:
Total Drainage Basin Area: 1.525 square miles
Subregional Basin Name & Code: Blackledge River; 4700
Regional Basin: Salmon River
Major Basin: Connecticut River Basin
Watershed Towns: Bolton, Hebron
MS4 Applicable? Although Bolton and Hebron are located within MS4 communities, Gay City Pond does not receive regulated stormwater discharges. Because of this, the MS4 Permit is not applicable to the pond.
Applicable Season: Recreation Season (May 1 to September 30)
Subregional Basin Landuse:

Land Use Category	Percent Composition
Forested	75.95%
Urban/Developed	8.65%
Open Space	12.03%
Water/Wetland	1.82%
Agriculture	1.55%

Data Source: Connecticut Land Use Land Cover Data Layer LANDSTAT (1995) Thematic Mapper Satellite Imagery.

Gay City Pond

Data Used in the Analysis

Monitoring Site: GYC-1, At Left Side of Beach in Gay City S.P.

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/24/00	0.65	0.70	0.70	**WET**	53	29.0	0.3494	88	0
5/31/00	0.00	0.00	0.00	DRY	10	4.5	0.0542	29	0
6/6/00	1.85	1.90	1.90	**WET**	42	26.0	0.3133	80	0
6/13/00	0.25	0.65	1.05	**WET**	200	53.0	0.6386	175	13
6/15/00	0.00	0.00	0.65	DRY	64	32.0	0.3855	96	0
6/20/00	0.00	0.00	0.20	DRY	20	13.0	0.1566	50	0
6/27/00	0.90	0.90	0.90	**WET**	31	20.0	0.2410	66	0
7/5/00	0.00	0.15	0.15	DRY	240	57.0	0.6867	197	18
7/11/00	0.00	0.00	0.05	DRY	110	41.5	0.5000	126	0
7/18/00	0.05	0.05	0.80	DRY	340	64.0	0.7711	235	31
7/25/00	0.15	0.15	0.15	**WET**	10	4.5	0.0542	29	0
8/1/00	0.00	0.30	0.70	**WET**	270	61.0	0.7349	225	17
8/3/00	0.05	0.10	0.40	DRY	36.5	23.5	0.2831	74	0
8/8/00	0.00	0.00	0.05	DRY	20	13.0	0.1566	50	0
8/10/00	0.45	0.50	0.50	**WET**	31	20.0	0.2410	66	0
8/15/00	0.00	0.65	0.75	**WET**	10	4.5	0.0542	29	0
8/22/00	0.00	0.00	0.00	DRY	10	4.5	0.0542	29	0
8/29/00	0.00	0.00	0.00	DRY	10	4.5	0.0542	29	0
5/21/02	0.00	0.00	1.10	DRY	31	20.0	0.2410	66	0
5/29/02	0.00	0.00	0.00	DRY	64	32.0	0.3855	96	0
6/4/02	0.00	0.00	0.00	DRY	160	49.5	0.5964	158	1
6/6/02	1.25	1.70	1.70	**WET**	250	59.0	0.7108	210	16
6/11/02	0.15	0.15	0.15	**WET**	160	49.5	0.5964	158	1
6/18/02	0.00	0.00	0.25	DRY	125	45.0	0.5422	139	0
6/25/02	0.00	0.00	0.00	DRY	53	29.0	0.3494	88	0
7/9/02	0.90	0.90	0.90	**WET**	20	13.0	0.1566	50	0
7/16/02	0.00	0.15	0.15	DRY	87	38.5	0.4639	116	0
7/23/02	1.45	1.45	1.45	**WET**	42	26.0	0.3133	80	0
7/30/02	0.00	0.00	0.25	DRY	10	4.5	0.0542	29	0
8/6/02	0.00	0.00	0.00	DRY	31	20.0	0.2410	66	0
8/13/02	0.00	0.00	0.00	DRY	20	13.0	0.1566	50	0
8/20/02	0.80	0.80	0.80	**WET**	20.5	17.0	0.2048	59	0
8/27/02	0.00	0.00	0.20	DRY	10	4.5	0.0542	29	0
5/20/03	0.00	0.00	0.00	DRY	53	29.0	0.3494	88	0
5/22/03	0.10	0.25	0.25	**WET**	20	13.0	0.1566	50	0
5/28/03	0.40	0.40	2.50	**WET**	620	71.0	0.8554	235	62
5/29/03	0.00	0.40	2.35	**WET**	410	69.0	0.8313	235	43
6/3/03	0.00	0.00	1.60	DRY	87	38.5	0.4639	116	0
6/10/03	0.00	0.00	0.40	DRY	81.5	36.0	0.4337	108	0
6/17/03	0.00	0.00	0.05	DRY	140	48.0	0.5783	151	0
6/24/03	0.00	0.40	1.55	**WET**	360	66.0	0.7952	235	35
6/25/03	0.00	0.00	1.40	DRY	129.5	46.0	0.5542	143	0
7/1/03	0.00	0.10	0.10	DRY	250	59.0	0.7108	210	16
7/8/03	0.00	0.00	0.05	DRY	15	9.0	0.1084	40	0
7/15/03	0.00	0.00	0.00	DRY	36.5	23.5	0.2831	74	0
7/22/03	1.80	1.90	1.90	**WET**	890	75.0	0.9036	235	74
7/23/03	0.15	1.95	2.05	**WET**	2000	82.0	0.9880	235	88
7/24/03	0.00	0.15	2.05	**WET**	2000	82.0	0.9880	235	88
7/29/03	0.00	0.00	0.00	DRY	75	34.5	0.4157	104	0
8/5/03	0.60	0.80	1.45	**WET**	75	34.5	0.4157	104	0
8/12/03	0.00	0.00	0.20	DRY	250	59.0	0.7108	210	16
8/13/03	0.00	0.00	0.20	DRY	87	38.5	0.4639	116	0
8/19/03	0.00	0.10	0.20	DRY	360	66.0	0.7952	235	35
8/20/03	0.00	0.00	0.20	DRY	220	54.5	0.6566	183	17
8/26/03	0.00	0.00	0.00	DRY	2000	82.0	0.9880	235	88
8/27/03	0.00	0.00	0.00	DRY	120	43.5	0.5241	133	0
8/29/03	0.00	0.00	0.00	DRY	180	51.0	0.6145	165	8
5/25/04	0.00	0.00	1.15	DRY	700	73.0	0.8795	235	66
5/27/04	0.00	1.15	1.15	**WET**	1700	80.0	0.9639	235	86
6/2/04	0.40	0.80	0.80	**WET**	230	56.0	0.6747	191	17

Statistics

# Samples DRY	**53**
# Samples WET	**30**
# Samples Total	**83**
Geomean	**108**
Log std deviation	**0.6466**

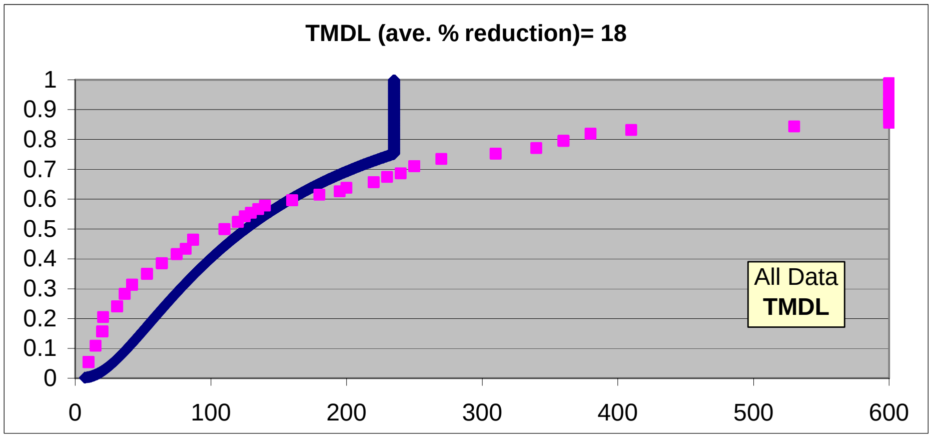
Avg % Reduction

Wet Weather Reduction	**28**
Dry Weather Reduction	**12**
Total (TMDL)	**18**

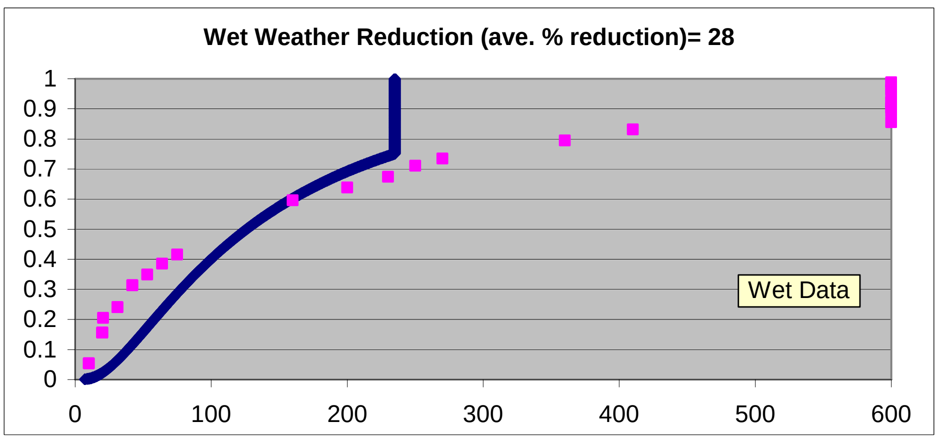
6/3/04	0.00	0.40	0.80	**WET**	1000	76.5	0.9217	235	77
6/8/04	0.00	0.00	0.00	DRY	360	66.0	0.7952	235	35
6/9/04	0.05	0.05	0.05	DRY	310	62.5	0.7530	235	24
6/15/04	0.00	0.05	0.05	DRY	195	52.0	0.6265	170	13
6/16/04	0.00	0.00	0.05	DRY	87	38.5	0.4639	116	0
6/22/04	0.00	0.00	0.10	DRY	10	4.5	0.0542	29	0
6/29/04	0.25	0.25	0.25	**WET**	64	32.0	0.3855	96	0
7/7/04	0.00	0.00	0.85	DRY	220	54.5	0.6566	183	17
7/13/04	0.35	0.35	0.35	**WET**	20	13.0	0.1566	50	0
7/20/04	0.00	0.05	0.55	DRY	42	26.0	0.3133	80	0
7/27/04	0.35	0.35	0.85	**WET**	20	13.0	0.1566	50	0
8/3/04	0.00	0.00	0.05	DRY	110	41.5	0.5000	126	0
8/10/04	0.00	0.00	0.00	DRY	530	70.0	0.8434	235	56
8/11/04	0.15	0.15	0.15	**WET**	815	74.0	0.8916	235	71
8/17/04	0.00	0.15	1.10	DRY	660	72.0	0.8675	235	64
8/18/04	0.00	0.00	1.10	DRY	1200	78.0	0.9398	235	80
8/19/04	0.00	0.00	0.15	DRY	380	68.0	0.8193	235	38
8/24/04	0.00	0.00	2.70	**WET**	1400	79.0	0.9518	235	83
8/25/04	0.00	0.00	0.00	DRY	135	47.0	0.5663	147	0
8/26/04	0.00	0.00	0.00	DRY	31	20.0	0.2410	66	0
8/31/04	0.10	0.10	0.10	**WET**	1000	76.5	0.9217	235	77
9/1/04	0.00	0.10	0.10	DRY	310	62.5	0.7530	235	24
9/2/04	0.00	0.00	0.10	DRY	120	43.5	0.5241	133	0

Precipitation and E. coli data provided by the Town of Manchester and CT DEP, respectively.
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. Duplicate samples were averaged.

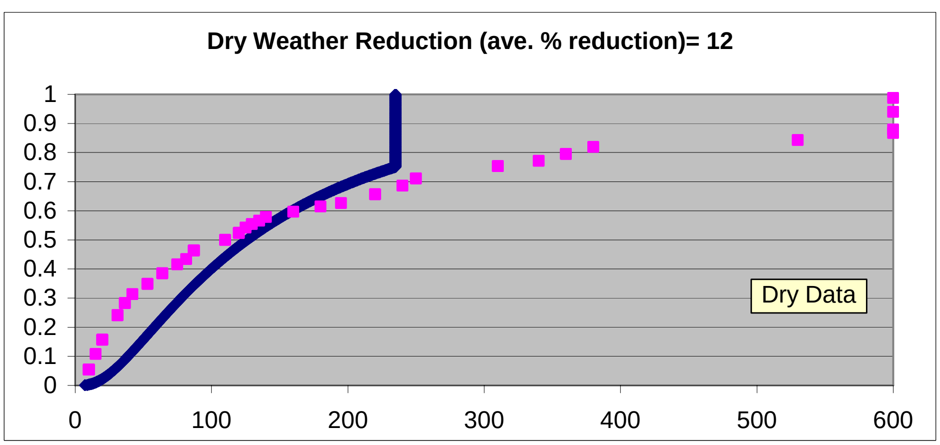
Gay City Pond Criteria Curve for Monitoring Site GYC-1
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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



Wet Weather Reduction needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Dry Weather Reduction needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Gay City Pond

Data Used in the Analysis

Monitoring Site: GYC-2, At Right Side of Beach in Gay City S.P.

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/24/00	0.65	0.70	0.70	**WET**	53	33.0	0.3976	99	0
5/31/00	0.00	0.00	0.00	DRY	10	5.5	0.0663	32	0
6/6/00	1.85	1.90	1.90	**WET**	42	25.5	0.3072	79	0
6/13/00	0.25	0.65	1.05	**WET**	225	60.0	0.7229	217	3
6/15/00	0.00	0.00	0.65	DRY	53	33.0	0.3976	99	0
6/20/00	0.00	0.00	0.20	DRY	10	5.5	0.0663	32	0
6/27/00	0.90	0.90	0.90	**WET**	53	33.0	0.3976	99	0
7/5/00	0.00	0.15	0.15	DRY	31	19.5	0.2349	65	0
7/11/00	0.00	0.00	0.05	DRY	10	5.5	0.0663	32	0
7/18/00	0.05	0.05	0.80	DRY	160	48.5	0.5843	153	4
7/25/00	0.15	0.15	0.15	**WET**	10	5.5	0.0663	32	0
8/1/00	0.00	0.30	0.70	**WET**	240	62.0	0.7470	232	3
8/3/00	0.05	0.10	0.40	DRY	20	13.5	0.1627	51	0
8/8/00	0.00	0.00	0.05	DRY	140	44.5	0.5361	137	2
8/10/00	0.45	0.50	0.50	**WET**	20	13.5	0.1627	51	0
8/15/00	0.00	0.65	0.75	**WET**	10	5.5	0.0663	32	0
8/22/00	0.00	0.00	0.00	DRY	10	5.5	0.0663	32	0
8/29/00	0.00	0.00	0.00	DRY	10	5.5	0.0663	32	0
5/21/02	0.00	0.00	1.10	DRY	53	33.0	0.3976	99	0
5/29/02	0.00	0.00	0.00	DRY	53	33.0	0.3976	99	0
6/4/02	0.00	0.00	0.00	DRY	310	68.0	0.8193	235	24
6/6/02	1.25	1.70	1.70	**WET**	140	44.5	0.5361	137	2
6/11/02	0.15	0.15	0.15	**WET**	220	58.0	0.6988	204	7
6/18/02	0.00	0.00	0.25	DRY	220	58.0	0.6988	204	7
6/25/02	0.00	0.00	0.00	DRY	31	19.5	0.2349	65	0
7/9/02	0.90	0.90	0.90	**WET**	10	5.5	0.0663	32	0
7/16/02	0.00	0.15	0.15	DRY	31	19.5	0.2349	65	0
7/23/02	1.45	1.45	1.45	**WET**	31	19.5	0.2349	65	0
7/30/02	0.00	0.00	0.25	DRY	20	13.5	0.1627	51	0
8/6/02	0.00	0.00	0.00	DRY	31	19.5	0.2349	65	0
8/13/02	0.00	0.00	0.00	DRY	10	5.5	0.0663	32	0
8/20/02	0.80	0.80	0.80	**WET**	42	25.5	0.3072	79	0
8/27/02	0.00	0.00	0.20	DRY	10	5.5	0.0663	32	0
5/20/03	0.00	0.00	0.00	DRY	270	66.0	0.7952	235	13
5/22/03	0.10	0.25	0.25	**WET**	31	19.5	0.2349	65	0
5/28/03	0.40	0.40	2.50	**WET**	460	75.0	0.9036	235	49
5/29/03	0.00	0.40	2.35	**WET**	180	52.0	0.6265	170	6
6/3/03	0.00	0.00	1.60	DRY	140	44.5	0.5361	137	2
6/10/03	0.00	0.00	0.40	DRY	42	25.5	0.3072	79	0
6/17/03	0.00	0.00	0.05	DRY	160	48.5	0.5843	153	4
6/24/03	0.00	0.40	1.55	**WET**	450	73.0	0.8795	235	48
6/25/03	0.00	0.00	1.40	DRY	180	52.0	0.6265	170	6
7/1/03	0.00	0.10	0.10	DRY	160	48.5	0.5843	153	4
7/8/03	0.00	0.00	0.05	DRY	20	13.5	0.1627	51	0
7/15/03	0.00	0.00	0.00	DRY	20	13.5	0.1627	51	0
7/22/03	1.80	1.90	1.90	**WET**	1400	81.0	0.9759	235	83
7/23/03	0.15	1.95	2.05	**WET**	2000	83.0	1.0000	235	88
7/24/03	0.00	0.15	2.05	**WET**	1300	80.0	0.9639	235	82
7/29/03	0.00	0.00	0.00	DRY	20	13.5	0.1627	51	0
8/5/03	0.60	0.80	1.45	**WET**	53	33.0	0.3976	99	0
8/12/03	0.00	0.00	0.20	DRY	240	62.0	0.7470	232	3
8/13/03	0.00	0.00	0.20	DRY	64	38.0	0.4578	114	0
8/19/03	0.00	0.10	0.20	DRY	140	44.5	0.5361	137	2
8/20/03	0.00	0.00	0.20	DRY	160	48.5	0.5843	153	4
8/26/03	0.00	0.00	0.00	DRY	290	67.0	0.8072	235	19
8/27/03	0.00	0.00	0.00	DRY	240	62.0	0.7470	232	3
8/29/03	0.00	0.00	0.00	DRY	555	77.0	0.9277	235	58
5/25/04	0.00	0.00	1.15	DRY	450	73.0	0.8795	235	48
5/27/04	0.00	1.15	1.15	**WET**	1850	82.0	0.9880	235	87
6/2/04	0.40	0.80	0.80	**WET**	250	64.5	0.7771	235	6

Statistics

# Samples DRY	**53**
# Samples WET	**30**
# Samples Total	**83**
Geomean	**93**
Log std deviation	**0.5982**

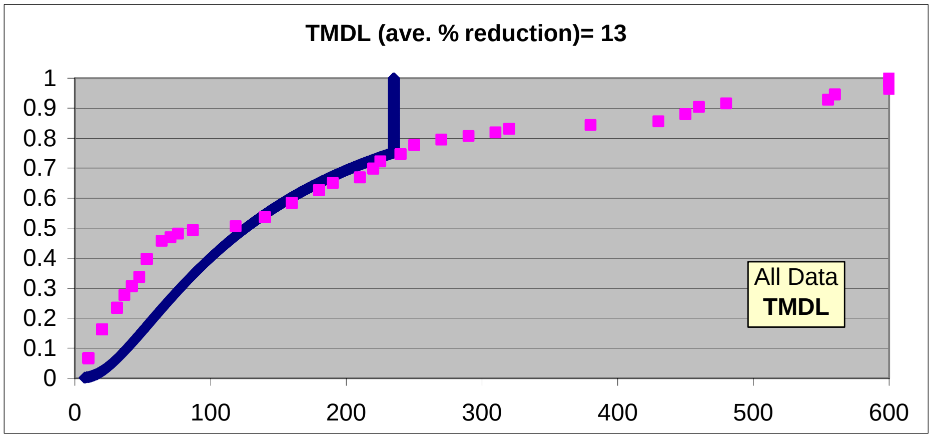
Avg % Reduction

Wet Weather Reduction	**21**
Dry Weather Reduction	**8**
Total (TMDL)	**13**

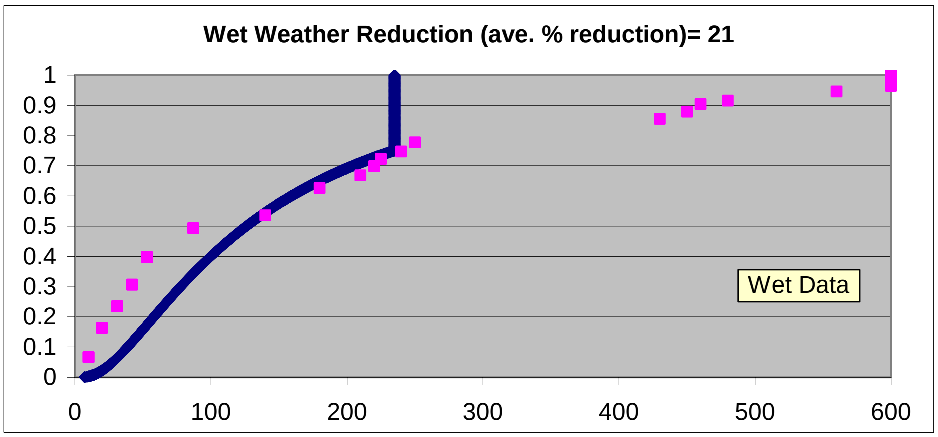
6/3/04	0.00	0.40	0.80	**WET**	560	78.5	0.9458	235	58
6/8/04	0.00	0.00	0.00	DRY	118.5	42.0	0.5060	128	0
6/9/04	0.05	0.05	0.05	DRY	210	55.5	0.6687	188	10
6/15/04	0.00	0.05	0.05	DRY	42	25.5	0.3072	79	0
6/16/04	0.00	0.00	0.05	DRY	53	33.0	0.3976	99	0
6/22/04	0.00	0.00	0.10	DRY	36.5	23.0	0.2771	73	0
6/29/04	0.25	0.25	0.25	**WET**	87	41.0	0.4940	124	0
7/7/04	0.00	0.00	0.85	DRY	180	52.0	0.6265	170	6
7/13/04	0.35	0.35	0.35	**WET**	53	33.0	0.3976	99	0
7/20/04	0.00	0.05	0.55	DRY	76	40.0	0.4819	121	0
7/27/04	0.35	0.35	0.85	**WET**	53	33.0	0.3976	99	0
8/3/04	0.00	0.00	0.05	DRY	220	58.0	0.6988	204	7
8/10/04	0.00	0.00	0.00	DRY	320	69.0	0.8313	235	27
8/11/04	0.15	0.15	0.15	**WET**	430	71.0	0.8554	235	45
8/17/04	0.00	0.15	1.10	DRY	380	70.0	0.8434	235	38
8/18/04	0.00	0.00	1.10	DRY	450	73.0	0.8795	235	48
8/19/04	0.00	0.00	0.15	DRY	560	78.5	0.9458	235	58
8/24/04	0.00	0.00	2.70	**WET**	210	55.5	0.6687	188	10
8/25/04	0.00	0.00	0.00	DRY	250	64.5	0.7771	235	6
8/26/04	0.00	0.00	0.00	DRY	190	54.0	0.6506	180	5
8/31/04	0.10	0.10	0.10	**WET**	480	76.0	0.9157	235	51
9/1/04	0.00	0.10	0.10	DRY	47.5	28.0	0.3373	86	0
9/2/04	0.00	0.00	0.10	DRY	70.5	39.0	0.4699	118	0

Precipitation and E. coli data provided by the Town of Manchester and CT DEP, respectively.
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. Duplicate samples were averaged.

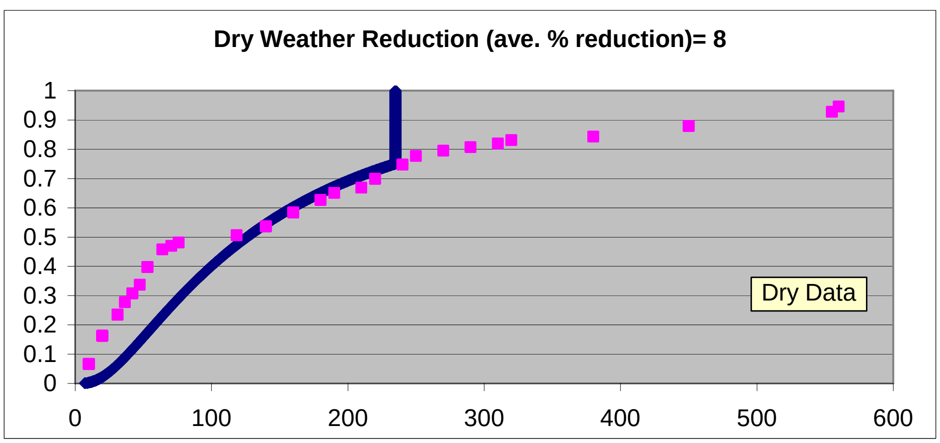
Gay City Pond Criteria Curve for Monitoring Site GYC-2
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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



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



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

Appendix A-2
Gay City Pond
TMDL Summary

The TMDL analysis for Gay City Pond was conducted at two sites, which are representative of one waterbody segment (CT4707-00-2-L2_01). The sources of *E.coli* in the pond are attributed exclusively to nonpoint sources active under both wet and dry weather conditions. A waste load allocation (WLA) for the pond was not warranted because it is located in a rural area where there are no MS4 regulated stormwater discharges or other point source discharges to the pond. The analysis indicates that the sites are influenced by sources of bacteria during wet weather conditions. Based on observations, Canadian geese appear to be the main source of elevated bacteria levels in Gay City Pond. However, a large population of beaver was also observed at Gay City State Park, which may also affect bacteria densities in the swimming area. Pet waste from the beach area may also augment bacteria levels in Gay City Pond. It is likely that stormwater runoff transports bacteria to the pond from goose and pet waste deposited on the shore.

Appendix A-3
Shreeder Pond
Waterbody Specific Information

<u>Impaired Waterbody</u>
Waterbody Name: Shreeder Pond
Segment ID: 5105-00-2-L1_01
Waterbody Segment Description: Chatfield Hollow State Park. Impoundment off Chatfield Hollow Brook; Killingworth

<u>Impairment Description:</u>
Designated Use Impairment: Contact Recreation
Surface Water Classification: Class A

<u>Watershed Description:</u>
Total Drainage Basin Area: 0.663 square miles
Subregional Basin Name & Code: Chatfield Hollow Brook, 5105
Regional Basin: South Central Eastern Complex
Major Basin: South Central Coastal Basin
Watershed Towns: Killingworth
MS4 Applicable? Killingworth (No)
Applicable Season: Recreation Season (May 1 to September 30)
Subregional Basin Landuse:

Land Use Category	Percent Composition
Forested	88.94%
Urban/Developed	2.76%
Open Space	4.18%
Water/Wetland	3.72%
Agriculture	0.41%

Data Source: Connecticut Land Use Land Cover Data Layer LANDSTAT (1995) Thematic Mapper Satellite Imagery.

Schreeder Pond

Data Used in the Analysis

Monitoring Site: CHH-1, At Left Side of Beach in Chatfield Hollow S.P.

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/23/00	0.04	0.24	0.48	DRY	64	47.0	0.6620	185	0
5/30/00	0.00	0.00	0.00	DRY	10	8.0	0.1127	41	0
6/5/00	0.00	0.00	0.63	DRY	20.5	25.0	0.3521	89	0
6/12/00	0.39	3.70	3.70	**WET**	720	70.0	0.9859	235	67
6/14/00	0.16	0.20	3.90	**WET**	99	57.5	0.8099	235	0
6/19/00	0.00	0.04	0.16	DRY	31	32.0	0.4507	112	0
6/26/00	0.04	0.04	0.04	DRY	53	43.5	0.6127	164	0
7/5/00	0.00	0.05	0.05	DRY	31	32.0	0.4507	112	0
7/7/00	0.00	0.00	0.05	DRY	10	8.0	0.1127	41	0
7/10/00	0.02	0.02	0.02	DRY	31	32.0	0.4507	112	0
7/17/00	0.00	0.06	1.76	DRY	20	20.0	0.2817	74	0
7/24/00	0.00	0.00	0.08	DRY	10	8.0	0.1127	41	0
7/31/00	1.06	1.22	1.22	**WET**	240	63.5	0.8944	235	2
8/2/00	0.20	0.24	1.46	**WET**	160	62.0	0.8732	235	0
8/4/00	0.00	0.51	0.75	**WET**	110	60.0	0.8451	235	0
8/7/00	0.87	0.99	0.99	**WET**	360	66.0	0.9296	235	35
8/9/00	0.00	0.00	0.99	DRY	42	39.0	0.5493	141	0
8/14/00	0.59	0.90	0.90	**WET**	75	51.5	0.7254	219	0
8/16/00	0.08	0.12	1.02	DRY	87	54.0	0.7606	235	0
8/21/00	0.00	0.00	0.08	DRY	31	32.0	0.4507	112	0
8/28/00	0.00	0.00	0.00	DRY	20	20.0	0.2817	74	0
5/20/02	0.00	0.00	1.46	DRY	20	20.0	0.2817	74	0
5/28/02	0.20	0.20	0.20	**WET**	64	47.0	0.6620	185	0
6/3/02	0.00	0.00	0.39	DRY	31	32.0	0.4507	112	0
6/10/02	0.00	0.00	0.67	DRY	75	51.5	0.7254	219	0
6/17/02	0.00	0.20	0.87	DRY	42	39.0	0.5493	141	0
6/24/02	0.00	0.00	0.00	DRY	53	43.5	0.6127	164	0
7/1/02	0.00	0.00	0.08	DRY	31	32.0	0.4507	112	0
7/8/02	0.00	0.00	0.00	DRY	10	8.0	0.1127	41	0
7/15/02	0.00	0.00	0.00	DRY	20	20.0	0.2817	74	0
7/22/02	0.00	0.00	0.83	DRY	20	20.0	0.2817	74	0
7/29/02	0.00	0.00	0.00	DRY	10	8.0	0.1127	41	0
8/5/02	0.00	0.00	0.47	DRY	10	8.0	0.1127	41	0
8/12/02	0.00	0.00	0.00	DRY	10	8.0	0.1127	41	0
8/19/02	0.00	0.00	0.00	DRY	53	43.5	0.6127	164	0
8/26/02	0.00	0.04	0.24	DRY	10	8.0	0.1127	41	0
5/19/03	0.00	0.00	0.00	DRY	10	8.0	0.1127	41	0
5/27/03	0.00	2.76	2.88	**WET**	1700	71.0	1.0000	235	86
5/29/03	0.00	0.08	2.84	**WET**	87	54.0	0.7606	235	0
6/2/03	0.00	0.67	0.95	**WET**	110	60.0	0.8451	235	0
6/9/03	0.00	0.00	0.43	DRY	25.5	26.0	0.3662	92	0
6/16/03	0.00	0.00	1.49	DRY	20	20.0	0.2817	74	0
6/23/03	0.00	0.20	0.59	DRY	42	39.0	0.5493	141	0
6/30/03	0.00	0.00	0.00	DRY	31	32.0	0.4507	112	0
7/7/03	0.04	0.04	0.04	DRY	64	47.0	0.6620	185	0
7/14/03	0.00	0.00	0.24	DRY	31	32.0	0.4507	112	0
7/21/03	0.04	0.04	0.08	DRY	20	20.0	0.2817	74	0
7/28/03	0.04	0.04	0.04	DRY	20	20.0	0.2817	74	0
8/4/03	0.08	0.08	0.75	DRY	75	51.5	0.7254	219	0
8/11/03	0.00	0.04	1.02	DRY	53	43.5	0.6127	164	0
8/18/03	0.00	0.31	0.94	**WET**	530	68.5	0.9648	235	56
8/20/03	0.00	0.00	0.31	DRY	110	60.0	0.8451	235	0
8/25/03	0.00	0.00	0.00	DRY	10	8.0	0.1127	41	0
5/24/04	0.00	0.47	0.47	**WET**	530	68.5	0.9648	235	56
5/27/04	0.39	0.43	0.43	**WET**	240	63.5	0.8944	235	2
6/1/04	0.16	0.20	0.24	**WET**	20	20.0	0.2817	74	0
6/7/04	0.00	0.04	0.04	DRY	26	27.0	0.3803	95	0
6/14/04	0.04	0.04	0.04	DRY	10	8.0	0.1127	41	0
6/21/04	0.00	0.00	0.00	DRY	10	8.0	0.1127	41	0
6/28/04	0.00	0.00	0.00	DRY	10	8.0	0.1127	41	0

Statistics

# Samples DRY	**52**
# Samples WET	**19**
# Samples Total	**71**
Geomean	**43**
Log std deviation	**0.5255**

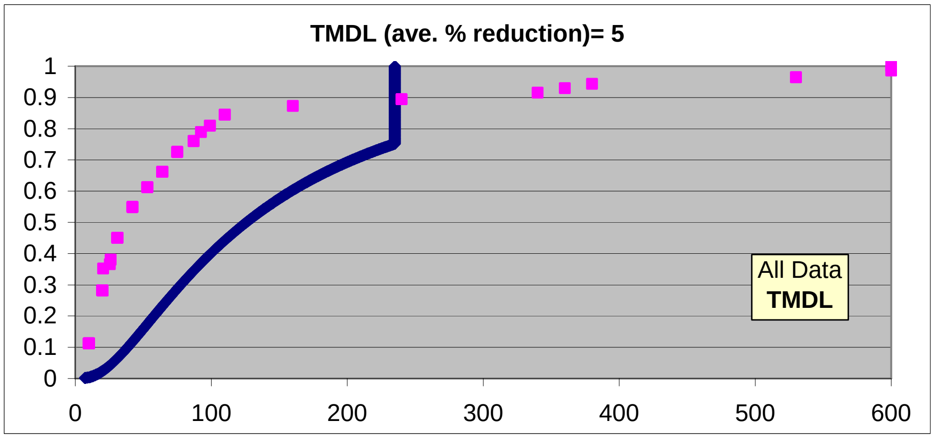
Avg % Reduction

Wet Weather Reduction	**18**
Dry Weather Reduction	**0.6**
Total (TMDL)	**5**

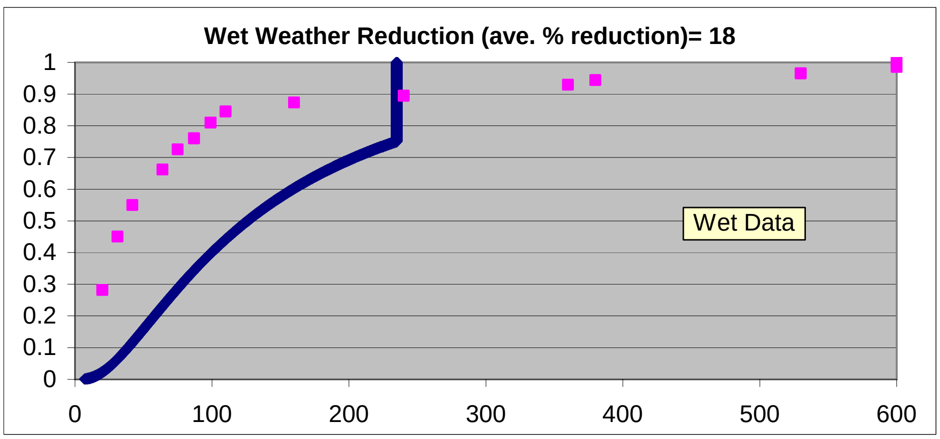
7/6/04	0.00	0.94	0.94	**WET**	87	54.0	0.7606	235	0
7/12/04	0.20	0.20	0.20	**WET**	31	32.0	0.4507	112	0
7/19/04	0.04	0.08	0.08	DRY	10	8.0	0.1127	41	0
7/26/04	0.00	0.00	0.08	DRY	10	8.0	0.1127	41	0
8/2/04	0.00	0.04	0.04	DRY	99	57.5	0.8099	235	0
8/9/04	0.00	0.00	0.00	DRY	75	51.5	0.7254	219	0
8/16/04	0.35	1.50	1.85	**WET**	380	67.0	0.9437	235	38
8/18/04	0.00	0.00	1.50	DRY	92.5	56.0	0.7887	235	0
8/23/04	0.00	0.00	1.10	DRY	340	65.0	0.9155	235	31
8/25/04	0.00	0.00	0.00	DRY	42	39.0	0.5493	141	0
8/30/04	0.47	0.47	0.47	**WET**	42	39.0	0.5493	141	0

Precipitation and E. coli data provided by the Regional Water Authority and CT DEP, respectively. **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. Duplicate samples were averaged.

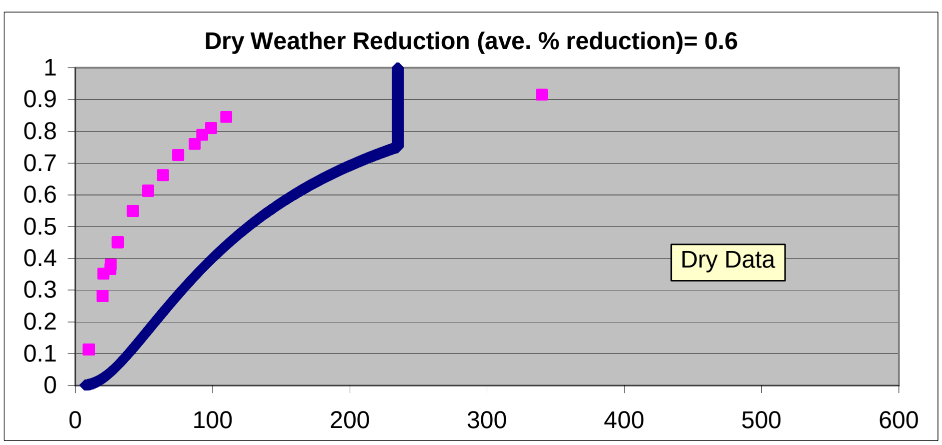
Schreeder Pond Criteria Curve for Monitoring Site CHH-1
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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.

Schreeder Pond

Data Used in the Analysis

Monitoring Site: CHH-2, At Right Side of Beach in Chatfield Hollow S.P.

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/23/00	0.04	0.24	0.48	DRY	10	9.5	0.1338	45	0
5/30/00	0.00	0.00	0.00	DRY	10	9.5	0.1338	45	0
6/5/00	0.00	0.00	0.63	DRY	10	9.5	0.1338	45	0
6/12/00	0.39	3.70	3.70	**WET**	700	70.0	0.9859	235	66
6/14/00	0.16	0.20	3.90	**WET**	120	59.0	0.8310	235	0
6/19/00	0.00	0.04	0.16	DRY	31	32.5	0.4577	114	0
6/26/00	0.04	0.04	0.04	DRY	31	32.5	0.4577	114	0
7/5/00	0.00	0.05	0.05	DRY	120	59.0	0.8310	235	0
7/7/00	0.00	0.00	0.05	DRY	10	9.5	0.1338	45	0
7/10/00	0.02	0.02	0.02	DRY	42	39.5	0.5563	144	0
7/17/00	0.00	0.06	1.76	DRY	10	9.5	0.1338	45	0
7/24/00	0.00	0.00	0.08	DRY	10	9.5	0.1338	45	0
7/31/00	1.06	1.22	1.22	**WET**	240	64.5	0.9085	235	2
8/2/00	0.20	0.24	1.46	**WET**	120	59.0	0.8310	235	0
8/4/00	0.00	0.51	0.75	**WET**	64	50.5	0.7113	210	0
8/7/00	0.87	0.99	0.99	**WET**	500	68.0	0.9577	235	53
8/9/00	0.00	0.00	0.99	DRY	53	44.5	0.6268	170	0
8/14/00	0.59	0.90	0.90	**WET**	20	21.5	0.3028	78	0
8/16/00	0.08	0.12	1.02	DRY	75	55.0	0.7746	235	0
8/21/00	0.00	0.00	0.08	DRY	10	9.5	0.1338	45	0
8/28/00	0.00	0.00	0.00	DRY	10	9.5	0.1338	45	0
5/20/02	0.00	0.00	1.46	DRY	31	32.5	0.4577	114	0
5/28/02	0.20	0.20	0.20	**WET**	53	44.5	0.6268	170	0
6/3/02	0.00	0.00	0.39	DRY	42	39.5	0.5563	144	0
6/10/02	0.00	0.00	0.67	DRY	160	61.5	0.8662	235	0
6/17/02	0.00	0.20	0.87	DRY	64	50.5	0.7113	210	0
6/24/02	0.00	0.00	0.00	DRY	75	55.0	0.7746	235	0
7/1/02	0.00	0.00	0.08	DRY	31	32.5	0.4577	114	0
7/8/02	0.00	0.00	0.00	DRY	10	9.5	0.1338	45	0
7/15/02	0.00	0.00	0.00	DRY	20	21.5	0.3028	78	0
7/22/02	0.00	0.00	0.83	DRY	64	50.5	0.7113	210	0
7/29/02	0.00	0.00	0.00	DRY	10	9.5	0.1338	45	0
8/5/02	0.00	0.00	0.47	DRY	10	9.5	0.1338	45	0
8/12/02	0.00	0.00	0.00	DRY	10	9.5	0.1338	45	0
8/19/02	0.00	0.00	0.00	DRY	10	9.5	0.1338	45	0
8/26/02	0.00	0.04	0.24	DRY	31	32.5	0.4577	114	0
5/19/03	0.00	0.00	0.00	DRY	31	32.5	0.4577	114	0
5/27/03	0.00	2.76	2.88	**WET**	1400	71.0	1.0000	235	83
5/29/03	0.00	0.08	2.84	**WET**	75	55.0	0.7746	235	0
6/2/03	0.00	0.67	0.95	**WET**	87	57.0	0.8028	235	0
6/9/03	0.00	0.00	0.43	DRY	20	21.5	0.3028	78	0
6/16/03	0.00	0.00	1.49	DRY	31	32.5	0.4577	114	0
6/23/03	0.00	0.20	0.59	DRY	47.5	41.0	0.5775	151	0
6/30/03	0.00	0.00	0.00	DRY	31	32.5	0.4577	114	0
7/7/03	0.04	0.04	0.04	DRY	31	32.5	0.4577	114	0
7/14/03	0.00	0.00	0.24	DRY	53	44.5	0.6268	170	0
7/21/03	0.04	0.04	0.08	DRY	26	26.0	0.3662	92	0
7/28/03	0.04	0.04	0.04	DRY	20	21.5	0.3028	78	0
8/4/03	0.08	0.08	0.75	DRY	160	61.5	0.8662	235	0
8/11/03	0.00	0.04	1.02	DRY	53	44.5	0.6268	170	0
8/18/03	0.00	0.31	0.94	**WET**	620	69.0	0.9718	235	62
8/20/03	0.00	0.00	0.31	DRY	64	50.5	0.7113	210	0
8/25/03	0.00	0.00	0.00	DRY	20	21.5	0.3028	78	0
5/24/04	0.00	0.47	0.47	**WET**	480	67.0	0.9437	235	51
5/27/04	0.39	0.43	0.43	**WET**	190	63.0	0.8873	235	0
6/1/04	0.16	0.20	0.24	**WET**	20	21.5	0.3028	78	0
6/7/04	0.00	0.04	0.04	DRY	10	9.5	0.1338	45	0
6/14/04	0.04	0.04	0.04	DRY	10	9.5	0.1338	45	0
6/21/04	0.00	0.00	0.00	DRY	31	32.5	0.4577	114	0
6/28/04	0.00	0.00	0.00	DRY	10	9.5	0.1338	45	0

Statistics

# Samples DRY	**52**
# Samples WET	**19**
# Samples Total	**71**
Geomean	**41**
Log std deviation	**0.5300**

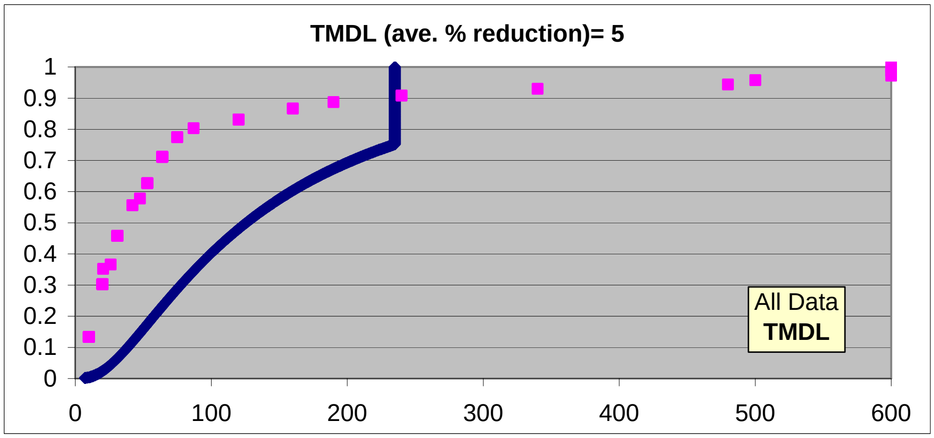
Avg % Reduction

Wet Weather Reduction	**18**
Dry Weather Reduction	**0.04**
Total (TMDL)	**5**

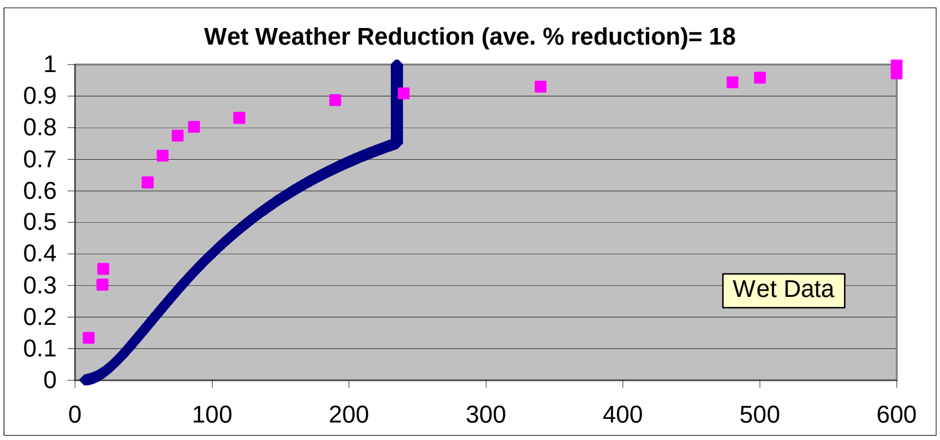
7/6/04	0.00	0.94	0.94	**WET**	53	44.5	0.6268	170	0
7/12/04	0.20	0.20	0.20	**WET**	10	9.5	0.1338	45	0
7/19/04	0.04	0.08	0.08	DRY	10	9.5	0.1338	45	0
7/26/04	0.00	0.00	0.08	DRY	31	32.5	0.4577	114	0
8/2/04	0.00	0.04	0.04	DRY	64	50.5	0.7113	210	0
8/9/04	0.00	0.00	0.00	DRY	53	44.5	0.6268	170	0
8/16/04	0.35	1.50	1.85	**WET**	340	66.0	0.9296	235	31
8/18/04	0.00	0.00	1.50	DRY	64	50.5	0.7113	210	0
8/23/04	0.00	0.00	1.10	DRY	240	64.5	0.9085	235	2
8/25/04	0.00	0.00	0.00	DRY	31	32.5	0.4577	114	0
8/30/04	0.47	0.47	0.47	**WET**	20.5	25.0	0.3521	89	0

Precipitation and E. coli data provided by the Regional Water Authority and CT DEP, respectively. **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. Duplicate samples were averaged.

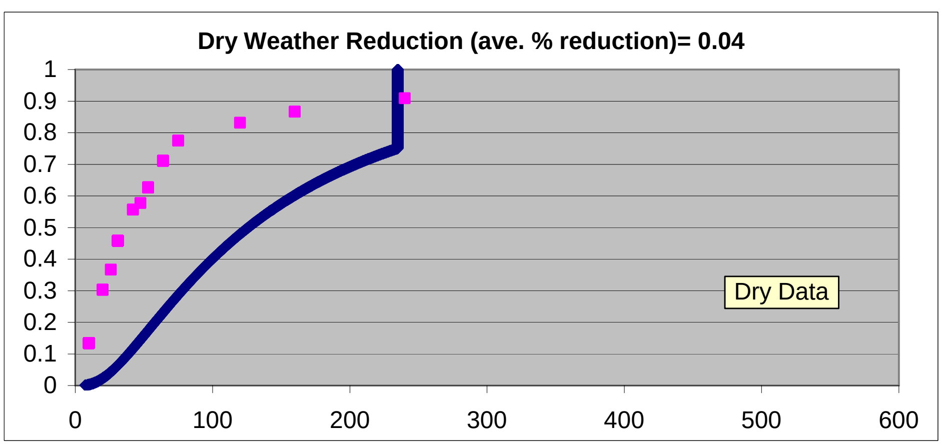
Schreeder Pond Criteria Curve for Monitoring Site CHH-2
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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



Wet Weather Reduction needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Dry Weather Reduction needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Appendix A-3
Schreeder Pond
TMDL Summary

The TMDL analysis for Schreeder Pond was conducted at two sites, which are representative of one segment (5105-00-2-L1_01). The sources of *E.coli* in the pond are attributed exclusively to nonpoint sources. A waste load allocation (WLA) was not warranted because the pond is located in a rural area where there are no MS4 regulated stormwater discharges or other point sources discharges to the pond. The analysis indicates that the sites are soley influenced by sources of bacteria during wet weather conditions. It is likely that pet waste is the main contributor of bacteria to Schreeder Pond. Pet waste was found along the road circling the Pond. Concrete channels that lead directly into the swimming area from the road, provide a direct route for pet waste to enter the area during storm events. Non-discharging toilets that deposit directly into a pit in the ground are found near the inlet to Schreeder Pond. The non-discharging toilets may potentially contribute to bacteria densities though groundwater leaching into the nearby water, particularly because the surrounding area slopes towards the water. While these toilets are not anticipated to contribute significant levels of bacteria to the water, BMPs may include precautionary measures such as frequent cleaning and prioritization for replacement with self-contained systems.

Appendix B

Technical Support Document for the Cumulative 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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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 31) 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	256col/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 75th, 90th, and 95th 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.

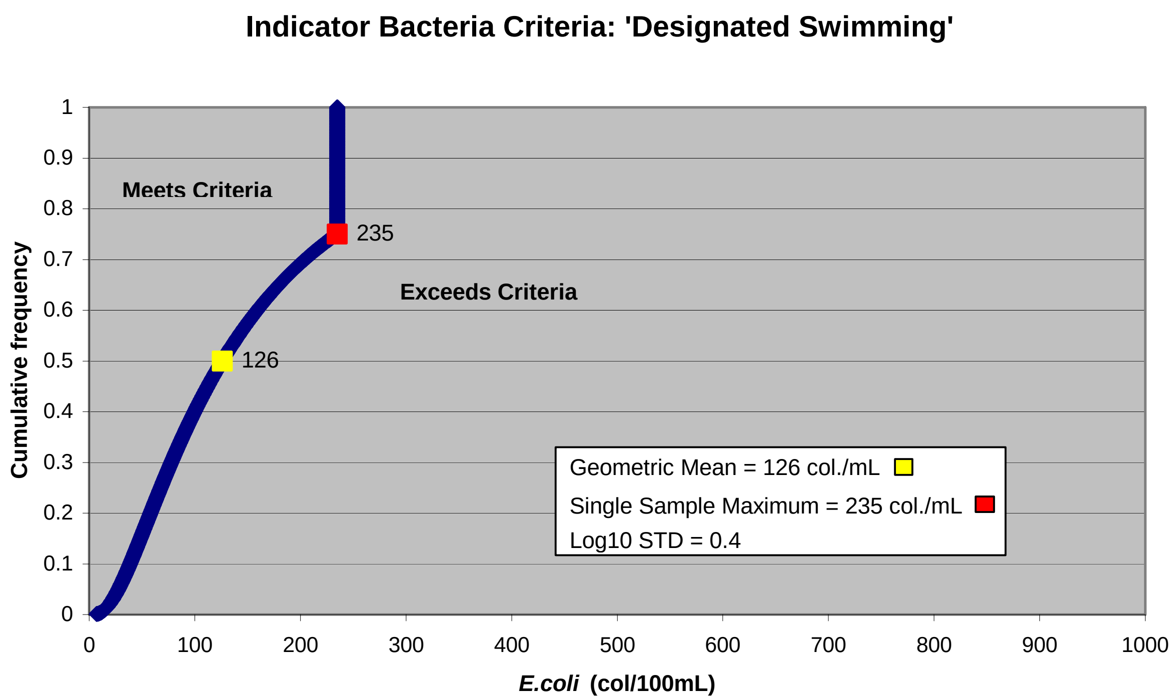

Figure 1a. Cumulative Relative Frequency Distribution representing water quality to support designated swimming use.

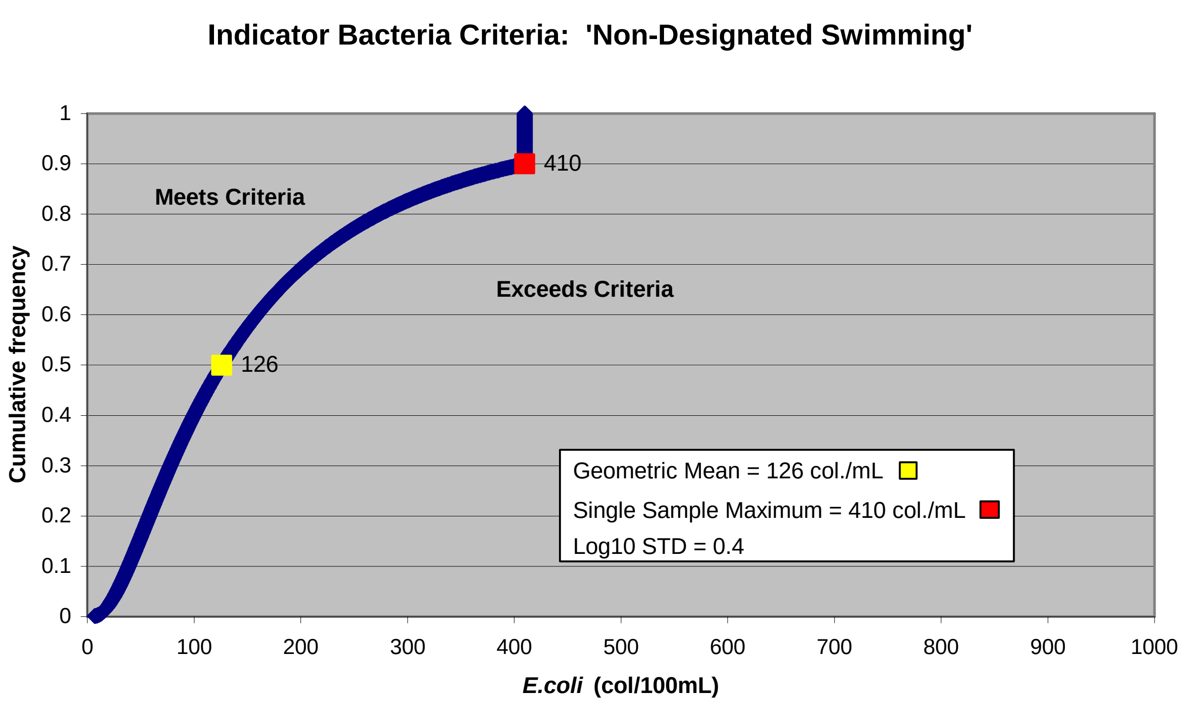

Figure 1b. Cumulative Relative Frequency Distribution representing water quality to support non-designated swimming use.

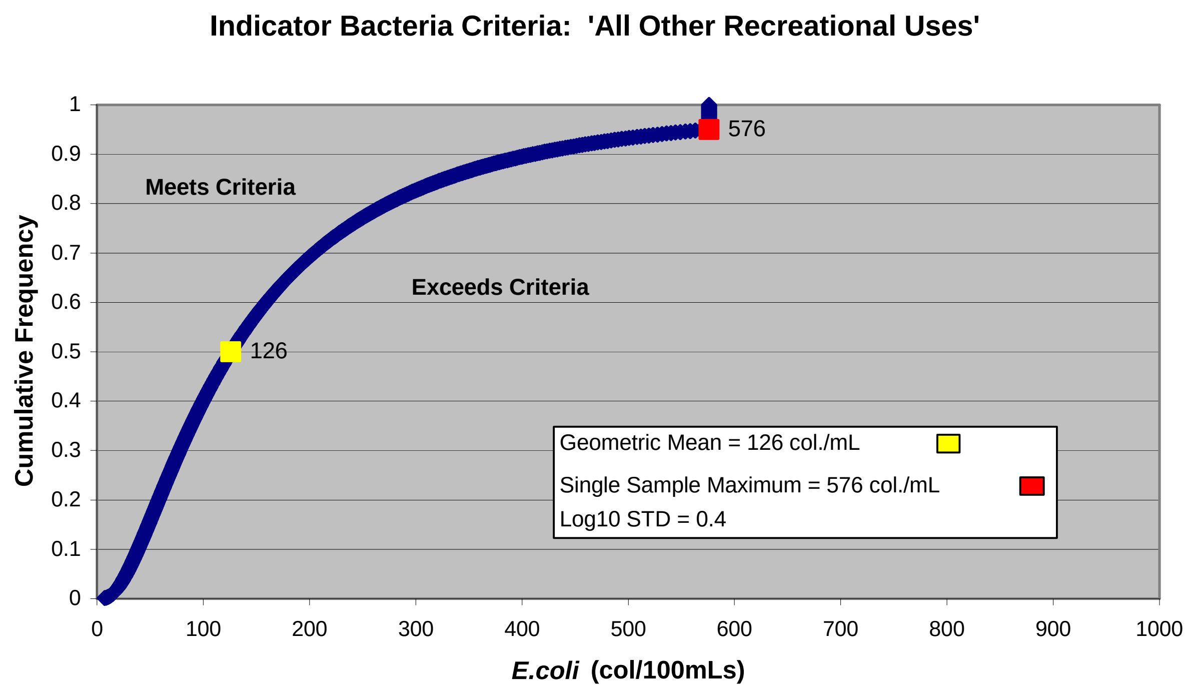

Figure 1c. Cumulative Relative Frequency Distribution representing water quality criteria to support all other recreational uses.

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.

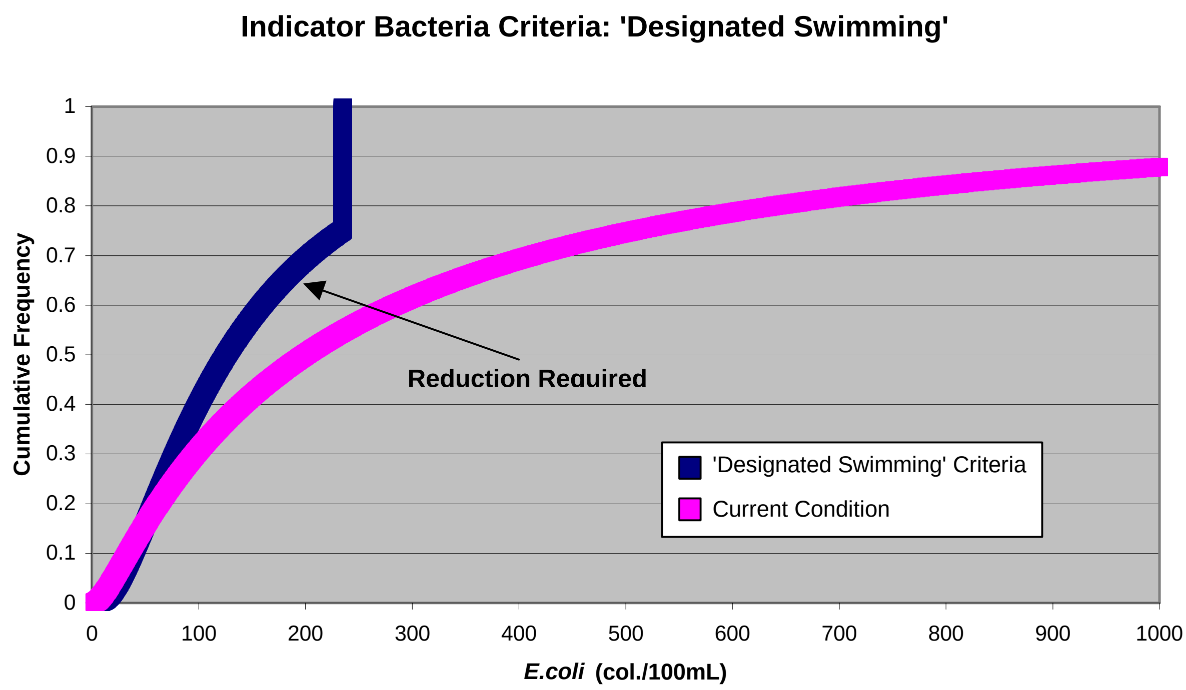

Figure 2a. Reduction indicator bacteria density needed from current condition to meet 'designated swimming' criteria based on cumulative relative frequency distribution.

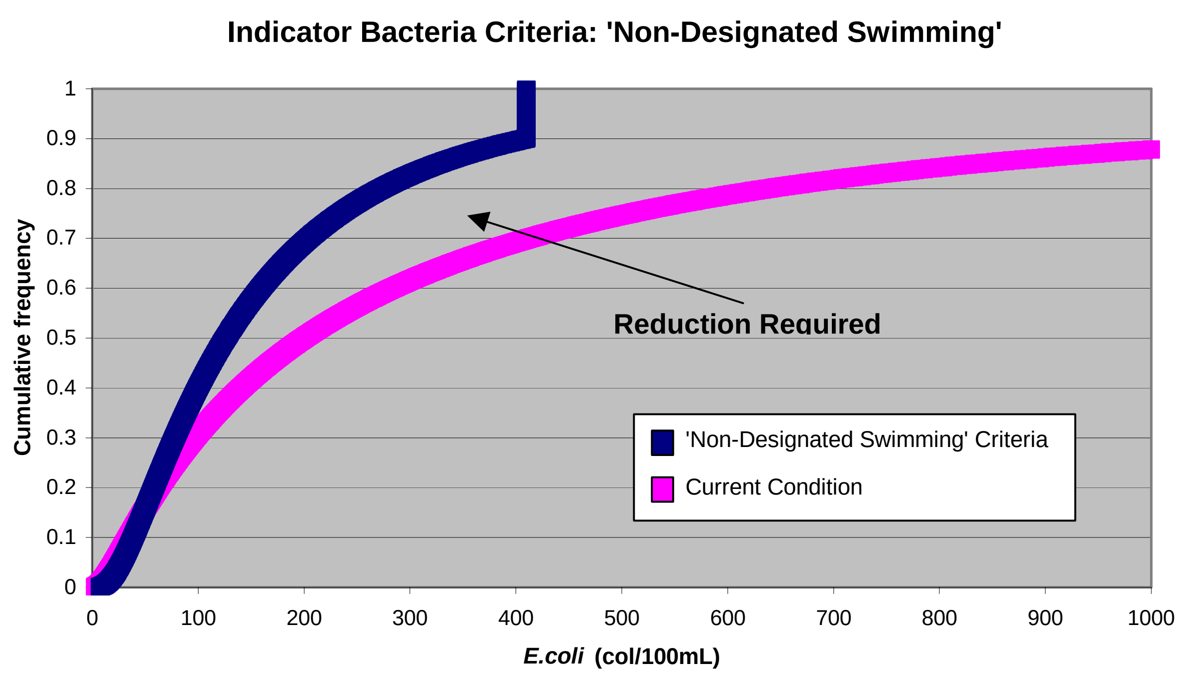

Figure 2b. Reduction indicator bacteria density needed from current condition to meet 'non-designated swimming' criteria based on cumulative relative frequency distribution.

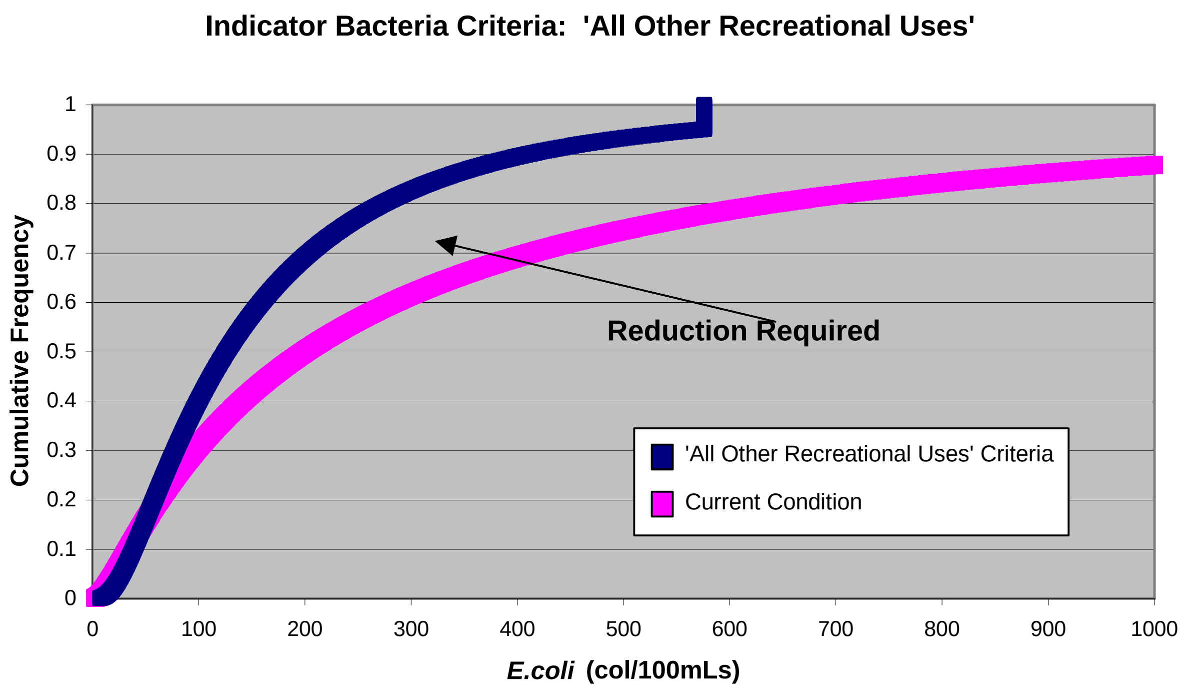

Figure 2c. Reduction indicator bacteria density needed from current condition to meet 'all other recreational uses' criteria based on cumulative relative frequency distribution.

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 DEP by contacting Thomas Haze at (860) 424-3734 or by email at thomas.haze@po.state.ct.us.

REFERENCES

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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

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Appendix C

Recommendations and Conclusions (Section 5)

'Wharton Brook State Park Water Quality Study Report'

5. Conclusions and Recommendations

5.1 Water Treatment Options

In preparing this study, DTC reviewed a number of treatment options for reducing bacteria levels in the stream through treatment. The following is a discussion of a number of possible methods considered:

5.1.1 Sedimentation

Sedimentation is a popular method for treating urban stormwater runoff. Design of sedimentation basins relies on the fact that particles and pollutants are heavier than the water in which they are suspended. Given sufficient time and low enough flow velocities, particles will settle out of the water column. Ironically, the pond itself provides an excellent opportunity to settle small particles such as bacteria. This fact could help to explain the lower bacteria levels observed downstream of the pond.

Opportunities for increasing stormwater settlement upstream of the pond swimming area may exist. Construction of an enlarged settlement forebay combined with dredging of the upstream pond reaches would help to settle some bacteria, particularly those that have bonded with larger sediment particles in the water column. This option however, would do little to protect the pond from the larger storm events which have caused pond closings throughout the years.

5.1.2 Sand Filtration

Sand filtration is another effective method of removing contaminants from water. Sand filtration is commonly used in water treatment plants to treat drinking water. Given the properly sized filter media, particles as small as bacteria can be captured. This process however, requires effective pretreatment methods, and regular maintenance of the filter media through backwashing. Pretreatment and backwashing are very difficult to implement due to the variable nature of stormwater flows. The costs associated with automated pretreatment and backwashing systems would be excessive.

5.1.3 Vegetative Filtration

Vegetative filters are gaining in popularity in stormwater treatment systems. Passing stormwater through a vegetated biofiltration basin or swale, has been shown to be effective in removing some types of stormwater contaminants. However, insufficient data currently exists evaluating the effects of biofiltration on bacteria levels. In addition, vegetative filters are generally most effective in screening low flows, not the storm related high flows causing the greatest bacterial levels in Wharton Brook Pond.

5.1.4 Solar/UV Disinfection

Using Ultra-Violet (UV) light to remove bacteria has been common in the water and wastewater treatment fields for years. This practice involves passing sheets of water through a UV light source of sufficient intensity to cause bacteria die off. In a water or wastewater plant, this involves the use of a series of high intensity UV emitting light bulbs. As the flow pass through the light field, a considerable number of the bacteria succumb to the light source. This same theory can be applied to solar UV light. Although emitted at less intensity than the light bulbs, the sun can play a role in bacteria reduction. Unfortunately numerous factors inhibit the effectiveness of UV radiation on bacteria mortality. The most significant is generally the clarity of the water being treated. Since light penetration depends heavily on the clarity of the water, only relatively clear flows can be effectively treated with this method. Since storm induced flows are not expected to have low turbidity, the effectiveness of this method is not likely to be high. In addition, the variability of the flow, lack of UV radiation during a storm event, and the costs associated with a man made UV source, make this option impractical on a large scale for stormwater.

5.1.5 Chemical Disinfection

Also prevalent in water and wastewater fields is the use of chemical disinfection to treat bacteria. Although a variety of chemicals have been used in killing bacteria, chlorine compounds are the most prevalent. The effective use of chlorine is dependent on proper feed ratios to provide enough chemical to kill the bacteria, but not too much so as to effect the rest of the environment. So called chlorine residuals are measured and monitored by the DEP to ensure that proper levels are being used.

Chlorine has been used in the State to treat stormwater associated with ponds used for swimming. In Glastonbury, the Town has installed a hypochlorite feed system to release chlorine into stormwater flows just upstream of Eastberry Pond. The release levels are based on measured flows in the stream, and are adjusted automatically as flows rise. This option may be worthy of further study for solving the bacteria problem at Wharton Brook Pond. Extreme care must be taken in assessment of the necessary chemical feed rates. Additional study of the bacteria levels and flow levels in the stream should be considered prior to design of such facilities.

5.2 Pollution Source Reduction

Perhaps the most effective, and environmentally advantageous methods for reducing bacteria loads are through reducing bacteria at its source. As discussed earlier in the report, a number of potential sources for bacteria have been identified. The following outlines the potential for bacteria reduction from each of these identified sources:

5.2.1 Pet Waste

Uncollected or improperly disposed of pet waste is perhaps the largest potential source of bacteria contamination in the watershed. Since the watershed has become almost completely developed with residential and condominium type development, the expected pet population can be quite high. According to recent studies, approximately 40% of households own a dog, and at least 40% of these owners can be expected to not clean up after their pet (Swann 1999, Hardwick 1997). Since fecal coliform and other bacteria densities in dogs can be nearly twice that of humans, dog pose a particular threat.

Like most communities, North Haven and Wallingford have clear "pooper scooper" laws on the books. It is however, the enforcement of these laws that pose the greatest problem. Since police forces do not have the manpower to regularly patrol neighborhoods looking for violators, they must rely in residential complaints as their first line of defense. Development of a widespread signing program would help in raising the awareness of the problem. Signs quoting the Town ordinances, stating the effects of bacteria contamination, and warning of fines would at least serve as a reminder. However, recent studies in Washington and Chesapeake Bay indicate that even with the threat of fines, a significant percentage of dog owners would still not pick-up after their animals (Hardwick 1997, & Swann 1999).

5.2.2 Waterfowl and Wildlife

Waterfowl have perhaps the highest concentrations of bacteria levels in their waste of any single source that can be expected in this watershed. Large populations of waterfowl can have significant and far-reaching effects on water quality. Although waterfowl have been observed at Wharton Brook State Park and at several locations within the watershed, the level of bird population does not appear to be significant. Efforts have been made by both golf courses in the watershed to control the goose population by utilizing noisemakers. Many other options exist for controlling the bird population including employment of dogs, repellant spraying, and vegetative means. These methods are quite invasive, and would conflict heavily with the mission of the golf course operations. Although the waterfowl populations certainly contribute to the bacteria levels in the pond, it is unlikely that even significant reductions in their already low numbers would have that great of an effect.

Other wildlife is also known to exist in the watershed. Squirrels, rabbits, and other birds have been observed, and given the suburban setting, populations of raccoon, opossum, and rats are likely present. As with the waterfowl situation, the wildlife in the watershed undoubtedly contributes to the bacteria levels. However, levels of bacteria contamination of rural stormwater are historically low when compared with urban/suburban runoff. This suggests that on its own, wildlife is not the major source of the bacteria that we are observing. Methods for controlling bacteria loading from wildlife are impractical from a wildlife conservation standpoint.

5.2.3 Human Bacteria Sources

Human bacteria loading can come from a variety of sources. Failed residential septic systems, damaged sanitary sewer systems, and illicit sanitary connections to storm drainage systems, are all potential sources. Since the vast majority of properties within the watershed are serviced by a sanitary sewer system, the number of possible failed septic systems is quite low. Based on our discussions with the Quinnipiac Valley Health District, and the Wallingford Health Department, no major septic systems failures have been reported or are suspected within the watershed.

Our discussions with the Wallingford Sewer Department indicated that no major sewer system failures or suspected trouble spots exist in the watershed. Illicit discharge connections are nearly impossible to locate without a wide spread inspection and study. Therefore if they are present, their elimination is impractical.

The Town of Wallingford maintains the Pond Hill Sewage Pumping Station with in the watershed limits. Overflows from such stations due to failure or from poor house keeping procedures can be a significant source of bacteria. Based on our visual inspection of the grounds surrounding the station, and our discussions with the Town, this station does not appear to be a significant bacteria source.

5.2.4 Other Sources

Other sources of contamination include keeping of livestock, roadway cleaning and maintenance, and fertilizer use. Based on our inspection of the watershed, little or no livestock remain in the watershed. Although once primarily agricultural in nature the development of residential houses and condominiums have squeezed out most of the farm operations. .

In general road side trash should not in itself represent a significant source of bacteria. Generally roadside areas are kept relatively clean of significant trash accumulations. Trash generally consists of paper wrappers, beer and soda bottles, and the like. An occasional discarded baby diaper may represent a bacteria source, but would be so isolated so as to not create any significant load. The DOT has a regular program of trash removal along I-95 and the Wharton Brook Connector. Trash accumulation along local roads is often controlled by residents or through municipal road sweeping programs.

Residential and Golf Course fertilizers represent a possible bacteria source depending on the type and volume of use. Chemical fertilizers, and nitrogen treatments are typically utilized in residential settings, and do not contribute bacteria. Livestock (horse/cow) manure is typically used for residential gardens, flower beds, and in farming. However the overall land area of application for these uses, and the naturally lower bacteria levels in this material is not likely to produce significant bacteria contribution. Discussions with the Golf Course staff indicate that all manure products are use exclusively in green repair and are from sterilized sources.

5.2.5 Source Reduction Conclusions

Based on the above analysis, the opportunities for considerable source reduction of bacteria loading are difficult to realize. Obvious sources such as unprotected manure piles can be readily identified and corrective actions implemented. However, sources such as pet feces, waterfowl, or illicit sanitary connections are very difficult to regulate and enforce. Implementation of public awareness campaigns can help to enlighten the residents, however even an effective program is unlikely to reduce bacteria levels below acceptable contact levels during a storm event. The considerable suburban land use as a whole in this watershed produces runoff that is less than ideal for human contact under all weather situations. But, the cumulative effect of implementing the above measures can potentially reduce the overall bacteria load, thus somewhat reducing the necessary pond closure times.

5.3 BMP Recommendations

5.3.1 DEP Park

Surface runoff from the park itself represents the most direct and concentrated route for stormwater contaminants to reach the pond water. For this reason, proper land management within the park property is critical to the success of any remedial measures undertaken for the project. Several measures should be considered in addressing this issue:

- Signs should be posted in conspicuous places describing the importance of water quality in the park, and detailing measures that are required of all park visitors.
- Rules regarding clean-up of dog feces, should be prominently posted, and enforced to the best on the Departments abilities, particularly during the bathing season.
- Although the park has strict rules against trash collection, consideration should be given to providing "Animal Waste Collection Stations" to make collection and disposal easier and more convenient for park patrons.
- Consideration may be given to construction of a pet exercise area within the park property. This area would include a fenced in field that is properly

bermed to prevent runoff during smaller storm events. Enforcement of feces collection would still be expected, however potential water quality degradation due to violations would be contained.

5.3.2 Municipal

Improvements to municipal watershed management practices should be investigated further. The following considerations should be reviewed with the municipal leaders for opportunities for possible implementation.

5.3.2.1. North Haven

Since the Town of North Haven has no formal "Pooper Scooper" laws or ordinances on the books, consideration should be made to development of such an ordinance. The proposed ordinance should require collection and proper disposal of animal waste on both public and private lands, and include an enforcement clause dictating the enforcement authority and associated fines.

The Town should also consider enacting regulations requiring proper handling, storage, and treatment of fertilizers and animal manure. Regular cleaning of livestock facilities, covering of manure stockpiles, and proper covered storage of fertilizers is necessary. Although it does not appear that there are any lots within the Wharton Brook Pond watershed which would legally qualify for hosting livestock, these regulations would serve to protect other areas of Town from similar water quality problems.

The Town, working in conjunction with the State should also consider participating in a public outreach program to educate residents on the importance of proper watershed management issues. The EPA has considerable resources on its web site to assist in the development of this program. The program should include development of a water quality pamphlet describing in layman's terms the issues surrounding watershed protection. Also worthy of consideration is the deployment of signs throughout the watershed, summarizing the new "Pooper Scooper" law, and other simple watershed protection measures. Often, the services of civil groups and high school clubs and organizations can be sought in offsetting the costs of such a program.

5.3.2.2. Wallingford

The Town of Wallingford has enacted a "Dog Defecation" ordinance to protect public properties in town. Unfortunately, this ordinance only deals with defecation on public properties. Animal feces uncollected in residential back yards may be an even larger water quality problem than the roadside dog walker causes. For this reason, the Town's ordinance should be revised to include private lands as well as public.

The Town has already created rather effective overlay zones to cover water supply watershed areas serving the municipal water system. Expansion of these zones to cover the Wharton Brook Pond watershed, would provide the type of zoning support needed to protect against inappropriate land use upstream of the State Park bathing area.

As discussed above, enactment of a public outreach program for the Town of Wallingford is also recommended.

5.4 Flow Augmentation Options

Several options were evaluated for augmenting flow through the pond in reducing bacteria levels. In each case, the goals of the flow augmentation need to be clear. Due to excessive concentrations expected during a storm event, dilution of incoming flows to acceptable levels is not possible. Flushing of the pond after a storm event may be feasible, but many factors influence the effectiveness of this solution. One important point to note when considering this option, is that the pond itself severs as an excellent treatment system for bacteria, due to the normally slow velocities, and a high propensity for settlement. Providing flow augmentation will serve to flush the pond of contaminated water, but the increased velocities associated with this flushing action will also decrease the ponds ability to naturally treat the flow entering from the watershed. It is believed that two factors work together during a storm event to elevate bacteria levels. The first is the obviously higher bacteria concentrations in the incoming water. The second is the increase in velocity into the pond, which adversely effects the ponds ability to settle out bacteria from the water column. Therefore, increasing velocities through the pond through flow augmentation will adversely effect the ponds ability to self cleanse the incoming watershed flows.

Approximately 3,000 GPM would be necessary to flush the pond contents within a 24 hour period after a storm event. Flushing the pond within 48 hours would cut those flows in half. Given the presence of a continuous contribution of bacteria laden flows even after a storm event, the flow augmentation needs and effects become even more difficult to accurately predict without much more extensive study. For a point of comparison, the following options assume a 48 hour flushing operation:

5.4.1 Redirection of Wharton Brook Flows

Wharton Brook joins Allen Brook just downstream of the dam discharge. The concept of redirecting Wharton Brook flows to the upstream end of the pond had been discussed as a possible option in our meeting with the DEP on the project. Sufficient flow should exist within Wharton Brook to provide the flushing operations required. However, it appears that grade differential between the streams would make this option impossible from a gravity flow standpoint. In addition, since the Wharton Brook watershed is also heavily developed, its bacterial levels are likely at or above the Allen Brook data gathered for this study. Since no dilution benefits of this option are anticipated, no further consideration was given to it.

5.4.2 Well Field Flow Supplement

Installation of a suitably sized well field to provide additional flows for bacteria dilution was also evaluated. Under this scenario, a well field and pump system would be installed and run during and/or immediately following storm events to dilute and flush contaminated water from the pond. For this to be a viable option, sufficient groundwater recharge rates would be necessary. Based on a review of surficial geology data, it appears that sufficient recharge capacity should be available in the vicinity of the pond area. Costs for this option would be high, and are detailed in Appendix F.

5.4.3 Pond Pump Back Supplement

In this option, water at the pond outlet would be pumped back to the pond inlet end to provide additional flows and flushing velocity through the pond system. Since the pond maintains a naturally capacity to cleanse itself, we can utilize this ability by speeding up the process

5.5 Swimming Area Screening

Since the primary point of concern in terms of bacteria contamination is the swimming area, methods to screen this area from bacteria were considered. Systems marketed by companies such as "Gunderboom" and "Eco Boom" provide synthetic filter curtains that block small particles, but allow water to pass. Information available from the manufacturers claim reductions on the magnitude of 90% for bacteria.

After review of studies of similar installations in Mamaroneck Harbor beach in Mamaroneck NY, and Magazine Beach on the Charles River in Boston MA, removal rates were considerably less than those indicated by the manufacturer. At Mamaroneck Harbor, in a 1993 report prepared by a group of Westchester County Department of Health officials, a reduction of fecal coliform levels of 52% was reported due to the fabric boom installation. In EPA's April 2001 study of Magazine beach, test installation of a "Gunderboom" system in June and August 2000 revealed, "No conclusive improvements were obvious for fecal coliform and enterococcus bacteria…"

Sufficient independent corroborating field testing of this technology does not yet exist. Although the concept is certainly valid, it does not appear that this technology alone would be sufficient to substantially reduce beach closures at the park. When considering a 75% removal rating, reductions in bacteria levels at sampling point P1 (upstream end of the pond) would marginally pass DOH criteria for E. Coli., and fail for four of the five samples for enterococci bacteria. When applying 75% reductions to DOH/DEP 2001 sampling data, the number of beach closures would not have changed, although the total duration of closures would have likely decreased by several days.

Due to the high initial costs and likely long term maintenance and repair/replacement costs, it is recommended to collaborate with the material manufacturers for a trial test of the technology. A small (approx. 20'x20') area would be protected with a fabric curtain over the period of one swimming season. Samples of pond water inside and outside the curtain would be collected by the DOH/DEP as part of their weekly sampling rounds. Results of the trial could then be evaluated for potential viability on the overall swimming area. If a significant reduction in necessary beach closures and total closed days is realized for samples from this test area, the overall beach protection investment may be justified. Deployment of a test sample would also allow DEP to evaluate maintenance and repair issues, and make adjustments in any overall systems, if full protection of the swimming area is warranted.

5.6 Conceptual Dredging Plan

5.6.1 Dredging History

According to state records, the pond was last dredged in 1974. Approximately 9,000 CY of material was removed from the pond bottom and deposited on a plateau area to the south. The purpose of this dredging operation was to create a distinct channel through the center of the pond, and to establish the swimming area that exists today. Since this time, it is estimated that approximately 7,000 CY of material has redeposited in the pond, essentially filling in the previously excavated channel.

5.6.2 Dredging Need

The most critical issue that must be discussed in evaluating possible dredging options is the need and benefits of doing so from a water quality standpoint. Dredging of the pond will serve to increase the detention time of stormwater in the pond, and/or change the flow characteristics of water traveling through the pond. From a bacteria standpoint, both of these dredging effects can serve to reduce bacteria levels downstream. The dredging operation will deepen the pond, allowing it to settle out smaller partials including additional bacteria. Dredging will also better channelize flow through the pond possibly directing the most heavily contaminated flows away from the swimming areas.

An additional argument for implementation of some sort of dredging plan has to do with the future life of the pond itself. As with most ponds, sedimentation is an ongoing process at this location. As sediment levels increase the pond depth is reduced, resulting in a rising of pond water temperatures, and degradation of water quality. Sedimentation, particularly in the upstream reaches of the pond has limited the pond depth to less than 2.0 feet in some places. Even at its deepest point, over the past 28 years the pond depth has decreased by 1/3. If left unremediated, this condition will continue, resulting in loss of pond area (sedimentation to the surface), and further water quality degradation. At its current rate, loss of pond area would begin to occur over the next five years.

5.6.3 Dredging Plan

After consideration of a number of options, reestablishment of the 1974 dredging limits is the most attractive from both a water quality and pond life standpoint. This plan would require removal of approximately 7,000 CY of material to deepen the pond, and reestablish the former channelized section through the pond center.

This plan concentrates the main flow channel at the pond bottom to direct the major pond flows away from the swimming area. Dredging operations would concentrate flows toward the southerly pond bank. This action would partially direct the most contaminated storm related flows past the swimming area, straight to the pond outlet.

This plan also maximizes dredging operations at the upstream end of the pond where the largest sedimentation has occurred. As with all ponds, sedimentation occurs most readily in the first 1/3 of the pond length, as higher velocity sediment laden flow drops its material in the lower velocity pond environment. Deeping the upstream pond reaches would allow greater sedimentation in the pond area upstream of the swimming area. This would tend to remove more bacteria from the water column before it reaches the sensitive beach

5.6.4 Hydraulic Residence Issues

Detention time in the existing pond has been estimated at approximately 2.7 days. Implementation of the dredging plan will serve to decrease the overall pond flushing rate, increase phosphorus detention time, reduce bacteria levels, and increase overall sedimentation.

After the dredging operations, the overall detention time in the pond is estimated at approximately 3.6 days. Based on our analysis, it does not appear the nutrient loading in either the existing or proposed condition will cause the pond to reach a eutrophic state.

5.6.5 Material Disposal Options

Based on a review of the limited sediment sample testing performed for this study, it appears that direct dredge spoil stockpile can be done adjacent to the pond or at other locations within the park boundaries. During the 1974 pond dredging operations, dredge spoil material was deposited on a ridge adjacent to the pond to the south. If the dredging option is pursued, this location is a prime candidate for disposal.

Additional sediment sampling should be performed as part of any future dredging design implementation. A gridded matrix of individual samples or structured composite sampling should be considered to properly characterize samples in all areas to be dredged.

5.7 Conceptual Cost Matrix

The previously described improvement options have been reviewed for conceptual implementation costs. The following cost matrix was developed to help understand the order of magnitude costs associated with each option. Additional study and design efforts are required to refine the scope of these options and their corresponding costs.

5.8 Permitting Matrix

As with the cost matrix, a permitting matrix was developed to identify possible permitting needs of the various improvement options: