

**TOTAL MAXIMUM DAILY LOAD ANALYSIS
FOR THE UPPER WILLIMANTIC RIVER,
STAFFORD, CT**

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

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INTRODUCTION

The Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA), requires that states adopt water quality standards that support designated uses for each waterbody within its boundary. Examples of designated uses adopted into Connecticut Water Quality Standards (WQS) include drinking water supply, fish and wildlife habitat, recreational use, agricultural use, industrial supply, and others. Section 303(d) of the CWA requires states to develop Total Maximum Daily Loads (TMDLs) for waters where current pollution controls are not stringent enough to attain or maintain compliance with adopted State Water Quality Standards.

The TMDL represents the maximum pollutant loading that a waterbody can receive without exceeding the adopted Water Quality Criteria (WQC) for that pollutant. Federal regulations require that the TMDL analysis identify the portion of the total pollutant loading which is allocated to point source discharges (termed the Wasteload Allocation or WLA) and the portion attributed to nonpoint sources and natural background (termed the Load Allocation or LA). In addition, TMDLs 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 must also be considered in TMDL analyses.

A TMDL analysis also provides a written report that describes the pollution control actions necessary to achieve acceptable water quality conditions in the impaired waterbody. Public review and comment is strongly encouraged. Following public review and comment, the TMDL established by the State is submitted to the Regional Office of the Federal Environmental Protection Agency (EPA) for review. EPA can either approve the State's TMDL or disapprove the TMDL and act in lieu of the State. TMDL reports also may include an implementation plan and a description of monitoring activities to confirm that the TMDL has been effectively implemented and that WQS have been achieved.

The section of the Willimantic River from 0.5 mile below Route 190 (approximate location of the Stafford Publicly Owned Treatment Works) to the confluence of Bonemill Brook was listed on the 1998 303(d) list, *Connecticut Waterbodies Not Meeting Water Quality Standards*¹ based on a review of Aquatic

Toxicity Monitoring Reports (ATMRs) submitted to CTDEP from the Stafford Publicly Owned Treatment Works (POTW). Calculations using data from ATMRs have shown a high probability of exceeding Connecticut Water Quality Criteria for copper, lead and zinc in the Willimantic River downstream of the discharge. Therefore, TMDLs were developed for copper, lead, and zinc at two locations downstream of the Stafford POTW discharge. TMDLs will be implemented by reissuing the National Pollutant Discharge Elimination System permit to the Stafford POTW with limits for copper, lead, and zinc calculated from the Wasteload Allocation developed in this analysis.

Willimantic River Watershed

The Willimantic River watershed drains an area of approximately 225 square miles in southern Massachusetts and northeastern Connecticut. The headwaters of the Willimantic watershed begin in the towns of Monson and Wales, Massachusetts. The watershed includes the Connecticut towns of Stafford, Union, Ellington, Tolland, Willington, Ashford, Vernon, Bolton, Coventry, Mansfield, Andover, Columbia, Windham, Hebron, and Lebanon (Figure 1). A total of 11 subregional drainage basins are contained within the Willimantic Watershed ².

Willimantic River

The Willimantic River originates at the confluence of Middle River and Furnace Brook in Stafford, Connecticut and then flows for approximately 25 miles before it joins the Natchaug River to form the Shetucket River. Natural streamflow in the Willimantic River is regulated by Staffordville Reservoir, located in the upper Furnace Brook Basin.³ Staffordville Dam was built in the late 1800's to provide water storage for power and industrial supply. Today, power and industrial supply are less important and water recreation has become the primary use of Staffordville Reservoir.

The Willimantic has been used for power generation and waste assimilation dating back to 1700's. Dams were built along the river to generate power for mill factories that became established in Willimantic and Stafford Springs. Many of these factories operated along the river for centuries and some are still active today. The river is

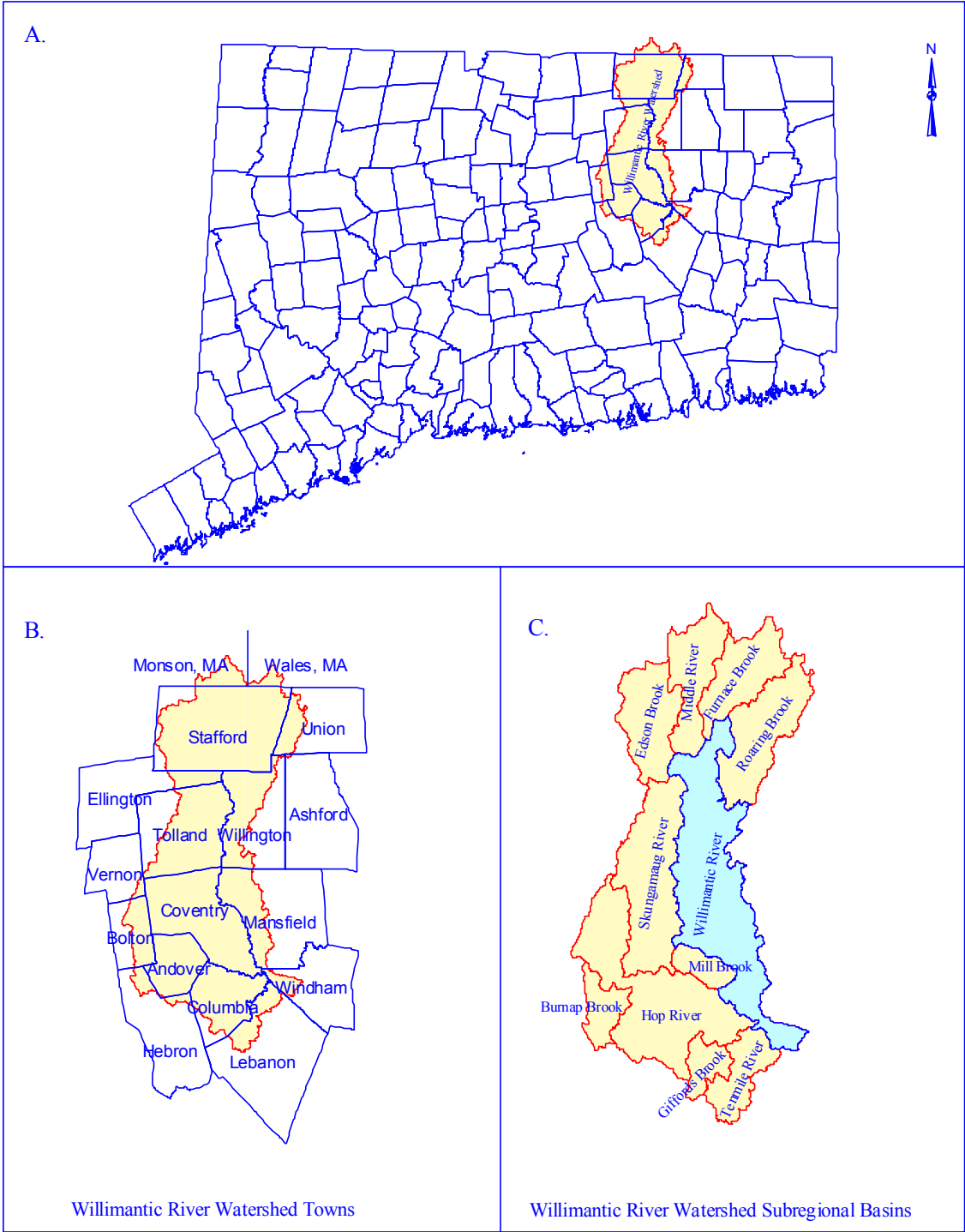


Figure 1. Willimantic River Watershed Location (A) , towns (B), and subregional drainage basins (C).

also utilized to assimilate treated sewage from POTWs in Stafford, Storrs, and Windham-Willimantic.

TMDL Segment of Willimantic River

The 1.5 mile section of the Willimantic River from the Stafford POTW to Bonemill Brook is the TMDL segment (Figure 2). Stafford Springs is the business center for the town of Stafford and is located just upstream of TMDL segment. Stafford is populated by approximately 12,000 residents and covers approximately 60 square miles, making it the third largest town by land area in Connecticut. Population density of Stafford is low; approximately 200 people per square mile.

Throughout the TMDL segment, the river has a moderately steep gradient. Average stream widths are approximately 20-30 feet and depths are generally less than one foot. Dominant substrate in the TMDL segment can be characterized as a mix of cobble, gravel, and sand. Land use in the TMDL segment is predominantly forested with a lightly developed residential area and business center to the north in Stafford Springs. This section of the Willimantic River is bordered by Nye-Holman State Forest to the west and portions of Nipmuck State Forest to the east. The only significant tributary in this section of river is Bonemill Brook, which delineates the downstream extent of the river addressed in this TMDL analysis.

The Stafford POTW is the only point source discharge in the TMDL segment. The Stafford facility was built in 1974 and currently provides secondary treatment of domestic, commercial, and industrial waste via the contact stabilization process. The wastewater is disinfected using ultraviolet radiation prior to discharge to the Willimantic River. The plant was designed to treat 2.0 million gallons per day (MGD). During the period from November 1998-October 1999, the average plant flow was 1.2 MGD based on monthly operating reports submitted to CTDEP. Typically, flows during the summer months (July-October) average approximately 1.0 MGD.

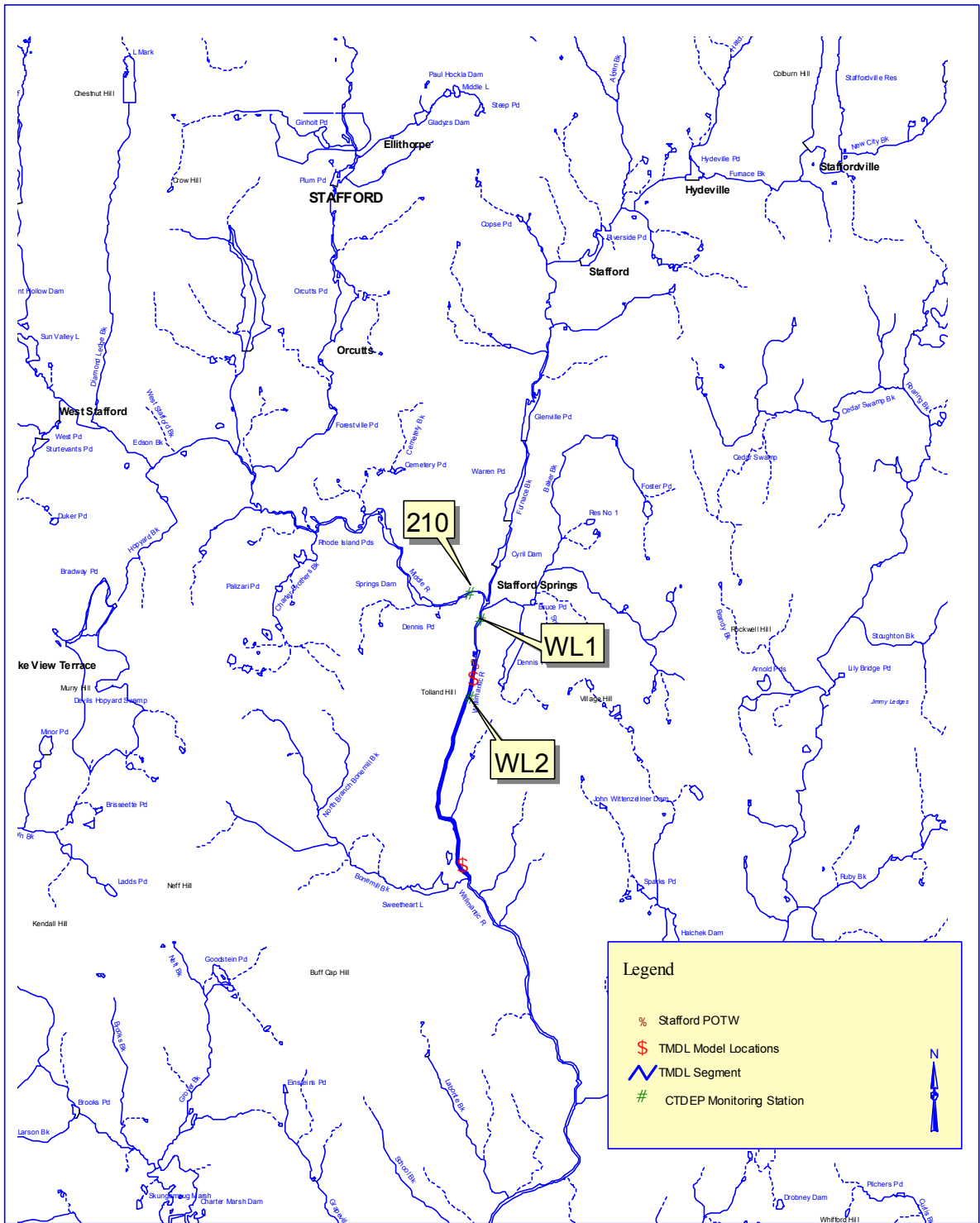


Figure 2. TMDL segment of Willimantic River.

CONNECTICUT WATER QUALITY STANDARDS AND WATER QUALITY CRITERIA

Connecticut WQSs have established separate water quality criteria to protect aquatic life from acute exposure (one hour) and chronic exposure (four-day average) to pollutants⁴. Adopted water quality criteria for copper, lead, and zinc that are applicable to this TMDL analysis are outlined in Table 1. Site specific criteria for copper have been adopted into the Connecticut WQS for the section of Willimantic River from the Stafford POTW to the confluence of Roaring Brook in Willington, which includes the entire TMDL segment. Site specific criteria for copper have been adopted for several waterbody segments that receive a contribution of biologically treated wastewater greater than or equal to 20% of base flow because these streams have been shown to exhibit a greater capacity to assimilate copper⁵.

Pollutant	Acute Criteria	Chronic Criteria
Copper ^{1,2}	25.7	18.1
Lead ²	30.0	1.2
Zinc ²	63.6	58.2

¹ Site specific criteria for copper apply from Stafford Springs POTW to the Trout Management Area in Willington.

² For acute exposure, biological integrity is impaired when the acute criteria is exceeded for 1 hour more than once every three years on average. For chronic exposure, biological integrity is impaired when 4-day average exceeds the chronic criteria more than once every three years on average.

Connecticut WQS designate the minimum daily flow for seven consecutive days that can be expected to occur once in ten years under natural conditions (7Q10) as the minimum flow to which surface water standards apply. In order to protect aquatic organisms in the Willimantic River, TMDL load calculations were performed using a steady-state model under different flow scenarios and the most protective condition was applied in this analysis.

The Willimantic River is a Class B surface water for its entire length. Designated uses for Class B surface waters include recreational use; fish and wildlife habitat; agricultural and industrial supply; and other legitimate uses including navigation. The WQS for Class B surface waters includes a narrative standard for benthic invertebrates

which inhabit lotic waters. Benthic invertebrates can provide useful biological indicators to evaluate whether target designated use goals are met in the TMDL segment.

Water Quality Monitoring

CTDEP Water Management Ambient Monitoring Program collected benthic samples and surface water chemistry data from the upper Willimantic River basin beginning in October 1999. Surface water chemistry samples were collected quarterly throughout the year assessment cycle ending October 2000. Surface water samples provided the data to develop the Load Allocation portion of the TMDL. Bioassessment metrics using benthic invertebrates have identified three sites in the upper Willimantic Basin as impaired using EPA's Rapid Bioassessment Protocols (RBP) ⁶.

There were two sites upstream of the TMDL segment - Middle River (site 210) and Willimantic River (WL1) - that were identified as impaired using RBP level III metrics. The cause of the impairment at these two locations is under investigation by the Department. These two sections, lower Middle River (site 210) and Willimantic River (WL1) will be listed on the next 303 (d) list until monitoring indicates that the biological community is meeting all designated use goals.

The third impaired site was within the TMDL segment about 0.25 mile downstream of the Stafford POTW. This site was ranked at 21% of the reference condition which ranks it at the lower end of the moderately impaired category using the RPB level III assessment protocol for macroinvertebrates. It is a goal of this TMDL to improve water quality within the TMDL segment such that the impaired locations will support a macroinvertebrate community structure that is similar to unimpaired reference sites within the basin.

Downstream below the TMDL segment, the biological community is fully recovered and shows no biological impairment. Fisheries goals are currently being met downstream of the TMDL segment. CTDEP Fisheries Division has designated the 2.4-mile section of the Willimantic River, from the mouth of Roaring Brook to Route 74 crossing in Willington, as a Trout Management Area (TMA). Today, the Willimantic TMA continues to be one of the most desirable angling destinations in northeastern Connecticut. The fishery is supported primarily by an annual trout stocking, and to a

lesser extent, by low densities of wild trout and a moderate-sized smallmouth bass population ⁷. Fisheries monitoring of the TMA has been conducted annually since the early 1980's and this section of the Willimantic continually supports all applicable designated uses. Further downstream, two monitoring sites in Merrow (site 47) and Coventry (WL3) sampled during fall 1999 were currently meeting Class B Water Quality Standards.

TMDL

A steady-state model was used to simulate loading capacity of each pollutant at two points in the TMDL segment of the Willimantic River:

- 1) Willimantic River below the Stafford POTW, and
- 2) Willimantic River above Bonemill Brook (*see Figure 2*).

The critical conditions (Table 2) were determined for each of the points in the TMDL segment. Critical conditions were defined as the "worst case" scenario of environmental conditions in the Willimantic River in which the pollutant load capacity expressed in a TMDL will not exceed Water Quality Criteria adopted by the State of Connecticut. For all pollutants, the critical streamflow condition was a function of low streamflow in the Willimantic River (7Q10) combined with flow contributed by the Stafford POTW discharge during the low flow months in the Willimantic River, July-October ⁸.

Estimates of 7Q10 streamflow were calculated using two methods- the Cervione Method ⁹ and using data provided by a USGS gauging station in Coventry. Both methods resulted in similar 7Q10 values ⁸. Estimates using the Cervione 7Q10 Method were more protective of aquatic organisms in the Willimantic River and subsequently used in this TMDL analysis.

Adjustments were made to the Cervione 7Q10 estimate to account for potential losses and additions to natural streamflow under low flow conditions. Cervione 7Q10 streamflow was adjusted by subtracting 0.6 cfs from all model points in the Willimantic River because of the potential loss of flow in the upper Furnace Brook Basin (i.e. above Staffordville Dam) during low flow months. The value of 0.6 cfs was the Cervione 7Q10 estimate for Furnace Brook upstream of Staffordville Reservoir. The Stafford POTW

was the only addition of flow in the TMDL segment. The minimum monthly average flow for the Stafford POTW during the low flow months in the Willimantic River (July-October) was estimated from monthly operating reports submitted to CTDEP. The minimum monthly flow value of 1.7 cfs from the Stafford POTW was added to all locations below the POTW.

TMDL SUMMARY

The TMDL at each model point was calculated by multiplying the adopted WQC for each pollutant (Table 1) by the critical streamflow condition in the Willimantic River at each model point (Table 2). A summary of load calculations is provided in Table 3 and Attachments 1-3.

Table 2. Hydrology and streamflow conditions used in the development of Willimantic River TMDL.						
Location	Drainage Area (mi ²)	Till (mi ²)	Stratified Drift (mi ²)	Cervione 7Q10 (cfs) ¹	Adjusted 7Q10 (cfs) ²	Critical Streamflow Condition (cfs) ³
Willimantic River below POTW	53.2	44.83	8.37	6.06	5.46	7.16
Willimantic River above Bonemill Brook	54.1	45.68	8.42	6.10	5.50	7.19

¹ Cervione 7Q10 (cfs) = (0.67 * square miles stratified drift) + (0.01 * square miles till) ⁹

² Adjusted 7Q10 (cfs) = Cervione 7Q10 - 0.6 cfs. The value of 0.6 cfs is the 7Q10 flow upstream of the Staffordville Reservoir.

³ Critical Streamflow Condition (cfs) = Adjusted 7Q10 + 1.7 cfs. The value of 1.7 cfs is the critical flow value from the Stafford POTW.

Load Allocations (LA)

The contribution of anthropogenic nonpoint sources and natural background levels of pollutants in the Willimantic River is unknown. Therefore, the portion of the TMDL allocated to the Load Allocation, or nonpoint sources plus natural background, was calculated by multiplying an estimated concentration of each pollutant by the critical streamflow condition. Estimated concentrations for copper, lead, and zinc represent target levels that were measured in a monitoring location in the Willimantic River above the Stafford POTW (WL1). Estimated concentrations of each pollutant were measured by CTDEP Ambient Water Monitoring field staff from October 1999 to October 2000 ¹⁰.

Table 3. Summary of TMDL for 2 model points in TMDL Segment of Willimantic River.					
TMDL at Willimantic River below Stafford POTW point of discharge					
Pollutant	Condition	TMDL (g/day)	WLA (g/day)	LA (g/day)	MOS (g/day)
Copper	Acute	450.83	410.70	40.13	0.00
	Chronic	317.51	277.38	40.13	0.00
Lead	Acute	526.26	519.57	6.69	0.00
	Chronic	21.05	14.36	6.69	0.00
Zinc	Acute	1115.67	997.95	117.72	0.00
	Chronic	1020.94	903.23	117.72	0.00
TMDL at Willimantic River above Bonemill Brook.					
Pollutant	Condition	TMDL (g/day)	WLA (g/day)	LA (g/day)	MOS (g/day)
Copper	Acute	453.35	410.70	40.43	2.22
	Chronic	319.28	277.38	40.43	1.48
Lead	Acute	529.20	519.57	6.74	2.89
	Chronic	21.17	14.36	6.74	0.07
Zinc	Acute	1121.90	997.95	118.58	5.37
	Chronic	1026.65	903.23	118.58	4.84

These values represent local estimated concentration of each pollutant in absence of the any point source contribution. Estimated concentrations were multiplied by adjusted 7Q10 streamflow to calculate Load Allocation at the two TMDL locations. Load Allocations were estimated as follows:

Copper:

The estimated concentration of copper used to develop the Load Allocation was 3.0 ug/l under all flow conditions. The value of 3.0 ug/l was the 95th percentile of the dissolved copper concentration measured in the Willimantic River above the Stafford sewage treatment plant from 5 samples October 1999-October 2000.

$$\text{LA below Stafford POTW} = (3.0 \text{ ug/l}) (5.46 \text{ cfs}) = 40.13 \text{ g/day}$$

$$\text{LA at Bonemill Brook} = (3.0 \text{ ug/l}) (5.50 \text{ cfs}) = 40.43 \text{ g/day}$$

Lead:

All measurements of dissolved lead measured in the Willimantic River above the Stafford sewage treatment plant were <1.0 ug/l. The value of 0.5 ug/l was used as a conservative estimation of dissolved lead.

$$\text{LA below Stafford POTW} = (0.5 \text{ ug/l}) (5.46 \text{ cfs}) = 6.69 \text{ g/day}$$

$$\text{LA at Bonemill Brook} = (0.5 \text{ ug/l}) (5.50 \text{ cfs}) = 6.74 \text{ g/day}$$

Zinc:

The estimated concentration of zinc used to develop the Load Allocation was 8.8 ug/l under all flow conditions. The value of 8.8 ug/l was the 95th percentile of the dissolved zinc concentration measured in the Willimantic River above the Stafford sewage treatment plant from 5 samples October 1999-October 2000.

$$\text{LA below Stafford POTW} = (8.8 \text{ ug/l}) (5.46 \text{ cfs}) = 117.72 \text{ g/day}$$

$$\text{LA at Bonemill Brook} = (8.8 \text{ ug/l}) (5.50 \text{ cfs}) = 118.58 \text{ g/day.}$$

The contribution of the Load Allocation during the critical conditions defined in this TMDL (i.e. 7Q10 low flow) is suspected to be minor in comparison to the contribution from the sole point source, the Stafford POTW. That is because the storm events necessary to transport anthropogenic nonpoint sources generally do not occur during low flow conditions and measured background levels of pollutants are generally low in the Willimantic River. When storm events occur, there is an added dilution effect that would reduce the impact of any additional loadings contributed by an increase in the Load Allocation.

Wasteload Allocation (WLA)

The Stafford POTW is the only point source in the TMDL segment of the Willimantic River for this TMDL analysis. Therefore, 100% of the Waste Load Allocation to the Stafford POTW at the point of discharge was calculated by subtracting the Load Allocation from the Load Capacity.

Margin of Safety (MOS)

A numerical Margin Of Safety was calculated by subtracting the sum of the Load Allocation and Waste Load Allocation from the Load Capacity at each model point. Under the critical condition identified in this TMDL, the numerical MOS is zero at the Stafford POTW point of discharge. The numerical MOS becomes larger downstream of the Stafford POTW as streamflow increases.

This TMDL analysis also has an implicit MOS built into the analysis. The TMDL was developed using a steady-state model under critical, or worst-case, conditions in the

Willimantic River. The modeled critical conditions, by definition, represent flow conditions that have a low probability of occurrence. The combination of 7Q10 flow in the Willimantic River plus the average flow estimate for the Stafford POTW during the low flow months of July-October represent a conservative approach to protecting aquatic life in the TMDL segment of Willimantic River.

To further support an implicit MOS, the TMDLs for copper, lead, and zinc assume that all of the available heavy metals will be in the dissolved form. This is a conservative approach because some portion of the total metal concentration will be adsorbed to particulate material in stream and therefore will not be available to cause toxicity to aquatic organisms.

Seasonal Analysis

Critical conditions were developed under the assumption that the critical period in the Willimantic River occurs during low flow months of July-October. Critical conditions in the TMDL segment were determined to be a function of natural streamflow in the Willimantic River combined with flow of the Stafford POTW. Streamflow during the low flow months July-October was represented by estimates of 7Q10 in the Willimantic River combined with flows from the Stafford POTW⁸. No seasonal variation was applied to the Water Quality Criteria concentration level for copper, lead, or zinc in this analysis since Water Quality Criteria adopted by the State Of Connecticut do not vary seasonally for these pollutants.

The TMDLs for the Willimantic River have been modeled using worst case low flow conditions which has been defined in Connecticut's Water Quality Standards as 7Q10. TMDLs were calculated using a steady-state simple dilution model assuming constant 7Q10 conditions. A steady-state model, by definition, assumes that the controlling input parameters such as flow and concentration of pollutants remain constant. During higher flows, the added dilution will increase the assimilative capacity of the river and will therefore buffer the added pollutant load contributed by stormwater runoff and nonpoint sources. Steady state model calculations at flows higher than 7Q10 confirm this fact (i.e. TMDL is greater under higher flow conditions). Therefore, TMDLs calculated under the critical conditions will be protective of all seasons.

IMPLEMENTATION

The TMDL will be implemented by incorporating the Wasteload Allocations for copper, lead, and zinc in this TMDL into a renewed NPDES permit for the Stafford POTW.

MONITORING

Water quality monitoring and assessment will be conducted by the Town of Stafford and CTDEP. At a minimum, CTDEP will require an annual chronic toxicity test of the POTW effluent when the NPDES permit is reissued to the Town of Stafford. The CTDEP protocol used to perform the chronic toxicity test requires that water from the Willimantic River be tested and used for dilution water in the analysis. An additional requirement is that tests be performed under summer low flow conditions - which are conditions that are similar to the critical flow analysis in this TMDL. In addition, the NPDES permit issued to the Stafford POTW will include monitoring requirements for copper, lead, and zinc.

Surface water chemistry and benthic macroinvertebrate data will continue to be collected from the Willimantic River by CTDEP Bureau of Water Management. Water quality monitoring and assessment will be conducted as described in the CTDEP Rotating Basin Ambient Monitoring Strategy ¹¹. Benthic macroinvertebrates will provide the primary metric to measure the progress of meeting Aquatic Life Support uses in the TMDL segment of the Willimantic River. The goal of this TMDL is to improve the water quality in the TMDL segment so that all aquatic life will be fully supporting the uses of the river. It is anticipated that an improvement in water quality will result in a shift in the macroinvertebrate community structure to an unimpaired status since habitat at the impaired site is suitable to support such organisms.

REASONABLE ASSURANCES

The NPDES permit issued to the Town of Stafford POTW provides a legally enforceable control document and offers reasonable assurances that WQS will be met in the TMDL segment of Willimantic River. This TMDL analysis is consistent with the CTDEP anti-degradation policy ⁴ because achievement of the loading capacity

calculations instream will result in meeting Water Quality Criteria adopted by the State Of Connecticut.

PROVISIONS FOR REVISING THE TMDL

The Department reserves the authority to modify the TMDL as needed to account for new information made available during the implementation of the TMDL. Any new source of copper, lead, or zinc (e.g. new stormwater NPDES Permit) that may affect TMDL calculations will be carefully considered by the Department and if necessary, revisions will be made to the TMDL. The Department will provide an opportunity for public participation prior to any modification of the TMDL and any modifications will be subject to the review and approval of the U.S. EPA as required by Federal law.

Biological monitoring of Willimantic River performed by the DEP in accordance with the monitoring plan and any monitoring performed by other parties in accordance with an approved quality controlled plan will be evaluated as this data becomes available. In the event that monitoring of Willimantic River indicates that aquatic life uses are not fully supported following implementation of the TMDL, the Department will review all readily available data and assess the need to modify the TMDL. The Department may propose other modifications to the TMDL analysis if the review indicates such a modification is warranted and consistent with the anti-degradation provisions in Connecticut Water Quality Standards. Willimantic River will continue to be listed in *Connecticut Waterbodies Not Meeting Water Quality Standards*² until such time as monitoring data confirms that aquatic life uses are fully supported.

PUBLIC PARTICIPATION

This TMDL analysis has been modified from earlier draft versions to reflect comments received from reviewers. A Public Notice soliciting comments from the public on the TMDL was published in the *Hartford Courant* on March 19, 2001¹². Public comments on the TMDL were reviewed and modifications to the TMDL made as a result of this process. Documentation of public participation and DEP's response to comments received on the TMDL is included in the transmittal letter submitting the TMDL to EPA for review and approval.

REFERENCES

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- ¹² Public Notice. In Legal Classified Section of Hartford Courant March 19, 2001.