

Nutrient and Siltation TMDL Development for Wissahickon Creek, Pennsylvania

Final Report

October 2003

U.S. Environmental Protection Agency
Region 3
1650 Arch Street
Philadelphia, Pennsylvania

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Executive Summary

The Wissahickon Creek drains approximately 64 square miles and extends 24.1 miles in a southeasterly direction through lower Montgomery and northwestern Philadelphia Counties. The Wissahickon Creek is designated for trout stocking, and is subject to all water quality criteria specific to this designated use and those defined for general statewide water uses including aquatic life, water supply, and recreation. As a result of biological investigations conducted by the Pennsylvania Department of Environmental Protection (PA DEP) that identified observed impacts on aquatic life and exceedances of applicable dissolved oxygen (DO) criteria, much of the Wissahickon Creek basin has been listed on the State's 303(d) list of impaired waters. The watershed is heavily impacted by urbanization and is listed as impaired due to problems associated with elevated nutrient levels, siltation, low dissolved oxygen concentrations, chlorine, water/flow variability, oil and grease, and pathogens. These TMDLs were developed to address impairments due to nutrients, siltation, and low dissolved oxygen levels. These were the impairments identified on Pennsylvania's 1996 Section 303(d) List. Future TMDLs will be required to address the chlorine and oil and grease impairments.

The Environmental Protection Agency Region III (EPA) establishes these Total Maximum Daily Loads (TMDLs) for the Wissahickon Creek basin to address those stream segments impaired as a result of excess nutrients and siltation. To address nutrient impairments, TMDLs have been established for ammonia nitrogen (NH₃-N), nitrate-nitrite nitrogen (NO₃+NO₂-N), ortho phosphate (ortho PO₄), and carbonaceous biochemical oxygen demand (CBOD) in order to attain and maintain applicable Water Quality Standards (WQS). There are presently no numeric criteria for nutrients or siltation defined by WQS for these streams. As a result, consideration was given to all biological indicators and stressors identified in previous biological assessments of the Wissahickon Creek basin. In order to achieve and maintain that aquatic life use EPA determined the endpoint for the nutrient TMDL based on the link between nutrient concentrations, DO concentrations, and biological activity in the streams. Of the components of instream biological activity, only DO has a numeric criteria for protection of aquatic life in stream segments of the Wissahickon Creek basin. As a result, the nutrient TMDL endpoint is based on achieving and maintaining both the minimum and minimum daily average DO criteria for the critical period associated with trout stocking. For siltation impaired stream segments, TMDLs have been established based on target load endpoints estimated from a reference unimpaired watershed.

As part of the nutrient TMDLs, EPA has allocated specific amounts of NH₃-N, NO₃+NO₂-N, ortho PO₄, and CBOD to certain point and nonpoint sources necessary to restore and maintain applicable WQS for DO. These TMDLs recommend that five facilities have their National Pollution Discharge Elimination System (NPDES) permits modified when next reissued to reduce the amounts of pollutants that may be discharged. The nutrient TMDL and WLAs reported herein are contingent on the assumption that NPDES permits for Ambler Borough (PA0026603), Abington Township (PA0026867), Borough of North Wales (PA0022586), Upper Gwynedd Township (PA0023256),

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and the Township of Upper Dublin (PA0029441) are amended to increase the effluent DO concentrations to a minimum of 7.0 mg/L.

TMDLs were determined for each of the most stringent applicable DO criteria necessary to provide aquatic life use protection as follows: Trout Stocking (February 15 to July 31) and Warm Water Fishes (remainder of year). For each DO criterion and impaired stream segment of Wissahickon Creek, EPA allocated waste load allocations (WLAs) for all point sources and load allocations (LAs) for all nonpoint sources as part of the TMDLs. The following tables summarize the total WLAs and LAs allocated to address nutrient impairments for each stream segment of the Wissahickon Creek basin included in the State's 303(d) list.

TMDL summary by stream segment for the Wissahickon Creek basin - Trout Stocking (February 15 to July 31)

Sum of Waste Load Allocations					
Segment Name	Segment ID	CBOD5 (lbs/day)	NH3-N (lbs/day)	NO3+NO2-N (lbs/day)	Ortho PO4 (lbs/day)
Wissahickon Creek	971218-1345-ACE	258.846	38.513	1057.952	96.224
Wissahickon Creek	971209-1430-ACE	0.000	0.000	0.000	0.000
Wissahickon Creek	971209-0930-ACE	1.034	0.202	0.321	0.046
Wissahickon Creek	971222-0930-ACE	543.402	81.466	1657.755	254.221
Wissahickon Creek	971222-1130-ACE	0.000	0.000	0.000	0.000
Lorraine Run	971215-1000-ACE	0.118	0.022	0.052	0.006
Sandy Run	971215-1133-ACE	244.684	23.571	986.281	60.511
Pine Run	971215-1300-ACE	0.000	0.000	0.000	0.000
Pine Run	971215-1303-ACE	116.740	20.572	335.664	13.266
Trewellyn Creek	971217-1145-ACE	0.000	0.000	0.000	0.000
Sum of Load Allocations					
Segment Name	Segment ID	CBOD5 (lbs/day)	NH3-N (lbs/day)	NO3+NO2-N (lbs/day)	Ortho PO4 (lbs/day)
Wissahickon Creek	971218-1345-ACE	0.670	0.011	0.457	1.215
Wissahickon Creek	971209-1430-ACE	832.692	101.270	4065.812	402.456
Wissahickon Creek	971209-0930-ACE	1058.705	131.464	4121.076	413.614
Wissahickon Creek	971222-0930-ACE	159.364	20.025	1033.639	90.568
Wissahickon Creek	971222-1130-ACE	222.733	33.223	1050.113	95.465
Lorraine Run	971215-1000-ACE	123.732	1.344	134.480	1.949
Sandy Run	971215-1133-ACE	110.735	19.379	336.908	13.127
Pine Run	971215-1300-ACE	1.181	0.040	0.986	0.100
Pine Run	971215-1303-ACE	1.181	0.040	0.986	0.100
Trewellyn Creek	971217-1145-ACE	1.922	0.049	0.162	0.029

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TMDL summary by stream segment for the Wissahickon Creek basin - Warm Water Fishes (August 1 to February 14)

Sum of Waste Load Allocations					
Segment Name	Segment ID	CBOD5 (lbs/day)	NH3-N (lbs/day)	NO3+NO2-N (lbs/day)	Ortho PO4 (lbs/day)
Wissahickon Creek	971218-1345-ACE	445.052	86.405	1051.573	170.411
Wissahickon Creek	971209-1430-ACE	0.000	0.000	0.000	0.000
Wissahickon Creek	971209-0930-ACE	1.034	0.202	0.321	0.046
Wissahickon Creek	971222-0930-ACE	543.402	81.466	1646.820	254.221
Wissahickon Creek	971222-1130-ACE	0.000	0.000	0.000	0.000
Lorraine Run	971215-1000-ACE	0.118	0.022	0.052	0.006
Sandy Run	971215-1133-ACE	326.145	65.235	986.281	150.935
Pine Run	971215-1300-ACE	0.000	0.000	0.000	0.000
Pine Run	971215-1303-ACE	137.319	22.868	300.307	21.062
Trewellyn Creek	971217-1145-ACE	0.000	0.000	0.000	0.000
Sum of Load Allocations					
Segment Name	Segment ID	CBOD5 (lbs/day)	NH3-N (lbs/day)	NO3+NO2-N (lbs/day)	Ortho PO4 (lbs/day)
Wissahickon Creek	971218-1345-ACE	0.000	0.000	0.000	0.000
Wissahickon Creek	971209-1430-ACE	973.035	167.356	4031.623	559.839
Wissahickon Creek	971209-0930-ACE	1239.972	206.190	4080.025	575.352
Wissahickon Creek	971222-0930-ACE	278.761	58.710	1032.974	159.435
Wissahickon Creek	971222-1130-ACE	383.300	77.696	1045.820	167.137
Lorraine Run	971215-1000-ACE	123.732	1.344	134.480	1.949
Sandy Run	971215-1133-ACE	130.034	21.600	301.853	20.805
Pine Run	971215-1300-ACE	1.181	0.040	0.986	0.100
Pine Run	971215-1303-ACE	1.181	0.040	0.986	0.100
Trewellyn Creek	971217-1145-ACE	1.922	0.049	0.162	0.029

To determine siltation endpoints adequate to protect the aquatic life uses discussed above, EPA used the reference watershed approach, the Wissahickon Creek and reference watersheds were matched. A reference watershed is selected as similar to the target watershed but meets applicable WQS. EPA used a watershed model to simulate the sediment loads from different sources. The sediment loads calculated for the reference watersheds were used as endpoints for the impaired watersheds. TMDLs were then developed for the impaired watersheds based on the endpoints. Summaries of the siltation TMDLs, WLAs, and LAs are provided in the following tables for each of the five modeled subwatersheds and stream segments of the Wissahickon Creek basin included on the 303(d) list as impaired. WLAs were provided for all point sources in the basin, including all MS4 stormwater permits for each municipality. For each MS4, WLAs were assigned to all contributions of siltation from both overland runoff and streambank erosion. .

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Note that in the tables, the WLA is presented in two different ways. In order to meet the reference watershed sediment loads that were determined to be the TMDL endpoints for each of the five modeled subwatersheds, the loads from NPDES dischargers were multiplied by the sediment delivery ratio (SDR) in each of the respective watersheds. This resulted in accounting for transport losses of the sediment from the dischargers as it travels through the watershed. The WLA (SDR applied) represents the sediment load from dischargers at the mouth of the watershed after the SDR has been applied. The WLA (SDR not applied) represents the sediment load at the “end of pipe” for each of the dischargers and was based on the permitted flow and TSS concentrations (which were converted to lbs/yr).

The draft TMDL report (public noticed June 2003) reported loads attributed to streambank erosion that were estimated using a simple routine available in AVGWLF. Although this application was used in previous applications, the difference in sizes of the Wissahickon Creek and reference watershed did not provide comparable loads for analysis. Following review of the application of this routine as a result of public comments, a more-detailed methodology was determined necessary to: (1) more-accurately estimate sediment loads attributed to streambank erosion using a process-based approach and (2) provide a reasonable and comparable measure for TMDL development using the reference watershed approach. The new methodology applied provides an analysis that considers site-specific, field-verified information in conjunction with generally accepted and applied, dynamic, process-based algorithms for determining streambank erosion characteristics and impacts.

The streambank erosion simulation module employed the algorithm used in the Annualized Agricultural Nonpoint Source Model (AnnAGNPS) model (Theurer and Bingner, 2000). Sediment transport/routing and streambank erosion simulation were performed using three particle size classes (clay, silt, and sand). For each subwatershed channel segment, the incoming sediment load is the total of local sources plus the loading from upstream subwatersheds. If the incoming load was greater than the downstream segment’s transport capacity, the sediment deposition algorithm was used to determine the transported load. If the incoming load was less than or equal to the segment’s transport capacity the sediment discharge at the outlet of the reach was less than or equal to the sediment transport capacity for an erodible channel. Sediment transport capacity is specific to the magnitude of flow. Therefore, the capacity for each particle size was calculated for each increment of the streamflow hydrograph. EPA changed the sediment loadings to correspond to the more accurate transport capacity which was based upon particle size, flow magnitude, and stream bank stability. Additional information on this approach can be found in Section 3.0 of the Modeling Report for Wissahickon Creek, Pennsylvania Siltation TMDL Development.

TMDLs for impaired watersheds within subwatershed 1

Subwatershed	LA (lbs/yr)	WLA (SDR not applied)* (lbs/yr)	WLA (SDR applied)* (lbs/yr)	MOS (lbs/yr)	TMDL (lbs/yr)
971217-1430-ACE	0.00	132472.14	132472.14	13523.44	145995.58

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North Wales Tributary					
971218-1045-ACE Wissahickon Creek	0.00	232627.14	232627.14	23977.92	256605.06
971218-1345-ACE Wissahickon Creek	0.00	832826.33	343101.57	23269.82	366371.39
981015-1100-ACE Tributary Upstream of North Wales Tributary	0.00	104064.32	104064.32	9938.99	114003.31
TOTAL	0.00	1301989.93	812265.17	70710.17	882975.34

*See explanation in above paragraph

TMDLs for impaired watersheds within subwatershed 2

Subwatershed	LA (lbs/yr)	WLA (SDR not applied)* (lbs/yr)	WLA (SDR applied)* (lbs/yr)	MOS (lbs/yr)	TMDL (lbs/yr)
971216-1415-ACE Rose Valley Tributary	0.00	812,868.14	307,981.49	18,834.77	326,816.25
971217-1015-ACE Willow-Run East	0.00	157,663.24	157,663.24	11,976.98	169,640.22
971217-1145-ACE Trewellyn Creek	0.00	177,794.61	177,794.61	15,424.21	193,218.82
971222-0930-ACE Wissahickon Creek	0.00	220,671.91	220,671.91	17,766.70	238,438.61
971222-1130-ACE Wissahickon Creek	0.00	115,823.55	115,823.55	13,152.62	128,976.17
Upstream Load**	132,446.30	0.00	0.00	0.00	132,446.30
TOTAL	132,446.30	1,484,821.45	979,934.79	77,155.28	1,189,536.38

*See explanation in above paragraph

**Upstream load includes the TMDL load from subwatershed 1

TMDLs for impaired watersheds within subwatershed 3

Subwatershed	LA	WLA (SDR not applied)	WLA (SDR applied)	MOS	TMDL
971215-1133-ACE Sandy Run	0.00	590,668.53	293,476.35	17,264.19	310,740.53
971215-1300-ACE Pine Run	0.00	129,773.35	129,773.35	9,773.98	139,547.34
971215-1303-ACE Pine Run	0.00	182,899.94	99,467.99	6,648.62	106,116.61
TOTAL	0.00	903,341.82	522,717.69	33,686.79	556,404.48

*See explanation in above paragraph

TMDLs for impaired watersheds within subwatershed 4

Subwatershed	LA (lbs/yr)	WLA (SDR not applied)* (lbs/yr)	WLA (SDR applied)* (lbs/yr)	MOS (lbs/yr)	TMDL (lbs/yr)
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971208-1000-ACE Wises Mill Tributary	0.00	13,828.33	13,828.33	1,379.47	15,207.80
971209-0930-ACE Wissahickon Creek	0.00	202,378.54	201,010.76	16,283.52	42,189.97
971211-1300-ACE Paper Mill Run	0.00	64,552.66	64,552.66	6,301.52	70,854.18
971215-1000-ACE Lorraine Run	0.00	897,469.23	189,501.11	5,094.41	194,595.52
971215-1130-ACE Tributary Downstream of Sandy Run	0.00	89,456.59	89,456.59	8,216.71	97,673.30
Upstream Load**	202,221.19	0.00	0.00	0.00	202,221.19
TOTAL	202,221.19	1,267,685.35	558,349.45	37,275.63	797,846.27

*See explanation in above paragraph

**Upstream load includes the TMDL load from subwatersheds 2 and 3

TMDLs for impaired watersheds within subwatershed 5

Subwatershed	LA (lbs/yr)	WLA (lbs/yr)	MOS (lbs/yr)	TMDL (lbs/yr)
971208-1235-ACE Valley Road Tributary	0.00	27,913.47	2,073.29	29,986.76
971208-1430-ACE Monoshone Creek	0.00	60,137.76	4,848.89	64,986.65
971209-1200-ACE Creshiem Creek	0.00	105,882.10	8,343.44	114,225.54
971209-1430-ACE Wissahickon Creek	0.00	139,955.17	10,915.42	150,870.59
971208-1000-ACE Wises Mill Tributary	0.00	45,843.44	3,307.20	49,150.63
Upstream Load*	147,601.56	0.00	0.00	147,601.56
TOTAL	147,601.56	379,731.93	29,488.24	556,821.73

*Upstream load includes the TMDL load from subwatershed 4