D.C. DEPARTMENT OF HEALTH
Environmental Health Administration
Bureau of Environmental Quality
Water Quality Division

DISTRICT OF COLUMBIA

FINAL

TOTAL MAXIMUM DAILY LOADS

FOR

ORGANICS AND METALS

IN

BATTERY KEMBLE CREEK, FOUNDRY BRANCH, AND DALECARLIA TRIBUTARY

AUGUST 2004

Government of the
District of Columbia
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GOVERNMENT OF THE DISTRICT OF COLUMBIA
DOH
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1. Introduction

1.1. TMDL Definition and Regulatory Information

Section 303(d) (1)(A) of the Federal Clean Water Act (CWA) states:

> *Each state shall identify those waters within its boundaries for which the effluent limitations required by section 301(b) (1)(A) and section 301(b)(1)(B) are not stringent enough to implement any water quality standards applicable to such waters. The State shall establish a priority ranking for such waters taking into account the severity of the pollution and the uses to be made of such waters.*

Further, Section 303(d) (1)(C) states:

> *Each state shall establish for the waters identified in paragraph (1)(A) of this subsection, and in accordance with the priority ranking, the total maximum daily load, for those pollutants which the Administrator identifies under section 304(a)(2) as suitable for such calculations. Such load shall be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.*

Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies, which are exceeding water quality standards.

In 1996, the District of Columbia (DC), developed a list of impaired waters that did not or were not expected to meet water quality standards as required by Section 303(d)(1)(A). This list, submitted to the Environmental Protection Agency every two years, is known as the Section 303(d) list. This list of impaired waters was revised in 1998 and also in 2002 based on additional water quality monitoring data. EPA, subsequently, approved each list. The Section 303(d) list of impaired waters contains a priority list of those waters that are the most polluted. This priority listing is used to determine which waterbodies are in critical need of immediate attention. For each of the listed waters, states are required to develop a Total Maximum Daily Load (TMDL), which establishes the maximum amount of a pollutant that a waterbody can receive without violating water quality standards and allocates that load to all significant sources. Pollutants above the allocated loads must be eliminated. By following the TMDL process, states can establish water-quality based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of their water resources.

1.2. Impairment Listing

As required by the Federal Clean Water Act, the District of Columbia prepared 303(d) list of water bodies for which the effluent limitations required by section 301(b)(1)(A) and section 301(b)(1)(B) are not stringent enough to meet the applicable Water Quality Standards (WQS). The list was prepared in 1996, 1998 and again in 2002. Depending on yearly monitoring of water bodies, the District has revised the pollutants of concerns and ranking of the water bodies. Figure 1-1 shows impaired Potomac River small tributaries according to the 303(d) lists.

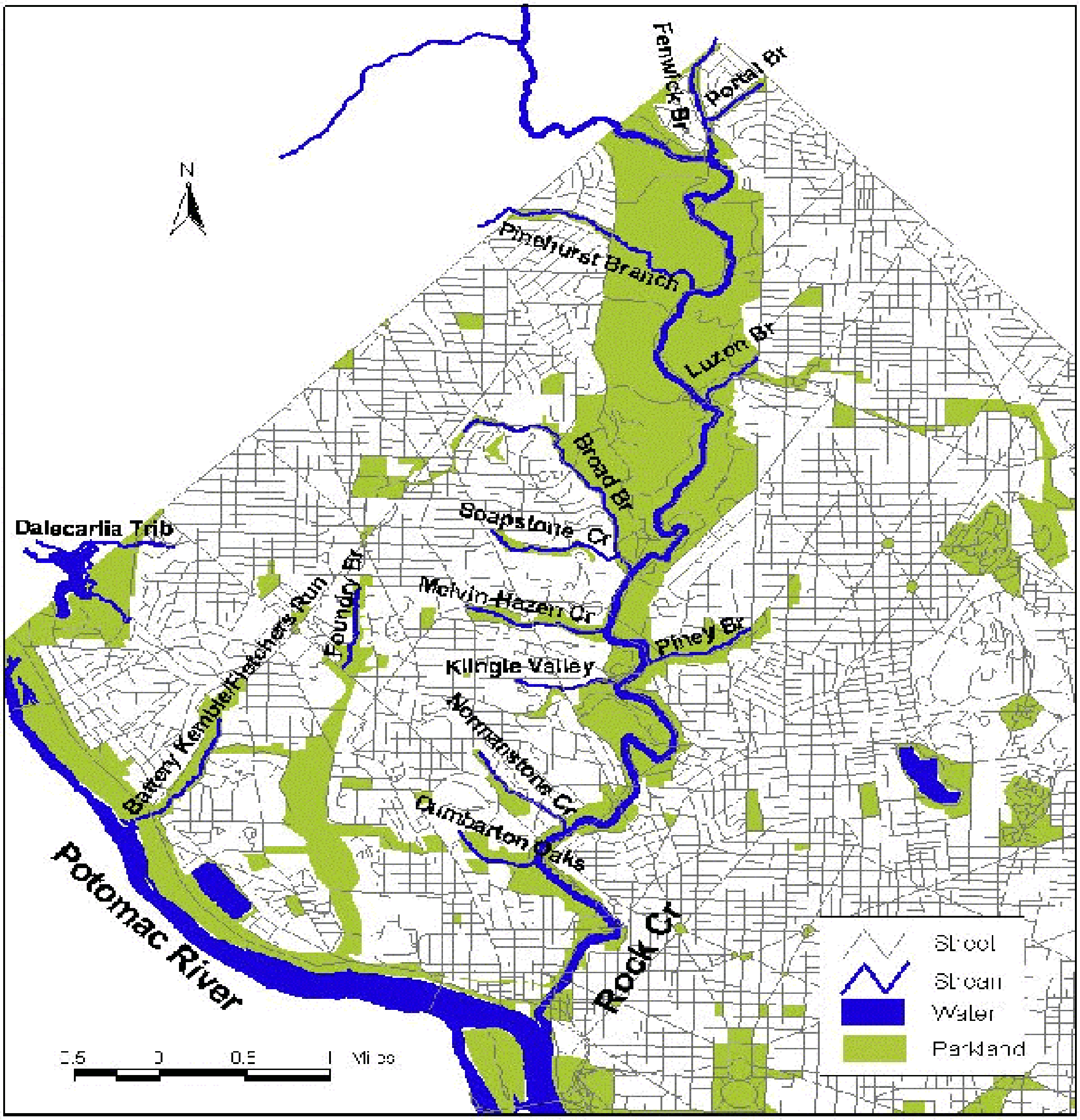

Figure 1-1: Potomac River Small Tributaries

Table 1-1, Table 1-2 and Table 1-3 show 303(d) lists of Potomac River Small Tributaries for 1996, 1998 and 2002, respectively.

Table 1-1: 1996 Section 303(d) Listing Information

S. No	Waterbody	Pollutant of Concern	Action Needed
1.	Battery Kemble Creek	Metals and Fecal Coliforms	Control nonpoint source (NPS) pollution
2.	Foundry Branch	Metals and Fecal Coliforms	Control NPS pollution
3.	Dalecarlia Tributary	Toxics and fecal Coliforms	Control NPS pollution

Table 1-2: 1998 Section 303(d) Listing Information

S. No	Waterbody	Pollutant of Concern	Action Needed
1.	Battery Kemble Creek	Bacteria	Control nonpoint source (NPS) pollution
2.	Foundry Branch	Metals and Bacteria	Control NPS pollution
3.	Dalecarlia Tributary	Bacteria	Control NPS pollution

Table 1-3: 2002 Section 303(d) Listing Information

S. No	Waterbody	Pollutant of Concern	Action Needed
1.	Battery Kemble Creek	Metals and Bacteria	Control nonpoint source (NPS) pollution
2.	Foundry Branch	Metals, Bacteria, Dissolved Oxygen	Control NPS pollution
3.	Dalecarlia Tributary	Organics and Bacteria	Control NPS pollution

2.0 Chemical of Concern, Beneficial Uses and Applicable Water Quality Standards

2.1 Chemicals of Concern

Because of general lack of data in the District's tributaries, the list of chemicals of concern for this TMDL were determined from data derived from fish tissue[1] and sediment[3] analysis in the Anacostia River. Fish tissue was harvested and analyzed for the list of suspected contaminants. The contaminants of concern that were discovered above the allowed concentration were identified. Sediment samples were also collected and analyzed for the contaminants of concern. Those that indicated high levels of exceedance above the screening criteria were identified as contaminants of concern. Table 2-1 represents the results of this assessment.

A data assessment study has also recently been conducted to determine potential chemicals of concerns for main-stem Rock Creek (LTI, 2003). This included analysis of several previous studies in the Rock Creek watershed, including the DCWASA LTCP study conducted in 1999-

2000 period, the USGS water quality baseline study for Rock Creek in 1999-2000 period, the 1995 Stormwater Permit Application, Bioassessments of Rock Creek, and STORET (includes data from DC routine monitoring program). These studies provided very limited data on Rock Creek toxics. Based on the study, a group of most likely and probable likely chemicals of concerns have been identified, with the most likely chemicals being cadmium, copper, lead, mercury, and zinc; and the probable likely chemicals being chlordane, DDT, endosulfan, heptachlor epoxide, hexachlorobenzene, total PAHs, and total PCBs. However, cadmium has been delisted as recent monitoring in main-stem Rock Creek show concentrations significantly below existing water quality standards.

Therefore, given the very limited amount of data available, chemicals listed in Table 2-1 are considered adequate to address toxics for the Potomac River small tributaries.

Table 2-1: Fish Tissue and Sediment Data Exceeding Screening Values

Organic/Metal Exceedance	Anacostia Fish tissue Data[1] (ppm)	EPA Screening Value[2] (ppm)	Anacostia Sediment Data[3] (ppm dw)	Sediment Screening value[4] (ppm dw)
Arsenic	0.026	0.026	N/A	N/A
Copper	N/A	N/A	312.5	31.6
Lead	N/A	N/A	586.54	35.8
Zinc	N/A	N/A	1,457.290	121
Chlordane	0.338	0.114	0.1699	0.00324
DDT	0.375	0.117	0.3194	0.00528
Dieldrin	0.0315	0.0025	N/A	N/A
Heptachlor Epoxide	0.0080	0.00439	NA	NA
Total PAHs	0.151	0.00547	97.878	1.61
Total PCBs	2.49	0.020	1.629	0.0598

Notes: N/A Data not available.

1. U.S. FWS. 2001. Analysis of Contaminant Concentrations in Fish Tissue Collected from the Waters of the District of Columbia. Final Report. Publication number CBFO-C01-01, Chesapeake Bay Field Office, Annapolis, MD.
2. U.S. EPA 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1, Fish Sampling and Analysis, Third edition. EPA 823-B-00-007, Office of Water, Washington D.C.
3. Academy of Natural Sciences, 2000, Data Assessment Report Anacostia River Sediments Patrick Center for Environmental Research, The Academy of Natural Sciences of Philadelphia, KQS Report Number 134-01R01. Appendix II. September 2000.
4. MacDonald, D.D., C.G. Ingersoll and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. *Arch. Environ. Contam. Toxicol.* 29-31.

2.2 Designated Beneficial Uses

Categories of DC surface water beneficial uses and water quality standards are contained in District of Columbia Water Quality Standards, Title 21 of the District of Columbia Municipal Regulations, Chapter 11 (DC WQS, Effective January 24, 2003). Section 1101.1 states:

> *For the purposes of water quality standards, the surface waters of the District shall be classified on the basis of their (i) current uses, and (ii) future uses to which the waters will be restored.*

The categories of beneficial uses for the Potomac River small tributaries are as follows:

Class A - primary contact recreation,
Class B - secondary contact recreation and aesthetic enjoyment,
Class C - protection and propagation of fish, shellfish, and wildlife,
Class D - protection of human health related to consumption of fish and shellfish, and;

2.3 Applicable Water Quality Standards

2.3.1 Narrative Criteria

The District of Columbia's Water Quality Standards include narrative and numeric criteria that were written to protect existing and designated uses.

Section 1104.1 states several narrative criteria designed to protect the existing and designated uses:

> *The surface waters of the District shall be free from substances attributable to point or nonpoint sources discharged in amounts that do any one of the following:*
>
> 1. *Settle to form objectionable deposits;*
> 2. *Float as debris, scum, oil, or other matter to form nuisances;*
> 3. *Produce objectionable odor, color, taste, or turbidity;*
> 4. *Cause injury to, are toxic to or produce adverse physiological or behavioral changes in humans, plants, or animals;*
> 5. *Produce undesirable or nuisance aquatic life or result in the dominance of nuisance species; or*
> 6. *Impair the biological community which naturally occurs in the waters or depends on the waters for their survival and propagation.*

2.3.2 Numerical Criteria

2.3.2.1 Metals Numerical Criteria

Table 2-2: Dissolved Metals Numerical Criteria

Constituent – Metals[1]	Criteria for Classes (ug/L)		
	C[2]		D
	CCC Four Day Average	CMC One Hour Average	30 Day Average
Arsenic	150	340	0.14
Copper[3]	12.31	18.61	N/A
Lead[4]	2.79	71.63	N/A
Zinc[5]	113.29	124.07	N/A

Notes:

1. D.C. Water Quality Standards, Effective January 24, 2003, Table 2. The criteria for the hardness dependant constituents (Copper, Lead and Zinc) were calculated utilizing the applicable formulas in the Notes for Table 2. To calculate the dissolved criteria, the formula results were multiplied by their respective EPA Conversion Factor. The respective EPA Conversions Factors were derived in accordance with subsection 1105.10 from 60 Fed. Ref. 22,231 (1995).
2. The Class C Criteria Maximum Concentration (CMC) and Criteria Continuous Concentration (CCC) standards were computed from the published District of Columbia standards (listed below under note 3, 4, and 5) assuming a hardness of 110 mg/L as $CaCO_3$. Given the geographic similarity of the Rock Creek and the Potomac small tributary watersheds, this value was based on the 50-percentile hardness value for data in Rock Creek from 1984-2000.
3. Copper is expressed as a function of hardness calculated using the following formula: $CCC = e^{(0.8545[\ln(hardness)]-1.465)} \times 0.96$; $CMC = e^{(0.9422[\ln(hardness)]-1.464)} \times 0.96$
4. Lead is expressed as a function of hardness calculated using the following formula: $CCC = [e^{(1.2730[\ln(hardness)]-4.705)}] \times [1.46203-[(\ln(hardness)(0.145712)]]$; and $CMC =[e^{(1.2730[\ln(hardness)]-1.460)}] \times [1.46203-[(\ln(hardness)(0.145712)]]$
5. Zinc is expressed as a function of hardness calculated using the following formula: $CCC = [e^{(0.8473[\ln(hardness)]+0.7614)}] \times 0.986$; $CMC = [e^{(0.8473[\ln(hardness)]+0.8604)}] \times 0.978$

2.3.2.2 Organics Numerical Criteria

Table 2-3: WQS Section 1104.7 Table 3 Organics Numerical Criteria

Constituent – Organics[1]	Criteria for Classes (ug/L)		
	C		D
	CCC Four Day Average	CMC One Hour Average	30 Day Average
Chlordane	0.004	2.4	0.00059
DDE	0.001	1.1	0.00059
DDD	0.001	1.1	0.00059
DDT	0.001	1.1	0.00059
Dieldrin	0.0019	2.5	0.00014
Heptachlor Epoxide	0.0038	0.52	0.00011
PAH 1[2]	50	N/A	14000
PAH 2[3]	400	N/A	0.031
PAH 3[4]	N/A	N/A	0.031
Total PCBs	0.014	N/A	0.000045

Notes:

1. WQS for PAH1, 2 and 3 were based on a conservative assumption that applicable water quality standards are the most stringent standard for a single PAH in the group. For example, the Class D water quality standard for fluoranthene, pyrene, benz[a]anthracene, and chrysene are 370, 11000, 0.031, and 0.031 ug/l,

respectively. Therefore the most stringent of the individual standards, 0.031 ug/l is given in Table 2-3 as the Class D standard for PAH2.

2. PAH1, is the sum of six 2 and 3-ring PAHs, naphthalene, 2-methyl napthalene, acenapthylene, acenapthene, fluorene, and phenanthrene.
3. PAH2, consists of the four 4-ring PAHs, fluoranthene, pyrene, benz[a]anthracene, and chrysene.
4. PAH3, consists of the six 5 and 6-ring PAHS, benzo[k]fluoranthene, benzo[a]pyrene, perylene, indeno[1,2,3-c,d]pyrene, benzo[g,h,i]perylene, and dibenz[a,h+ac]anthracene.

2.4 TMDL Endpoint

Section 2.3 describes applicable D.C. water quality standards for this TMDL analysis. The analysis used the numeric criteria to achieve load allocations for the tributaries.

3.0 Watershed Characterization

3.1 Potomac River Small Tributaries

There are three small tributaries to the Potomac in the District of Columbia. The watersheds of the Battery Kemble Creek and Foundry Branch are within the city limits of the District of Columbia. The Dalecarlia Tributary, however, originates in D.C. but then crosses into Maryland before discharging to the Potomac River. Characterization of the watershed for the tributaries takes into consideration of both the topographic drainage and the storm water drainage that, in some cases, cover areas outside the topographic drainage. Figure 1-1 shows the Potomac tributaries listed below. Appendix A contains detailed maps of the tributaries.

3.1.1 Battery Kemble Creek/Fletchers Run

Battery Kemble Creek is a tributary of the Potomac River that drains Battery Kemble Park. The stream originates at Nebraska Avenue and Foxhall road. The watershed area is 239 acres, of which 60 percent is parkland and forest with the remaining area as residential. The stream is buffered on both sides by about 300 feet of forested parkland.

3.1.2 Foundry Branch

Foundry Branch is a tributary of the Potomac, which is now largely enclosed in storm water pipe. The watershed measures 168 acres. About 80% of the watershed is residential and light commercial property. The remaining 20% is forested parkland operated by the National Park Service. The surface portion of the stream flows for about 2,050 feet through a forested section of Glover-Archibold Park giving the stream a forested buffer of approximately 200 feet on each side.

3.1.3 Dalecarlia Tributary

Dalecarlia is a tributary of Little Falls Run in Maryland that flows to the Potomac. The stream's watershed measures 1111 acres and lies almost entirely (97.3%) in the District of Columbia with a small portion of its lower reaches falling in Maryland prior to entering a stream that flows into Little Falls Run. West of Dalecarlia Parkway, the tributary flows through sloping parkland accounting for one-quarter of the stream's watershed. The remainder of the watershed is suburban type residential housing.

Stream flows in the smaller tributaries described earlier are comparatively very low. A number of storm water outfalls discharge to the streams increasing the flows by several folds during rainfall. Estimated base flow for Foundry Branch is about 0.9 cubic feet per second.

4.0 Source Assessment

Within the District of Columbia, there are three different networks for conveying wastewater. Originally, a combined sewer system was installed that collected both sanitary waste and storm water and transported the combined flow to the wastewater treatment plant. When storm water caused the combined flow to exceed the pipe capacity leading to the treatment plant, the excess flow was discharged, untreated, through the Combined Sewer Overflow (CSO) outfalls to the river.

In the upper two thirds of the drainage area, a separate sanitary sewer system and a storm sewer system were constructed. A separate sanitary sewer line has no storm water inlets to the system and it flows directly to the wastewater treatment facility. Storm water pipes collect storm water from the streets and parking lots and are discharged to nearby rivers and streams. The Potomac River small tributaries do not receive CSOs from the combined system. Appendix B shows stormwater and CSO outfalls in D.C.

4.1 Assessment of Nonpoint Sources

The Potomac River small tributary watersheds are served by the separate storm sewer system. In addition, direct runoffs from parklands flanking the water bodies and not serviced by storm water sewers also occur along the Potomac small tributaries. Therefore, during wet weather events, there is a combination of direct storm water runoff and storm water being carried by pipes to receiving water bodies.

The separate storm sewer system is regulated under the NPDES MS4 permit program. Although historically considered a nonpoint source, current EPA policy requires defining NPDES MS4 systems as point sources and requires wasteload allocations for such systems.

5.0 Technical Approach

5.1 Seasonal Variations and Critical Conditions

Because of the episodic nature of rainfall and storm water runoff, developing a daily load is not an effective means of determining the assimilative capacity of the receiving waters. Rather, looking at total loads over a range of conditions is a more relevant way to determine the maximum allowable loads. A statistical analysis of rainfall records over a period of fifty years was conducted and a dry year, a wet year, and an average rainfall year, were identified based on total annual rainfall and other factors such as average intensity and number of events per year

(DCWASA, 2002). The consecutive years of 1988, 1989, and 1990, represent a relatively dry year, a relatively wet year, and an average precipitation year, respectively. These three years were considered the period of record for determining compliance with the water quality standards for the TMDL analysis. Determination of compliance with the water quality standards was based on the frequency of violations as calculated by the simulation model for these three years.

5.2 Small Tributaries Models

The Potomac small tributaries were evaluated using a simple mass balance model that predicts daily water column concentrations of constituents of concern in the tributaries (ICPRB, 2003). The model, called the DC Small Tributaries TMDL Model and developed by the Interstate Commission for the Potomac River (ICPRB), treats each tributary as a “bathtub” which, on each day of the simulation period, receives a volume of water representing storm water runoff and a volume of water representing base flow from groundwater infiltration, and completely mixes. A brief overview of the model is in Appendix C.

The tributary model includes sub-models, one of which is for organic pollutants and one for inorganic pollutants (metals). These two sub-models predict daily water column concentrations of each pollutant in each of the tributaries under current conditions and allow evaluating load reduction scenarios by simple percent reductions of base and storm loads.

The constituents of the organic chemicals sub-model include the pesticides, chlordane, dieldrin, heptachlor epoxide, and dichloro-diphenyl-trichloroethane (DDT), none of which are currently in use. The organic chemicals sub-model also includes polycyclic aromatic hydrocarbons (PAHs), a class of chemicals present in coal, motor oils, gasoline, and their combustion products, and polychlorinated biphenyls (PCBs), the chemical constituents of a type of heavy oil that was formerly used in transformers, capacitors, heat exchangers, fluorescent light bulbs, and other products.

The constituents of the inorganic chemicals sub-model are arsenic, which has been used in pesticides, herbicides and wood preservatives, lead, which has been used as an additive in paints and gasoline, and also the metals, zinc and copper.

The sub-models used for different Potomac River tributaries are listed in the following table.

Table 5-1: Potomac River Small Tributary Models

Tributary	**Included in Organic Chemicals Model**	**Included in Inorganic Chemicals Model**
Battery Kemble Creek		√
Foundry Branch		√
Dalecarlia Tributary	√	

The model was simulated using precipitation records for the three-year period of 1988 to 1990. The tributary model, in addition to predicting daily water column concentrations of modeled constituents, also compares these concentrations to the WQS in section 2.3 in order to predict on how many days WQS are violated during the three-year simulation period. Using the WQS guideline, four-day averages of predicted concentrations are used to compare with Class C CCC standards, and 30-day averages of predicted concentration are used to compare with Class D standards.

5.3 Scenario and Model Runs

A number of scenarios were run with different levels of stormwater loads for the tributaries. For the watersheds shared by both the District and Maryland, the load allocation was taken in proportion to the drainage areas situated within the jurisdiction. This is done assuming the land use and other factors affecting pollutant loads to be similar in both cases. To determine allocated loads, several scenarios were run for each constituent before attaining an optimum balance that would eliminate any violations of the most stringent criteria within a constituent.

The selected scenarios for each part of the model resulted in the following load reduction levels for the District's stormwater runoffs to meet the desired standards.

Table 5.2 Stormwater Reductions for Inorganics (Total Metals)

Tributary	**Arsenic**	**Copper**	**Lead**	**Zinc**
Battery Kemble Creek	70	60	65	0
Foundry Branch	75	60	70	0

Table 5.3 Stormwater Reductions for Organics

Tributary	**Chlordane**	**DDD**	**DDE**	**DDT**	**Dieldrin**
Dalecarlia Tributary	85	90	92	97	80

Tributary	**Heptachlor Epoxide**	**PAH1**	**PAH2**	**PAH3**	**TPCB**
Dalecarlia Tributary	90	0	98	98	Note 1

Note 1: PCB contamination in the Potomac watershed is due to atmospheric deposition, historic spills, land applications (e.g., dust suppression), and sediment contamination. Atmospheric deposition is expected to decrease over time since the production and use of PCBs was banned in the 1970s. The releases from unidentified land sources are accounted for in the model by the storm water loads. For allocating PCB loads among sources, existing loads and watershed atmospheric deposition loads of PCBs were calculated. Existing loads were calculated using the DC small tributaries model. Available atmospheric deposition loads for the tributaries were based on average annual atmospheric deposition flux provided by Chesapeake Bay Program data (Chesapeake Bay Program, 1999). The atmospheric load represents much of the source of the storm water loads to the tributaries. Total PCB loads for sources other than atmospheric loads

(i.e., land-based) were determined by subtracting atmospheric loads from existing loads in the watershed (see Appendix D for detailed calculations). For the Dalecarlia tributary, 99.9 percent reductions of the existing loads are required to meet water quality standards

6.0 Total Maximum Daily Load (TMDL) Allocations and Margins of Safety

The following sections present existing loads and allocable TMDL loads for the Potomac River small tributaries. All loads are represented as an annual average loads based on three years (1988, 1989, 1990) of hydrologic conditions in the areas.

An explicit margin of safety equal to one percent of the TMDL load has been considered for the allocation for all the constituents, except for PCBs. For PCBs, load reduction is 99.9 percent for the Dalecarlia Tributary. With regards to PAHs, the most stringent criterion of the 3 PAH groups were selected for the TMDL analysis.

6.1 Battery Kemble Creek Loads and TMDL

For the District of Columbia storm water runoff sources, the following table shows the existing loads and allowable metal TMDLs for Battery Kemble Creek that met the applicable WQS with a margin of safety of one percent. The total allowable loads for Battery Kemble Creek reflects the reductions needed in order to meet the following WQS: Class D criteria for Arsenic at 0.14 ug/L; Class C, CCC criteria for Copper at 12.31, Lead at 2.79, and Zinc at 113.29 ug/L, respectively. The allocable loads meet these Class C four-day average criteria for the constituents.

The following reductions were required for the District's storm water runoffs to meet these WQS: Total Arsenic at 70%; Total Copper at 60%; Total Lead at 65%; Total Zinc at 0%;

Battery Kemble Creek Loads and TMDL – pounds/average year

Constituent	Battery Kemble Creek Existing Load			TMDL	1% MOS	Storm Water	Direct Runoff
	SS Load	CSO Load	Total Load				
Arsenic (total)	6.206E-01	0.000E+00	6.206E-01	1.862E-01	1.862E-03	1.782E-01	6.170E-03
Copper (total)	2.264E+01	0.000E+00	2.264E+01	9.056E+00	9.056E-02	8.665E+00	3.001E-01
Lead (total)	1.085E+01	0.000E+00	1.085E+01	3.798E+00	3.798E-02	3.634E+00	1.258E-01
Zinc (total)	6.695E+01	0.000E+00	6.695E+01	6.695E+01	6.695E-01	6.406E+01	2.218E+00

6.2 Foundry Branch Loads and TMDL

For the District of Columbia storm water runoff sources, the following table shows the existing loads and allowable metal TMDLs for Foundry Branch that met the applicable WQS with a margin of safety of one percent. The total allowable loads for Foundry Branch reflects the reductions needed in order to meet the following WQS: Class D criteria for Arsenic at 0.14 ug/L; Class C, CCC criteria for Copper at 12.31, Lead at 2.79, and Zinc at 113.29 ug/L, respectively. The allocable loads meet these Class C four-day average criteria for the constituents.

The following reductions were required for the District's storm water runoffs to meet these WQS: Total Arsenic at 75%; Total Copper at 60%; Total Lead at 70%; Total Zinc at 0%;

Foundry Branch Loads and TMDL – pounds/average year

Constituent	Foundry Branch Existing Load			TMDL	1% MOS	Storm Water	Direct Runoff
	SS Load	CSO Load	Total Load				
Arsenic (total)	6.764E-01	0.000E+00	6.764E-01	1.691E-01	1.691E-03	1.674E-01	0.000E+00
Copper (total)	2.608E+01	0.000E+00	2.608E+01	1.043E+01	1.043E-01	1.033E+01	0.000E+00
Lead (total)	1.289E+01	0.000E+00	1.289E+01	3.868E+00	3.868E-02	3.830E+00	0.000E+00
Zinc (total)	7.816E+01	0.000E+00	7.816E+01	7.816E+01	7.816E-01	7.738E+01	0.000E+00

6.3 Dalecarlia Tributary Loads and TMDL

For the District of Columbia storm water runoff sources, the following table shows the existing loads and allowable organics TMDLs for the Dalecarlia Tributary that met the applicable WQS with a margin of safety of one percent. The total allowable loads for the Dalecarlia Tributary reflects the reductions needed in order to meet the following WQS: Class D criteria for Chlordane at 0.00059 ug/L; Class D criteria for DDD, DDE and DDT at 0.00059, respectively; Class D criteria for Dieldrin at 0.00014 ug/L; Class D criteria for Heptachlor Epoxide at 0.00011 ug/L; Class C-CCC for PAH 1 at 50 ug/L; and Class D for PAH2 and PAH3 at 0.031 ug/L, respectively. The allocable loads also meet Class C four-day average criteria for the constituents.

The following reductions were required to meet these WQS: Chlordane at 85%; DDD at 90%; DDE at 92%; DDT at 97%; Dieldrin at 80%; Heptachlor Epoxide at 90%; PAH 1 at 0%; PAH 2 at 98%; and PAH 3 at 98%. The PCB issues are discussed in section 5.3. Consequently, the allocations shown below reflect the atmospheric loads and resulting allocations for PCB at this time.

Approximately 2.7 percent of the Dalecarlia Tributary drainage area is in Maryland. Accordingly the same percentage of the total loads and allocations are directed to Maryland.

Maryland Dalecarlia Tributary Loads and TMDL – pounds/average year

Constituent	Maryland Dalecarlia Tributary Existing Load	TMDL	1% MOS	Maryland Total Allocable
Chlordane	7.238E-04	1.086E-04	1.086E-06	1.075E-04
DDD	4.997E-04	4.997E-05	4.997E-07	4.947E-05
DDE	1.149E-03	9.189E-05	9.189E-07	9.097E-05
DDT	3.092E-03	9.277E-05	9.277E-07	9.184E-05
Dieldrin	6.083E-05	1.217E-05	1.217E-07	1.204E-05
Heptachlor Epoxide	1.057E-04	1.057E-05	1.057E-07	1.047E-05
PAH1	4.964E-02	4.964E-02	4.964E-04	4.915E-02
PAH2	2.941E-01	5.882E-03	5.882E-05	5.823E-03
PAH3	1.874E-01	3.748E-03	3.748E-05	3.711E-03

	Maryland Load	Atmospheric Load	TMDL (Land-Based)
TPCB	6.167E-03	1.334E-03	4.833E-06

Approximately 97.3 percent of the Dalecarlia Tributary drainage area is in the District of Columbia, and the total loads and allocations are distributed accordingly.

District of Columbia Dalecarlia Tributary Loads and TMDL – pounds/average year

Constituent	Dalecarlia Tributary Existing Load			TMDL	1% MOS	Storm Water	Direct Runoff
	SS Load	CSO Load	Total Load				
Chlordane	2.594E-02	0.000E+00	2.594E-02	3.891E-03	3.891E-05	3.550E-03	3.015E-04
DDD	1.791E-02	0.000E+00	1.791E-02	1.791E-03	1.791E-05	1.634E-03	1.388E-04
DDE	4.116E-02	0.000E+00	4.116E-02	3.293E-03	3.293E-05	3.005E-03	2.552E-04
DDT	1.108E-01	0.000E+00	1.108E-01	3.325E-03	3.325E-05	3.034E-03	2.576E-04
Dieldrin	2.180E-03	0.000E+00	2.180E-03	4.360E-04	4.360E-06	3.979E-04	3.379E-05
Heptachlor Epoxide	3.789E-03	0.000E+00	3.789E-03	3.789E-04	3.789E-06	3.458E-04	2.936E-05
PAH1	1.779E+00	0.000E+00	1.779E+00	1.779E+00	1.779E-02	1.624E+00	1.379E-01
PAH2	1.054E+01	0.000E+00	1.054E+01	2.108E-01	2.108E-03	1.924E-01	1.634E-02
PAH3	6.716E+00	0.000E+00	6.716E+00	1.343E-01	1.343E-03	1.226E-01	1.041E-02

	SS Load	CSO Load	Total Load	Atmospheric Load	TMDL (Land-Based Source)	Storm Water (Land-Based Source)	Direct Runoff (Land-Based Source)
TPCB	2.210E-01	0.000E+00	2.210E-01	4.789E-02	1.731E-04	1.596E-04	1.355E-05

7.0 Reasonable Assurance

The District of Columbia has several programs in place to control the effects of storm water runoff and promote nonpoint source pollution prevention and control. The District is a signatory to the Chesapeake Bay Agreement, pledging to reduce nutrient loads to the Bay by 40 percent or more by the year 2010. In addition, other source control measures described in the following will help reduce toxics pollution of the District's waters.

7.1 Agreements

On June 28, 2000, Mayor Williams, Governor Glendening, U.S. EPA and others signed the new Chesapeake Bay Agreement. The goals of the agreement include:

> "Achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries and to protect human health"
>
> and
>
> "By 2010, correct the nutrient- and sediment-related problems in the Chesapeake Bay and its tidal tributaries sufficiently to remove the Bay and the tidal portions of its tributaries from the list of impaired waters under the Clean Water Act"

Thus, an agreement is in place that clearly demonstrates a commitment to the restoration of Potomac River and its tributaries by the year 2010. This establishes a completion date for implementation of those activities necessary to achieve the load reductions allocated in this TMDL.

7.2 Source Control Plan

7.2.1 Storm Water Load Reductions

The District of Columbia Water Pollution Control Act (DC Law 5-188) authorizes the establishment of the District's Water Quality Standards (21 DCMR, Chapter 10) and the control of sources of pollution such as storm water management (21 DCMR, Chapter 5).

The DC Department of Health has an extensive storm water management, sediment, and erosion control program for construction activities. It also has a Nonpoint Source Management Plan to address the reduction of nonpoint source pollution (D.C. Department of Health, 2002).

A number of activities to reduce pollutant runoff are carried out as part of the Municipal Separate Storm Sewer Permit (MS4) for the District of Columbia. The most pertinent of these are contained in the storm water management plan. The plan provides additional mechanisms for achieving the load reductions needed.

Major currently operating programs in DC that reduce loads are as follows:

1. Street sweeping programs by the Department of Public Works.
2. Requirements for storm water treatment on all new development and earth disturbing activities such as road construction.
3. Regulatory programs restricting illegal discharges to storm sewers and enforcing the erosion control laws.
4. Environmental education and citizen outreach programs to reduce pollution causing activities.

Federal lands encompass approximately 18 percent of the land inside DC. The federal facilities such as the National Park Service will need to develop storm water management plans to reduce their loads and implement those plans.

In terms of legacy compounds such as PCBs, many of these compounds are banned from widespread use and/or strictly regulated under the Toxics Substances Control Act (TSCA). As toxics and other pollutants are associated with particles and washes to streams during wet weather conditions, different storm water management initiatives, including BMPs that reduce suspended solids loads to the receiving water bodies will, in turn, reduce toxics pollution.

7.2.2 NPDES Permits

Additional requirements, as necessary, will be added to all permits that are issued, reissued or modified by U.S. EPA and certified by DC DOH after the approval of this TMDL. Permits, as an EPA policy, are not reopened to incorporate TMDL requirements. However, in rare cases, a permit would be reopened, upon approval of a TMDL to incorporate necessary requirements of the TMDL, when egregious impacts to the environment are observed or if the permittee is determined to be a significant contributor and there is obvious environmental impact that needs immediate attention. Per EPA guidance, the requirements that will be incorporated into storm water permits are in most cases, BMPs and not numeric effluent limits.

Each source/permit holder in a category will not be required to make the same reductions. Reductions will be determined on a facility-by-facility basis and, in most cases for storm water permit holders, reductions are required in the form of BMPs. EPA will give credit to facilities that are implementing BMPs at the time of permit re-issuance. BMPs will be required to be checked for effectiveness and if additional controls are needed, additional BMPs would be required upon permit reissuance.

Point source facilities that currently have no monitoring for certain TMDL parameters will not necessarily be considered to be a source. However, this will be determined as follows:

First, the facility may be asked to volunteer to monitor for that particular constituent in order to determine whether or not they are a source. Second, the permit may be modified upon reissuance to require monitoring for the constituent with no limit placed. Third the permit may be modified upon reissuance to require monitoring with a clause that if the parameter is detected at levels above the TMDL WLA then the facility must take measures to determine the particular source of the constituent and enact controls to reduce. Then if levels are not reduced the next permit may have limits. A fourth option, if a permittee refuses to take a voluntary sample, EPA can require sampling by issuing a 308 order.

7.2.3 Monitoring

The Department of Health maintains an ambient monitoring network that includes the Potomac and Anacostia Rivers and Rock Creek and tributaries. DOH will continue to compile data that become available.

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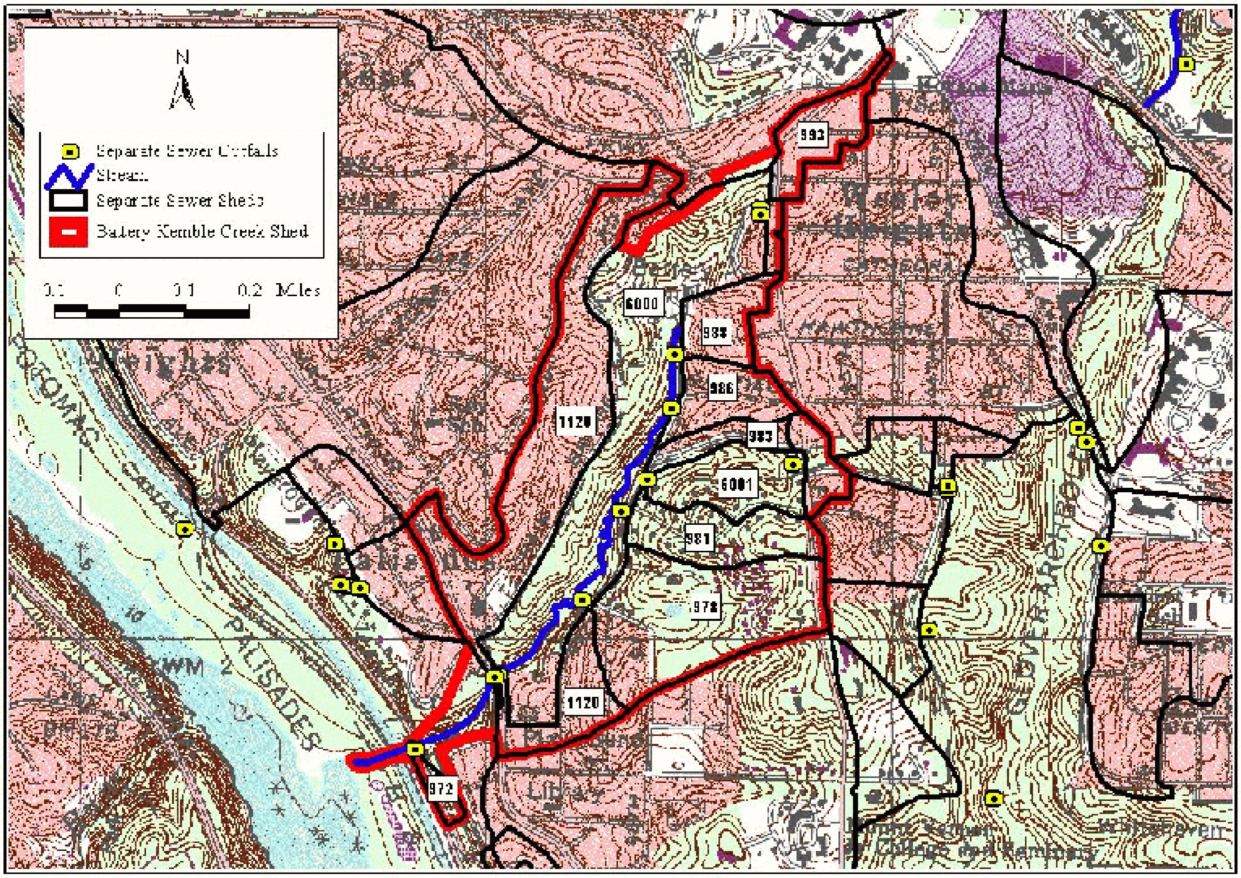
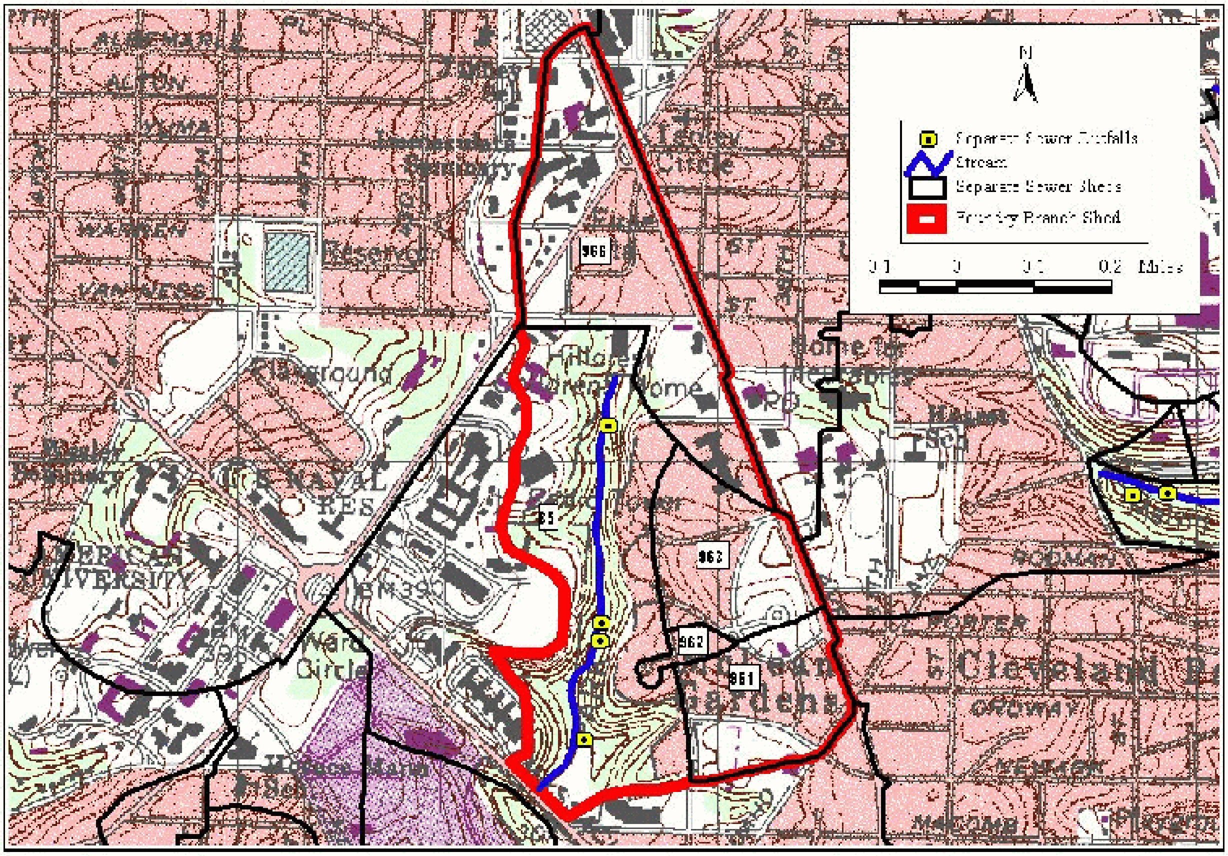
APPENDIX A

Maps of Potomac River Small Tributaries

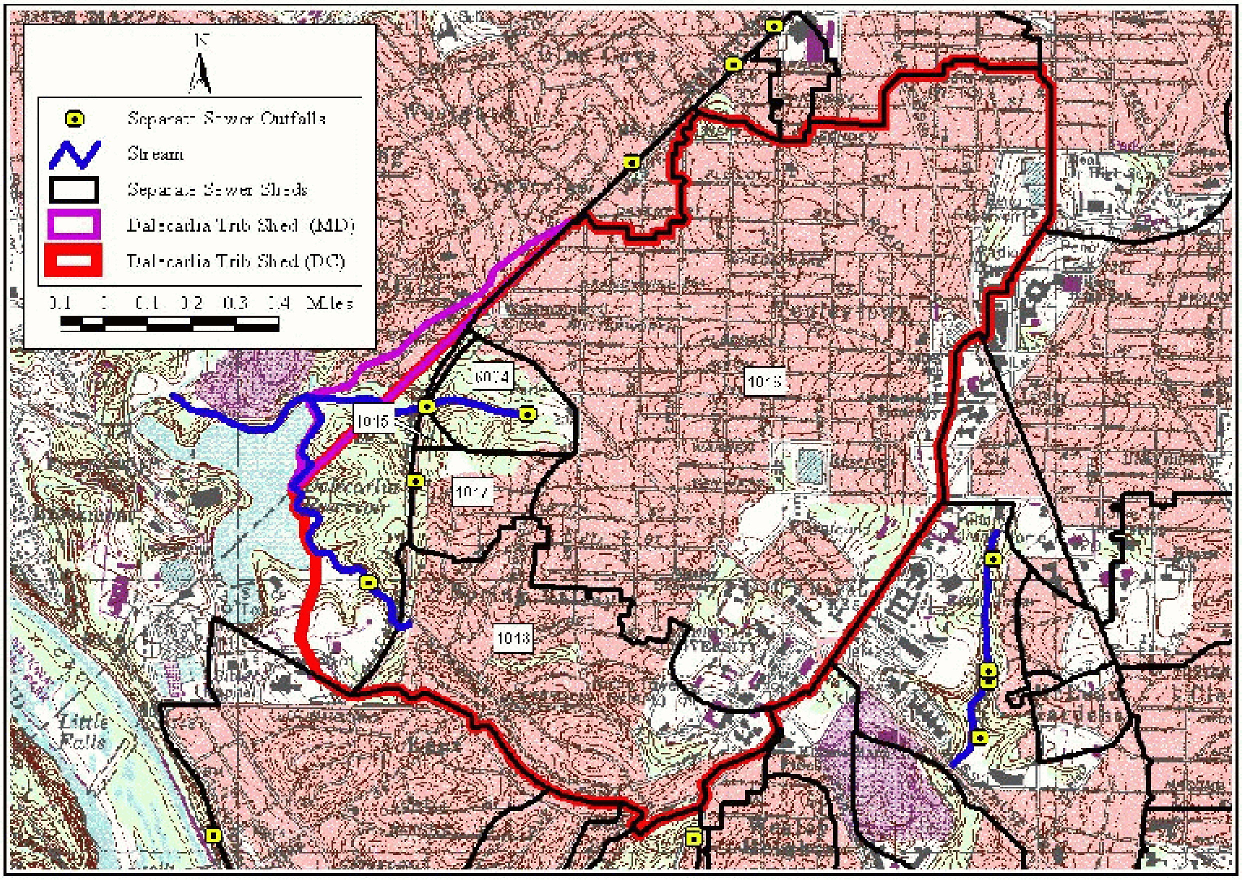
BATTERY KEMBLE CREEK/FLETCHERS RUN



FOUNDRY BRANCH

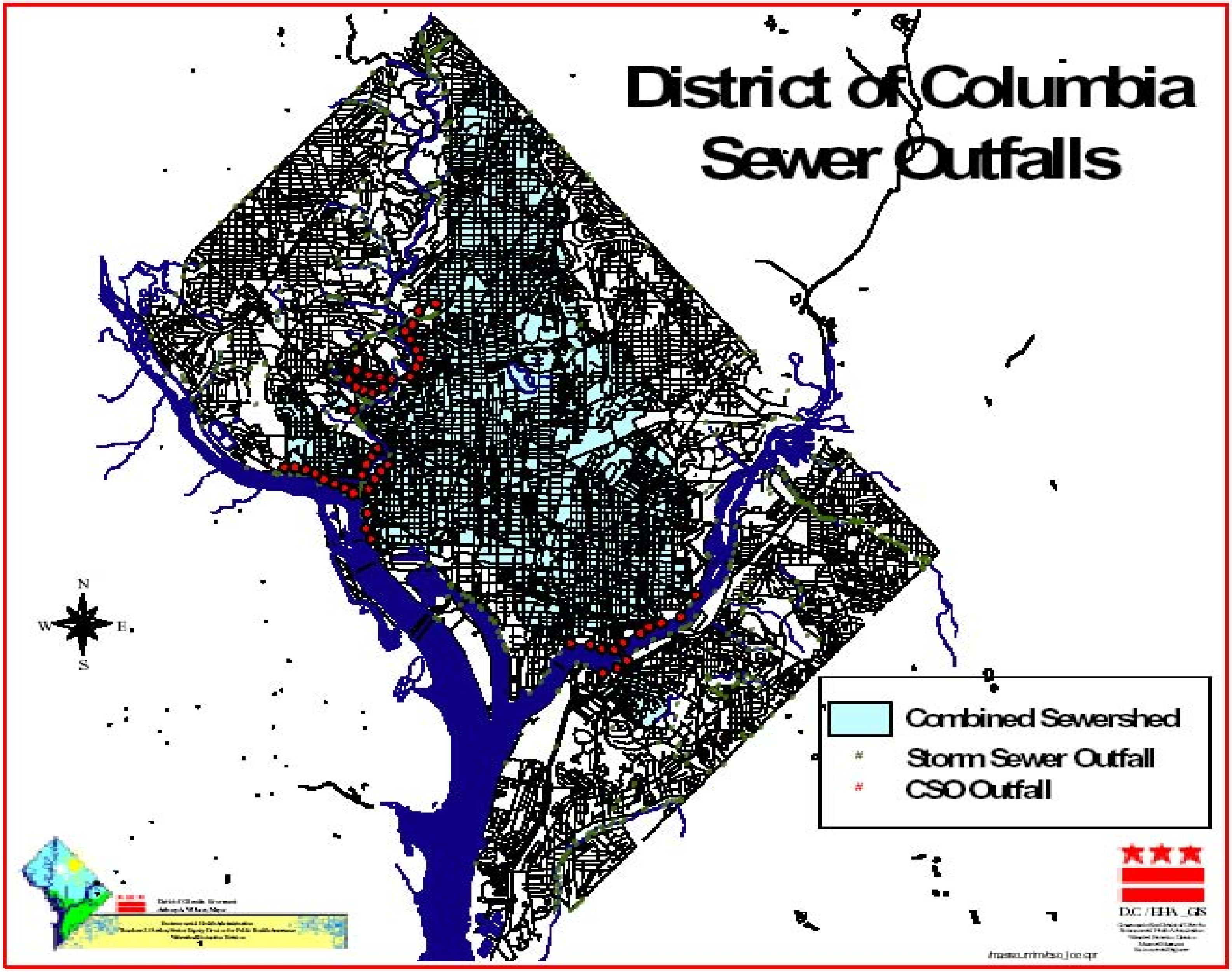


DALECARLIA TRIBUTARY



APPENDIX B

Map of District of Columbia Storm Sewer and CSO Outfalls


District of Columbia
Sewer Outfalls
N
W
E
S
Combined Sewershed
Storm Sewer Outfall
CSO Outfall
D.C. / EHA _GIS

APPENDIX C

DC Small Tributaries TMDL Model

The model, called the DC Small Tributaries TMDL Model developed by the Interstate Commission for the Potomac River (ICPRB), treats each tributary as a “bathtub” which, on each day of the simulation period, receives a volume of water representing storm water runoff and a volume of water representing base flow from groundwater infiltration, and completely mixes (ICPRB, 2003). The simple mass balance model predicts daily water column concentrations of constituents of concern in the tributaries. In stream processes, such as sediment resuspension or decay, are not simulated.

Daily estimates of baseflow and stormflow volumes for each tributary is based on ICPRB’s Watts Branch HSPF model (Mandel and Schultz, 2000). Within the model, the storm runoff volume predicted by the HSPF model includes both separate storm sewer runoff as well as direct runoff flanking the tributaries. An HSPF model simulates hydrologic processes, such as infiltration, evapotranspiration, surface runoff, and ground water flow, from a watershed based on land use within the shed boundaries and on local precipitation and other climatic data. In this HSPF model, land use is divided into three land use categories: 1) impervious; 2) urban pervious; and 3) forested pervious. Because tributaries receive discharge from the District’s separate sewer system, tributary sheds were not delineated based on topography alone but based on a combination of topographic information, information on the sewer outfalls discharging into the tributary, and engineering judgment.

The HSPF model was calibrated using stream flow data from the USGS gage on Watts Branch. The model was used for the Potomac tributaries under the assumption that these nearby urban sub-sheds have hydrologic properties similar to those of the Watts Branch sub-shed. Even there are some differences in hydrolgeological properties between Watts Branch and the Potomac River small tributaries, it is considered appropriate to use this model given the simplistic approach of modeling and the lack of data in the Potomac River small tributaries.

The tributary model includes three sub-models, one of which is for organic pollutants and one for inorganic pollutants (metals). These two sub-models predict daily water column concentrations of each pollutant in each of the tributaries under current conditions and allow evaluating load reduction scenarios by simple percent reductions of base, storm and CSO loads.

Average concentrations for each constituent used as model input for base flow and storm flow were based on available monitoring data from several studies and/or monitoring programs in the District, including data from the Northeast/Northwest Branches study, the DC MS4 monitoring program, and the DC WASA LTCP monitoring program, and described elsewhere in more details (ICPRB, 2003). Little toxics data exists for the tributaries, and what does exist relates primarily to metals. In cases were samples were analyzed for organics, the detection level was frequently higher than the water quality standards. The same average concentrations were used for all the tributaries in the model. The following tables present the average concentrations for organic-chemical and inorganic-chemical sub-models respectively.

Table A. Constituents of the DC Small Tributary Organic Chemicals Sub-Model

Constituent	Base Flow Conc. (µg/L, dissolved + particulate)	Storm Flow Conc. (µg/L, dissolved + particulate)	CSO Conc. (µg/L, dissolved + particulate)	Class C WQS - CCC (µg/L, dissolved + particulate)	Class C WQS - CMC (µg/L, dissolved + particulate)	Class D WQS (µg/L, dissolved + particulate)
Total Chlordane	0.000963	0.00983	0.00983	0.004	2.4	0.00059
4,4'-DDD	0.00462	0.003	0.003	0.001	1.1	0.00059
4,4'-DDE	0.00393	0.0133	0.0133	0.001	1.1	0.00059
4,4'-DDT (Watts Br only)	0.01226 (0.00061)	0.0342 (0.00171)	0.0342 (NA)	0.001	1.1	0.00059
Dieldrin	0.000641	0.00029	0.00029	0.0019	2.5	0.00014
Heptachlor Epoxide	0.000641	0.000957	0.000957	0.0038	0.52	0.00011
PAH1	0.0825	0.6585	0.6585	50	NA	14000
PAH2	0.219	4.1595	4.1595	400	NA	0.031
PAH3	0.1065	2.682	2.682	NA	NA	0.031
Total PCBs	0.0115	0.0806	0.0806	0.014	NA	0.000045

Table B. Constituents of the DC Small Tributary Inorganic Chemicals Sub-Model

Constituent	Baseflow Conc. (µg/L, dissolved + particulate)	Stormflow Conc. (µg/L, dissolved + particulate)	CSO Conc. (µg/L, dissolved + particulate)	Class C WQS - CCC [1] (µg/L, dissolved)	Class C WQS - CMC 1 (µg/L, dissolved)	Class D WQS (µg/L, dissolved)
Zinc	7.5	173	213	165.3	182.5	NA
Lead	0.6	29	80	6.2	159.2	NA
Copper	3.5	57	76	18.5	29.1	NA
Arsenic	0.2	1.4	1.4	150	340	0.14

[1] Zinc, lead, and copper values computed from the published District of Columbia standards assuming a hardness of 169 mg/L as $CaCO_3$.

As noted earlier, the DC Small Tributaries TMDL Model uses the assumption that on each day of the simulation period a volume of base flow and a volume of storm flow water discharges into each tributary and completely mixes. The model was simulated using precipitation records for the three-year period of 1988 to 1990. For a given constituent, all tributary base flow volumes and storm flow volumes are assumed to have the estimated base flow concentrations and storm flow concentrations given in Tables A and B.

Model estimates of daily base flow and storm flow volumes discharging into each tributary are obtained as follows:

BaseFlow = $\underset{\cdot}{V}_1$ * (PervArea * PerviousBase + ForPervArea * ForestBase) **(1)**

StormFlow = $\underset{\cdot}{V}_1$ * (ImpArea * ImperviousStorm + PervArea * PerviousStorm + ForPervArea * ForestStorm) **(2)**

where

BaseFlow	= base flow entering tributary (m^3/sec)
StormFlow	= storm flow (separate storm sewer plus direct overland runoff) entering tributary (m^3/sec)
PerviousBase	= base flow per unit urban pervious area from Watts Br HSPF model (ac-in/ac-hr)
ForestBase	= base flow per unit forested area from Watts Br HSPF model (ac-in/ac-hr)
ImperviousStorm	= storm flow per unit impervious area from Watts Br HSPF model (ac-in/ac-hr)
PerviousStorm	= storm flow per unit urban pervious area from Watts Br HSPF model (ac-in/ac-hr)
ForestStorm	= storm flow per unit forested area from Watts Br HSPF model (ac-in/ac-hr)
PervArea	= urban pervious area of tributary sub-shed (ac)
ImpArea	= impervious area of tributary sub-shed (ac)
ForPervArea	= forested pervious area of tributary sub-shed (ac)
$\underset{\cdot}{V}_1$	= 0.02855 = conversion factor from (ac-in/hr) to (m^3/sec)

Daily constituent concentrations for each tributary are then predicted using the following:

C = (BaseFlow * BFConc + StormFlow * SFConc) * LoadMult / (BaseFlow + StormFlow) **(3)**

where

C	= model estimate of total constituent concentration (dissolved + particulate) in tributary
BFConc	= constituent baseflow concentration (dissolved + particulate)
SFConc	= constituent stormflow concentration (dissolved + particulate)
LoadMult	= load multiplier for simulating effect of potential load reduction scenarios

and where C, BFConc, and SFConc are in consistent units.

Finally, the total daily load for each constituent for each tributary is calculated by

$$\text{Load} = V_2 * (\text{BaseFlow} * \text{BFConc} * \text{LoadMult} + \text{StormFlow} * \text{SFConc} * \text{LoadMult})$$

where

$$V_2 = 0.0864 = \text{conversion factor from (g/sec) to (kg/day)}$$

District of Columbia Water Quality Standards for the inorganic chemicals modeled in table B are given in terms of the dissolved fraction of these constituents. Therefore, in order to compare predictions of the inorganic chemicals sub-model with WQS, daily predictions for total zinc, lead, copper and arsenic are used to compute daily predictions for the dissolved fractions of these constituents using the assumption of instantaneous equilibrium partitioning, where the partitioning between the solid phase and the dissolved phase is assumed to be linear, that is,

$$C_s = K_d\, C_w \qquad \textbf{(6)}$$

where the total constituent concentration is given by

$$C = C_w + C'_s \qquad \textbf{(7)}$$

with

$$C'_s = C_s\, TSS \qquad \textbf{(8)}$$

and

C_s = concentration of contaminant on solid phase (µg/g)
C'_s = concentration of contaminant on solid phase (µg/L)
C_w = concentration of contaminant in dissolved phase (µg/L)
TSS = concentration of total suspended solids (g/L)
K_d = partition coefficient (L/g)

Thus, combining equations (6), (7), and (8), the dissolved phase concentration, C_w, can be expressed in terms of the total concentration, C, as

$$C_w = C/(1 + TSS\, K_d) \qquad \textbf{(9)}$$

Equation (9) is used in the DC Small Tributaries TMDL sub-model for inorganics to convert the model's daily predictions of total zinc, lead, copper, and arsenic concentrations to predictions of corresponding dissolved concentrations.

Because very little concentration data are available for the 23 tributaries with both dissolved and solid phase values, partition coefficients were taken from the District's TMDL model for toxics in the Anacostia River, the TAM/WASP Toxics Screening Level Model (Behm et al., 2003). Values for TSS in equation (9) are obtained from model predictions of daily TSS values using equations (1) through (3), and assuming base flow, and storm flow TSS concentrations of 0.002 and 0.094, also taken from the TAM/WASP model.

K_d Values Used in the DC Small Tributaries TMDL Model

Constituent	**K_d (L/g)**
Zinc	420
Lead	400
Copper	94
Arsenic	100

The tributary model does a fair job in simulating daily concentrations of modeled constituents based on comparisons of model results with available data. In plots of predicted versus observed concentrations of zinc, lead, copper for Hickey Run and Watts Branch, the two streams for which the most data are available, model predictions fall reasonably close to observed values for the majority of the data points (ICPRB, 2003).

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APPENDIX D

Dalecarlia Tributary PCB Atmospheric Deposition and Allocated Load

Allocated PCB Load = Existing Load – Available Atmospheric Deposition Load

Existing PCB load for the tributary was determined using the DC Small Tributaries Model (See Appendix D). The calculations performed to determine the Total Available PCB Atmospheric Load to the Dalecarlia Tributary Watershed are described in the following:

Available atmospheric load was determined using average annual atmospheric deposition flux in the Chesapeake Bay (Chesapeake Bay Program, 1999). The annual fluxes are:

Wet Urban Deposition = 8.3 ug/m2-year;
Dry Urban Deposition = 8.0 ug/m2-year; and
Total Wet-Dry Deposition = 16.3 ug/m^2-year

The PCB atmospheric load for the Dalecarlia tributary watershed was calculated by multiplying the total wet-dry flux rate by the watershed area to generate total annual atmospheric loading. This result was then multiplied by the watershed runoff coefficient to determine the available atmospheric load for the watershed. Direct surface loading to the tributary is negligible compared to the watershed-based loading, hence, not specifically considered. For the respective watershed portions in Maryland and the District of Columbia, available atmospheric loads were divided based on the area ratio.

The runoff coefficient was determined by using the following formula:
Runoff Coefficient = 0.05 + .009 * (percent imperviousness)

Percent imperviousness of the Dalecarlia tributary watershed is as follows (ICPRB, 2003):

Tributary	**Total Area (ac)**	**Impervious Area (ac)**	**Percent Imperviousness**
Dalecarlia Tributary	1111	306	27.5

The PCB loadings for the Dalecarlia Tributary are as follows:

Waterbody	Drainage Areas Sq Miles	Drainage Area Sq.Meters	Total Atmospheric Load lbs/yr	Runoff Coefficient	Available Atmospheric Load (DC + MD) lbs/yr	Total MD Existing PCB Load	MD Land-Based Load	Total DC Existing PCB Load	DC Land-Based Load	TMDL (land-based source)
Dalecarlia Tributary	1.784	4621510	0.1657	0.297	4.922E-02	6.167E-03	4.833E-03	2.210E-01	1.731E-01	1.731E-04