

DISTRICT OF COLUMBIA
FINAL
TOTAL MAXIMUM DAILY LOADS
for
TOTAL SUSPENDED SOLIDS
in
WATTS BRANCH

June 2003



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DEPARTMENT OF HEALTH
ENVIRONMENTAL HEALTH ADMINISTRATION
BUREAU OF ENVIRONMENTAL QUALITY
WATER QUALITY DIVISION
WATER QUALITY CONTROL BRANCH

June 2003

INTRODUCTION

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.

In 1996, the District of Columbia (DC), developed a list of waters that do not or are not expected to meet water quality standards as required by section 303(d)(1)(A). The list was revised in 1998. The list of water bodies contains a priority list of those waters which are the most polluted. This priority listing is used to determine which of those water bodies are in critical need of immediate attention. This list, submitted to the Environmental Protection Agency every two years, is known as the Section 303(d) list. For each of the listed waters, states are required to develop a Total Maximum Daily Load (TMDL) which calculates the maximum amount of a pollutant that can enter the water without violating water quality standards and allocates that load to all significant sources. Pollutants above the allocated loads must be eliminated.

The District of Columbia's section 303(d) list shows that Watts Branch does not meet water quality standards. One of the pollutants listed is total suspended solids (TSS). The pollutant of total suspended solids was used to represent a habitat problem caused by severe channel erosion during high flows. The District of Columbia does not have a criteria for total suspended solids. Watts Branch was listed as upper and lower Watts Branch in the 303(d) list. The Water Quality standards include Watts Branch with no segmentation.

APPLICABLE WATER QUALITY STANDARDS

Watts Branch is listed on DC's 1996, 1998 and 2002 303(d) lists because excessive channel erosion has degraded aquatic habitat. Title 21 of the District of Columbia Municipal Regulations (DCMR) Chapter 11 contains the Water Quality Standards (WQS). Watts Branch has the designated beneficial uses of:

1. Class B- secondary contact recreation,
2. Class C- protection and propagation of fish, shellfish, and wildlife; and,
3. Class D - protection of human health related to consumption of fish and shellfish.

The endpoint for the TMDL has basis in the DC Water Quality Standards. The DC Water Quality Standards Section 1104.5 states: Class C waters shall be maintained to support aquatic life. The District of Columbia's Section 303(d) list shows that Watts Branch does not meet water quality standards. One of the pollutants listed is total suspended solids (TSS). The pollutant of total suspended solids was used to represent a habitat problem caused by severe channel erosion during high flows. The District of Columbia does not have criteria for total suspended solids. The end point is the reduction of stream bank erosion to provide a stable channel for the aquatic life. This end point also achieves the loadings needed for water quality standards in the main stem Anacostia TSS TMDL. Calculating loadings for Watts Branch on the summer period has little effect on the end point because it is a channel stability problem that must be corrected.

Biologic Integrity

The evaluation of Watts Branch aquatic life support use is based on a Level II U.S. EPA Rapid Bioassessment conducted in 1997. For the lower 0.3 miles of the stream from the Anacostia River through the U.S. National Park Service's Kenilworth Park, Watts Branch was not supporting of its aquatic life use designation as reported in the 1998 water quality report to the US EPA and the U.S. Congress. A bioassessment score of 35% and a habitat assessment score of 95% of its reference stream was determined. For the upper 3.7 miles of Watts Branch reach through the DC Parks and Recreation Department's portion of Watts Branch Park, the aquatic life use designation was not supported by the stream. A bioassessment score of 35% and a habitat assessment score of 57% of Watts Branch reference stream was determined.

Benthic Macroinvertebrates

Macroinvertebrates are important members of the stream ecosystem. They help filter stream water and provide nutrition for higher trophic levels. Macroinvertebrates were sampled in both Spring and Fall of 1997 and 1998, in two widely separated reaches of the nontidal portion of Watts Branch. The benthic macroinvertebrates structure in Watts Branch is dominated by toxics tolerant chironomid midge larvae and organics tolerant oligochaete worms. The Upper and Lower Watts Branch sampling sites provided Tipuladae, Physid, Ancylidae, Rhagionidae and Ephemeroptera in negligible proportion to the Oligochaete and chironomid populations. The streambank stabilization site was restricted to oligochaete and chironomid populations.

The pre-implementation IBI score for macroinvertebrates in Watts Branch were consistently calculated to be eleven (11). The scale for IBI used by adjoining jurisdictions was created to distinguish between streams with widely varying degrees of impairment. This scale cannot be directly applied to District streams because the long

term effects of city-wide urbanization resulting in a cluster of scores at the poor end of the scale.

Fish

Fish were sampled at the Upper Watts Branch and Lower Watts Branch sites in the fall of 1997 and 1998. Lower Watts Branch contained a wide variety of fish, mostly likely due to its close proximity to the Anacostia River. There is some question that the Lower Watts Branch sampling site may have been within the tidal influence, hence the sampling reach was reevaluated in 1998, and moved approximately 100 yards upstream in order to eliminate that concern. This move did not affect the diversity of fish species collected.

A listing of actual species found at Lower Watts Branch includes:

Mummichog, *Fundulus heteroclitus*

Mosquitofish, *Gambusia affinis*

Banded Killifish, *Fundulus diaphanus*

Blacknose Dace, *Rhinichthys atratulus*

Bluegill, *Lepomis macrochirus*

Redbreast, *Lepomis megalotis*

American Eel, *Anguilla rostrata*

Brown Bullhead Catfish, *Ictalurus nebulosus*

Tessellated Darter, *Etheostoma olmstedii*

According to sample results, species diversity at Upper Watts Branch is low. This can be attributed to multiple factors, including lack of in stream habitat, obstructions to fish passage, and toxic and organic inputs. The two species found in this area are Blacknose dace, *Rhinichthys atratulus*, and Mosquitofish, *Gambusia affinis*.

BACKGROUND

The District of Columbia, as many cities in the 19th and early 20th centuries, developed a combined sewer system, which transported both rainfall and sanitary sewage away from the developed areas and discharged it into the rivers. The two major combined sewage outfalls were at the present location of the “O” Street Pump Station and at the Northeast Boundary Sewer just below Kingman Lake. In the 1930s, Blue Plains Wastewater Treatment Plant (WWTP) was constructed and dry weather sewage flows were transported across the Anacostia River to Blue Plains. However, the wet weather flows were and are often greater than the transmission capacity of the pump stations and piping system and resulted in overflows. Later, sewer system construction techniques utilized two pipes so that the storm water could be kept separate from the sanitary sewage. Storm water is transported to the nearest stream channel and discharged while the sanitary sewage is transported to Blue Plains WWTP for treatment. There are a number of small tributaries which flow into the Anacostia and may carry significant loads of sediment during wet weather. The largest of these is Watts Branch.

CURRENT LAND USE

The headwaters of Watts Branch drain Prince George=s County, Maryland. The mainstem of Watts Branch begins just above the District limits, at Southern Avenue in Southeast DC. The stream flows three miles from the eastern corner of the District in a northwesterly direction to meet the Anacostia River in Kenilworth Park , a National Park Service landholding. The tidal influence of the Anacostia River travels approximately 0.3 miles of Watts Branch in the Kenilworth Park reach of the tributary. The mouth of Watts Branch in Kenilworth Park is across the Anacostia River from the National Arboretum and Kingman Lake, and adjacent to the Kenilworth Marsh restoration.

The entire Watts Branch watershed measures 3.53 square miles, 47% of which is in the District. 0.50 square miles, or less than 15% of the watershed is forested; the remainder is urban residential and commercial.

Watts Branch. Land Use/Land Cover Summary	
Land Use/Land Cover Category	Percent of Watershed
Low and Medium Density Residential	73.2
Deciduous Forest	11.0
Parks and Open Space	8.2
Commercial, Industrial, and Government Lands	7.3
Open Water and Wetlands	0.3
Total Percentage	100.0

All of Watts Branch was at one time property of the U.S. National Park Service. A 1973 agreement with the District transferred authority of Watts upstream of the Kenilworth Park property to the DC Department of Parks and Recreation.

The geology of the Watts area is complex. The watershed is underlain by coastal plain geological deposits. The general soil associations found in the watershed can be broken down into three broad groups. Watts Branch itself flows through the Luka-Linside-Codorus association. These soils are deep, nearly level, moderately well drained soils that are underlain by stratified alluvial sediment or man-deposited dredged material on flood plains. The most prevalent general soil association in the District portion of the watershed is the Urban land-Christiana-Sunnyside association. These soils are deep and are nearly level to steep, well drained soils that are underlain by unstable clayey sediment and are predominantly on uplands. A third minor association that Watts flows through is the Urban land-Galestown-Rumford association which are also deep, nearly level to moderately sloping and somewhat excessively drained soils that are mostly sandy throughout and are a part of old terraces. Several other soil formations are associated with the Watts Branch watershed. In decreasing order of their prevalence, they are:

Patapsco Formation and Arundel Clay (Upper Cretaceous)
Pamlico Formation and Recent Alluvium (Pleistocene / Recent)
Wicomico Formation (Pleistocene)
Brandywine Gravel (Pliocene) Chesapeake Group (Miocene Coastal Plain
Aquia Greensand (Eocene)
Monmouth Formation (Upper Cretaceous)

The stream bed is dominated by gravels and sand, with silt and organic deposits in shallow pools. Numerous undercut banks are clays and some highly erodible sandy loams.

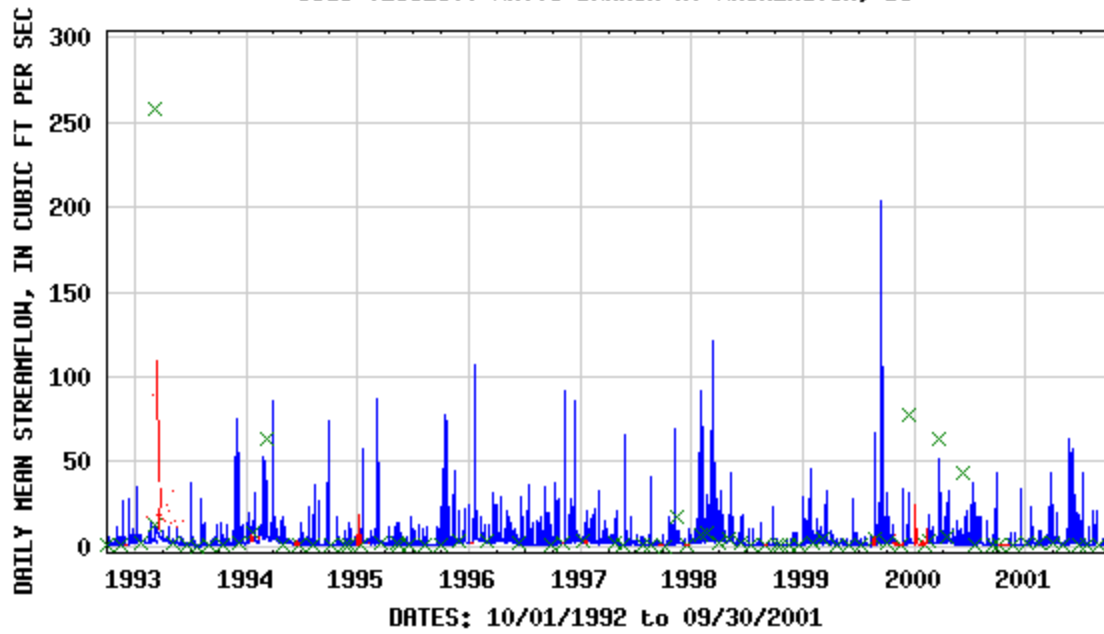
Due to the impacts of urbanization and channelization, the conditions at Watts Branch represent a departure from its potential stable condition. In some areas, higher peak discharges and flow velocities have resulted in an increased sediment transport capacity. Where the sediment transport capacity exceeds the sediment supply, the stream is degrading. Additionally, where sediment supply exceeds the sediment transport capacity, the stream is aggrading.

STREAM FLOW

Watts Branch is a perennial, low gradient, warm water stream. The stream width varies from approximately 20 feet at its widest to approximately 5 feet where it enters the District. The stream gradient along the reach for Watts is 1% as read from the USGS quadrangle and also as read by clinometer at numerous sampling sites. This gradient is relatively low and is common for slower moving coastal plain streams.

The USGS, with cooperation from the Department of Health, is operating an active gage station on Watts Branch, located 200 feet upstream from Minnesota Avenue. The gage station was established in June 1992 and has a drainage area of 3.28 square miles. The average mean annual discharge is 4.48 cubic feet per second (cfs), with the lowest and highest mean annual discharge of 2.84 cfs and 5.87 cfs, respectively. The lowest measured flow is 0.28 cfs and the highest peak flow is 1510 cfs.

USGS 01651800 MATTS BRANCH AT WASHINGTON, DC

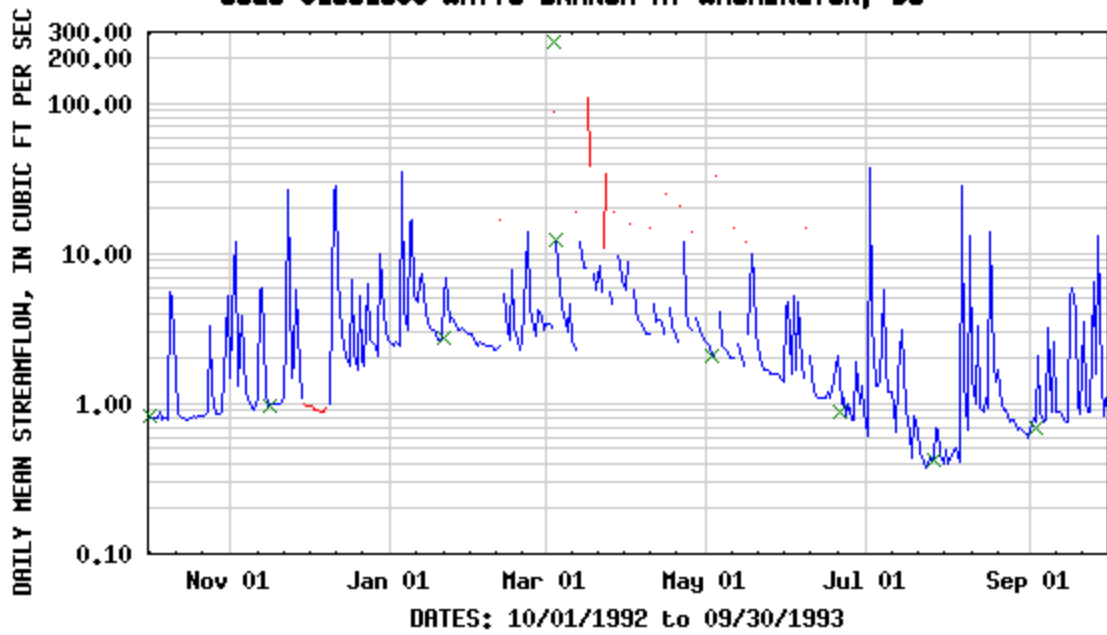


EXPLANATION

— DAILY MEAN STREAMFLOW × MEASURED STREAMFLOW — ESTIMATED STREAMFLOW



USGS 01651800 WATTS BRANCH AT WASHINGTON, DC

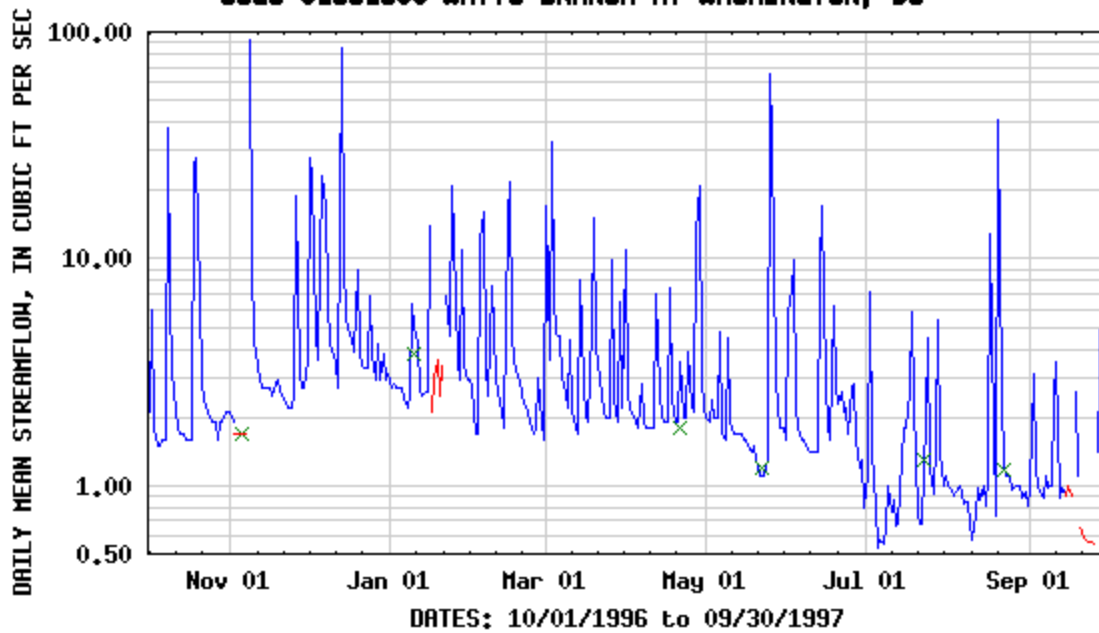


EXPLANATION

— DAILY MEAN STREAMFLOW × MEASURED STREAMFLOW — ESTIMATED STREAMFLOW



USGS 01651800 WATTS BRANCH AT WASHINGTON, DC



EXPLANATION

— DAILY MEAN STREAMFLOW × MEASURED STREAMFLOW — ESTIMATED STREAMFLOW

Year	Annual mean streamflow, in ft ³ /s	Year	Annual mean streamflow, in ft ³ /s	Year	Annual mean streamflow, in ft ³ /s
1993	4.75	1996	6.05	1999	4.30
1994	5.07	1997	3.74	2000	3.80
1995	3.95	1998	4.71		

YEAR	Monthly mean streamflow, in ft ³ /s											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992							4.12	1.96	2.54	1.43	3.26	4.28
1993	5.56	4.17	15.0	6.39	4.31	2.12	2.31	2.65	2.17	2.27	5.18	4.70
1994	8.11	8.48	15.7	4.90	3.55	1.83	3.44	4.32	5.00	1.51	1.73	2.44
1995	5.36	2.80	5.25	2.36	3.73	2.47	2.97	1.67	1.67	9.08	6.27	3.59
1996	9.71	5.19	5.91	6.55	6.53	4.64	4.54	3.03	5.39	5.15	6.31	9.57
1997	4.72	4.70	5.54	3.54	5.05	3.32	1.73	2.68	1.43	3.00	6.74	2.50
1998	8.59	11.3	12.0	5.90	6.72	4.01	1.63	1.23	1.37	.73	1.37	2.14
1999	6.49	3.22	5.42	2.71	1.59	2.50	1.67	4.39	13.0	3.20	3.39	4.06
2000	3.31	4.33	5.93	6.44	3.21	4.38	5.72	3.32	3.64	.82	1.72	2.89
2001	3.10	2.65	5.57	3.32	6.73	6.54	5.10	3.72	1.46			
Mean of monthly streamflows	6.11	5.20	8.48	4.68	4.60	3.53	3.32	2.90	3.77	3.02	4.00	4.02

SOURCE ASSESSMENT

The significant hydrologic modification caused by urbanization has taken its toll on the habitat structure and water quality of Watts Branch. Streambank stabilization projects have been implemented to maintain the existing conditions but the force of peak stormflows often scour seemingly stable banks. The sedimentation of Watts is caused almost exclusively from the erosion of its streambanks.

The driving force behind the physical, chemical and biological degradation of Watts Branch is uncontrolled stormwater flows. The heavily urbanized nature of the watershed, and its subsequent imperviousness, create the conditions for highly flashy and intense flow conditions in the stream channel even during the most moderate of storm events.



The stream was broken into segments for assessment purposes.

	Reach	Stream Type	Stream Length		Reach	Stream Type	Stream Length
Upper Reach	WB-01	F4	2,717	Upper Reach	WB-09	F4	1,343
	WB-02	F4	779		WB-10	F4	741
	WB-03	F4	905		WB-11	F4	965
	WB-04	F4	401		WB-12	F4	941
	WB-05	F4	241	Lower Reach	WB-13	F4	2,588
	WB-06	F4	884		WB-14	F4	1,082
	WB-07	Culvert	1,343		WB-15	F4	665
	WB-08	F4	499		WB-16	F4	785

Upper Reach of Watts Branch

The Upper Reach of Watts Branch is significantly impacted by urbanization and stream alterations. The flow regime for the stream has changed in response to the urbanization and land use changes. Changes to the flow regime include increased stormwater runoff, peak discharges, and increased flashiness. The stream has also been channelized and its floodplain lost due to floodplain fill and/or channel capacity enlargement.

In response to the urbanization and stream alterations, the stream is actively adjusting to accommodate the higher discharges within the channel. These adjustments are indicative of the significant instability found in the Upper Reach of Watts Branch. Reaches WB-01 to WB-09 are both vertically and laterally unstable. Reaches WB-10 to WB-12 are stable with localized areas of instability. The USF&WS identified approximately 2,647 linear feet of moderate to high erosion along the stream, which is approximately 29 percent of the Upper Reach. The moderate to high erosion is due to a variety of causes, including moderate to extreme bank erosion hazard indices and moderate to very high near bank shear stress. Some factors which contribute to an increased bank erosion hazard index and near bank shear stress are higher entrenchment, a steeper stream slope from channelization, little bank and riparian vegetation, less consolidated bank material, and higher shear stress in the near bank one-third area of the stream. Some of the stream stability is derived from existing stabilization projects, including rip-rap, gabion baskets, and concrete block revetments. This reach has approximately 11,074 linear feet of the stream stabilization, which is approximately 50 percent of the Upper Reach. The length of stabilization is reported for both banks, where applicable, and thus may exceed the length of the reaches. The stability from these revetments is temporary and some areas are undermined and are falling into the stream. This is a significant concern because the stream has a very high erosion potential. Failure of these revetments will likely result in further lateral erosion and sediment contributions into the stream.

Stream adjustments affect channel dimensions, meander pattern, and longitudinal profile. To accommodate the higher discharges within the channel, the stream has incised and entrenched, reducing access to the floodplain. Higher flows are required to breach the top of bank to access the abandoned floodplain. Since the stream no longer has an active floodplain, it will laterally erode to increase channel capacity. This adjustment will result in a wider stream width and a higher width/depth ratio. The higher width/depth ratio results in shallower flow depths across the stream. Because the stream is channelized, there is virtually no meander pattern or stream geometry (*e.g.*, sinuosity, beltwidth, radius of curvature, meander wavelength). Channelization reduces the stream length, which results in an increase in stream slope.

For this reach, the sediment transport capacity generally exceeds the sediment supply, causing the stream to degrade. This degradation and changes in the channel dimensions, meander pattern, and longitudinal profile impact bed feature development. Most of the bed features are poorly defined, with only a few moderately to well-defined features. In general, the riffles are short, the runs are shallow, and the pools are shallow and irregularly spaced along the longitudinal profile.

Historically, the stable stream form for this reach was mostly likely a meandering stream with a well-developed floodplain. However, channelization and urbanization caused the stream to vertically and laterally erode in an attempt to re-establish a stable channel dimension, meander pattern, and longitudinal profile. Currently, the stream is entrenched with a high width/depth ratio (*i.e.*, Rosgen F stream type). If allowed to freely evolve, the stream would continue to widen until it establishes a proper beltwidth. Beltwidth is the widest extent a stream meanders across the stream valley. The stream would also begin to aggrade, creating a new floodplain within the existing degraded stream. As the floodplain develops, the stream would become less entrenched, with a lower width/depth ratio.

This reach has a poor instream habitat rating, due primarily to poor water quality and low habitat diversity. The low habitat diversity is the result of marginal bed feature development, shallow water depths, and lack of instream cover (*e.g.*, large woody debris, and overhanging vegetated banks).

Riparian buffer widths range from 0 to 250 feet, with the average buffer width less than 10 feet. These averages frequently represent one side of the stream, and it is common to find a narrow or nonexistent buffer along the other bank. Approximately 45 percent of the Upper Reach has no buffer. In areas with high stream bank heights and/or entrenchment, the lack of vegetation and/or shallow rooting depths may result in lateral instability and subsequent sediment loads from bank erosion, particularly at higher flows. Areas of moderate to extreme erosion were commonly associated with a lack of vegetation and/or shallow rooting depths.

Lower Reach of Watts Branch

The Lower Reach of Watts Branch is also significantly impacted by urbanization and stream alterations. The impacts associated with urbanization and stream alterations are similar to those discussed above in the Upper Reach.

In response to the urbanization and stream alterations, the stream made adjustments to accommodate the higher discharges within the channel. However, the Lower Reach is generally vertically aggrading and laterally stable. The lateral stability is indicated by lower bank erosion hazard indices and lower near bank shear stresses. Some of the factors contributing to the increased bank stability are lower entrenchment, lower stream slope, and more bank and riparian vegetation. Although the majority of stream is laterally stable, the USF&WS identified approximately 1,279 linear feet of moderate to high bank erosion, which is approximately 25 percent of the Lower Reach. Compared to the Upper Reach, this reach derives less of its stream stability from stream stabilization projects. The USF&WS identified 1,136 linear feet of bank stabilization, consisting of mortared rip-rap. The rip-rap comprises approximately 13 percent of the Lower Reach. As noted in the Upper Reach, the long term stability of this revetment is questionable.

The channel dimensions, meander pattern, and longitudinal profile reflect stream changes to accommodate the higher discharges within the channel. Although the stream is aggrading, the stream still has a high width/depth ratio and entrenchment. As the stream aggrades, the stream may begin to laterally adjust to accommodate higher flows, which will compromise the future lateral stability of the stream. Because the stream is channelized, there is virtually no meander pattern or stream geometry. Although channelization increases stream slope, the lower slope in this reach is associated with its proximity to the Anacostia River.

The higher width/depth ratio and lower slope reduces the sediment transport capacity, thus causing this reach to aggrade. Most of the bed features in this reach are poorly defined, with short riffles, shallow runs, and the shallow irregularly spaced pools.

Similar to the Upper Reach, the stable stream form for this reach was most likely a meandering stream with a well-developed floodplain and wetland system. Due to channelization and urbanization, the stream is attempting to re-establish a stable channel dimension, meander pattern, and longitudinal profile. Similar to the Upper Reach, the stream has a high width/depth ratio and entrenchment.

For this reach, the instream habitat rating is poor, due primarily to poor water quality and low habitat diversity. The reason for the poor water quality and low habitat diversity are similar to those discussed above in the Upper Reach.

Riparian buffer widths range from 0 to 200 feet, with the average buffer width less than 30 feet. These averages frequently represent one side of the stream, and it is common to find a narrow or nonexistent buffer along the other bank. Approximately 12 percent of the Lower Reach has no buffer.

Critical Environmental Conditions: Rosgen Stream Type Characteristics

Both the Upper and Lower Reach of Watts Branch are characterized as an F4 Rosgen stream type. In general, the F4 stream type is an entrenched, deeply incised, riffle/pool stream, with a moderate to a high width/depth ratio and a slope generally less than 2 percent (Rosgen 1996). The stream substrate consists primarily of gravel and sand, with gravel the dominant material. The potential for erosion and sediment input are high and dependent on stream stability. Additionally, the F4 stream type has a poor recovery potential on its own, even if the cause of instability is corrected (Rosgen 1996). Although depositional features are common in F4 stream types, they were less frequent in reaches with higher entrenchment and lower width/depth (*i.e.*, WB-01, WB-02, and WB-04). These conditions hinder bar development because of increased flow velocities and sediment transport capacities, particularly at higher flows. Depositional features are more common in the Lower Reach because of the lower stream slope, lower entrenchment, and higher width/depth ratio.

Bankfull Determination

The bankfull discharge is the discharge or the range of discharges which is responsible for the formation and maintenance of the stream channel dimensions, planform patterns, and longitudinal profile. An accurate determination of the bankfull discharge is one of the most critical aspects of assessing an impaired stream and developing an appropriate and effective stream restoration design. Although urbanization tends to cause higher peak discharges in streams, the bankfull discharge may not increase but instead become more frequent. Typically, the recurrence interval of bankfull is between one and two years in rural streams. However, the recurrence interval of bankfull in urban streams can be as low as 0.45 years.

Because Watts Branch must accommodate all discharge events within its banks, the resulting high stream velocities and stream power have diminished the formation of typical geomorphic features; which are less defined and inconsistent. The USF&WS identified a few geomorphic features in the stream, with bankfull most likely the lowest feature. The development of the higher geomorphic features may be indicative of the higher flows confined in the entrenched stream or these features may represent relic bankfull indicators abandoned by the stream as it degrades.

The calculated bankfull discharges range from 60 to 80 cfs at the confluence of Watts Branch and the Anacostia River, depending on the calculated Manning's "n. For the purposes of the TMDL, peak flows at or exceeding 100cfs were used as exceeding bankfull capacity.

Nonpoint Sources

Stream processes are not only influenced by a change in the watershed hydrology but also by stream channelization. Essentially 100 percent of the stream in the Upper Reach has been channelized or altered. Channelization affects stream stability by reducing plan form resistance and increasing the slope of the stream. The stream loses its ability to dissipate energy along the meandering plan form and bed features of the stream. In response to this loss, and coupled with a change in the watershed hydrology, the stream vertically erodes, causing stream incision and entrenchment. The stream will continue to vertically erode until one of two situations occurs: 1) the stream bank height exceeds the critical bank height for stability causing mass bank failure or 2) the stream encounters resistant bed materials and cannot erode. When one of these conditions occurs, the stream may instead laterally erode to increase floodplain area which increases the width/depth ratio of the stream.

In the Upper Reach of the Watts Branch, both of the above situations have occurred and continue to occur. The Upper Reach lost access to its floodplain due to fill and/or channel capacity enlargement. A floodplain attenuates higher flow velocities, thus reducing stream power and erosion during higher discharges. The loss of floodplain caused the stream to incise and entrench because it was forced to accommodate higher discharges within the active channel. Additionally, the channelization reduced the stream

length and increased the stream slope, causing higher flow velocities which also promotes vertical and lateral erosion.

The Lower Reach, historically, was degraded in a manner similar to the Upper Reach, and for the same reasons. However, this reach appears to be aggrading because the sediment supply is exceeding the sediment transport capacity. An increase in sediment supply is likely the result of stream instability in the Upper Reach. A decrease in the sediment transport capacity in the Lower Reach is the result of two major conditions: 1) an increase in width/depth ratio and 2) a decrease in stream slope, due to the stream's proximity to the Anacostia River. Additional stream bank erosion may occur as the stream continues to aggrade and then attempts to develop a floodplain and meander pattern.

Stream instability directly influences both sediment supply and sediment transport. Sediment supply increases as a result of stream bank and bed erosion. Typically, the bed material size increases and deposits in the wider portions of the stream. Since the stream energy has decreased from channel over-widening, these depositional features are constantly shifting and may remain as temporary storage for years (Schueler, 1987). These shifting bars generally aggravate streambank erosion by deflecting flows directly into streambanks. The USF&WS observed that the Upper Reach of Watts Branch is in a stream-degradation trend, while the Lower Reach is in a stream-aggradation trend.

TOTAL MAXIMUM DAILY LOADS AND ALLOCATION

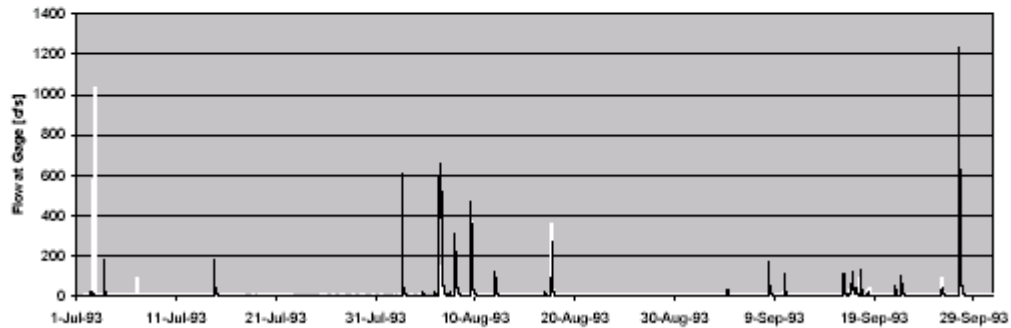
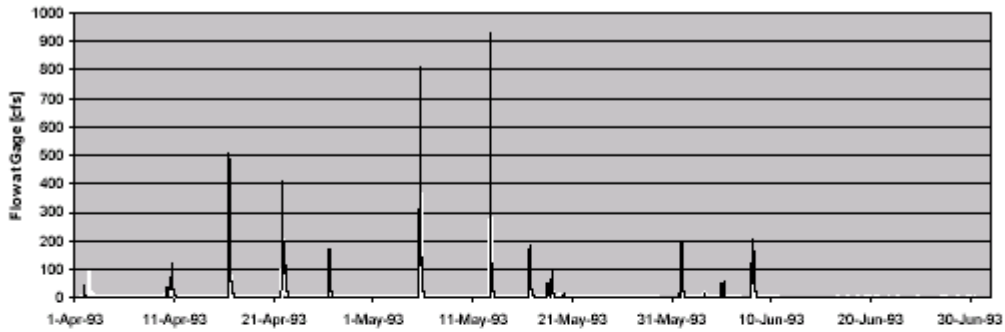
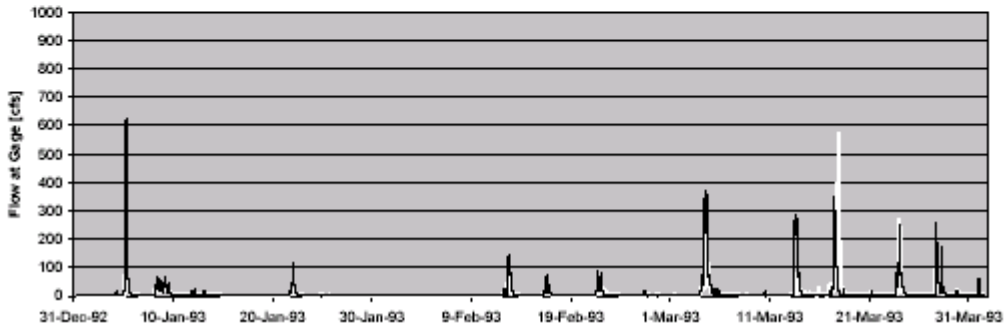
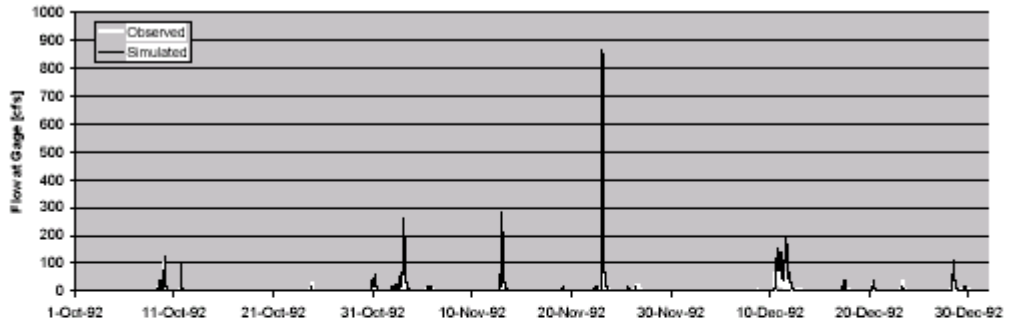
Analysis Framework

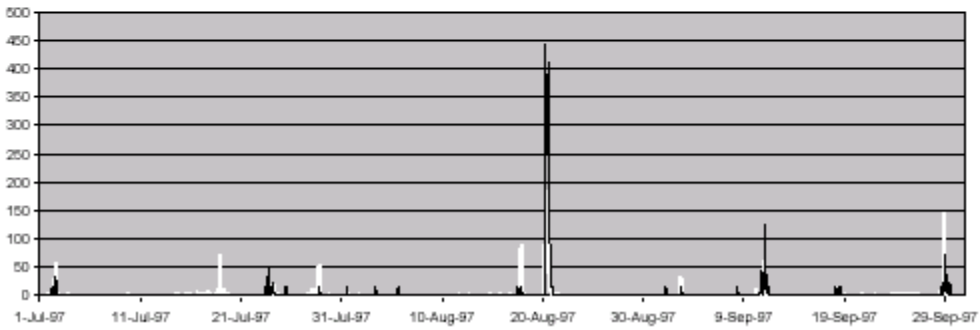
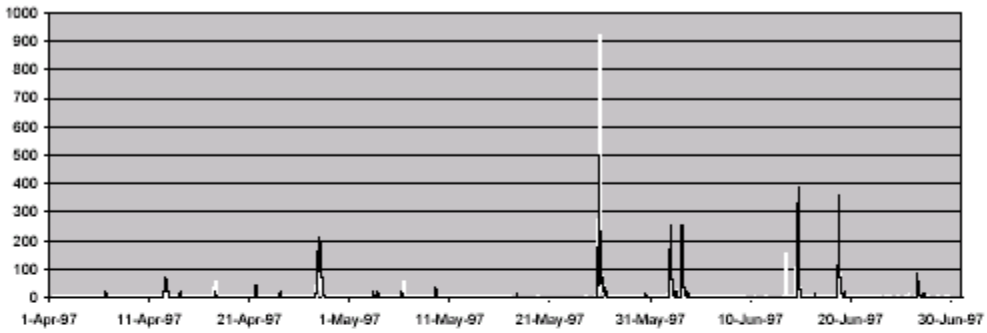
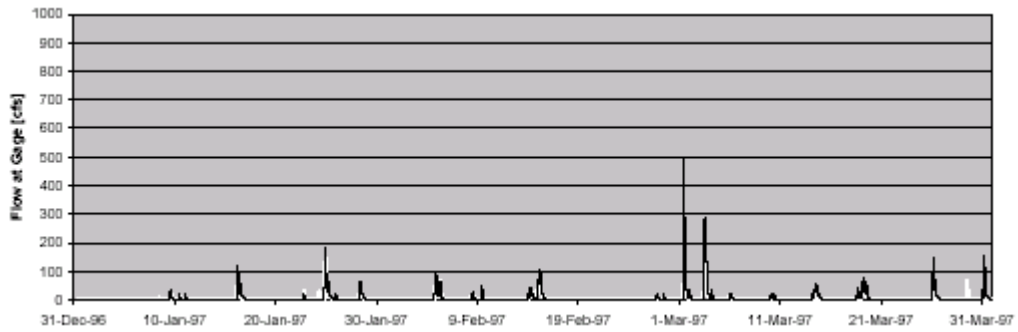
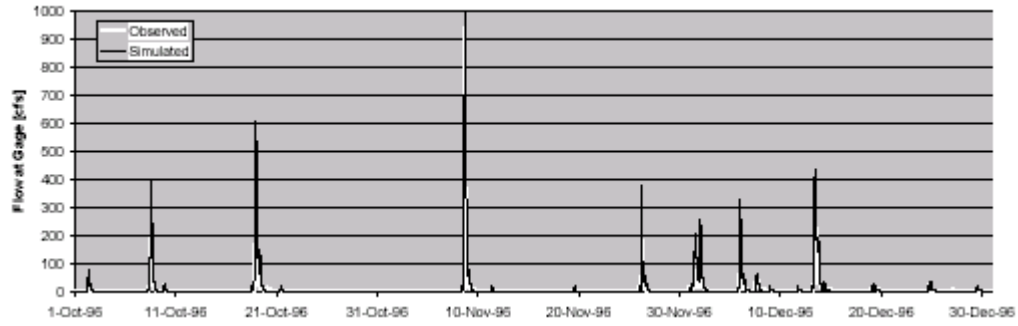
Because of the hypothesized importance of bed and bank erosion as a sediment source in Watts Branch, DOH funded a study to apply the U.S. Army Corps of Engineers' HEC-6 model to simulate scour and redeposition along Watts Branch. HEC-6 is a "one dimensional movable boundary open channel flow numerical model designed to simulate and predict the movement of stream bed and bank sediment materials for a temporal sequence of flows".

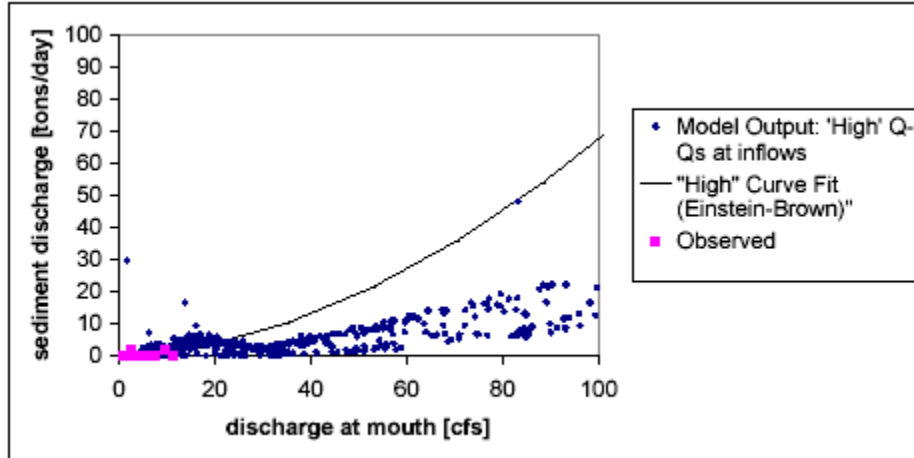
Inflows to the HEC-6 model must be provided by an urban watershed runoff model. The EPA's Storm Water Management Model (SWMM) was selected as the submodel for this component. SWMM is a "dynamic rainfall-runoff simulation model, primarily but not exclusively for urban areas, for single-event or long-term (continuous) simulation". HEC-6 is capable of modeling multiple stream segments with multiple tributaries. For Watts Branch, only one stream reach was modeled with seven local tributaries or inflow points. The model begins at the Maryland-DC border and proceeds to the confluence with the Anacostia River. Although approximately 2 miles of the watershed is located in Maryland, modeling in-stream processes outside the District of Columbia was outside of the scope of this project. Local inflows or tributaries were entered based on topographic maps and a storm drain map.

The modeling exercise confirmed that instantaneous flows had very severe impacts upon Watts Branch. The peak instantaneous flows could be two orders of magnitude greater than the daily flow. Because the DOH sampling data for the stream did not capture a significant number of peak flow events there was no TSS data with which to calibrate the model at the extreme flows. Regression techniques were used to provide a range of estimates of TSS carried at the higher peak flow events.

Time series of HEC-6 modeled and observed flow at USGS Gage for WY 1993 and 1997







Previous estimates used in the Anacostia TSS TMDL provide an average load to the Anacostia River of 720,000 pounds. Using the flows generated by the HEC-6 model and the sediment discharge curve, with some adjustments, the following rationale was used to estimate the sediment loads from channel erosion.

Storm flows of less than 10 cfs daily average will have an instantaneous peak of about 100 cfs which is bank full and will deliver about 2 tons per day.

Storm flows greater than 10 cfs daily average will have instantaneous flows of greater than 200 cfs and will deliver about 8 tons per day; except that, about twice a year rainfall patterns will cause instantaneous peaks of about 1,000 cfs and will deliver about 32 tons per day.

During the water year 1997 months of April through October there were 12 flow events greater than 100 cfs and 9 of those were greater than 200 cfs. For the same period of water year 1993 there were 19 flow events greater than 100 cfs and 13 greater than 200 cfs. There are about two events per year with flow that approach or exceed 1,000cfs . Averaging these two years together gives the following estimates of Channel erosion sediment loads.

200>Q<100	5 events	@2T	=	10T
1000>Q>200	9 events	@ 8T		72T
Q>1000	= 2 events	@32T		64 T
TOTAL EROSION				146T

Average flow for the seven months for water year 1993 is 3.05 cfs and for 1997 is 3.27 cfs.

Base flow = 1 cfs during April-October

Assume 5 ppm TSS which gives 2.5 tons TSS

Storm flow = 2 cfs @ 60 mg/l = 64.7 tons

Total Loads

TSS AVERAGE LOADS IN TONS DURING APRIL THROUGH OCTOBER

STREAMBANK EROSION	146 T
STORM WATER	64.7 T
BASEFLOW	2.5 T
TOTAL	212TONS

Using the percent drainage area as a basis, the loads are divided between Maryland and DC as follows:

MARYLAND

WATTS BRANCH 53%	112TONS
STORM WATER	34.3T
STREAMBANK EROSION	77T
BASEFLOW	1.3T

DISTRICT OF COLUMBIA

WATTS BRANCH 47%	100T
CSO	0
STORM WATER	30.4T
STREAMBANK EROSION	68T
BASEFLOW	1.2

ALLOCATIONS, REDUCTIONS, MARGIN OF SAFETY, AND THE TMDL

The total allowable load of TSS reflects the Anacostia River TMDL reduction needed in order to allow clarity to remain over 0.8 m as stated in the WQS criteria at the average seasonal flow. The allowable load at the mouth is 64,000 pound or 32 tons for the period of April through October as defined in the Anacostia TMDL.

TSS AVERAGE LOADS IN POUNDS DURING APRIL THROUGH OCTOBER

MARYLAND

WATTS BRANCH	10 TONS
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For District of Columbia sources, the following table shows the allowable TSS load.

DISTRICT OF COLUMBIA

MARGIN OF SAFETY	0.1 Tons
CSO	N/A
STORMWATER 54% reduction	13.9
BASEFLOW	1.2
<u>STREAMBANK EROSION 90%</u>	<u>6.8 TONS</u>
TOTAL	22.0 TONS

Waste Load Allocation

Storm sewers are point source, however it is the TSS symbolized by the eroding stream channel that must be reduced in order for this TMDL to achieve Class C aquatic life habitat needs. The TSS from storm water and other sources need to be reduced to meet the downstream needs of the DC Water Quality Standards Class C criteria. Monitoring for the MS 4 permit near Nash Run which is north of Watts Branch and at another site to the south of Nash Run give TSS results of about 60 mg/l on an annual average for storm sewers. No specific reduction is assigned to point sources in this TMDL.

Load Allocation

Stream bank erosion in upper Watts Branch is assigned a reduction of 90% and lower Watts Branch is assigned a reduction of 90%. Both reaches contain about 25% of their banks as being subject to moderate to high erosion. The upper segment has a stream channel length of 11,759 feet and the lower segment has a stream channel length of 5,120 feet. Load reductions are partitioned according to the ratio of the lengths, which are 43% and 57%. Upper Watts Branch is allocated a load of 12.7 and lower Watts Branch is allocated 9.2 tons for the period of April through October.

There is no reduction assigned to base flow and it remains at an estimated 1.2 tons

DC Source	Lower Watts Branch	Upper Watts Branch	Total	% reduction
Stormwater	5.9	8.0	13.9	54
Baseflow	0.5	0.7	1.2	
Streambank erosion	2.8	4.0	6.8	90
Total	9.2	12.7		

Margin of Safety

The final load allocations include a margin of safety of one tenth of a ton from the total load allocations. An implicit margin of safety is included because no accounting of grain size has been performed.

Implementation

On May 10, 1999, Mayor Williams signed a new Anacostia Watershed Restoration Agreement with Maryland, Prince George's County, Montgomery County, and U.S. EPA to increase efforts to improve water quality. The Agreement has six major goals. The first one pertains to this TMDL:

Goal #1: dramatically reduce pollutant loads, such as **SEDIMENT**, toxics, CSOs, other nonpoint inputs and trash, delivered to the tidal river and its tributaries to meet water quality standards and goals.

On June 28, 2000, Mayor Williams, Governor Glendening, U.S. EPA and others signed the new Chesapeake Bay Agreement which states:

By 2010, the District of Columbia, working with its watershed partners, will reduce pollution loads to the Anacostia River in order to eliminate public health concerns and achieve the living resources, water quality, and habitat goals of this and past agreements.

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

There are two specific activities which are ongoing to deal with the improvement of the aquatic habitat in Watts Branch. The first is that the environmental organization, Parks and People has been planting a lot of trees in the buffer zone of the stream. The second is that DOH has an ongoing bank stabilization program for Watts branch.

Monitoring

The Department of Health maintains an ambient monitoring network which includes Watts Branch. Data is collected on TSS at least monthly. Additionally, DOH and USGS operate a flow gauging station on Watts Branch.