UPPER WATTS BRANCH STREAM RESTORATION
10 PERCENT PRELIMINARY CONCEPTS

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Stream Habitat Assessment and Restoration Program
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office

CBFO-S05-02

Prepared in cooperation with:

District of Columbia, Department of Health, Watershed Protection Division

and with assistance from:

District of Columbia, Department of Parks and Recreation
Washington Parks and People
District of Columbia Water and Sewer Authority
District of Columbia Department of Transportation

April 2005

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EXECUTIVE SUMMARY

The District of Columbia (District), Department of Health, Environmental Health Administration (DOH) and the U.S. Fish and Wildlife Service (Service) – Chesapeake Bay Field Office (CBFO) intend to restore the upper portion of Watts Branch. Watts Branch is a perennial stream severely impacted by urbanization. Watts Branch is laterally and vertically unstable due to channel incision, channel straightening, and loss of connection between the Watts Branch channel and its floodplain. Water quality in the steam is poor due to contamination from urban stormwater runoff, leakage from sanitary sewers, and litter.

The Service is developing plans to restore the upper portion of Watts Branch that extends from Southern Avenue to Minnesota Avenue using natural channel design methods. The purpose of this report is to discuss objectives for the stream restoration and to describe the Services approach to restoring Watts Branch. The Service will use comments on this report and the accompanying plan set to refine development of the 30 percent concept plans in the next phase of work.

The report discusses the overall strategy for stream restoration. The Service separated the upper portion of Watts Branch into 11 Project Areas. The report describes the physiography of each Project Area, presents specific recommendations for stream restoration within each Project Area, and discusses design issues that factor into the recommendations. In addition to this report, the Service prepared a set of 17 24" x 36" plan sheets showing the stream restoration recommendations. The report and the plan set serve as starting point for refining and developing final design plans for the Upper Watts Branch stream restoration project.

I. INTRODUCTION

A. BACKGROUND

In 2002, the District of Columbia (District), Department of Health, Environmental Health Administration (DOH) and the U.S. Fish and Wildlife Service (Service) - Chesapeake Bay Field Office (CBFO) implemented a partnership agreement (Agreement 1902-0172) to pursue restoration efforts for the Potomac River, the Anacostia River, and their tributaries.

As one of the first tasks under the partnership agreement, the Service prepared a watershed and stream assessment of Watts Branch, a tributary to the Anacostia River (Eng 2002). Based on assessment results, the Service recommended that the District undertake a comprehensive stream and watershed restoration of the District's portions of Watts Branch. Stream restoration would restore natural stream stability and create habitat by reconfiguration of the stream using natural stream design principles. Watershed restoration efforts would include stormwater retrofits to reduce storm flow impacts on receiving streams and to treat stormwater for the purpose of improving water quality. Improvements to the riparian buffer and stream improvements would work to improve habitat, to improve water quality, and to reduce bank erosion. The Service recommended also that Prince Georges County, Maryland restore the portions of Watts Branch and its tributaries lying within the county.

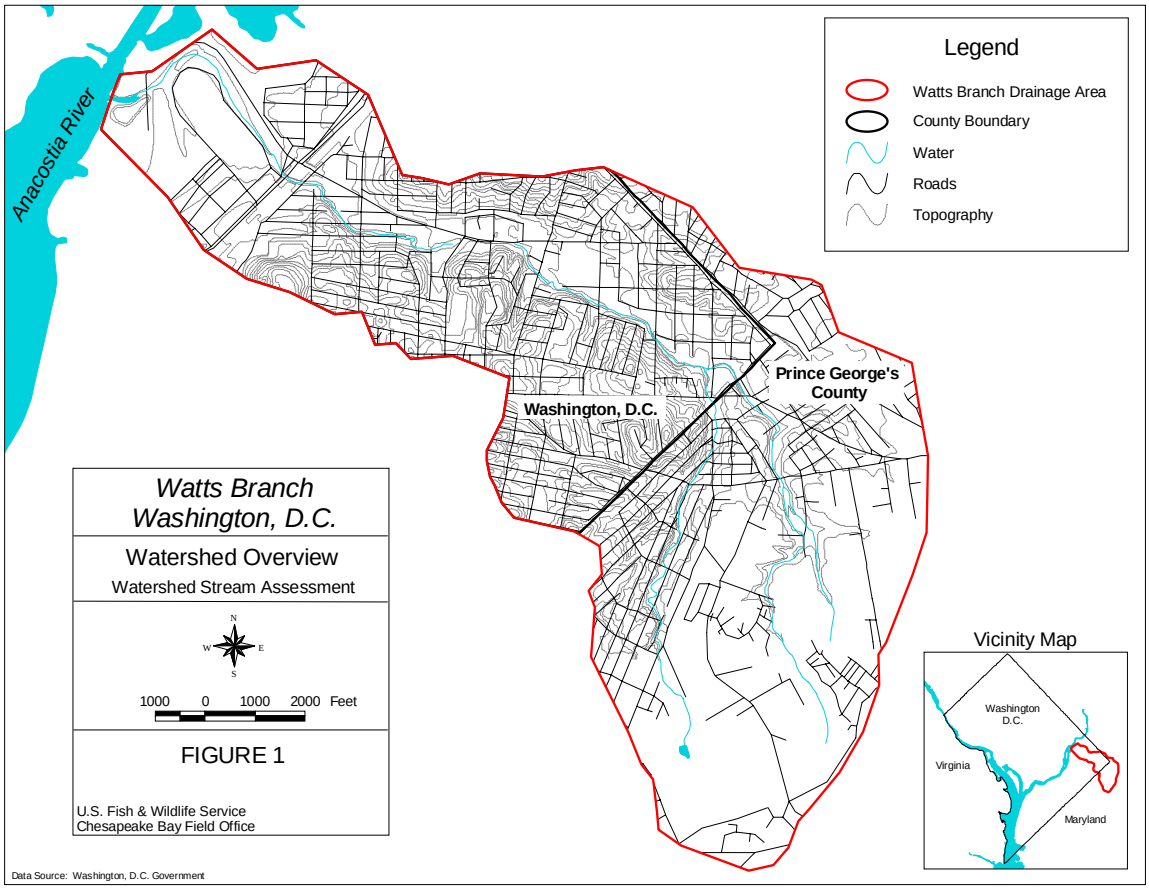
In 2004, the DOH and the Service agreed to prepare full stream restoration design plans for the portion of Watts Branch that extends from where Watts Branch enters the District at Southern Avenue to the Minnesota Avenue, N.E.[1] crossing of Watts Branch. The Service's first tasks in developing the restoration plans are to collect field data to support preparation of plans and to identify alternatives for stream restoration.

The purpose of this report is to discuss objectives for the stream restoration and to describe the Services approach to restoring Watts Branch. The Service will use comments on this report and the accompanying plan set to refine development of the 30 percent concept plans in the next phase of work.

B. WATTS BRANCH WATERSHED CONDITIONS

Watts Branch originates in Prince Georges County, Maryland (Figure 1). It enters the District at Southern Avenue just north of East Capitol Street. Watts Branch flows through the District in a generally west-northwest direction and discharges into the Anacostia River below the junction of the Northwest and Northeast Branches of the Anacostia River. Watts Branch is a perennial stream that generally maintains flow year

[1] The portion of Watts Branch that extends from Southern Avenue to Minnesota Avenue N.E. is hereafter referred to as Upper Watts Branch. The portion of Watts Branch that extends from Minnesota Avenue N.E. to the Anacostia River is referred to as Lower Watts Branch. The portion of Watts Branch lying upstream of Southern Avenue is located within Prince Georges County, Maryland and is referred to as the Prince Georges portion of Watts Branch.



round. The Watts Branch watershed is heavily developed. Approximately 73 percent of the land use is medium and low density residential housing and seven percent is commercial, industrial, or federal facilities. Some open space has been preserved in the watershed, generally adjacent to Watts Branch. Upper Watts Branch flows through the District's Watts Branch Park. Lower Watts Branch flows through the National Park Service's Anacostia Park. For more details on the Watts Branch watershed refer to the stream and watershed assessment report (Eng 2002).

Watts Branch and its tributaries have been significantly altered by channelization, urbanization, and floodplain loss. Portions of the stream have been straightened, relocated, or replaced by culverts. Within the District, all the tributaries to Watts Branch have been filled in, enclosed in pipes, or confined in concrete channels, with the exception of 500 linear feet of one tributary. The highly urbanized watershed results in flashy storm flows with low base flow between storm events. The remaining open stream reaches are severely entrenched, resulting in high bank stress and bank erosion. Over the years, numerous bank stabilization projects that employed concrete or rock walls were constructed along the stream in attempts to stabilize the stream. Many of the stabilization projects are now undermined and falling into the stream. Leaks from aging sanitary sewers and untreated stormwater pollution adversely impact water quality. The major problems facing Watts Branch today are poor water quality, poor aquatic and riparian habitat, flashy and erosive stormflow, and poor baseflow conditions.

C. STREAM RESTORATION PARTNERS

Restoration of Watts Branch is one of several on-going environmental restoration efforts in the Watts Branch watershed. DOH and the Service are working in conjunction with other District agencies, community groups, and federal agencies to improve conditions in the watershed. A key element of the stream restoration plan is the interrelationship between Watts Branch and Watts Branch Park. Successful restoration of Watts Branch has great potential to aid in revitalizing and rehabilitating Watts Branch Park and adjacent neighborhoods.

Groups involved in the restoration of the Watts Branch Park and the Watts Branch watershed include:

- The **District Department of Parks and Recreation** (DPR) is actively working on reclaiming and restoring green space (*i.e.*, Watts Branch Park) through civic partnerships and improved landscape standards. DPR works also with DOH to implement Low Impact Development (LID) strategies for stormwater retrofit to reduce the quantity and improve the quality of stormwater discharged into Watts Branch.
- **Washington Parks and People** (WPP) is a non-profit organization dedicated to restoring and enhancing public parks within the District. DPR has assigned WPP a major role in rehabilitating Watts Branch Park. In February 2001, WPP launched the "Down By The Riverside Campaign," in partnership with DPR, to restore, reclaim, and revitalize Watts Branch Park. The "Down By the Riverside Campaign" has helped renew community interest in Watts Branch Park. WPP has developed and is implementing a mater plan to rehabilitate Watts Branch Park. DOH and the Service are coordinating development of stream restoration with WPP's master plan.
- The **District Department of Transportation** (DOT) is working on rehabilitating and improving the Watts Branch bike trail system. The primary bike trail runs parallel to Watts Branch. DOT works also on improving street maintenance to improve the quality of stormwater discharged into Watts Branch. DOT and DPR have coordinated with DOH and the Service on the development of the bike trail rehabilitation plans. DOH and the Service have attended field-walks and plan review meetings.

Other groups involved in the restoration of the Watts Branch watershed include:

- The **District Housing Authority** (HA) is in the process of redeveloping two former public housing projects in the Watts Branch Watershed. Redevelopment presents opportunity to efficiently correct the sewage and stormwater drainage problems associated with the old site designs.
- The **District Department of Public Works** (DPW) is working on improving solid waste, recycling, and street and alley cleaning programs. Dumping in Watts Branch is a frequent occurrence that degrades the stream.
- The **District Water and Sewer Authority** (WASA) maintains the sanitary and stormwater sewers within the District of Columbia portion of the Watts Branch

watershed. WASA repairs to sanitary sewer leaks as they are discovered. WASA is conducting City-wide inspections to locate leaks and develop capital improvement plans.

- The **U.S. National Park Service** (NPS) manages Anacostia Park. Lower Watts Branch flows through Anacostia Park before reaching the Anacostia River. Stream restoration of Upper Watts Branch will not directly impact NPS lands, but DOH intends to address stream problems in Lower Watts Branch after completion of the Upper Watts Branch stream restoration.
- The **U.S. Army Corps of Engineers** (Corps) provides technical assistance to DOH under the Section 206 Small Aquatic Ecosystem Restoration program. The Corps initiated work on developing a stream and watershed restoration project for Watts Branch. Due to funding restrictions, however, the Corps was unable to continue with the project.
- The **U.S. Geological Survey** (USGS) maintains a stream gage on Watts Branch just upstream of where Watts Branch crosses Minnesota Avenue N.E. The USGS has assisted the Service by providing 15-minute stream discharge data and other data.

D. RESTORATION OBJECTIVES

During the watershed and stream assessment, the Service identified existing and potential stream problems, the formative processes causing stream and watershed degradation, and the types of stream adjustments that have the best potential to remedy identified stream problems. Working with DOH, the Service developed an initial set of restoration objectives based on the needs for stream, watershed, and habitat improvement. DOH and the Service held meetings with restoration partners to identify other restoration objectives. The Service reviewed restoration objectives and identified the stream restoration design elements that may be implanted to achieve the various restoration objectives. Stream restoration objectives and stream restoration design elements are presented in Appendix A. Constraints on implementing objectives and actions that other partners are undertaking are presented also in Appendix A.

Restoration objectives are grouped in Appendix A by category. Major issues in each category are:

1. Water Quality:

Watts Branch is negatively impacted by water borne pollutants, sewage leaks and sanitary sewer overflows, litter and trash, high suspended sediment, and stormwater. Stream restoration can remedy some, but not all of causes of water quality impairments. Therefore, stream restoration project objectives for water quality improvements are to focus on reducing bank erosion (a primary source of suspended sediment) and to implement stormwater retrofits where feasible.

Continuing efforts by others are necessary to fully address water quality issues. Sediment erosion from Prince Georges County will continue until similar efforts are undertaken in the Prince Georges portions of Watts Branch and its tributaries to stabilize streambanks. Stormwater retrofit in combination with stream restoration efforts will reduce, but not

eliminate water borne pollutants, litter and trash. Stormwater management retrofit efforts throughout the watershed will be necessary to reduce the impact of stormwater on Watts Branch. Stormwater management retrofits should reduce the amount of hydraulically connected impervious area; implement water quality treatment of stormwater runoff from urban areas; and work to increase infiltration. WASA's efforts to rehabilitate the District's sewage collection system are critical to long-term water quality improvements.

2. Stream Stability:

The Service's stream assessment (Eng 2002) found that Upper Watts Branch is laterally and vertically unstable, entrenched, and has poor aquatic habitat. Urbanization and development of the Watts Branch watershed created the following stream impacts:

- Increased watershed imperviousness modified the flow regime of Watts Branch. Stormflow has higher peaks and greater volumes. Baseflow is minimal.
- Stream modifications and increased stormflow caused the stream to incise, to lose direct connection with the floodplain, and to become entrenched. As the stream incised, larger storm events with higher shear were held within the stream boundaries. Stream down-cutting and increased shear eroded banks and resulted in stream widening.
- Another impact of increases in shear stress is that stream has greater capability to mobilize stream sediment. Shear stress associated with large stormflow events (*i.e.*, bankfull discharge and greater), can mobilize the entire channel bed. The result is that Watts Branch possesses large areas of loose sediment and few bed features that can dissipate flow energy.
- Aquatic habitat is poor due to loss of pools and unstable channel sediment. Riparian habitat is poor because channel incision lowered groundwater levels adjacent to the stream and because of urban encroachment.
- Confinement of flood flows has resulted in bank erosion, failing and oversteepened streambanks. To address bank erosion problems, many of the streambanks have been armored or lined with rock walls.

To address these stream impacts, the objective of the stream restoration project is to reconfigure the stream so that the stream can self-maintain stability while transmitting the flows and sediment delivered from upstream and from stormflow over time. To reduce the high bank and stream stresses associated with frequent stormflow events, the floodprone width of the stream must be increased and stormflow energies must be dissipated.[2] The ability to reconfigure the stream to meet these objectives is constrained, however, by existing urban development, floodplain management objectives, and other

[2] Floodprone width is the stream cross section width at twice maximum bankfull depth. Channel entrenchment is measured using the entrenchment ratio which is calculated as the floodprone width of the channel divided by the bankfull channel width. Channels with entrenchment ratios less than 1.4 are classified as "entrenched". Channels with an entrenchment ratio greater than 1.4 and less than 2.2 are classified as "moderately entrenched". Channels with entrenchment ratios greater than 2.2 are classified as "slightly entrenched".

uses of Watts Branch Park. The restoration plan balances the stream adjustments required to satisfying stream stability objectives with the grading impacts created by the stream reconfiguration. Details on the design approach required to meet stream stability objectives are provided in *Section II, Restoration Design Approach*.

3. Floodplain Management

The Federal Emergency Management Agency (FEMA), which oversees the National Flood Insurance Program (NFIP), prepared a Flood Insurance Study for the District in 1985 that established the 100-year floodplains and a floodway for Watts Branch (FEMA 1985). FEMA defines the 100-year floodplain as the area inundated by a discharge with a return period of 100 years. A floodway is a protected zone with a defined boundary within the floodplain that provides the majority of flood conveyance. The floodplain fringe is the area within the 100-year floodplain, but outside the floodway. Appendix B contains copies of the FEMA floodplain maps for the District portion of Watts Branch.

FEMA regulations were developed to reduce flood risk by preventing any development within the floodway and only limited development within the floodplain fringe. Because stream restoration of Watts Branch will result in changes to the FEMA floodway and floodplain, the stream restoration is subject to permitting under FEMA regulations. DOH and the Service must demonstrate through hydraulic analyses that the proposed stream restoration does not impact flood elevations.

Watts Branch has existing flooding problems. There are several bridges crossing Watts Branch that are subject to overtopping or pressure flow during a 100-year return period discharge. Therefore, the floodplain management objectives for the stream restoration are to maintain or lower flood elevations.

4. Aquatic and Riparian Habitat

Watts Branch possesses poor aquatic and riparian habitat. There is little shelter for fish; pools are few in number and generally shallow. Baseflow is low and stream conditions result in shallow flow depths and high water temperatures during the summer. Riparian buffer is discontinuous and generally narrow.

Stream restoration objectives for aquatic and riparian habitat are to increase the variety and robustness of aquatic habitat and increase the amount and complexity of riparian habitat. Stream adjustments will increase the complexity of aquatic habitat by providing a greater number of pools and increasing the average depth of pools. In-stream structures will create a diverse hydraulic environment and aerate the stream. Vertical barriers to fish passage created by stream down-cutting at sanitary sewer crossings will be removed. Riparian plantings will augment existing riparian buffer which will shade the stream during summer months, provide cover and shelter for wildlife, and improve water quality.

5. Quality of Life

Watts Branch is a significant feature of Watts Branch Park and the adjacent neighborhoods. A restored Watts Branch will improve the aesthetic quality of the park and work to attract people to use the park. Passive recreation opportunities will be increased by reconnecting the stream with the park. Design of the restoration is being coordinated with the WPP master plan for park improvements and DOT plans for

rehabilitating the Watts Branch bike trail. Improving the connection of the park with the stream will improve the quality of Watts Branch Park and its adjacent neighborhoods.

II. RESTORATION DESIGN APPROACH

A. RESTORATION PARADIGMS

1. Natural Channel Design Alternatives

There are a variety of approaches that may be used to restore incise, urban streams systems such as Upper Watts Branch. Rosgen (1997) classified restoration approaches for incised streams as falling into four categories called Priority 1 to 4. Priority 1 restoration approaches restore incised streams to the planforms, elevations, and cross sections that they possessed prior to disturbance. For Upper Watts Branch, this would mean raising the stream elevation to its pre-incision elevation, restoring a meandering pool-riffle sequence, and narrowing the stream width. This is not a practicable alternative because the original Watts Branch floodplain has been significantly modified. Restoring Watts Branch to its original configuration would create conflicts with utilities and roadways and increase flood risks to buildings constructed in the Watts Branch floodplain. Priority 4 restoration represents the other end of the spectrum in which a stream is stabilized as an incised channel. Past efforts to stabilize Watts Branch with rock walls and lined channels were a de-facto Priority 4 restoration. Unfortunately, Priority 4 restorations are prone to failure and have low habitat value. Many of the rock walls lining Upper Watts Branch are failing because high stress flows have undermined the base of the walls. Stabilizing Watts Branch in its existing configuration would maintain the low habitat quality of the stream.

Priority 2 and Priority 3 restoration approaches are a middle ground between Priority 1 and Priority 4. In a Priority 2 restoration, channel incision is decreased by raising the stream to a higher level, but not to the original level. Cross sections are shaped to increase floodprone area and reduce shear stress for flows higher than bankfull. In a Priority 3 restoration, stream cross section is modified to reduce stress at or about the existing stream elevation. Shear stresses are higher with Priority 3 than with Priority 2, but less grading is required.

2. Recommended Natural Channel Design Alternatives

The Service and DOH will restore Watts Branch using natural channel design methodologies. The recommended priority restoration for Upper Watts Branch is a Priority 3 with some elements of a Priority 2 restoration. A Priority 1 restoration is not feasible because: (1) the opportunities to raise stream grade in Upper Watts Branch are limited by existing flooding problems and by installed infrastructure: (2) the outfalls of many storm sewers are at or just above existing stream grade; and (3) several bridges are already overtopped by floods with return periods of 10-years, so increasing the flood risk is not acceptable. Implementing a Priority 2 restoration is not feasible in all of areas of Upper Watts Branch because in some areas increasing the floodprone area will create: (1) conflicts with roadways, and paths; (2) too much grading and excavation; and

(3) undesirable loss of established trees and vegetation. The decision on whether to implement a Priority 2 or Priority 3 restoration will be made on a reach-by-reach basis.

B. RESTORATION STRATEGY

1. Existing Conditions and Problems

Upper Watts Branch is predominantly a Rosgen F4 stream type[3]. Most of the stream reaches are entrenched. As flow levels rise above bankfull depth, there is little increase in stream width. Thus, shear stress continues to rise with depth during major flow events increasing bank erosion potential.

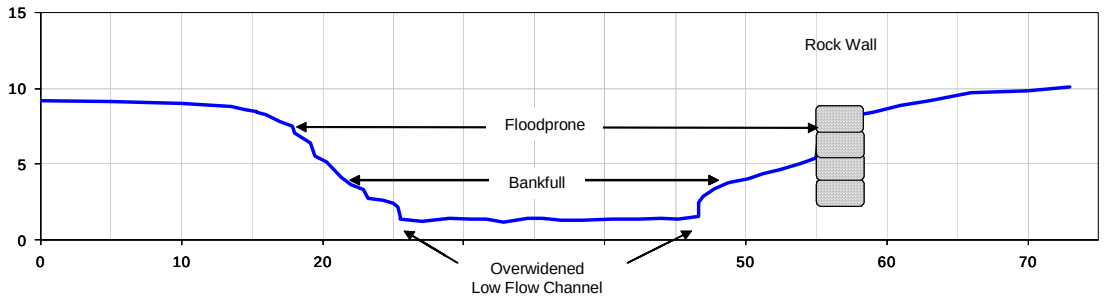
Figure 1(a) shows a typical cross section of an entrenched stream section in Watts Branch. Flashy flood flows and unstable bed sediment eroded from banks create an overwidened low flow channel. Typical flow conditions between storm runoff events consist of very shallow flow spread across the stream. Flow depths are insufficient for fish and water temperatures increase rapidly on hot days. Stream down-cutting led to the stream entrenchment and broke the connection between the stream and the floodplain.

2. Recommended Restoration Strategy

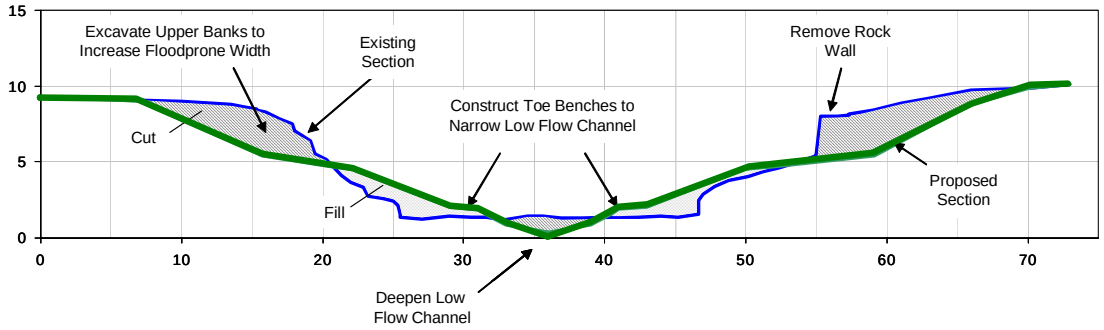
The Service recommends restoring Upper Watts Branch by converting the stream type from a Rosgen F4 stream type to a combination of Rosgen C4 (Priority 2) and B4c (Priority 3) stream types. A Rosgen F4 stream type has an entrenchment ratio of less than 1.4. A Rosgen C4 stream type has an entrenchment ratio greater than 2.2 ("slightly entrenched"), while a Rosgen B4c stream type has an entrenchment ratio of between 1.4 and 2.2 ("moderately entrenched"). Conversion from a Rosgen F4 stream type to either a Rosgen C4 or B4c stream type will increase the floodprone width of the cross section and reduce high shear stresses experienced during channel shaping flow events.

In general, conversion to a Rosgen C4 stream type is preferable because stream entrenchment is reduced more than with a Rosgen B4c stream type, but the amounts of disturbance and excavation are greater for a Rosgen C4 stream type conversion than a Rosgen B4c stream type conversion. Rosgen C4 stream types are preferable also because they tend to dissipate energy more efficiently than Rosgen B4c stream type. Rosgen C4 stream types are more sinuous and dissipate energy through planform meandering. The Rosgen B4c stream type does provide as much energy dissipation as the Rosgen C4 stream type because the Rosgen B4c stream type possesses lower sinuosity and lower stream entrenchment. Therefore, energy must be dissipated through use of in-stream structures such as step-pools.

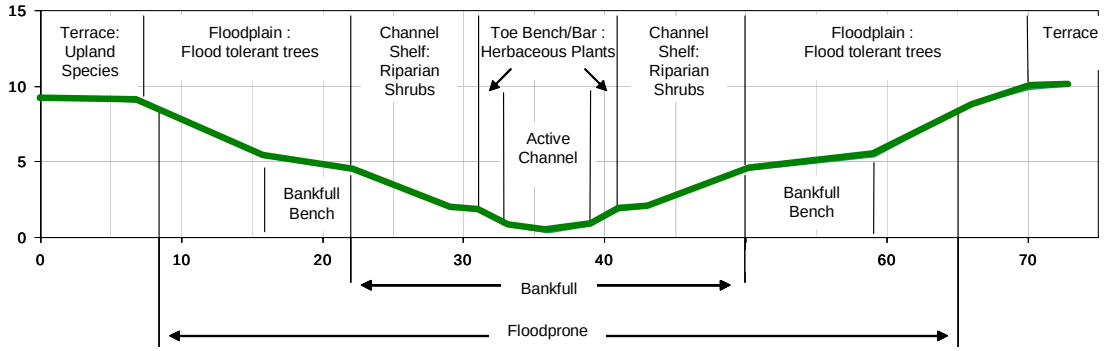
[3] Streams are classified in accordance with the Rosgen Stream Classification System (Rosgen, 1996).



(a) Typical Existing Stream Cross Section (units in feet)



(b) Cross Section Adjustments



(c) Proposed Cross Section Features and Vegetation Zones

Figure 2: Cross Section Adjustments – F4 Stream to B4c Stream

Figure 1(b) depicts the conversions that would take place using the typical cross section from Figure 1(a). The top of the banks are excavated to increase the floodprone width of the stream. Toe benches will be constructed to create a low-flow channel within the bankfull channel that concentrates flow into a narrow, deep channel between storm events. The inner channel is formed by toe-benches that are constructed from fill, and are held in place by rock, woody debris, and riparian shrubs. Rock walls are removed and steep high banks are graded back to stable angles.

The morphological adjustments in Figure 1 reflect a conversion from a Rosgen F4 stream type to a Rosgen B4c stream type. The entrenchment ratio is raised from 1.28 in the existing cross section to 2.06 in the proposed section. The bankfull width/bankfull mean depth ratio (W/d) is reduced slightly from 13.0 in the existing section to 12.3 in the proposed section.

In this example, both banks were cut to increase floodprone area. It may not be possible or desirable to perform grading in all locations. Grading that might be necessary to achieve a stable stream cross section may conflict with valuable, existing stands of trees, or structures and infrastructure. Site-specific decisions will be required to determine the extents of grading and stream adjustments that are desirable in each reach.

In-stream structures and riparian plantings will be installed to stabilize the stream cross section. In-stream structures will consist of rock vanes, log vanes, J-hooks, cross vanes, and rock step-pools. The in-stream structures will be designed to steer the flow through tight bends, dissipate energy, and prevent high stress on streambanks.

The in-stream structures provide a skeleton for the stream, but in the long-term, it is the riparian plantings that will maintain stream stability. Riparian plantings will provide rooting to increase the strength of streambanks, riparian habitat, and increase stream roughness that will slow down stream stormflow velocities. Riparian planting zones are depicted in Figure 1(c). No planting occurs within the low flow or active channel. The active channel area is where stream gravel transport occurs. The toe-benches are located between the active channel and channel shelf. The channel shelf is a frequently flooded area located below bankfull elevation. Riparian vegetation that can withstand frequent flooding and provide strong rooting will be planted in this zone. Large woody debris will be placed in the channel shelf during construction to provide some initial channel roughness and for habitat. The floodplain zone starts above bankfull. This area will contain trees that can withstand occasional inundation. The bankfull bench is a flat or shallowly sloped zone above bankfull that slows high velocity flows during flows above bankfull. Flow velocities at the outer edge of the bankfull bench will be too slow to erode the steeper banks connecting the bench to the upper terraces.

3. Restoration Design Criteria

Detailed stream cross section shape parameters will be determined using natural channel design principles. Reference reach data has been collected for Rosgen C4 and B4c type streams and is being used to develop natural channel design parameters for Watts Branch. This work is on-going and will be finalized during the next design work-phase. The reference reach data provides dimensionless ratios that are scaled by bankfull discharge to provide specific design parameters for the restoration design. Shape parameters

include bankfull width, bankfull area, and bankfull depth for riffles, pools, runs, and glides. Planform parameters developed from reference reach data include pool spacing, meander length and curvatures, and guidance for locating in-stream structures. Design parameters will be determined for each reach based on local slope, stream sinuosity, and existing conditions and uses of the stream and floodplain.

a. Stream Cross Section Morphology

Design of detailed channel morphology is on-going. To develop the ten percent concept plans, the Service used an average bankfull depth in riffle that ranges between 2.25 to 2.50 feet and a bankfull width of 28 feet, and a floodprone width of 60 feet. The Service anticipates that design values of bankfull depths in riffle that ranges between 2.25 to 2.50 feet, and that the bankfull width will range from 25 to 35 feet, and floodprone width will range from 55 to 80 feet.

b. Stream Planform Adjustments

The stream planform will be modified as opportunities allow. Currently, there are many sections of stream that are straight or have very low sinuosity[4]. Opportunities to increase stream sinuosity are constrained in locations because of existing uses of the floodplain, the degree of stream incision in many areas, and the many bridge crossings. The restoration will increase stream sinuosity by opportunistically grading alternate sides of the stream to allow a slight degree of stream meandering. The stream assessment showed that there are few pools in Watts Branch. Through use of in-stream structures and planform adjustments, new pools will be created.

The planform shown in the ten percent plans assumes a radius of curvature of between 125 and 150 feet, or about four to five times the bankfull width. Pool spacing is about five to seven times the bankfull width of 28 feet. The ratios of radius of curvature to bankfull width and pool spacing are typical of Rosgen C4 stream types.

c. Stream Grade Adjustments

In general, stream grade (the elevation of the stream) will be maintained at its existing elevation. Raising the stream would create some conflicts with existing stormwater infrastructure, bridges, and floodplain management objectives. There are two exposed sanitary sewer crossings where stream down-cutting downstream of has created large vertical drops in the stream. The drops create barriers to upstream fish passage and act to destabilize the stream. Stream grade will be gradually raised in the reaches downstream of the exposed sanitary sewers using in-stream grade controls to remove the vertical barriers to fish passage. Grade drops will be limited to the height that is acceptable for passage of resident and anadromous fish species.

[4] Channel sinuosity maybe calculated as the total channel length divided by the down-valley channel length. Channels with low sinuosity have greater erosive energy because average slopes are greater. Channel with higher sinuosity have higher planform energy losses.

4. Stormwater Retrofit

Stormwater retrofit is required in the Watts Branch Watershed to reduce the large percentage of directly connected impervious area. The watershed's storm sewer and street drainage network quickly transmit rainfall on impervious areas to outfalls in Watts Branch. The stormwater network negatively impacts Watts Branch in three ways: (1) stormflow peaks are very high resulting in frequent erosion of streambanks and uprooting of riparian vegetation; (2) stormflow on impervious areas does not have the chance to infiltrate and recharge the surficial aquifer that supplies baseflow to Watts Branch; and (3) pollutants and litter washed off of impervious areas reach Watts Branch without any treatment and degrade Watts Branch's water quality.

The long-term strategy for the watershed is to reduce the amount of directly connected impervious area. The Upper Watts Branch stream restoration project can address only a portion of the problem. Stormwater management retrofits for the stream restoration project are limited to those sites in the immediate vicinity of the stream. Retrofits will improve the quality of Watts Branch by collecting stormwater-borne trash at outfalls, creating settling pools for large sediment, and providing opportunities for stormwater to infiltrate before reaching the stream, thereby reducing stormwater peaks and augmenting baseflow. Proposed stormwater concepts include the following elements:

a. Outfall and Storm Sewer Modifications

As space allows, stormwater outfalls will be removed from the stream to a point back in the floodplain that will be determined during the final design. The final location will be selected on the basis of hydraulic grade and avoidance of disturbance to park areas and paths. Energy dissapators will be constructed where stormwater outfalls can not be relocated from the stream.

b. Trash separation/sediment Forebays

Trash collection and sediment forebay areas will be installed to trap storm sewer-borne trash and debris. Forebays will require maintenance and cleanout to remove litter. Maintenance can be rolled into existing park programs designed to pick up litter and trash. To minimize maintenance requirements, the Service will design trash collectors that do not require mechanically-assisted clean-out.

c. Bio-swales

Where space allows, outfall pipes to the stream will be replaced with infiltration trenches augmented with bioretention materials and plantings that will filter and treat water quality. Appropriately sized bio-swales provide 30-80 percent pollutant removal– including decreases in total suspended solids, total phosphorous, total nitrogen, floating trash, heavy metals, biological oxygen demand, bacteria, greases, oils, and turbidity. Bio-swales will be sized in accordance with stormwater loading to maintain minimum velocities during scour events. Depressions and sills will be installed to create retention areas for long-term infiltration into the floodplain. Placement of swales will be routed to avoid significant trees.

Because some of the storm sewers drain large areas and the space along the stream is limited in some areas, some of the swales may be undersized for the amount of flow that they will receive. The Service believes, however, it is better to provide partial treatment than no treatment when providing full treatment is not an option.

d. Wetland Creation

There is room for creation of wetlands in some of the low-lying areas within the park. Wetlands would possess frequently flooded zones that support wetland vegetation. Wetlands creation might be combined with adjustments to storm sewer outfalls and stormwater management retrofits. Wetlands would increase infiltration of stormflow, provide water quality treatment, and increase the range of habitats.

e. Braided Channel Outfalls

Outflow from the swale systems will be routed through distributary channels that will spread flow across the floodplain and gradually release flow into Watts Branch. Flow velocities will be maintained at non-eroding velocities and the channels will provide further opportunities for infiltration. Braided channels would be lined with small stone and logs salvaged during construction would be used to create steps and pools.

III. PROJECT AREAS

The Service prepared a set of plan sheets showing preliminary stream restoration recommendations for Upper Watts Branch[5]. The plans show the locations of proposed stream thalweg adjustments, potential streambank grading areas, areas where stormwater management might occur, and any special or unusual local conditions that might affect the restoration plan. The grading boundary assumes a target floodprone width of 60 feet, but the actual width will vary from site to site as designs advance.

The Service separated Upper Watts Branch into eleven project areas. The boundaries of the project areas are generally at major road crossings that separate the stream into separate work areas. Because the horizontal location and vertical clearance of bridges are treated as fixed, stream grade and stream alignments must tie in at existing bridge crossings. Thus, road boundaries provide effective points for starting and stopping different restoration work phases.

The sections below discuss the alternatives for each project area. The particulars and special conditions found in each of the project areas are described under "*Physiography.*" Specific recommendations for stream restoration in project area are provided under *"Recommendations."* The accompanying plan sheets show the preliminary alternative that the Service recommends for each reach. A discussion (*"Design Issues"*) is provided at the end of each section that provides insights on the reasoning used by the Service in selecting the recommended alternatives and other restoration options.

[5] *Watts Branch Stream Restoration: Southern Avenue to Minnesota Avenue 10 Percent Preliminary Concept Alternatives*, 17 sheets, April 2005, prepared by U.S. Fish and Wildlife Service, Stream Habitat Assessment and Restoration Program, Annapolis, MD.

Project Areas are numbered from 1 to 11, proceeding from upstream to downstream with the exception of Project Area 2, the East Capitol Street tributary to Watts Branch. Project areas are shown in Figures 3 and 4.

A. PROJECT AREA 1: SOUTHERN AVENUE TO 61ST STREET N.E.

1. Physiography

Watts Branch enters the District through a box culvert underneath Southern Avenue. The stream exits Project Area 1 through the 61st Street N.E. Bridge. Watts Branch is confined to a narrow, deeply incised stream slightly over 500 feet in length in this project area. Fences are located at the top of bank on both sides of the stream. A ball field is located on the left[6] side of the stream. Basketball courts, a playground area, and the Watts Branch Community Center are located on the right side of the stream. A pedestrian bridge crosses the stream about midway through the reach.

The streambanks are vegetated with a mixture of shrubs, scrub trees, and occasional larger trees. Because of the fencing and the trees, much of the stream is hidden from view. There is little or no public access to the stream.

The U.S. Natural Resources Conservation Service (NRCS) constructed several stream projects in this reach consisting of cross vanes, rock vanes, and imbricated riprap walls. The projects provided some stream stability, but did not reduce stream entrenchment.

2. Recommendations

The objectives in this section are to reduce stream entrenchment, to increase stream sinuosity, and to provide more access to the stream, while maintaining existing park uses (playground and ballfield). Preliminary restoration recommendations are:

- Increase floodprone area and stream sinuosity by grading back alternate banks.
- Grade oversteepened banks to stable angle.
- Install sub-bankfull toe-benches to decrease baseflow width and to increase baseflow depth.
- Install cross vanes and J-hook instream structures to steer flow away from streambanks. Salvage rock from existing rock walls for use in constructing structures.
- Maintain large trees to the extent possible and salvage small trees in grading areas.
- Replant disturbed areas with riparian vegetation that enhances habitat.

[6] By convention, stream cross sections are oriented based on viewing the stream in the downstream direction. The left bank is on the left side when looking downstream. Watts Branch flows in a generally west northwest direction. The left side of the stream is generally the south side of the stream. The right side of the stream is generally the north side of the stream.

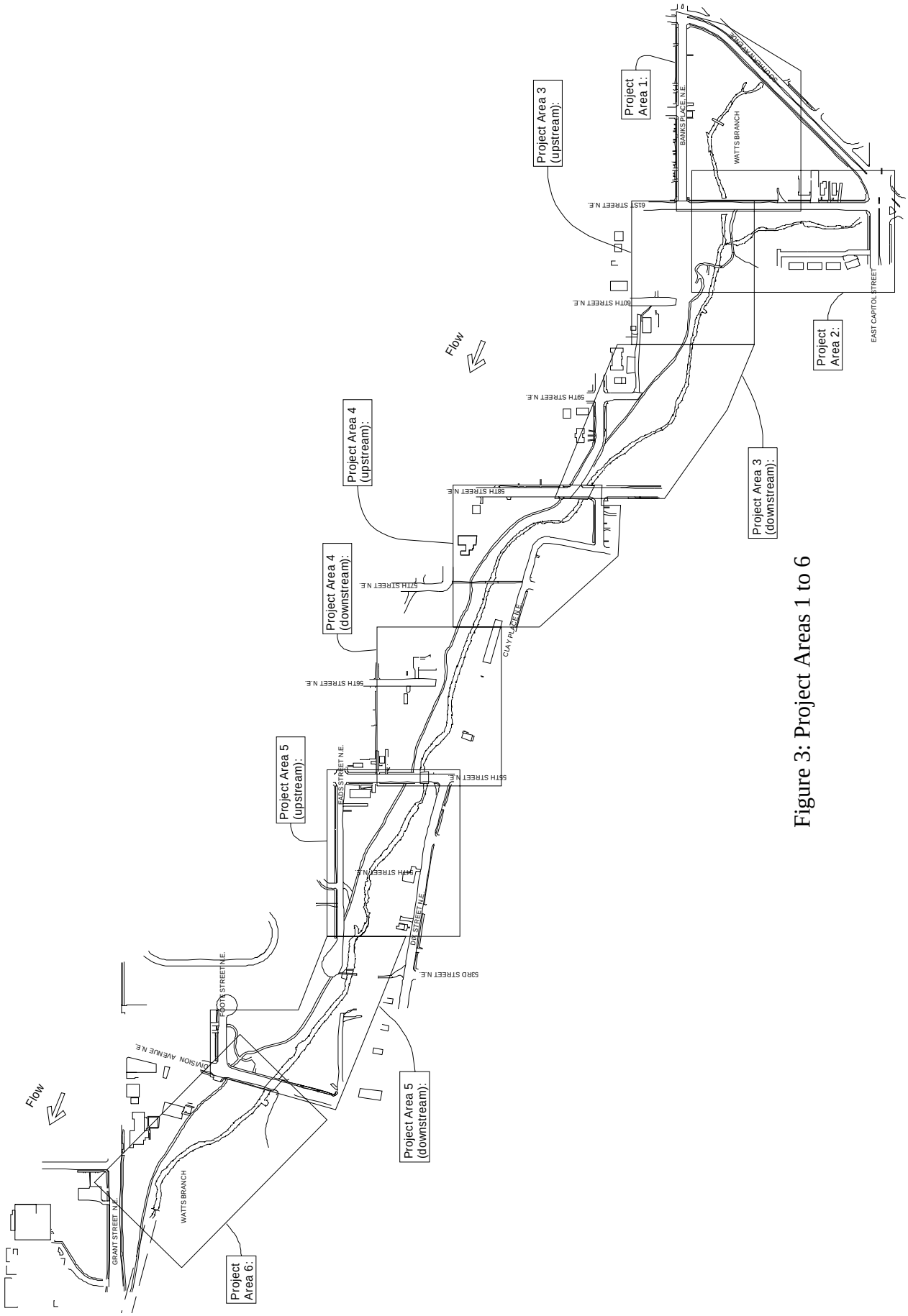


Figure 3: Project Areas 1 to 6

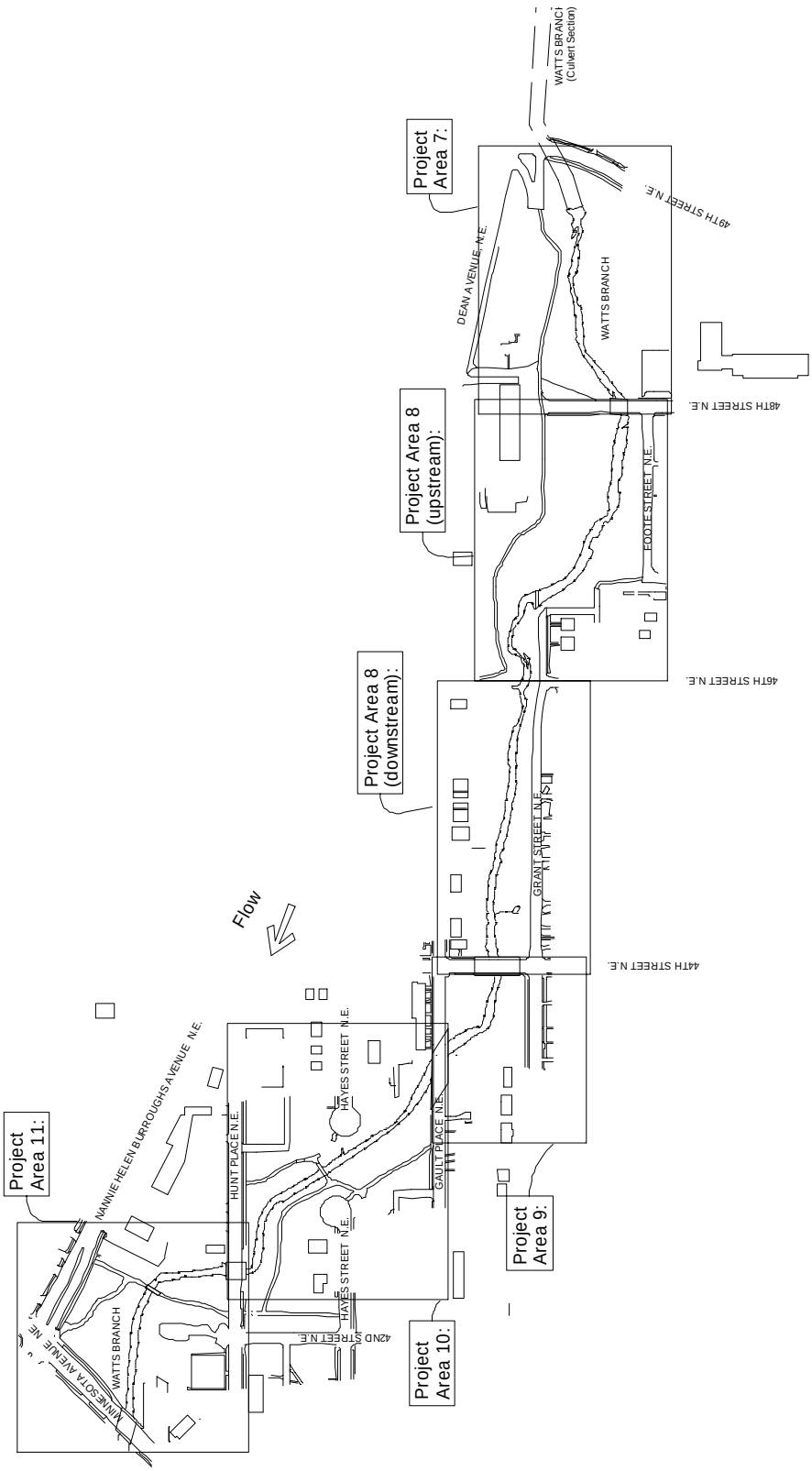


Figure 4: Project Areas 7 to 11

- Adjust fence lines to accommodate bank grading.
- Consider fence removal to allow stream access.
- Place protection for right pedestrian bridge abutment.
- Reduce height of imbricated rock wall to bankfull height and grade back upper bank.

3. Design Issues

The stream is hidden from view in this Project Area by fencing. Grading the banks and removing fencing would provide community access to the stream.

B. PROJECT AREA 2: EAST CAPITOL STREET TRIBUTARY

1. Physiography

Project Area 2 covers the East Capitol Street tributary. The stream starts at the outfall of a concrete culvert that originates on the south side of the Capitol Heights Metro Station. The tributary stream flows generally north and joins the main stem of Watts Branch about 150 feet west of 61st Street N.E. The tributary is bordered by riparian woods on both sides of the stream.

The tributary is not entrenched and has access to its floodplain. There is good riparian buffer along the stream. There are two concrete wall grade controls in the stream that may be preventing down-cutting of the stream.

There are several issues at the confluence of the tributary with Watts Branch. A pedestrian bridge crossing the tributary will be removed as part of the bike trail improvements. The lower grade control structure is located just upstream of the pedestrian bridge. Streambanks below the structure are in poor condition. The outflow jet from the tributary stream intersects the right bank of Watts Branch at an abrupt angle.

2. Recommendations

Improvements in the tributary reach (Project Area 2) focus on the confluence of the tributary with Watts Branch and stormwater retrofits.

- Modify angle of tributary at confluence to reduce erosion of opposite bank of main stem stream (See Project Area 3).
- Remove the concrete grade control upstream of the pedestrian bridge and replace with boulder cascade waterfall and grade control. The boulder cascade will create a more aesthetically appealing grade control structure and will better dissipate flow energy.
- Open curb cuts on 61st Street N.E. (see plans), close street drains, remove SWM outfalls at stream, and install SWM swales to treat road drainage.
- Install energy dissipation at the culvert outfall at the head of the tributary.
- Replant disturbed areas with riparian vegetation that enhances habitat.

- Remove the upstream concrete grade control and replace with a cross vane.

3. Design Issues

Above the grade control at the confluence, the tributary stream is stable. Replacement of the upper grade control structure would be primarily for aesthetic reasons. That is, to provide a natural stream feature rather than a concrete channel feature. The upper grade control structure could remain in place.

Flow from the tributary hits the main stem at a right angle. Below the confluence, flow impinges on the opposite bank of the main stem. A rock wall protects the bank from failing. Replacement of the lower grade control would facilitate realignment of the angle of the confluence and realignment of the downstream main stem stream. If the lower grade control structure is not replaced, then realignment of the downstream stream is not recommended.

C. PROJECT AREA 3: 61ST STREET N.E. TO 58TH STREET N.E.

1. Physiography

Project Area 3 begins at the 61st Street N.E. Bridge and ends at the 58th Street N.E. Bridge. There is a pedestrian bridge that crosses the stream between 60th Street N.E. and 61st Street N.E. The stream is relatively straight through the project area. Rock walls line the streambanks along much of the length of the stream. The left side of the stream is wooded. The floodplain on the right bank contains open grassland with scattered mature trees.

Between 59th Street N.E. and 60th Street N.E., it appears that a meander loop was purposely cut-off in an attempt to straighten the stream. The stream is locally steep in this area. The stream is armored with large rock in the cutoff channel.

2. Recommendations

The objectives in this project area are to reduce stream entrenchment and to increase stream sinuosity and stream stability, while maintaining existing park uses. Preliminary restoration recommendations are:

- Increase floodprone area and stream sinuosity by grading back alternate banks (as shown on plans).
- Remove vertical rock walls. Grade oversteepened banks to stable angle.
- Install sub-bankfull toe-benches to decrease baseflow width and to increase baseflow depth.
- Install cross vanes and J-hook instream structures to steer flow away from streambanks. Salvage rock from existing rock walls for use in constructing structures.
- Stabilize confluence with East Capitol Street Tributary.
- Reoccupy original stream channel between 59th Street and 60th Street. Fill in existing channel.

- Maintain large trees to the extent possible and salvage small trees in grading areas.
- Determine causes of poor drainage and standing water on north side of bike path between 59th Street N.E. and 61st Street N.E. Implement SWM practices that provide infiltration or create wetlands in these areas.
- Replant disturbed areas with riparian vegetation that enhances habitat.

3. Design Issues

Pedestrian bridge

Realignment of the stream downstream of the East Capitol Street Tributary requires replacement of the pedestrian bridge across the Watts Branch main stem. The Service and DOH have recommended to DOT and DPR that the bike trail improvements include replacement of the pedestrian bridge. In January 2005, DOT indicated that they did not think funds were available to accomplish the bridge replacement. Watts Branch is enclosed within a narrow channel in the vicinity of the pedestrian bridge. Our preliminary stream restoration concept calls for reducing the stream entrenchment by widening the floodprone area. This is not possible if the existing pedestrian bridge remains in place.

Increasing the floodprone area will decrease the elevation of frequent floods. Under current conditions, the pedestrian bridge is overtopped by low return period floods (i.e., a two-year to five-year return period flood). Replacing the pedestrian bridge rather than rehabilitating the existing pedestrian bridge should reduce long-term maintenance costs for the crossing and will decrease the flood risk at the crossing.

Clay Street

The 58th Street N.E. Bridge is located close to the intersection of 58th Street N.E. and Clay Street N.E. Stream adjustments near the bridge are constrained by the Clay Street N.E. embankment which is located close to the stream. The stream can not be widened without because it must align with the bridge opening and because Clay Street N.E. is too close to the existing stream.

D. PROJECT AREA 4: 58TH STREET N.E. TO 55TH STREET N.E.

1. Physiography

Watts Branch enters Project Area 4 through the 58th Street N.E. Bridge and makes an immediate sharp turn to the north. In this reach, the floodplain and stream are closely bordered by a network of streets (Dix Street N.E., 58th Street N.E., and Clay Street N.E.). The stream flows north for about 150 feet before turning sharply to the west. There is a large concrete stormwater outfall structure on the outside of the bend. The stream flows generally west from the bend through a straightened channel. A pedestrian bridge crosses the stream opposite 56th Street N.E. A series of houses abuts the stream on the left bank downstream of the bridge. Below the houses, a sewage pump station pinches the stream on the right. Between the bend and the sewage pump station, the banks are high and the stream is incised. Below the sewage pumping station, the stream widens, and banks heights drop. Just before the 55th Street Bridge, the stream bottom is lined with block.

2. Recommendations

- Increase floodprone area and stream sinuosity by grading back banks (as shown). Stream adjustments must be made to steer the stream around several structures near the banks: the concrete outfall structure at the stream bend; the pedestrian bridge; the row of houses on the left bank; and the sewage pumping station on the right bank.
- Remove vertical rock walls. Grade oversteepened banks to stable angle.
- Because of size and lack of room for stormwater retrofits, the concrete stormwater outfall on the outside of the bend will be maintained, but energy dissipation will be installed to protect the stream.
- Stabilize banks at pedestrian bridge to protect abutments.
- Install sub-bankfull toe-benches to decrease baseflow width and to increase baseflow depth.
- Install cross vanes and J-hook instream structures to steer flow away from streambanks. Salvage rock from existing rock walls for use in constructing structures.
- Install SWM treatment swales to infiltrate and treat stormwater. Install a larger SWM infiltration area at the corner of Clay Street N.E. and Dix Street N.E.
- Remove stream lining upstream of 55th Street N.E. and restore natural channel.
- Maintain large trees to the extent possible and salvage small trees in grading areas.
- Replant disturbed areas with riparian vegetation that enhances habitat.

3. Design Issues

There is a large stormwater outfall that enters the stream at the bend. The outfall originates from the direction of 58th Street N.E. An alternative would be to daylight the outfall near 58th Street N.E. This alternative was not recommended because this would require a bridge to be constructed for the bike path. Given the size of the structure, further investigations will be undertaken to identify is there are other alternatives.

E. PROJECT AREA 5: 55TH STREET N.E. TO DIVISION STREET N.E.

1. Physiography

Project Area 5 starts at the 55th Street N.E. Bridge and extends to the Division Street N.E. Bridge. The left bank is high and steep for most of the project area. Immediately below 55th Street N.E., an outfall on the left bank creates a pinch in the stream that causes an abrupt bend to the right. The stream then flows generally west northwest in a fairly straight stream. A pedestrian bridge crosses the stream near the end of Eads Street N.E. Just upstream of the pedestrian bridge, there is an exposed sanitary sewer crossing that creates a vertical barrier to fish passage. Below the pedestrian bridge, there is a high retaining wall on the left bank.

2. Recommendations

- Increase floodprone area and stream sinuosity by grading back the right bank (as shown) between the sanitary sewer crossing and Division Street N.E. Between 55th Street N.E. and the sanitary sewer, grade banks as shown.
- Adjust the stream alignment using in-stream structures to steer the stream through the pinch point below the 55th Street N.E. Bridge.
- Raise stream grade between the sanitary sewer crossing and Division Street N.E. using grade controls.
- Install step-pools below the sanitary sewer crossing to dissipate energy and to provide fish passage.
- Grade oversteepened banks to stable angle.
- Install sub-bankfull toe-benches to decrease baseflow width and to increase baseflow depth.
- Install cross vanes and J-hook instream structures to steer flow away from streambanks. Salvage rock from existing rock walls for use in constructing structures.
- Install SWM treatment swales to infiltrate and treat stormwater.
- Maintain large trees to the extent possible and salvage small trees in grading areas.
- Replant disturbed areas with riparian vegetation that enhances habitat.

3. Design Issues

The area near Division Street N.E. is of particular WPP concern. WPP is developing plans to modify areas adjacent to the right bank of the stream on the upstream and downstream side of Division Street. Design of stream adjustments and stormwater management will be carefully coordinated with WPP in this area.

There are three major stormwater outfalls in this Project Area. The one on the left bank is difficult to retrofit because of the steepness of the left bank. There are limited areas available at the two outfalls on the right bank. Daylighting the two outfalls might require significant grading because of the depth of the sewers. Stormwater management improvements might be limited to providing energy dissipation and rudimentary trash collectors. Further investigations are required to better define alternatives.

The retaining wall on the left bank below the pedestrian bridge will remain in place. Ground surface above the wall is high above the stream. The retaining wall is required to hold the left bank; the bank is too steep to be stable without the retaining wall.

F. PROJECT AREA 6: DIVISION STREET N.E. TO CULVERT ENTRANCE

1. Physiography

Project Area 6 extends from Division Street N.E. to the entrance of the culvert where Watts Branch flows underground. Just below Division Street, there is a large stormwater

outfall on the left bank. The left bank is high and steep through the Project Area. On the right bank, the remnants of fill for a long-abandoned trolley line form large high areas adjacent to the stream. At the culvert, Watts Branch enters a closed channel system that reemerges above ground below 49th Street N.E. The lower end of the stream in this project area was straightened and relocated to line it up with the culvert entrance. Prior to its relocation, Watts Branch turned to the north and flowed on the north side of Nannie Helen Burroughs Avenue.

2. Recommendations

- Increase floodprone area and stream sinuosity by grading back banks (as shown).
- Grade oversteepened banks to stable angle.
- Install sub-bankfull toe-benches to decrease baseflow width and to increase baseflow depth.
- Install cross vanes and J-hook instream structures to steer flow away from streambanks.
- Install SWM treatment swales to infiltrate and treat stormwater. Install outfall erosion protection and energy dissipation at large outfall on left bank.
- Maintain large trees to the extent possible and salvage small trees in grading areas. Replant disturbed areas with riparian vegetation that enhances habitat.
- Grading plans will be developed to provide open sightlines into the stream areas to discourage illegal activities.

3. Design Issues

WPP is developing plans to remove the large area of fill on the right bank and to convert the area to a playground and community activity area. Stream adjustments will be coordinated with the WPP design.

G. PROJECT AREA 7: CULVERT EXIT TO 48TH STREET N.E.

1. Physiography

Project Area 7 starts where Watts Branch emerges from the culvert below 49th Street N.E. and extends to the closed 48th Street N.E. bridge. The left bank borders the Aiton Elementary School. There is a high, chain link fence at the top of the bank that separates the school from the stream. The existing bike path approaches close to the stream on the right bank. Proposed bike path changes will move the bike path away from the stream.

2. Recommendations

- Increase floodprone area and stream sinuosity by grading back the right bank.
- Install armored scour hole and cross vane at culvert outfall to dissipate energy.
- Grade oversteepened right bank to stable angle.

- Install sub-bankfull toe-benches to decrease baseflow width and to increase baseflow depth.
- Install cross vanes and J-hook instream structures to steer flow away from streambanks. Salvage rock from existing rock walls for use in constructing structures.
- Install SWM treatment swales to capture flow from 49th Street and Nannie Helen Burroughs Avenue.
- Maintain large trees to the extent possible and salvage small trees in grading areas.
- Replant disturbed areas with riparian vegetation that enhances habitat.

3. Design Issues

The 48th Street N.E. Bridge is closed to traffic. As part of bike path and other park improvements, the bridge will be converted to a community gathering area. The bridge length is short and restricts flow to less than stable floodprone width. Maintaining the bridge restricts the potential for stream restoration in this reach, however, WPP has plans to use the bridge to foster community development activities. The bridge is also the only pedestrian connection between the left and right bank of Watts Branch between 49th Street N.E. and 44th Street N.E. Leaving the bridge in place will require the use of hard stream design to protect the channel.

The initial design approach in Project Area 7 avoided any disturbance to the lands maintained by Aiton Elementary School. Discussions with WPP suggested that options that open the stream to the Aiton Elementary School might provide value in the form of educational opportunities and tie-ins to park activities.

H. PROJECT AREA 8: 48TH STREET N.E. TO 44TH STREET N.E.

1. Physiography

Project Area 8 extends from the 48th Street N.E. Bridge to the 44th Street N.E. Bridge. Between 48th Street N.E. and 46 Street N.E., there right floodplain is forested. Just above 46th Street N.E., there is an exposed sanitary sewer that creates a vertical barrier and destabilizes the stream. Below the sanitary sewer, the stream is highly unstable. Bank erosion on the right bank was, until recently, threatening to undermine portions of the existing bike trail. Recent tree-fall into the active channel is deflecting flows away from the threatened bank and a bench has formed at the base of the slope.

2. Recommendations

- Install cross vane grade controls below sanitary sewer crossing (near 46th Street N.E.) to raise stream invert in the reach from the sanitary sewer crossing downstream to 44th Street N.E. Maintain existing flood elevations by compensating with additional floodprone area.
- Realign stream at sanitary sewer crossing to a wider bend radius to relieve erosion of roadway embankment on left bank.

- Construct two vernal pools[7] in wooded floodplain area on right bank. Coordinate design of vernal pools with nature trail under development by WPP.
- Increase floodprone area and stream sinuosity by grading back banks (as shown). Remove vertical rock walls.
- Grade oversteepened banks to stable angle.
- Install sub-bankfull toe-benches to decrease baseflow width and to increase baseflow depth.
- Install cross vanes and J-hook instream structures to steer flow away from streambanks. Salvage rock from existing rock walls for use in constructing structures.
- Install SWM treatment swales for Grant Street drainage.
- Install energy dissipation for outfall on right side of stream at 46th Street N.E.
- Maintain large trees to the extent possible and salvage small trees in grading areas.
- Replant disturbed areas with riparian vegetation that enhances habitat.

3. Design Issues

A pedestrian bridge will be constructed across Watts Branch below 46th Street N.E. as part of bike path improvements. Stream adjustments will tie into the new pedestrian bridge.

I. PROJECT AREA 9: 44TH STREET N.E. TO GAULT PLACE N.E.

1. Physiography

Project Area 9 extends from the 44th Street N.E. Bridge to the Gault Place N.E. Bridge. Project Area 9 is small and consists of a single bend that turns the stream to flow towards the north. The outer (left) bank is high and contains fill material. Erosion along the outer bank has caused collapse of the lower slope, which has triggered failures along the upper slope and loss of large trees at the top of the bank. The erosion has created difficulties for design of bike path improvements.

2. Recommendations

- Realign the stream to cross the inner (right) bank and away from steep slope on the outer bank (as shown). Increase bend radius to stable radius (approximately 150 - 175'). Fill slope at toe of failed slope. Stabilize bend with J-hooks or rock vanes.
- Grade oversteepened banks to stable angle.
- Install sub-bankfull toe-benches to decrease baseflow width and to increase baseflow depth.
- Replant disturbed areas with riparian vegetation that enhances habitat.

[7] Vernal pools will create a habitat for frogs and amphibians and increase the diversity of the floodplain.

- Remove large trees on upper bank that are likely to fail and cause bank collapse.

3. Design Issues

Rehabilitation of the bike trail in this project area might be delayed until stream improvements take place. At present, the alternatives for locating the bike path are poor. Because of unstable fill beside the stream and vertical sight distance restrictions, the bike path is limited to a route away from the stream and close to park borders. Stabilizing the stream and regrading the slope with stable fill should allow for a better bike path alignment.

J. PROJECT AREA 10: GAULT PLACE N.E. TO HUNT PLACE N.E.

1. Physiography

Project Area 10 extends from the Gault Street N.E. Bridge to the Hunt Place N.E. Bridge. Project Area 10 contains the southern portion of Lady Bird Johnson Park. The ground level on the left bank is generally high. The right bank is generally low. The stream is confined to a narrow channel. There are long stretches of masonry rock walls, primarily along the left bank, but also on the right bank near Hunt Place. A pedestrian bridge crosses the stream at Hayes Street N.E. There is a tight bend near Hunt Place which turns the stream to the west to run parallel a short distance along Hunt Place. A second tight bend turns the stream north again to pass under Hunt Place.

2. Recommendations

- Increase floodprone area by minor grading on right bank and by excavating floodprone terrace on let bank. Increase channel sinuosity by realigning channel with low amplitude meanders. Remove rock wall on left bank except at the Hunt Place Bridge, the foot bridge that crosses the stream and at the Gault Place Bridge. Reconstruct new wall at edge of floodprone terrace.
- Install sub-bankfull toe-benches to decrease baseflow width and to increase baseflow depth. Meander toe-benches to increase sinuosity of low flow channel. Bankfull channel will have only slight increase in sinuosity.
- Install cross vanes and J-hook instream structures to steer flow away from streambanks. Salvage rock from existing rock walls for use in constructing structures and new wall.
- Close eastern Hayes Street Circle and install SWM demonstration area. Add public information signs.
- Create public area adjacent to stream for stream activities.
- Daylight portion of Hayes Street storm sewer (to edge of circle). Install SWM pond and energy dissipation.
- Realign stream to increase radius of stream on approach to Hunt Place N.E. Bridge. Install vanes to reduce stress on outer (left) bank. Remove existing wall that is undermined. Excavate a floodprone terrace and construct an imbricated wall to stabilize upper slope.

- Maintain large trees to the extent possible (as possible) and salvage small trees in grading areas.
- Replant disturbed areas with riparian vegetation that enhances habitat.

3. Design Issues

Removal of the rock wall might be subject to historical or cultural review.

K. PROJECT AREA 11: HUNT PLACE N.E. TO MINNESOTA AVENUE N.E.

1. Physiography

Project Area 11 extends from the Hunt Place N.E. Bridge to the Minnesota Avenue N.E. Bridge. The stream enters the project area from the south and turns about 90 degrees to the west, and passes under Minnesota Avenue N.E. A pedestrian bridge is located at the bend. The USGS Watts Branch stream gage is located just downstream of the pedestrian bridge. Erosion at the base of a rock wall just upstream of the pedestrian bridge on the outer (right) bank has caused the rock wall to fail. Debris from the failed wall has intensified erosion just upstream from the pedestrian bridge and a portion of the pedestrian bridge abutment is being undermined.

Project Area 11 contains the northern portion of Lady Bird Johnson Park. WPP plans call for modifying the park in this area to create a gateway for Watts Branch Park. Under the WPP plans, the pedestrian bridge near the bend will be removed and a new bridge installed further downstream across a straight section of stream.

2. Recommendations

- Increase floodprone area and stream sinuosity by grading back banks. The alignment shown for stream adjustments assumes removal of the existing pedestrian bridge and installation of a new pedestrian bridge in accordance with WPP plans.
- Grade oversteepened banks to stable angle.
- Remove rock walls upstream and downstream of pedestrian bridge.
- Install sub-bankfull toe-benches to decrease baseflow width and to increase baseflow depth.
- Install cross vanes and J-hook instream structures to steer flow away from streambanks. Salvage rock from existing rock walls for use in constructing structures.
- Remove stream lining below pedestrian bridge and above Minnesota Avenue.
- Maintain large trees to the extent possible and salvage small trees in grading areas.
- Replant disturbed areas with riparian vegetation that enhances habitat.

3. Design Issues

It appears at this time that the pedestrian bridge will be replaced. Earlier discussions with DPR and DOT indicated that funding might not be available for the pedestrian bridge

replacement. In the event the funds are not available, DPR and DOT would attempt to rehabilitate the existing pedestrian bridge and it would remain in its present location.

Some provision should be made to allow for continued operation of this location as a USGS gaging station. The Service will consult with USGS to identify a replacement location for the stream-gage and other issues involved with stream-gage replacement after design alternatives have been selected.

IV. FUTURE WORK

The next step in the design process is to review preliminary plans with restoration partners. Preliminary concepts will be modified based on the review process. The concepts will then be refined and preliminary grading plans and longitudinal profiles developed. Grading plans and profiles will be evaluated for compliance with geomorphic design criteria, sediment transport capabilities, and floodplain hydraulics. Concept level plans will be submitted for review showing grading plans and longitudinal profiles.

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APPENDIX A

RESTORATION OBJECTIVES

Restoration Objectives for Upper Watts Branch – Southern Avenue to Minnesota Avenue, N.E.				
	Restoration Objectives	**Stream Restoration Design Elements**	**Design Constraints/ Design Issues**	**Actions by Others**
Water Quality				
1)	Reduce direct loading of heavy metals, PAHs, PCBs and pesticides to Watts Branch and the Anacostia River.	• Retrofit SWM outfalls: o Relocate SWM outfalls from stream channel to outer edges of stream corridor; o Provide opportunities for infiltration; o Install wetlands/natural systems for water quality treatment.	• Vertical grade between outfalls and stream bed limits hydraulic head for treatment facilities. • Conflicts with existing/proposed uses of park land. • Limited area for treatment facilities.	• Ongoing efforts by Department of Health Watershed Protection (DOH) to develop stormwater retrofits (*e.g.*, use of small "triangle parks" for LID SWM retrofit). • Stormwater Pollution Protection Plans (SWPPP) are required for all new development.
2)	Reduce raw sewage entering Watts Branch.	• Protect sanitary sewer infrastructure.	• Relocation of sanitary sewers considered economically infeasible	• District of Columbia Water and Sewer Authority (DCWASA) addressing exfiltration from sanitary sewers through capital improvements and rehabilitation.

Restoration Objectives for Upper Watts Branch – Southern Avenue to Minnesota Avenue, N.E.				
	Restoration Objectives	**Stream Restoration Design Elements**	**Design Constraints/ Design Issues**	**Actions by Others**
3)	Reduce litter and large trash in Watts Branch.	• Install litter traps at SWM retrofits.		• Washington Parks and People cleans large trash out of stream channel, picks up litter in parks, and working to reduce introduction of new litter and trash.
4)	Decrease sediment loading into Watts Branch.	• Stabilize streambanks and reduce erosion potential through stream cross section adjustments.	• Much of Watts Branch is entrenched which causes great potential for erosion. Reduction of stream entrenchment without changing stream grade requires substantial excavation.	• Sediment inflow from Prince Georges County is high. The District should continue to request Prince Georges County to undertake remediation to reduce sediment influx.

Restoration Objectives for Upper Watts Branch – Southern Avenue to Minnesota Avenue, N.E.				
	Restoration Objectives	**Stream Restoration Design Elements**	**Design Constraints/ Design Issues**	**Actions by Others**
5)	Reduce high water temperatures during summer.	• Improve riparian buffer to reduce direct insolation. • Increases infiltration of stormwater. • Create deeper pools. • Decrease width and increase depth of baseflow channel.	• Conflicts with existing/proposed uses of riparian corridor. • Availability of area for stormwater management is limited.	

Restoration Objectives for Upper Watts Branch – Southern Avenue to Minnesota Avenue, N.E.				
	Restoration Objectives	**Stream Restoration Design Elements**	**Design Constraints/ Design Issues**	**Actions by Others**
Stream Stability				
6)	Restore Watts Branch to a stable, self-maintaining state.	• Construct reconfigured stream: o Decrease bankfull width; o Provide floodprone area to reduce stress during high flow events; o Increase sinuosity; o Stabilize banks; o Install grade and stability structures (*e.g.*, rock vanes, J-hooks, etc.).	• Floodplain management issues require that flood elevations not be increased. • Options for restoring stream to original grade limited by conflicts with flood management, bridges, and stormwater infrastructure. • Options for lateral adjustments limited by bridges and other infrastructure. • Bedload transport must be maintained. • Disposal of excavated material could be a significant cost.	• Previous work undertaken by U.S. Natural Resources Conservation Service.

Restoration Objectives for Upper Watts Branch – Southern Avenue to Minnesota Avenue, N.E.				
	Restoration Objectives	**Stream Restoration Design Elements**	**Design Constraints/ Design Issues**	**Actions by Others**
7)	Reduce impacts of stormwater.	• Retrofit SWM outfalls: o Relocate SWM outfalls from stream channel to outer edges of stream corridor; o Dissipate energy before stream channel; o Capture trash at outfall; o Provide opportunities for infiltration; o Install wetlands/natural systems for water quality treatment; o Retard stormflow peaks and dissipate flow energy by installing distributary channel system between outfall and stream channel.	• Vertical grade between outfalls and stream may not be sufficient. • Amount of excavation may be large. • Locations may conflict with current/proposed park lands.	• On-going efforts by DOH to reduce SWM loading and install SWM retrofits.

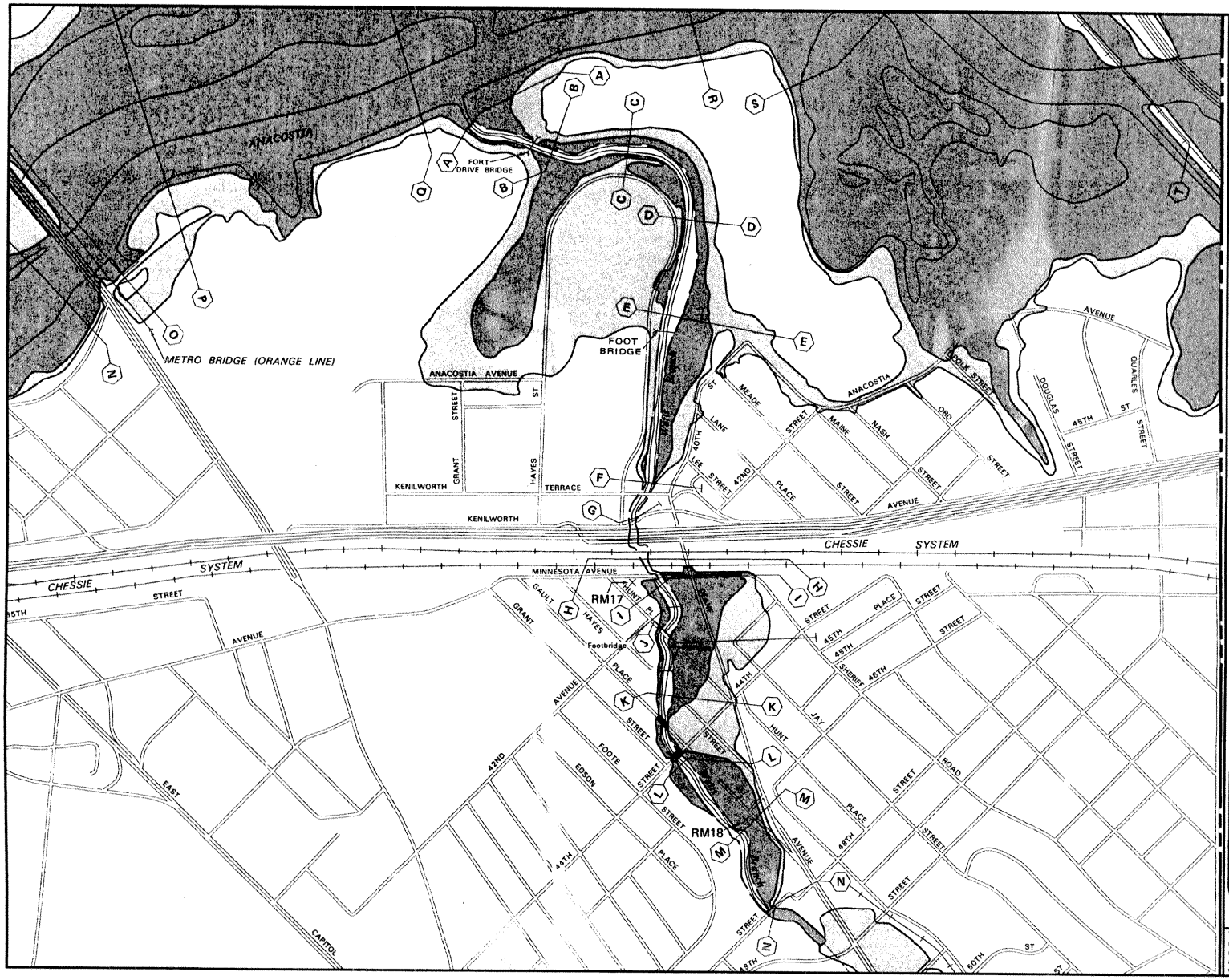
Restoration Objectives for Upper Watts Branch – Southern Avenue to Minnesota Avenue, N.E.				
	Restoration Objectives	**Stream Restoration Design Elements**	**Design Constraints/ Design Issues**	**Actions by Others**
8)	Reduce impact of sanitary sewer and other utility crossings.	• Construct grade control structures at utility crossings to prevent bed degradation. • Construct bank protection measures at utility crossings to direct flow away from banks at crossing.		
Floodplain Management				
9)	Reduce (or do not increase) flood risk.	• Maintain or decrease water surface elevations.	• Several of the bridges crossing Watts Branch are overtopped or undergo pressure flow during a 100-year return period discharge. Many private houses are located near the limits of the 100-year floodplain. Increases in flood elevations (or risk) are not considered feasible.	

Restoration Objectives for Upper Watts Branch – Southern Avenue to Minnesota Avenue, N.E.				
	Restoration Objectives	**Stream Restoration Design Elements**	**Design Constraints/ Design Issues**	**Actions by Others**
Aquatic and Riparian Habitat				
10)	Improve stream habitat for local and anadromous fish.	• Reconfigure stream: o Increase frequency and depth of pools; o Increase flow depths; o Decrease temperature through stream reconfiguration; o Improve water quality; • Increase base flow by employing infiltration practices. • Employ large woody debris in restoration design to provide instream cover.		
11)	Improve riparian buffer habitat.	• Integrate riparian buffers plantings with stream and floodplain restoration plan. • Plant native vegetation.	• Maintain open sight lines within park land. • Coordinate plantings with park master plan.	

Restoration Objectives for Upper Watts Branch – Southern Avenue to Minnesota Avenue, N.E.				
	Restoration Objectives	**Stream Restoration Design Elements**	**Design Constraints/ Design Issues**	**Actions by Others**
Quality of Life				
12)	Enhance recreational opportunities for District residents	• Integrate public areas (overlooks, paths, fords) into stream restoration		
13)	Coordinate stream restoration with other Watts Branch park improvements.	• Partner with District of Columbia Parks and Recreation, Washington Parks and People, and District Department of Transportation.		• District Department of Transportation working with District of Columbia Parks and Recreation and Washington Parks and People to rehabilitate bike path. • Washington Parks and People is developing master plan for Watts Branch Park redevelopment.

APPENDIX B

WATTS BRANCH FEMA FLOODPLAIN MAPS



APPROXIMATE SCALE

800 0 800 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FLOODWAY

FLOOD BOUNDARY AND FLOODWAY MAP

DISTRICT OF COLUMBIA
WASHINGTON, D.C.

PANEL 30 OF 30

COMMUNITY-PANEL NUMBER
110001 0030

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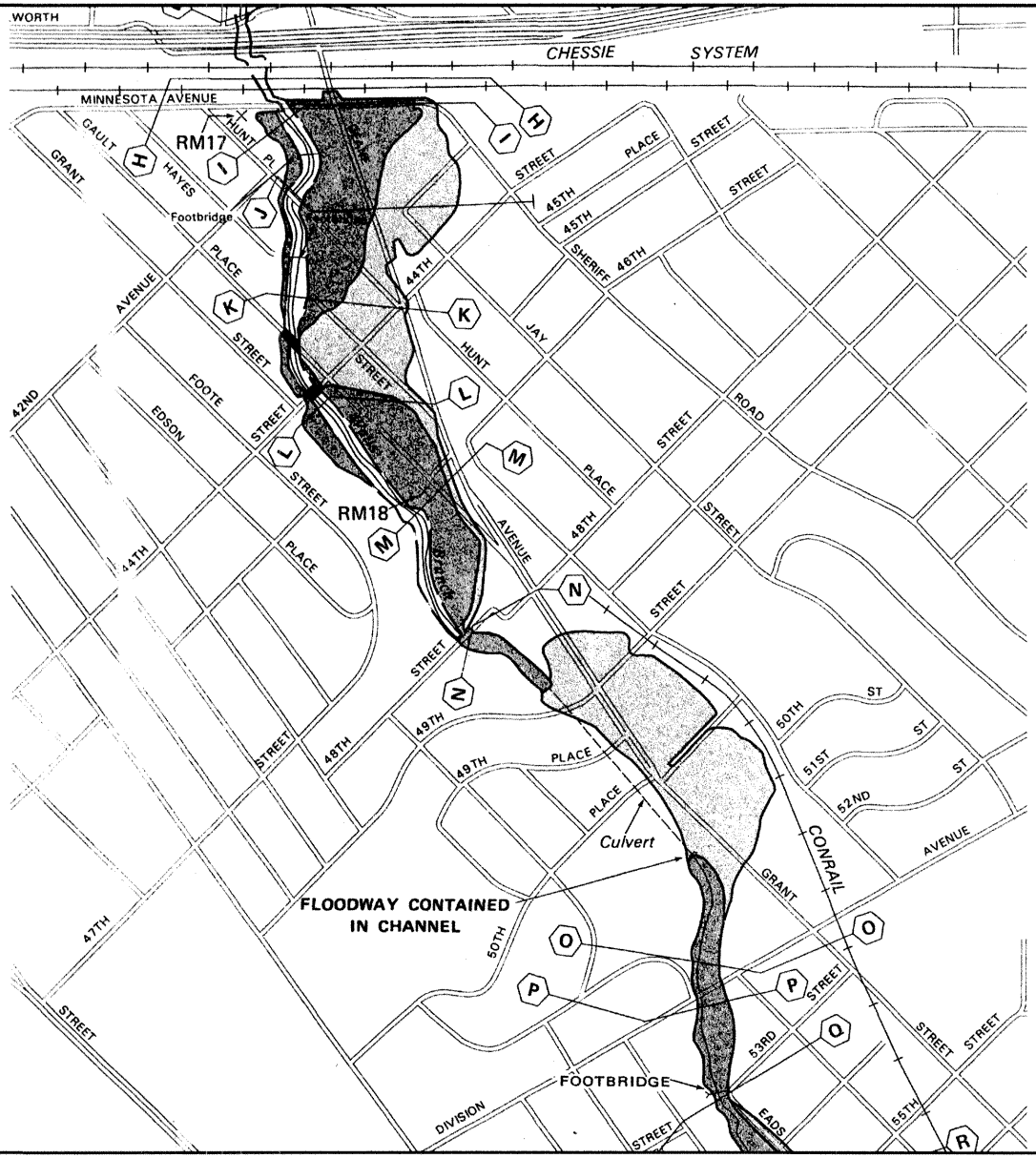
Federal Emergency Management Agency



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