U.S. Fish & Wildlife Service

Springhouse Run Stream Restoration Washington, DC

10 percent Conceptual Design

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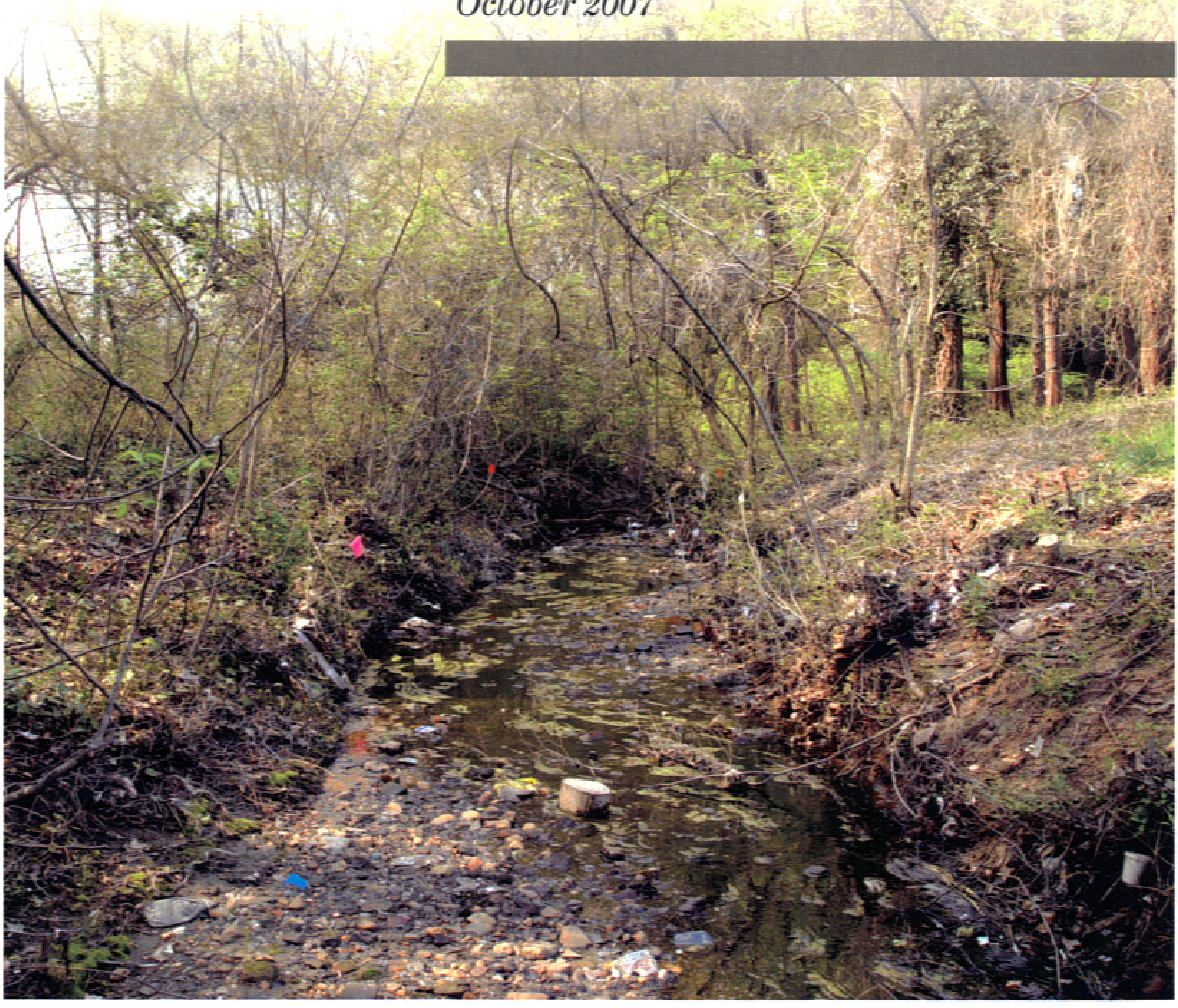

SPRINGHOUSE RUN STREAM RESTORATION, WASHINGTON, D.C.: 10 PERCENT CONCEPTUAL DESIGN

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District of Columbia, Department of Environment, Watershed Protection Division; and
U.S. Department of Agriculture, National Arboretum

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOGRAPHS

A. INTRODUCTION

The District of Columbia (D.C.), Department of the Environment, Watershed Protection Division (DOE) and the U.S. Fish and Wildlife Service (Service) – Chesapeake Bay Field Office entered into a Memorandum of Understanding (MOU) (Agreement 51410-1902-0172) to implement stream and riparian habitat restoration projects within the D.C. watershed. As part of the MOU, the Service completed an assessment of the main-stem and tributaries of Hickey Run located on U.S. National Arboretum (Arboretum) and U.S. National Park Service property. The Service, in partnership with the Arboretum and DOE, is developing a stream restoration design for a 1,268-foot section of Springhouse Run, one of the tributaries to Hickey Run (Figure 1).

The goal of stream restoration is to return Springhouse Run to a stable, self-maintaining state while meeting the aesthetic goals of the Arboretum. Stream stability is not a static state but a dynamic process with a tendency towards equilibrium between stream discharge, sediment transport, and channel dimension, plan form, and longitudinal profile. Restoring a stream to this stable state and restoring its riparian buffer will address a number of aquatic and riparian habitat concerns. A successful stream restoration will also address some water quality issues including reducing sediment and nutrients, which are significant issues for the Chesapeake Bay and its natural resources.

The first task in developing the restoration plans was to conduct a watershed and stream assessment. The Service presented the findings and recommendations of this assessment in the *Hickey Run, Washington, D.C.: Watershed and Stream Assessment* (Starr and McCandless, 2005). Based on the watershed and stream assessment, the Arboretum, DOE, and Service selected Springhouse Run as a stream restoration demonstration project. In 2007, the Service completed the Springhouse Run topographic survey, which augmented the existing topographic data provided by the Arboretum.

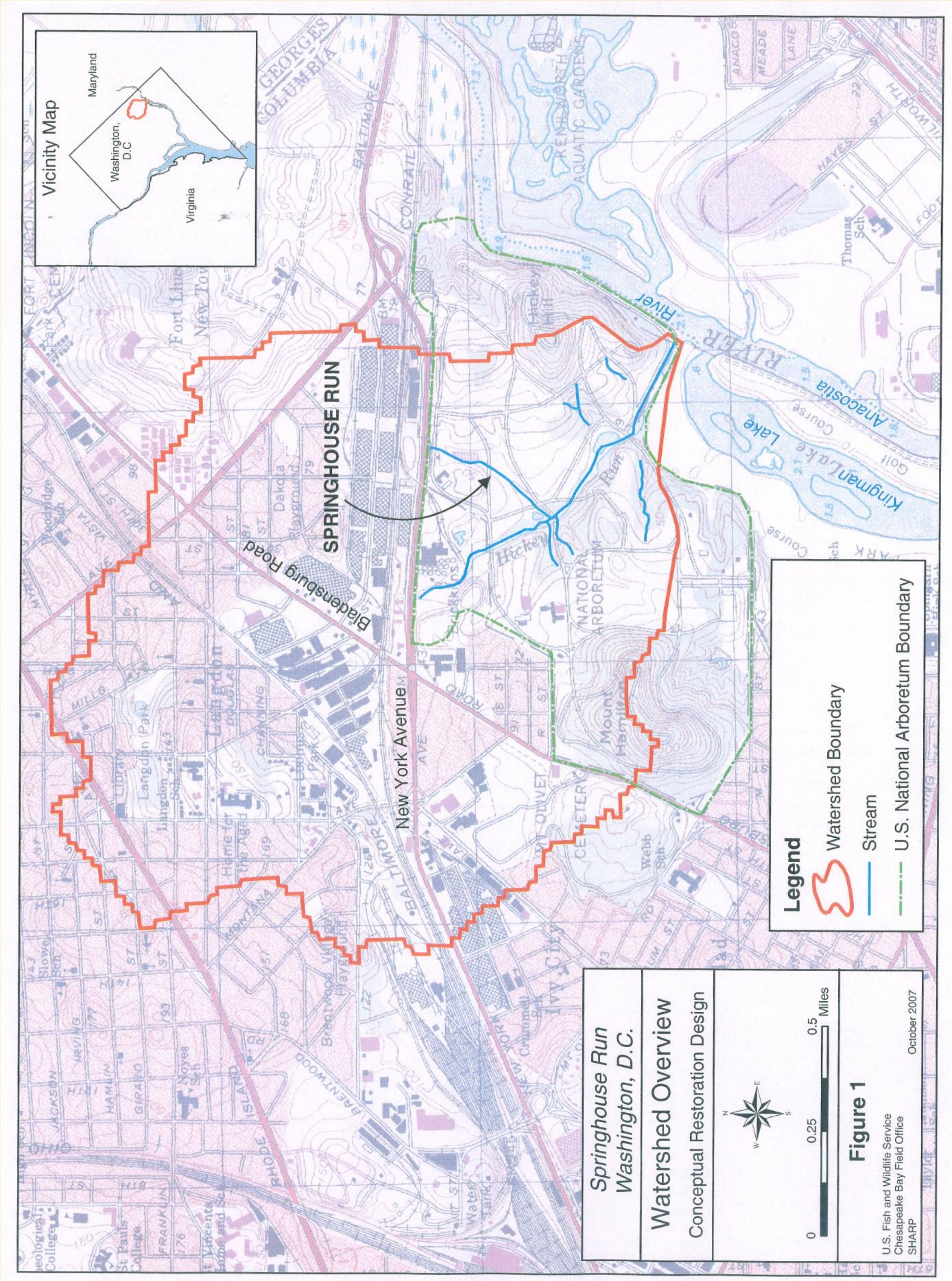
The purpose of this report is to present the ten percent conceptual stream restoration (10%) design developed by the Service, through cooperation with the Arboretum and DOE. The 10% design report briefly presents the design methodology, restoration strategies, and restoration alternatives. The 10% design plans show the existing conditions and the conceptual stream alignment.

B. 10 PERCENT DESIGN DEVELOPMENT

This section presents a brief summary of the methods used by the Service to develop the 10% design. The Service uses a natural channel design approach that uses stable reference stream characteristics as a template for restoring the impaired stream.

1. Natural Channel Design Methodology

The Service used natural channel design methodology to design the stream cross section, planform, and profile for restoring Springhouse Run. Natural channel design methodology


Vicinity Map
Maryland
Washington, D.C
Virginia
SPRINGHOUSE RUN
Bladensburg Road
New York Avenue
Anacostia
Kingman Lake
Legend
Watershed Boundary
Stream
U.S. National Arboretum Boundary
Springhouse Run
Washington, D.C.
Watershed Overview
Conceptual Restoration Design
0 0.25 0.5 Miles
Figure 1
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
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employs geomorphic measurements from stable streams as a template for restoring the impaired stream. Measurements from the stable streams are converted to dimensionless ratios by dividing by various bankfull characteristics, which allows the Service to apply characteristics from references streams of difference sizes to the impair stream.

The objective of natural channel design is to make adjustments in stream cross section, planform, and longitudinal profile such that the restored stream will accommodate the flow regimes and sediment supply without creating excessive erosion or deposition in project area, or upstream or downstream of the project area.

For the 10% design, the Service used cross section and planform dimensionless ratios to develop the conceptual stream alignment. In subsequent design phases, the Service will further develop cross section and profile design using additional dimensionless ratios.

2. Restoration Objectives

The Service developed restoration objectives based on input from the Arboretum and DOE, and Service mission statements. The conceptual phase of the design is the time to refine, add or delete any of the objectives. The objectives are the primary criteria that will guide the design process and influence the final design. Therefore, it is critical for the Arboretum, DOE and the Service to finalize the objectives before moving forward with the restoration design

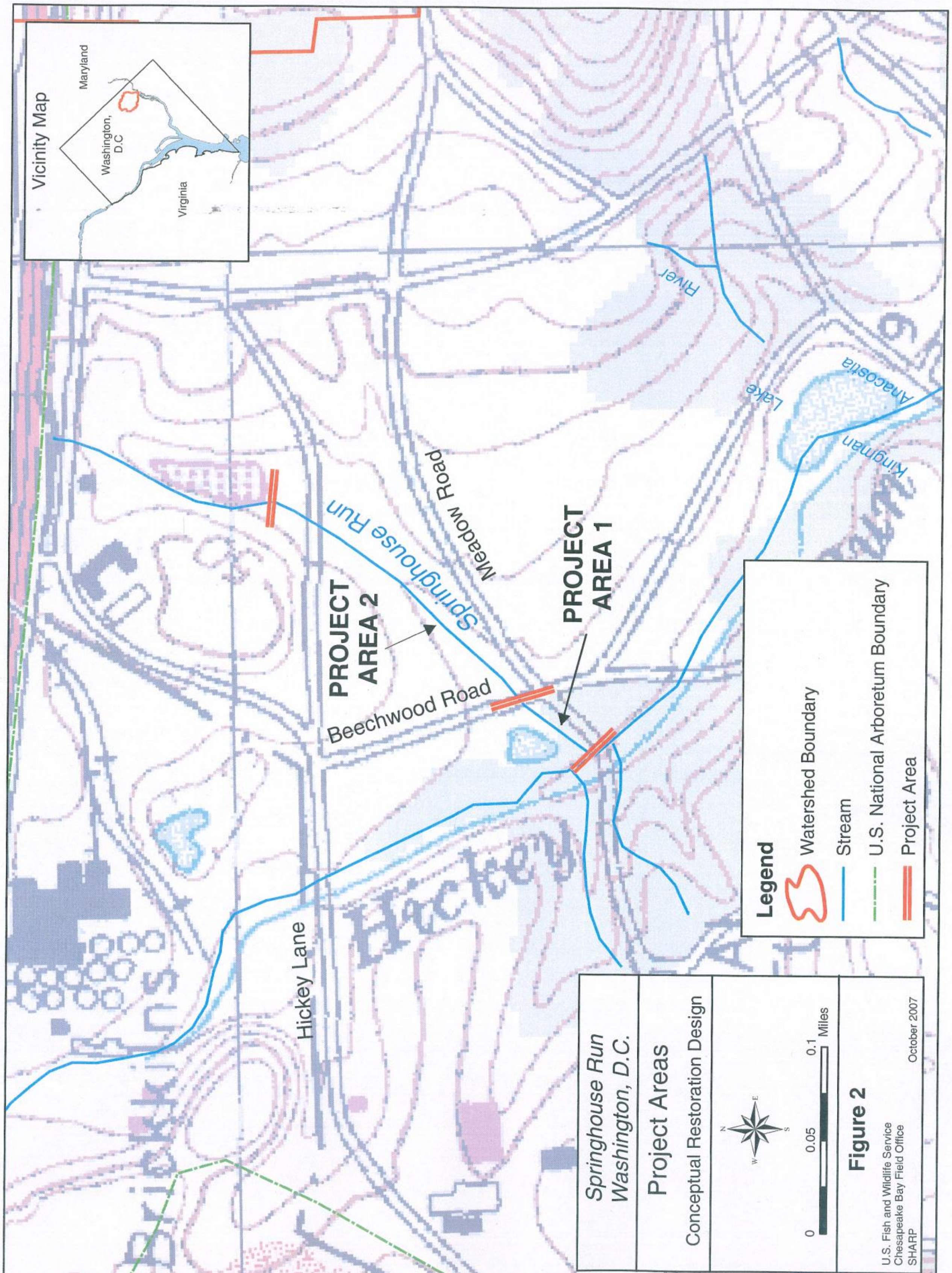
- Restore a natural, self-sustaining stream
- Apply natural channel design principles
- Improve instream habitat (i.e., diversity and quality)
- Maintain Arboretum landscape, aesthetics, and infrastructure
- Improve water quality (e.g., reduce temperatures and sediment)
- Require low maintenance
- Establish a native riparian buffer
- Address infrastructure (e.g., terracotta drainage) and contaminant constraints

3. Natural Channel Design for Springhouse Run

The Service divided the restoration area into two project areas (Figure 2). Project Area 1 is approximately 279 feet and is located between the confluence of Springhouse Run and Hickey Run, and Beechwood Road. Project Area 2 is approximately 989 feet and is located between Beechwood Road and Springhouse Pond.

a. Restoration Strategy

The Service proposes to use two restoration strategies for Springhouse Run (Table 1). Project Area 1 is a Priority 3 restoration and Project Area 2 is a Priority 2 restoration. For Project Area 1, the Service will create a moderately entrenched stream with an increased floodprone area, within or near the existing channel, because of site constraints (i.e., Heart Pond and Meadow Road). For Project Area 2, the Service will create a meandering stream with a wider floodplain, at the existing bankfull elevation.



Vicinity Map
Maryland
Washington, D.C
Virginia
River
Lake
Anacostia
Kingman
Meadow Road
Springhouse Run
PROJECT AREA 1
PROJECT AREA 2
Beechwood Road
Hickey Lane
Hickey
Legend
Watershed Boundary
Stream
U.S. National Arboretum Boundary
Project Area
Springhouse Run
Washington, D.C.
Project Areas
Conceptual Restoration Design
0
0.05
0.1
Miles
Figure 2
U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
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Table 1. Restoration Strategy
Priority 2: Establishment of a Stream and Floodplain within the Existing Stream
This strategy establishes a new stream dimension, pattern, and longitudinal profile within the existing degraded stream. Excavation of the existing degraded stream may be required to create the proper meander pattern. The floodplain is either created at the existing grade or the elevation of the stream bed is raised to allow access to an abandoned floodplain. Although the floodplain is narrower than restoring the stream to the original floodplain, the presence of a reduced floodplain still attenuates flow velocities, and bank and bed shear stresses during higher flows. This alternative also relies more on bank vegetation to stabilize the stream but may require additional bank stabilization methods.
Priority 3: Establishment of a Stream with an Increased Floodprone Area within the Existing
This strategy stabilizes the stream within the existing degraded stream. While this option does not require the creation or establishment of a floodplain, it does require the creation of a floodprone area for energy dissipation. The new stream dimensions will decrease the width/depth ratio and increase the entrenchment of the stream. This alternative relies more on grade control structures to stabilize the stream and dissipate the energy of the stream than the previous alternative. This option reduces land required to establish a stable stream and reduces the need to relocate adjacent land uses encroaching on the floodplain. Additional material costs are required and this alternative does not create a diverse aquatic habitat. This alternative has a lower success rate than the first alternative and may require some maintenance.
Modified from Rosgen, 1996

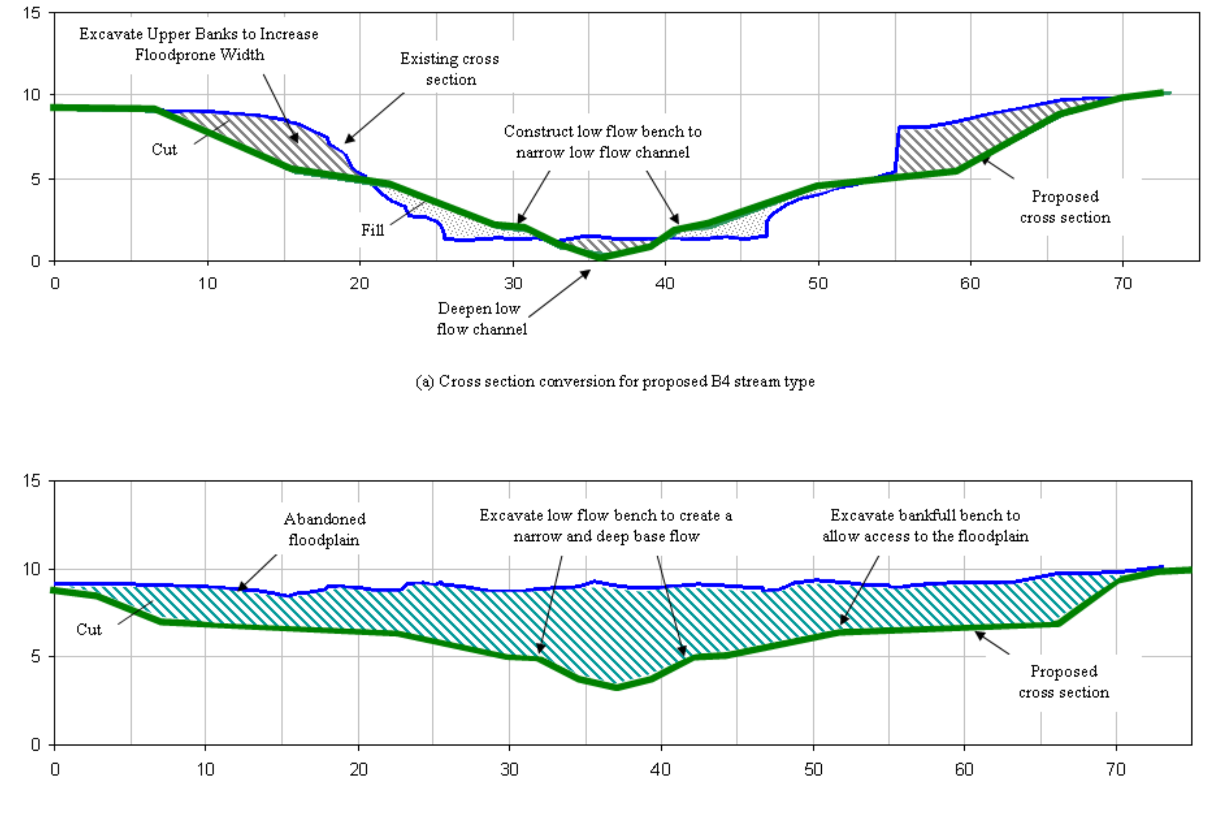
Both restoration strategies will have similar channel cross section conversions that involve creating a low flow active channel bench, and increasing the width of the bankfull floodplain. The difference between the two strategies will be in the floodplain widths. The floodplain for Project Area 1 will be narrower and created, within the existing channel, by excavating the top of existing stream banks. Figure 3a illustrates the cross section conversion. For Project Area 2, fixed control points, such as the bed elevations at road crossings, prevented the Service from reconnecting the stream to its original floodplain. However, an adequate floodplain can be created, at the existing bankfull elevation, by excavating in the abandoned floodplain (Figure 3b).

b. Restoration Stream Type

The Service selected two Rosgen stream types (Rosgen, 1996) to develop the restoration design criteria for Springhouse Run, based on the valley type and site constraints (e.g., channel confinement and control elevations). The Service selected a B4 Rosgen stream type for Project Area 1 (see 10% design plans). Several factors influenced the decision to create a less sinuous, moderately entrenched stream with an increased floodprone area. First, the proximity of the existing stream to Heart Pond and Meadow Road limited the beltwidth required to designing a meandering stream. Second, creating a high sinuous channel for the highly incised stream would require significant excavation. Finally, creating a meandering stream between two fixed control points (i.e., culvert and confluence) over such a short distance is very difficult.

For Project Area 2, a C4 or E4 Rosgen stream type typically exists in this valley type. These stream types are the most stable stream types in this landscape, and provide excellent habitat.

However, an E4 stream type would require significant floodplain excavation to create the proper sinuosity. Therefore, the Service selected a C4 stream, which requires a lower sinuosity and beltwidth, resulting in less earth work (see 10% design plans).



(a) Cross section conversion for proposed B4 stream type

(b) Cross section conversion for proposed C4 stream type

Figure 3. Illustration of Cross Section Conversions (modified from Shea et al., 2005)

c. Reference Reach

A suitable reference reach should possess similar hydrologic, geologic, and physiographic characteristics to the restoration reach. The shape of a particular stream represents the balance between erosive forces applied to a stream by water flowing down a slope and the resistive forces supplied by native stream substrate and streambanks. Streams formed in differing types of alluvium or rock respond differently to the same hydrology. Likewise, streams of the same lithology and geology exhibit differing forms if subjected to differing hydrologic regimes. For example, compare two streams within the same area, one of which possesses an undeveloped watershed and the other possessing an urbanized watershed.

Urbanization changes the timing and volume of stormflows causing urban streams to have an enlarged cross section. Because of differences in the response of streams to differences in boundary conditions (*i.e.*, stream flow, vegetation, geology, and lithology), it is important to select a reference reach with similar hydrophysiographic characteristics. Generally, this would be a stream located in the same general area with similar land use, physiography, valley characteristics, and lithology.

Finding reference reaches for urban stream restoration is difficult. It is rare to locate a stream that possesses both an urban discharge regime and stable stream characteristics. If a suitable reference reach cannot be located, streams from remote locations may be used for reference reaches if there is close similarity in physiographic conditions (Hey, 2006). The Service was unable to locate a reference reach (*i.e*., a stable stream) near Springhouse Run. Therefore, the Service compiled data for C4 reference reaches from streams with similar physiographic conditions in Washington, D.C., Maryland, and North Carolina. The B4 reference reaches were from streams in a different physiographic condition; however, the existing site conditions and constraints allow this to be appropriate.

Natural channel design methodology employs the characteristics of stable streams as a template for designing restored streams. Selection of a Rosgen stream type identifies the broad characteristics for the restored stream, but does not provide sufficient design parameters to develop stream restoration plans. Additional geomorphic measurements must be collected from stable streams that fully detail the characteristics of a stable stream's cross section, planform, and profile. A stream possessing stable characteristics is termed a "reference reach." The geomorphic characteristics of the reference reach are used as a template for designing stream restoration projects. The primary requirement of a reference reach is that the stream reach is stable. The reference reach is not required to be in a natural, undisturbed state. As in the case with Springhouse Run, the Service selected stable reference reaches with stream characteristics that are common to urban, coastal plain streams (e.g., less sinuous and narrower beltwidth).

d. Bankfull Determination

The bankfull discharge is the discharge (or range of discharges) which is responsible for the formation and maintenance of the stream channel dimensions, plan form, and longitudinal profile. The stream typically develops bankfull indicator(s), such as a significant slope break and floodplain feature, along the stream banks at the bankfull stage. An accurate determination of the bankfull indicator(s) is one of the most critical aspects of assessing and restoring a stream because surveyors will base the entire survey, assessment, and restoration on its determination.

The Service identified bankfull during the field assessment and surveyed a representative cross section (Table 2). The Service presents a more detailed discussion of the bankfull determination for Hickey Run and its tributaries in *Hickey Run, Washington, D.C.: Watershed and Stream Assessment* (Starr and McCandless, 2005). The process used by the Service to validate the bankfull determination is present in *Upper Watts Branch Stream Restoration - 30 Percent Concept Design* (Shea, 2006).

Table 2. Representative Bankfull Characteristics	
Bankfull Characteristics	Representative Cross Section
Area (ft^2)	17.1
Width (ft)	11.7
Mean Depth (ft)	1.5
Discharge (cfs)*	31.6
* Determined by Manning's equation using Manning's n by stream type	

e. Restoration Techniques

The Service selected three stream restoration techniques based on the restoration objectives and the stability problems identified during the watershed and stream assessment. The Service only considered restoration alternatives based on natural channel design (NCD) principles. Therefore, such alternatives like riprap revetments, concrete channels, and bioengineering techniques were not included in the alternative analysis.

1) Soil Fabric Lifts

The Service proposes to use soil lifts in situations where fill is required to create the low flow, active channel and bankfull benches (Photographs 1 and 2). Soil fabric lifts are layers of soil held temporally in-place with a bio-degradable fabric. The soil lifts are typically vegetated with a grass seed mix and live cuttings are place in between the soil layers. Roots from the grass and live cutting establish and naturally maintain the soil layers, replacing the degrading fabric. Adjustments to the vegetation plan can be changed to accommodate Arboretum objectives.

2) Rock and Log Instream Structures

Rock and log structures are instream structures, made of rocks and logs, used to divert erosive stream flows away from streambanks and maintain streambed elevations. The most typical rock and log structures used from stream restoration are cross vanes, J-hook vanes, vanes, and step pools (Photographs 3, and 4). The instream structures are designed to redirect the flow through tight bends, dissipate energy through turbulence, and prevent high shear stress on streambanks. The rock and log structures provide streambed and bank stability and allow the streambed to naturally armor and the riparian vegetation to establish. In addition, provide excellent instream habitat and convey stream flows through constricted bridge crossings.

3) Riparian Buffer

The instream structures and soil fabric lifts provide a skeleton for the stream, but in the long-term, the riparian plantings will maintain the stability of the stream (Figure 4). Riparian plantings will provide rooting to increase the strength of streambanks, riparian habitat, and increase stream roughness that will slow down stream stormflow velocities. No planting occurs within the low flow or active channel. The active channel area is where stream gravel transport occurs.

Photograph 1. Soil fabric lifts under construction.

Photograph 2. Soil fabric lifts 17 months after construction.

Photograph 3. Example of a log/rock j-hook.

Photograph 4. Example of a rock cross vane.

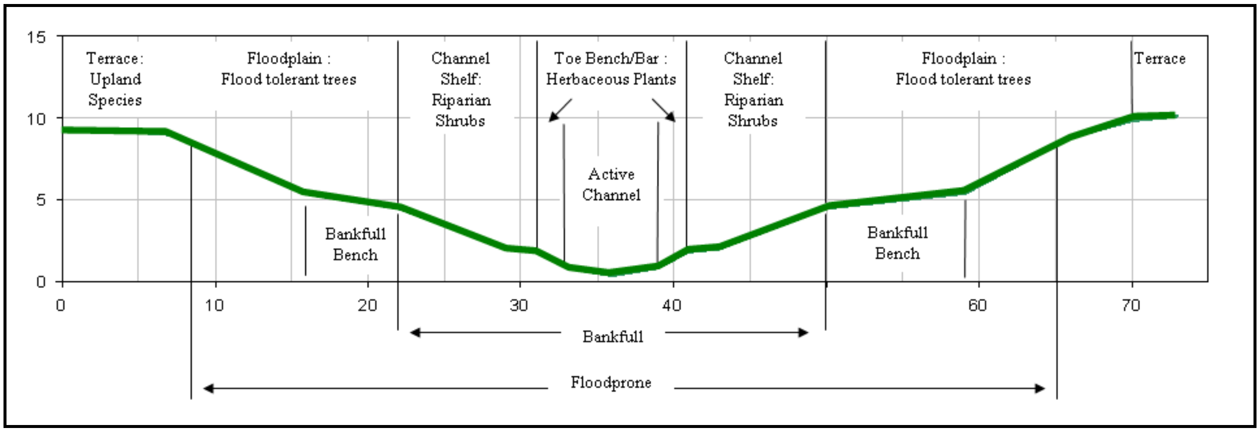


Figure 4. Illustration of Riparian Planting Zones (modified from Shea et al., 2005)

The low flow benches are located between the top of the active channel and bankfull depth. The top of the low flow benches is a frequently flooded area located below bankfull elevation

Riparian vegetation that can withstand frequent flooding and have a dense root system will be planted in this zone. The floodplain zone starts above bankfull. This area will contain riparian shrubs or 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 flood-prone area.

C. CONCEPTUAL DESIGN SUMMARY

The development of a restoration design is an iterative process and the 10% design is the first step. The proposed stream alignment and riparian buffer is the Service's first attempt at developing a design that meets all the partners' objectives. As a partner in the restoration of Springhouse Run, the Service encourages the Arboretum and DOE to continue to provide suggestions and constructive critiques of the restoration project. It is the goal of the Service, to develop the best restoration design, which fulfills all the objectives of the Arboretum, DOE and the Service.

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