HAMILTON RUN, HAGERSTOWN, MARYLAND: WATERSHED CHARACTERIZATION AND ACTION PLAN REPORT

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ECOSYSTEM
PLANNING &
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I.   INTRODUCTION

A.   OVERVIEW

Hamilton Run is a perennial stream that flows through the City of Hagerstown (City). Originally founded in 1762, Hagerstown primarily developed as an industrial city through the 20th century. This development led to significant areas of impervious cover being established in the City limits before stormwater management controls were implemented in the 1980s. As a result, Hamilton Run receives a significant amount of urban runoff during storm events, which has adversely impacted water quality, accelerated bank erosion, and led to channel straightening and channel incision.

Streams are routinely impacted from changes in flow regimes within an urban environment. Urban environments with large areas of untreated impervious surface create increased surface runoff due to reduced groundwater infiltration. This situation leads to stream instability because larger flood flows and higher velocities, associated with increased runoff, alter stream flow dynamics. In an attempt to adjust to new environmental conditions, channels typically evolve into more incised, straightened channels through stream bed and bank erosion. Erosion from stream beds and banks lead to increased sediment and nutrient loads downstream. In addition, runoff from impervious surface can include oils from roads, debris and other pollutants that lead to decreased water quality.

As a result of adverse impacts urbanization has on streams, stream restoration and concurrent implementation of best management practices (BMPs) for stormwater runoff treatment are one of several strategies used to mitigate impervious surface runoff while improving stream system stability.

B.   PERMITS AND REQUIREMENTS

The City is covered under a Phase II National Pollutant Discharge Elimination System (NPDES) MS4 permit that is expected to be renewed in 2017. The current permit requires measures be taken to limit pollution discharge through: 1) public education and outreach, 2) public involvement and participation, 3) illicit discharge detection and elimination, 4) construction site stormwater runoff control, 5) post construction stormwater management, and 6) pollution prevention and good housekeeping.

The renewed permit is expected to require the City to develop a specific plan to reduce pollutants entering streams, meet total maximum daily load (TMDL) requirements and treat currently unmanaged impervious surface runoff. These requirements were established under the Chesapeake Bay TMDL goals for 2025 and Watershed Implementation Plans (WIP) were developed to provide guidance on how treatment for impervious surface and associated TMDL reductions would be achieved.

C.   WATERSHED IMPLEMENTATION PLAN

The City combined its Phase II WIP with Washington County in July 2012 (Maryland Department of the Environment, 2012). Two submissions were directly related to the Hamilton Run corridor:

- Under direction from the City Council, seek funding to study additional sections of Hamilton Run, Marsh Run, and Antietam Creek within the City's corporate limits to identify sites for future stream restoration projects; and
- Continue designing plans for the reconstruction/reconfiguration of the Pangborn lake with a more natural lake shoreline, and the restoration of approximately 400 linear feet of the existing Hamilton Run stream channel adjacent to the Panborn park.

Phase III WIPs are expected to be published in December 2018 and will provide an update on implementation actions taken so far, as well as future implementation plans to meet bay restoration goals between 2018 and 2025. It can be expected that, funding permitting, future WIP milestones will include the design and construction of stream restoration projects to help achieve partial attainment of TMDL goals.

D.   WATERSHED CHARACTERIZATION AND ACTION PLAN

Frederick, Seibert and Associates (FSA) and Ecosystem Planning and Restoration (EPR) worked collaboratively to develop a watershed assessment and action plan for the City. The watershed assessment documents existing watershed and riparian corridor conditions of Hamilton Run and identified areas where stream restoration and BMPs could provide ecological uplift and reduce sediment and nutrient loads. This data was then used to develop the watershed action plan that recommends and prioritizes cost effective restoration solutions. Concept level plans were developed for the three highest priority restoration projects and recommendations regarding land use and management practices were developed. This document was developed to provide information that will aid the City in submitting proposals required to secure funding for implementing priority stream restoration projects and BMPs. Successful completion of projects along Hamilton Run will help the City meet TMDL and impervious acre treatment requirements as part of their NPDES MS4 permits.

Funding for the watershed characterization and action plan study was secured from grants provided by the Watershed Assistance Planning Grant from the Chesapeake Bay Trust, Maryland Department of the Environment and matching funds provided the City general fund.

II.   WATERSHED CHARACTERIZATION METHODOLOGY

A.   WATERSHED ASSESSMENT

The purpose of the watershed assessment is to determine the influence of watershed health on the proposed project area. Specifically, watershed characteristics are evaluated to document hydrology (i.e., flow regime), sediment transport load (i.e., sources and amount), water quality

(i.e., types and sources), and biology (i.e., locations and health). By understanding watershed conditions, it can be determined if programmatic goals are achievable, as well as the restoration potential of the project reach.

The watershed assessment involved two levels: land-based assessment and stream-based assessment. The land-based assessment analyzed land use/land cover patterns, soils, geology, hydrology, valley type, existing water quality and biological data, and watershed development. In addition, EPR reviewed previous reports prepared for the City regarding the hydrology (McCrone Inc., 1997) and BMPs (URS Corporation, 2013) in place throughout the Hamilton Run watershed. The watershed assessment involved a visual assessment of stream characteristics and stability conditions upstream and downstream of the project area. The fluvial geomorphic conditions observed included channel dimensions, pattern, profile, substrate material, vertical and lateral stability, sediment supply potential, Rosgen stream type, and channel evolution. Information regarding channel dimensions was compared to reference data, such as Stream Stats (USGS) and localized regional curves that predict channel dimensions from drainage area, to provide a comparison of stream characteristics to similar streams. Water quality was preliminarily assessed by consulting the Maryland Department of the Environment's (MDE) 303d list for impaired waterways. In addition, measurements of nutrient, sediment and microbial parameters were conducted on water samples taken from Hamilton Run for independent analysis of water quality.

B.   STREAM REACH LEVEL ASSESSMENT

The purpose of the reach level function-based assessment is to establish existing conditions, determine stressors, and identify constraints. EPR assessed the entire mainstem of Hamilton Run using the Function-based Rapid Assessment Methodology (Starr et al., 2015; Appendix A – Function-based Rapid Assessment Form). The methodology rapidly assesses critical stream functions associated with hydrology, hydraulics, geomorphology, water quality and biology. The Function-based Rapid Assessment Methodology was developed following the "A Function-Based Framework for Stream Assessment and Restoration Projects" (Harman et al., 2012). This document is based on the premise of a hierarchal relationship of stream functions where lower-level functions support higher-level functions, all influenced by local geology and climate, which underlies the Pyramid (Figure 1). The Pyramid is a broad-level view of stream functions and consists of five functional categories that evaluate stream functions. Each category has a functional statement that describes its primary function.
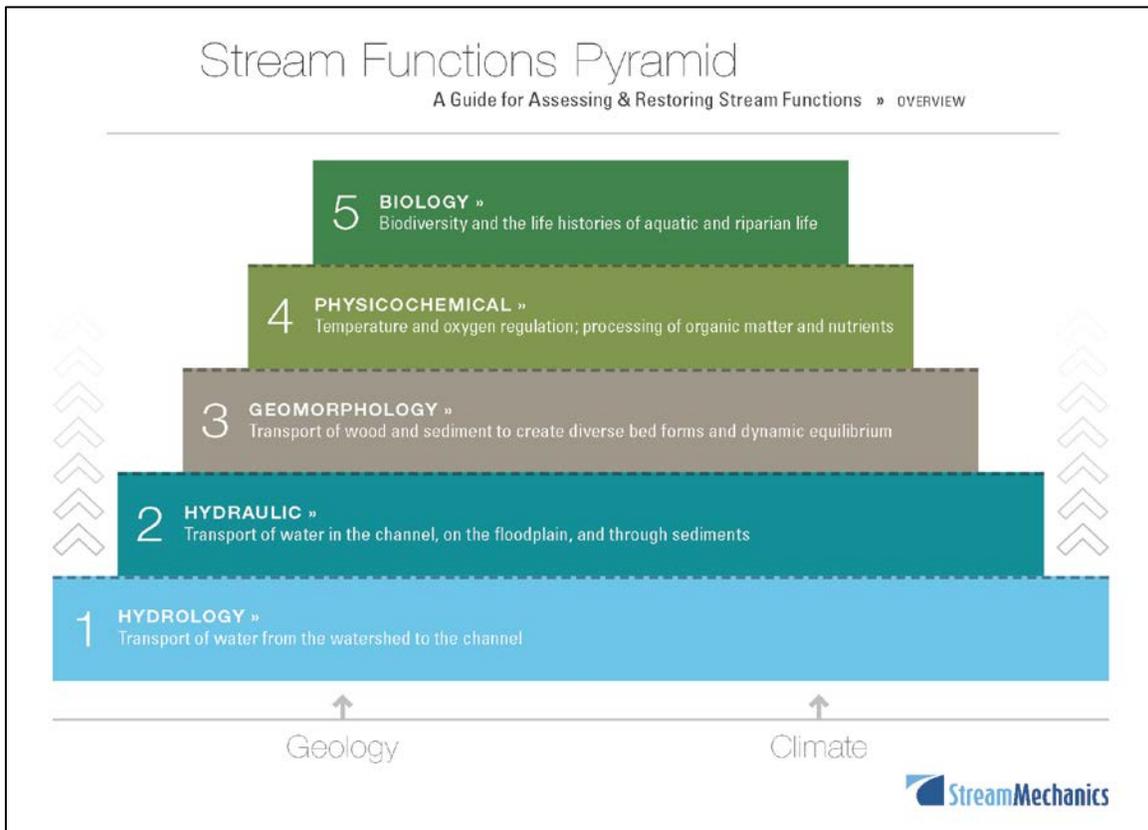
Figure 1. Stream Function Pyramid (Harman et al., 2012)

The framework that supports the Pyramid, commonly referred to as the Stream Functions Pyramid Framework (SFPF) is a "drilling down" approach that provides more detailed forms of analysis and quantification of stream functions (Figure 2). The function-based assessment parameters describe and support the functional statements within each functional category. The "measurement methods" are specific tools, equations, assessment methods, etc. that are used to quantify the function-based parameter.

The following assessment parameters, by pyramid level, were evaluated:

Level 1 - Hydrology – concentrated flows, and flashiness (flow regime)
Level 2 - Hydraulics – floodplain connectivity, vertical stability extent, and floodplain drainage
Level 3 - Geomorphology – bedform diversity, lateral stability and riparian vegetation
Level 4 - Physicochemical – overall water quality and accumulation of detritus
Level 5 - Biology – macroinvertebrate communities and fish communities
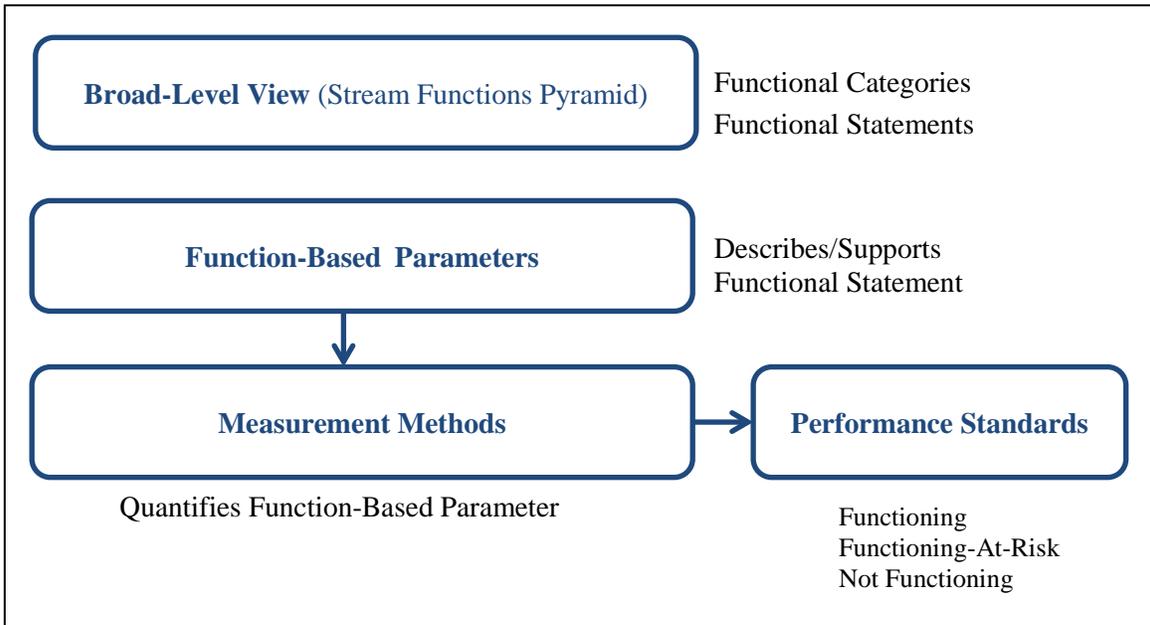
Figure 2. Stream Functions Pyramid Framework (Harman et al., 2012)

Each assessment parameter had at least one measurement method to quantify the existing function-based condition. Then each measurement was scored from 1 to 10, 10 being the highest functioning score, and assigned a rating of either functioning (F), functioning-at-risk (FAR), or not functioning (NF) based on set performance standards. Additionally, the reach level assessment included an evaluation of current channel evolution trends. Channel evolution describes the current and potential future stream stability (e.g., degrade, aggrade or remain stable) based on watershed and reach level morphological data. This information is useful because it can be used to develop cause and effect relationships and for prioritization based on the likelihood of the stream condition to worsen or self-stabilize. The results of the rapid assessment are displayed in tabular form and digitally geo-referenced on a map.

A rapid Bank Assessment for Non-point source Consequences of Sediment (BANCS, Rosgen 2006) assessment was conducted for all actively eroding bank on the Hamilton Run mainstem. A Bank Erodibility Hazardous Index (BEHI) rating, Near Bank Stress (NBS) rating, bank height, and bank length was collected for each assessed bank. The BEHI and NBS ratings were based on visual observation. The results of the BANCS assessment are displayed in tabular form (i.e., individual bank ratings and tons of sediment yield) and digitally geo-referenced on a map.

A stream restoration feasibility assessment was conducted for each reach assessed (Appendix B – Stream Restoration Feasibility Assessment Form). The purpose of the feasibility assessment is to determine restoration potential and level and complexity of restoration. It includes such parameters as land ownership, construction access, constraints, BMP potential, costs, uncertainty and risk. It also scored each assessment parameter from 1 to 10, but assigned a rating of optimal, suboptimal, marginal and poor. The results of the feasibility assessment are displayed in tabular form and digitally geo-referenced on a map.

Lastly, the results of all the assessments were used to develop and prioritize general restoration solutions (e.g., Natural Channel Design Priority Level, Valley Restoration, Regenerative Stormwater Conveyance, and BMPs) for each assessed reach as part of the watershed action plan. The results of the recommended restoration solutions and prioritization are displayed in tabular form and digitally geo-referenced on a map.

III.   WATERSHED CHARACTERIZATION

A.   WATERSHED ASSESSMENT

1.   HYDROLOGY

The Hamilton Run watershed drainage area is 5.5 square miles (Figure 3 – Hamilton Run Watershed) and is underlain almost completely by carbonite rock. Carbonite rocks are highly porous and watersheds that have over 30% carbonite rock will have reduced flow volumes (Chaplin, 2005). Typically, groundwater feeds stream base flows through the hyporheic zone. However, in watersheds with high amounts of carbonite rock, the opposite occurs and stream flows feed into the groundwater. These stream types are commonly called "losing streams." Understanding this condition is important because channel dimensions are developed based on stream flows. If stream flows are over-estimated, then there is a potential for channel design dimensions to be oversized, which could lead to stream instability problems.

While a "losing stream" does affect flow volume, it has less of an effect on the flashiness of flows. Flashiness of flows is more affected by land use and land cover, basin slope and shape, and non-porous soils and geology. The watershed of Hamilton Run is highly developed with 37 percent impervious cover. Forest cover is only 5 percent and urban development has decreased riparian buffer widths along the stream banks. The decreased riparian buffer widths reduce the ability of the buffers to manage runoff from nearby impervious surfaces, resulting in concentrated flows and increases to runoff volume and velocity. The basin shape itself is twice as long as it is wide, with an average slope of 2.8 percent. Given the high level of development, area of impervious surfaces and limited riparian vegetation, this watershed has a flashy flow regime. However, within the basin a majority of the soils are classified as well-drained, which slightly alleviates the effects of concentrated runoff where pervious surfaces are present. Together, the flashy flow regime and well-drained soils suggest that designing floodplain access in reaches where open areas exist would be beneficial. Those reaches that have available space to create a large floodplain would provide areas for stormwater storage and groundwater recharge while also providing some TMDL credits depending upon the frequency and volume of inundation. This beneficial floodplain access would help reduce stream shear stresses, leading to decreased erosion rates while potentially alleviating the adverse flooding that occurs at specific points along Hamilton Run.
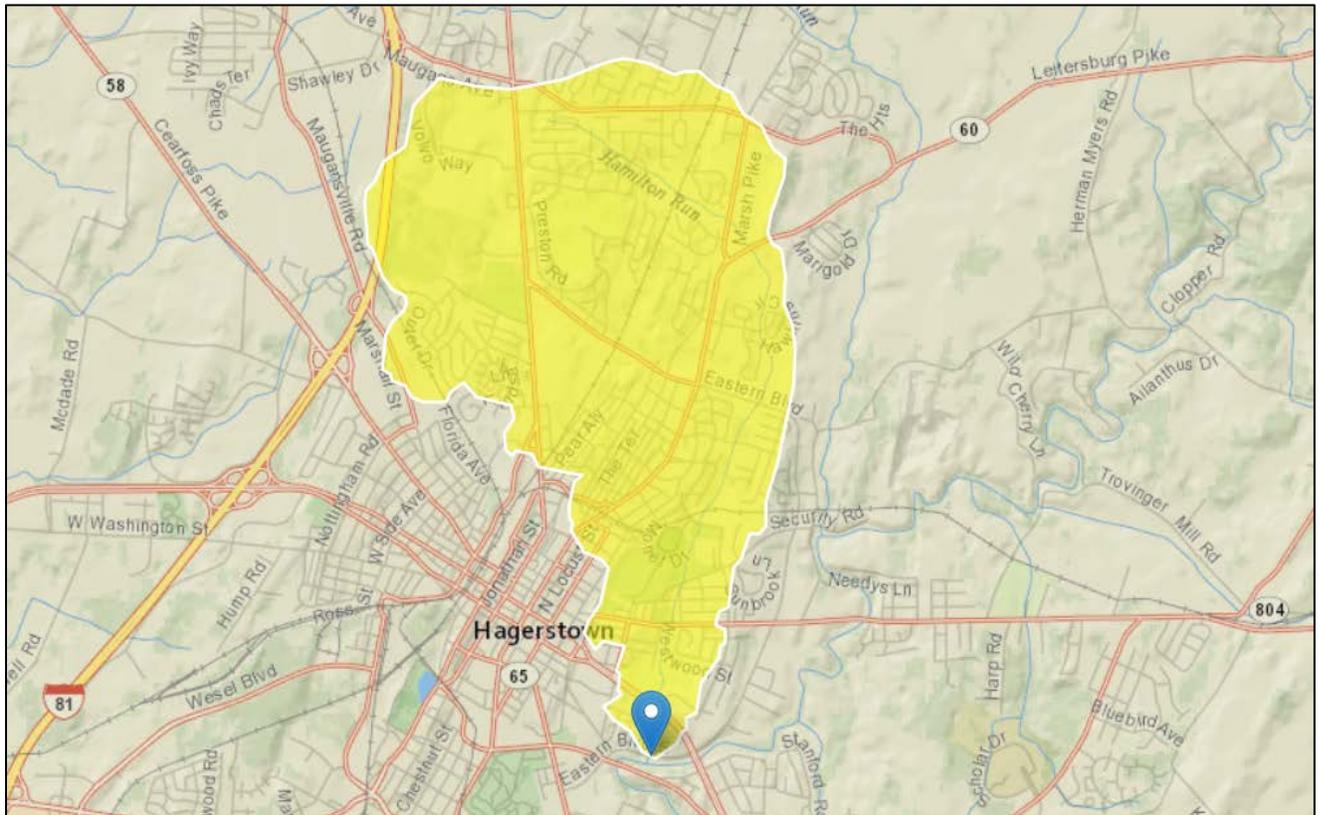
Figure 3. Project Drainage Area (Shaded in Yellow, Source: StreamStats USGS)

Flooding has also been altered as a result of the installation of culverts under road crossings within the Hamilton Run watershed. The assessment found seven reaches where culverts were undersized for bankfull flows. In addition, the Hamilton / Marsh Run Stormwater Improvement Phase I report (McCrone, Inc., 1997) lists three locations that experience extensive flooding due to road culverts constraining larger flood flows through the watershed. This included a culvert below Medway road and a second culvert below the entrance to the American Legion. The report describes that at both these locations backwater develops and causes flooding onto nearby residential property and roadways. The report also described a primary flow constraint at the railroad crossing over Hamilton Run upstream from Pangborn Lake. The culvert at this location is undersized for flood flows and during large storm events the culvert and railroad crossing functionally act as a dam that holds back flood flows. The report describes fives houses that are significantly impacted by flooding during storm events from this impoundment. The constriction limits flood flows to Hamilton Run downstream of the railroad crossing and has influenced channel dimensions. The channel has adjusted to smaller dimensions (cross sectional area, width, and depth) compared to channels with similar drainage areas and therefore may no longer be appropriately sized to convey the expected discharges a channel would naturally convey given the watershed drainage area. To ensure long term stability of future stream restoration projects downstream of any flow constraint, development of channel design criteria should consider the influence of constricted flood flows on channel dimension sizing.

2. <u>Sediment Supply</u>

The sediment supply being generated from the watershed runoff and eroding banks of Hamilton Run is moderate. The BANCS assessment characterized 125 eroding banks with a total length of 7,027 feet from the headwaters of Hamilton Run to the confluence with Little Antietam Creek, with a predicted erosion total of 822 tons of sediment per year (Table 1 - BEHI and NBS ratings and Predicted Erosion Amounts) (Figure 4 –Streambank Erosion). The dominant Bank Erodibility Hazard Index (BEHI) is moderate, while Near Bank Stress typically varied from Low to High across the reaches. Reference Appendix C – BANCS Assessment Data for a breakdown of collected field data. Across Hamilton Run, the assessment reaches were rated relative to each other in their annual production of sediment with assessment reaches producing less than ten tons of sediment per year rated low, assessment reaches producing between ten and forty tons per year rated moderate and assessment reaches producing greater than forty tons of sediment per year rated high. Additionally, the urbanized watershed and lack of riparian buffer allow sediment to be carried from adjacent lands into the stream during runoff events, increasing sediment load. To ensure long term stability of future stream restoration projects, channel design criteria should be developed to convey this sediment supply to reduce potential aggradation.
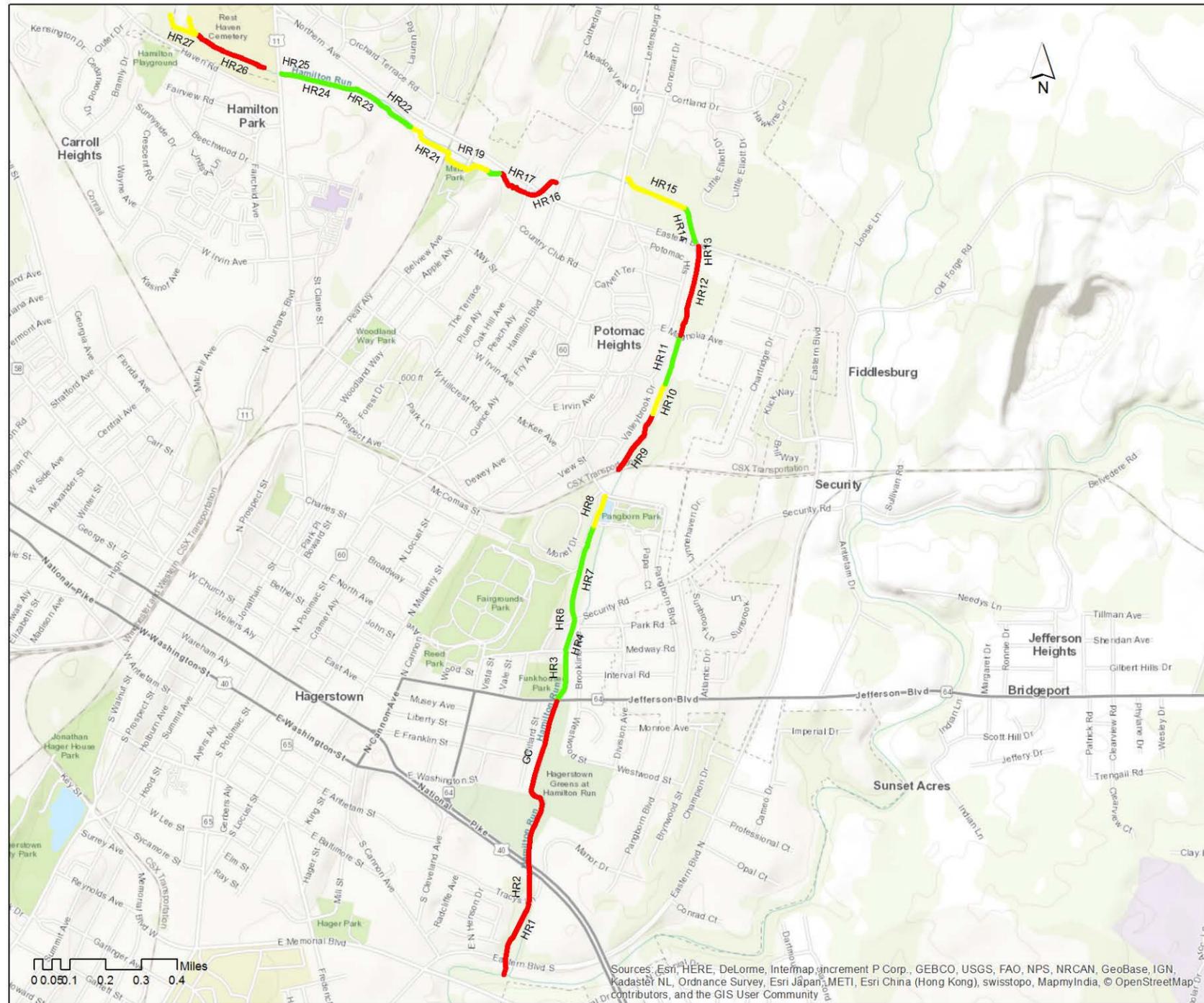
Figure 4. Streambank erosion summary from BANCS assessment along Hamilton Run.

Assessment Reach	Length of Eroding Banks (ft)	Predicted Erosion Amount (tons / year)	Predicted Erosion Amount Rating	Dominant BEHI Rating	Dominant NBS Rating
1	770	105	High	Moderate	Moderate
2	236	41	High	Moderate	Moderate
Golf Course	600	47	High	Moderate	Moderate
3	116	7	Low	Moderate	Moderate
4	16	1	Low	Moderate	Moderate
5	0	0	Low	-	-
6	22	1	Low	Moderate	Moderate
7	48	2	Low	Moderate	Moderate
8	101	21	Moderate	High	Moderate
9	1415	63	High	Moderate	Low
10	273	11	Moderate	Moderate	Low
11	224	7	Low	Moderate	Low
12	522	42	High	Moderate	Low
13	298	60	High	Moderate	Moderate
14	96	4	Low	Moderate	Low
15	366	35	Moderate	Moderate	Low – Moderate
16	117	41	High	High	High
17	525	173	High	High	High
18	30	6	Low	Moderate	High
19	162	27	Moderate	Moderate	Moderate
20	27	14	Moderate	Very High	High
21	145	40	Moderate	Moderate	High
22	23	4	Low	Moderate	High
23	82	2	Low	Moderate	Low
24	55	4	Low	Moderate	Moderate
25	22	5	Low	Moderate	High
26	477	44	High	High	Moderate
27	257	13	Moderate	Moderate-High	Moderate
Assessment Totals	7,027	822	N/A	N/A	N/A

Table 1. BEHI and NBS ratings and Predicted Erosion Amounts

3. <u>Water quality</u>

A limited number of water quality measurements were taken to assess water quality along Hamilton Run. Specifically, water grab samples were taken at three different locations (Figure 5 – Water Quality Sampling Locations) along Hamilton Run on the morning of September 28, 2016 and the afternoon of September 29, 2016. Each sample was lab analyzed for temperature, pH, turbidity, total suspended solids, E. Coli, total Kjeldahl (organic) nitrogen, nitrate / nitrite, total nitrogen, and total phosphorus following approved protocols (Table 2 - Mean Value of Water Quality Samples). The interpretation of the collected data was conducted based on surface water quality standards issued from MDE (Code of Maryland Regulations (COMAR)). See Reference Appendix D – Water Quality Laboratory Reports for field data.

Measurements for indicator bacteria of fecal coliform, E. Coli, were above quantification limits (> 2400 MPN / 100 mL) for 4 of the 6 sampling events, suggesting that water quality in Hamilton Run is degraded from E. Coli contamination. Fecal coliform is capable of being introduced into streams through both human and livestock pathways. Human introduction is mainly through either failing septic systems or leaking sewer pipes. There are currently minimal agricultural practices occurring within the watershed that suggests the source of fecal coliform is most likely from leaks in old sewer pipes.

Average values of temperature, pH, and turbidity show that Hamilton Run falls within MD water quality standards for these parameters. In evaluating the measured nutrient parameters, only ammonia had required surface water quality standards. The measurement values of Kjeldahl Nitrogen, which includes ammonia, as well as other organic nitrogen compounds, suggest that concentrations for ammonia in Hamilton Run fell within required standards for all measured samples. However, additional standards for concentrations of nitrogen and phosphorus nutrients in streams can be developed through total nitrogen and total phosphorus TMDL requirements. A more robust sampling assessment is required to make detailed conclusions about individual water quality parameters in Hamilton Run, beyond the general assessment conducted here.

Water Quality Parameter	Average value (± standard deviation)
Temperature (°C)	16.8 ± 0.4
pH	8.1 ± 0.4
Turbidity (NTU)	25 ± 21
Total Suspended Solids (mg / L)	44 ± 50
E. Coli (MPN / 100 mL)	> 2400*
Total Kjeldahl Nitrogen (mg / L)	0.70 ± 0.18**
Nitrate / Nitrite (mg / L)	2.2 ± 1.3 / <0.2**
Total Nitrogen (mg / L)	2.6 ± 1.1
Total Phosphorus (mg / L)	0.2 ± 0.1**

Table 2. Mean value of water quality samples across sampling locations along Hamilton Run.

*4 of 6 sampling values were above the upper quantification limit, **statistical averages and standard deviations do not include samples with measured values below detection limit.
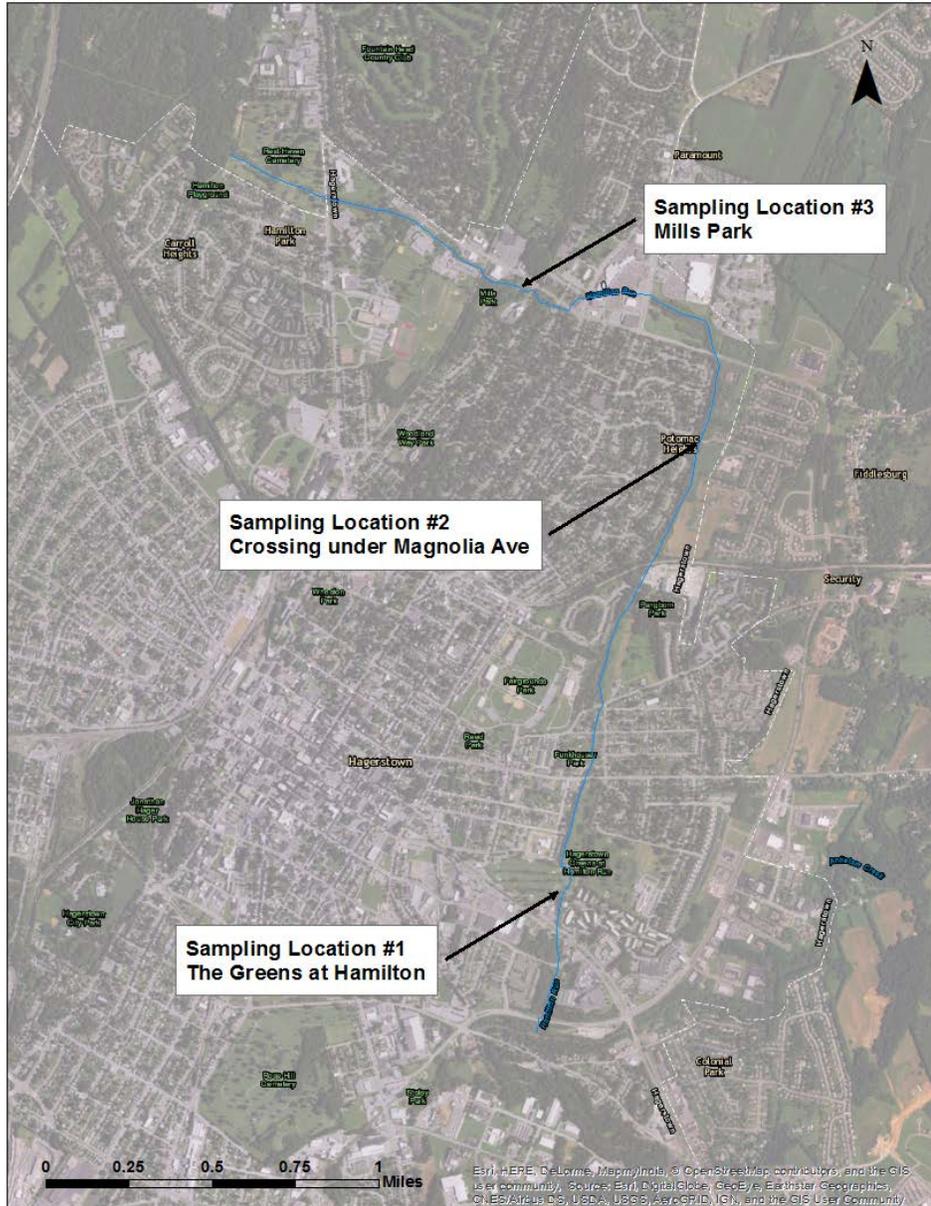
Figure 5. Water Quality Sampling Locations

Combining the water quality and sediment supply data, there is reason to suggest that sediment and fecal bacteria primarily impair the water quality in Hamilton Run. Additionally, urbanized watersheds are often impacted by a variety of pollutants that, while present in smaller quantities, are still capable of adversely affecting water quality. These pollutants, such as trace metals, gasoline byproducts, pesticides and herbicides, are accumulated as runoff makes its way over parking lots, roadways, and lawns (Shaver, Horner, Skupien, May, & Ridley, 2007; Center for

Watershed Protection, 2003). The highly-urbanized watershed of Hamilton Run suggests that water quality is impacted by a variety of these pollutants associated with urban runoff. A visual assessment of the stream found that Hamilton Run was slightly turbid across all reaches, which can adversely impact habitat and aquatic species. It was also noted that there was a lack of detritus buildup that acts as primary inputs of carbon to help support the foundation of the aquatic food web in most streams.

Taken together, the assessment characterizes the water quality in Hamilton Run as functioning-at-risk due to impacts from urban runoff, eroding banks, and pathogenic bacteria. Water quality could be improved through better management of urban runoff in the watershed to decrease nutrient and pollutant loading rates of runoff entering the stream. Improved measures along the stream bank, such as improved riparian buffers and stabilization of eroding banks, would also help minimize pollutant, sediment and nutrient loading, as well as dispersion of concentrated flows. To help lower E. Coli concentrations in the stream, the city has completed sanitary sewer line repairs in some locations within the watershed. However, water quality impairments still exist and cause adverse impacts to aquatic biological communities in Hamilton Run. This result is supported through observations that species of macroinvertebrates tolerant to poor water quality and limited quantities of fish are present in the stream.

4.   __Landscape connectivity__

Landscape connectivity between project areas play a role in the ability of a stream restoration project to result in biological uplift by natural recolonization from adjacent and nearby stream reaches. The urban environment that Hamilton Run passes through partially disconnects several sections of Hamilton Run, making it more difficult for natural fish passage and recolonization of macroinvertebrates. The disconnection mainly stems from several road culverts and designed storm drainage networks that route the stream through developed areas. This includes approximately 1,100 feet of completely underground piping as the stream passes underneath a shopping development from Leitersburg Pike to Eastern Boulevard. While there are barriers that will slow natural recolonization, the return of macroinvertebrates and fish from upstream and downstream reaches to restored areas could be expected to occur naturally over time, albeit at a slower rate.

B.   __REACH LEVEL FUNCTION-BASED ASSESSMENT__

The reach level assessment conducted by EPR identified 27 distinct stream assessment reaches within the project area based on existing function-based stream conditions (Figure 6 – Assessment Reaches). A summary table listing the function-based conditions for each assessment reach is found below (Table 3 – Existing Function-Based Assessment). Assessment parameters were numerically scored to provide an objective measure of current conditions and potential uplift at each level of the Stream Functions Pyramid, described previously. From the individual pyramid level assessments, an overall function-based condition is then assigned to each assessment reach.
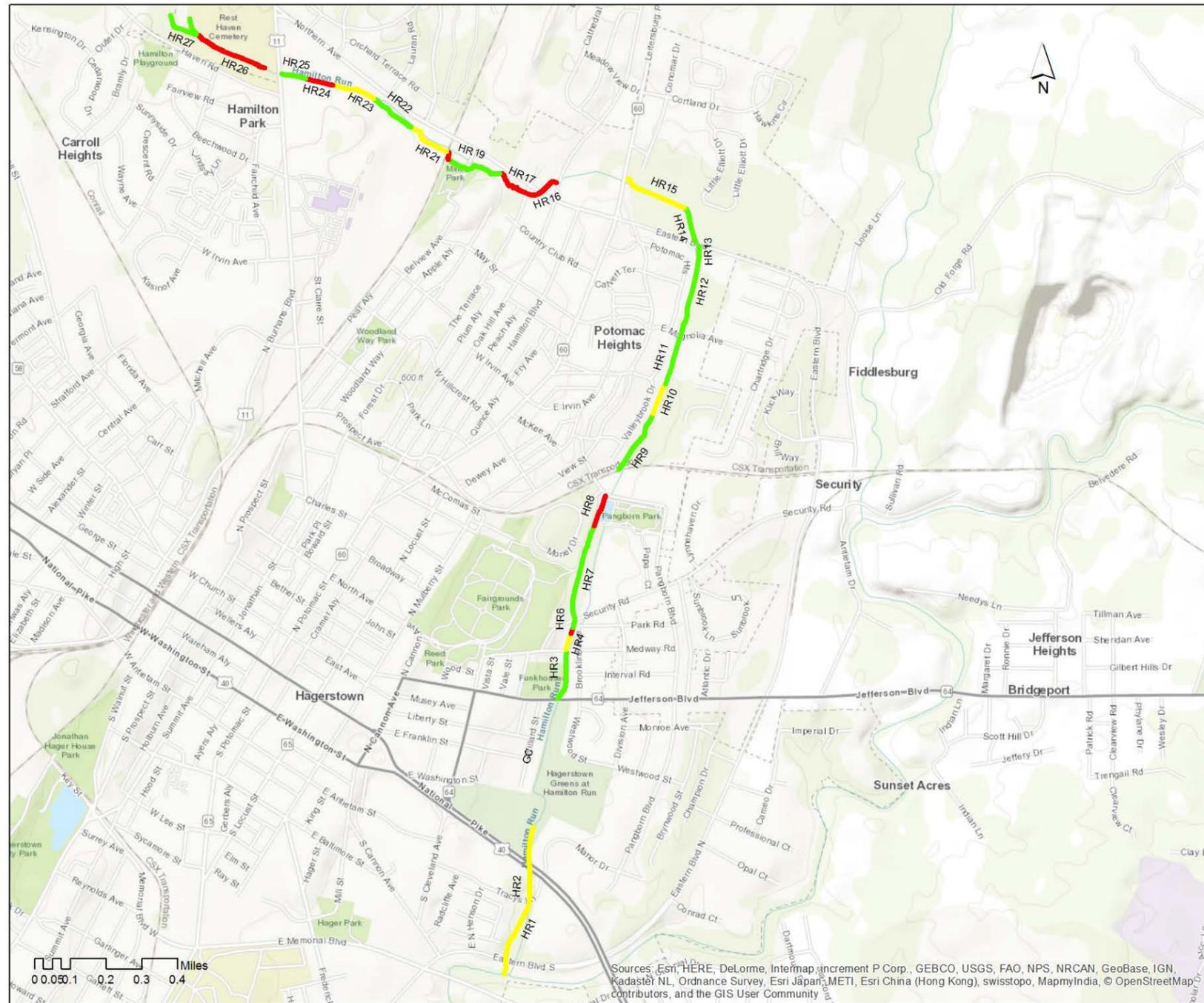
Figure 6. Summary of Overall Existing Function-Based Rating from the Hamilton Run Rapid Assessment.

There were no assessment reaches described by the Stream Functions Pyramid Framework as fully functioning (F). Most of the stream assessment reaches, making up a total length of 13,425 feet, were characterized as functioning-at-risk (FAR) with 8 assessment reaches (2,740 feet) described as not functioning (NF). Additionally, an overall existing function-based rating was assigned to compare reaches within Hamilton Run. Assessment reaches with an existing function-based score greater than 90 were rated as high, reaches with a function based score between 80 and 89 were rated as moderate, and reaches with a function based score below 79 were rated as low. The majority of impairments are a result of urban encroachment along the stream that have altered natural conditions and development within the watershed. This section includes a summary of the reach level assessment findings broken down by level of the Stream Functions Pyramid. Reference Appendix E – Reach Level Function- Based Assessments for detailed reach level data.

Assessment Reach	Reach Length	Level 1 - Hydrology	Level 2 - Hydraulics	Level 3 - Geomorphology			Level 4 - Physicochemical	Level 5 - Biology	Overall Existing Function-Based Condition (Score)	Existing Function-Based Rating
		Runoff	Floodplain Connectivity	Riparian Vegetation	Lateral Stability	Bedform Diversity	Water Quality and Nutrients	Presence		
		Existing (Score)	Existing (Score)	Existing (Score)	Existing (Score)	Existing (Score)	Existing (Score)	Existing (Score)		
HR 1	1125	FAR (9)	FAR (29)	FAR (7)	FAR (8)	FAR (13)	FAR (9)	FAR (13)	FAR (88)	Moderate
HR 2	1100	NF (6)	FAR (23)	NF (3)	FAR (14)	FAR (19)	FAR (10)	FAR (12)	FAR (87)	Moderate
HR 3	700	FAR (8)	FAR (31)	NF (3)	F (16)	FAR (16)	FAR (7)	FAR (12)	FAR (93)	High
HR 4	270	FAR (9)	NF (19)	NF (3)	FAR (15)	FAR (14)	FAR (8)	FAR (12)	NF (80)	Moderate
HR 5	70	FAR (9)	NF (20)	NF (2)	F (16)	FAR (14)	FAR (8)	FAR (10)	NF (79)	Low
HR 6	250	FAR (9)	FAR (31)	NF (2)	FAR (16)	FAR (18)	FAR (8)	FAR (11)	FAR (95)	High
HR 7	1300	FAR (10)	FAR (32)	FAR (6)	F (18)	NF (10)	FAR (8)	FAR (11)	FAR (95)	High
HR 8	470	FAR (7)	NF (21)	NF (2)	FAR (15)	NF (10)	FAR (8)	FAR (11)	NF (74)	Low
HR 9	870	FAR (9)	FAR (34)	FAR (6)	FAR (12)	FAR (12)	FAR (11)	FAR (11)	FAR (95)	High
HR 10	450	FAR (9)	NF (19)	FAR (4)	FAR (14)	FAR (12)	FAR (11)	FAR (11)	NF (80)	Moderate
HR 11	740	FAR (9)	FAR (30)	FAR (6)	FAR (14)	FAR (16)	FAR (11)	FAR (11)	FAR (97)	High
HR 12	980	FAR (8)	FAR (29)	NF (2)	FAR (14)	FAR (19)	FAR (12)	FAR (11)	FAR (95)	High
HR 13	350	FAR (10)	FAR (20)	NF (2)	FAR (13)	FAR (21)	FAR (12)	FAR (13)	FAR (91)	High
HR 14	550	FAR (6)	FAR (30)	FAR (7)	F (18)	FAR (16)	FAR (11)	FAR (11)	FAR (99)	High
HR 15	930	FAR (8)	FAR (16)	FAR (6)	FAR (15)	FAR (17)	FAR (10)	FAR (11)	FAR (83)	Moderate
HR 16	510	FAR (8)	NF (18)	NF (3)	F (16)	NF (7)	FAR (9)	FAR (9)	NF (70)	Low
HR 17	450	FAR (6)	NF (15)	FAR (6)	NF (9)	FAR (19)	FAR (9)	FAR (9)	NF (73)	Low
HR 18	120	FAR (9)	FAR (34)	FAR (6)	F (16)	FAR (16)	FAR (10)	FAR (9)	FAR (100)	High
HR 19	680	FAR (8)	FAR (30)	FAR (6)	FAR (12)	FAR (21)	FAR (10)	FAR (9)	FAR (96)	High
HR 20	120	FAR (7)	NF (13)	NF (2)	FAR (12)	NF (11)	FAR (10)	FAR (9)	NF (64)	Low
HR 21	640	FAR (7)	FAR (24)	NF (3)	FAR (13)	FAR (17)	FAR (10)	FAR (9)	FAR (83)	Moderate
HR 22	660	NF (6)	FAR (31)	NF (2)	F (18)	FAR (14)	FAR (12)	FAR (11)	FAR (94)	High
HR 23	630	NF (6)	FAR (27)	NF (3)	FAR (14)	FAR (16)	FAR (11)	FAR (11)	FAR (88)	Moderate
HR 24	400	NF (6)	NF (19)	NF (3)	FAR (14)	NF (11)	FAR (10)	FAR (11)	NF (74)	Low
HR 25	360	FAR (9)	F (36)	FAR (5)	FAR (15)	NF (10)	FAR (10)	FAR (11)	FAR (96)	High
HR 26	1100	FAR (11)	FAR (21)	NF (1)	FAR (10)	NF (8)	FAR (10)	FAR (11)	FAR (72)	Low
HR 27	340	FAR (11)	FAR (23)	NF (3)	FAR (12)	FAR (16)	FAR (14)	FAR (11)	FAR (90)	High

Table 3. Existing Function-Based Assessment. Functional conditions are notated by functioning (F), functioning at risk (FAR) and not functioning (NF).

1.   <u>**Existing Function-Based Condition**</u>

3.2.1.1 – Hydrology (Level 1)

Hydrology, as described by the Stream Functions Pyramid, is the transport of water from the watershed to the stream channel. At the assessment reach level, hydrology is measured by how runoff is managed as it enters the stream through both concentrated flow and flashiness of flow. Only two assessment reaches (1,440 ft.) were characterized as functioning, with minimized concentrated flow potential from runoff (Table 4 - Hydrology). The rest of the assessment reaches (14,725 ft.) were characterized as functioning-at-risk or not functioning due to the potential for concentrated flow runoff. The characterization of flashiness was either functioning-at-risk or not functioning across all reaches as a result of the highly-urbanized watershed. Hydrology could be improved by consistently placing measures to appropriately manage concentrated runoff, such as constructed BMPs. Because of the outside constraints associated with an urbanized watershed, it is difficult to alter the flow regime and achieve hydrologic uplift from reach level restoration activities.

Hydrology Assessment Parameter (Measurement Method)	Functioning Assessment Reaches	Functioning-at-risk Assessment Reaches	Not functioning Assessment Reaches
Runoff (Concentrated Flow)	26, 27	1, 3 – 13, 15, 16, 18, 19, 21, 25,	2, 14, 17, 20, 22 – 24
Runoff (Flashiness)	None	18 – 21	1 – 17, 22 - 27

Table 4. Hydrology Function-Based Assessment of Reaches

3.2.1.2 – Hydraulics (Level 2)

Hydraulics, as described by the Stream Functions Pyramid, is the transport of water and sediment both in the channel and on the floodplain. This level of the pyramid was assessed by floodplain connectivity, floodplain drainage, and vertical stability extent. Floodplain connectivity is measured by the bank-height-ratio and entrenchment ratio. The bank-height-ratio provides a measurement of how quickly stream flows are capable of overtopping banks and inundating the floodplain. The entrenchment ratio then describes how much floodplain is available for flood flows, once stream flows have overtopped its banks. Floodplain drainage is a measurement of differences between sheet and concentrated flow, while also incorporating if ponding or wetland retention is taking place in the floodplain. Finally, vertical stability describes the potential for aggradation or degradation on the channel bed, which can lead to changes in channel dimensions and flow dynamics.

Five assessment reaches (2,710 ft.) in Hamilton Run had a bank-height-ratio considered functioning (Table 5 - Hydraulics). The rest of the assessment reaches ranged from moderately incised (functioning-at-risk) to highly incised (not functioning). Incision is a typical result of

urbanization that causes increased stream energy and channelization. However, 13 assessment reaches spanning over half of the total length of Hamilton Run had a high entrenchment ratio. This suggest, with proper channel adjustments, it would be feasible to access an existing and wide floodplain more frequently. This would increase ecological uplift and shift some assessment reaches from not-functioning and functioning-at-risk to assessment reaches with a functioning floodplain connectivity. 23 of the assessment reaches (14,115 ft.) had floodplain drainage characterized as functioning-at-risk, which means an equal quantity of sheet and concentrated flow runoff was entering the stream with few areas present for natural retention. This result is consistent with details in the watershed and hydrology assessment. The final assessment parameter, vertical stability, had 16 assessment reaches (9,215 ft.) characterized as functioning-at-risk, with 9 assessment reaches (5,900 ft.) characterized as functioning. This can be interpreted to mean there is a moderate risk of overall changes in bed elevation which could lead to changes in stream flow dynamics.

Hydraulic Assessment Parameter (Measurement Method)	Functioning Assessment Reaches	Functioning-at-risk Assessment Reaches	Not functioning Assessment Reaches
Floodplain Connectivity (Bank Height Ratio)	3, 9, 18, 22, 25	1, 2, 6, 7, 11, 12, 14, 19, 21, 23, 26, 27	4, 5, 8, 10, 13, 15 – 17, 20, 24
Floodplain Connectivity (Entrenchment Ratio)	1, 3, 6, 7, 9, 11, 12, 14, 18, 19, 22, 23, 25	2, 21, 26, 27	4, 5, 8, 10, 13, 15 – 17, 20, 24
Floodplain Drainage (FWS Rapid Assessment)	6, 25, 27	1, 3 – 5, 7 – 24, 26	2
Vertical Stability Extent (FWS Rapid Assessment)	3, 7 – 9, 11, 18, 19, 22, 25	1, 2, 4 – 6, 10, 12 – 14, 16, 17, 21, 23, 24, 26, 27	15, 20

Table 5. Hydraulic Function-Based Assessment of Reaches

3.2.1.3 – Geomorphology (Level 3)

Geomorphology, as described by the Stream Functions Pyramid, is the transport of wood and sediment to create diverse bed forms and dynamic equilibrium. This level of the pyramid was assessed by riparian vegetation, lateral stability and bedform diversity. The evaluation of riparian vegetation primarily looks at how wide across the riparian vegetation extends along the stream corridor. Lateral stability then assesses how quickly banks are eroding and the total extent to which banks along the stream are eroding. Finally, bedform diversity assesses variables such as pool-to-pool spacing, pool depth and shelter for fish. This parameter provides a measure to determine if the physical environment necessary for natural stream processes to occur is present.

Typical of an urbanized stream, there was less than 100 feet of riparian buffer on either bank of the Hamilton Run channel along most of its entire length, which characterizes all reaches as either functioning-at-risk or not functioning (Table 6 - Geomorphology). Encroachment from development along the stream channel is typical of urbanized streams and is difficult to re-establish due to lack of consistent open space. Lateral stability is provided in several assessment reaches from rock and concrete that has been installed to stabilize banks and prevent erosion. However, where natural channel stream banks exist, there is potential for lateral instability and eroding banks.

Overall, there are 19 reaches (11,805 ft.) that are characterized as functioning-at-risk for the lateral stability assessment. Bedform diversity is mainly impacted by an increase in stream energy which, in general, has led to straightening and incision of the channel across Hamilton Run. This has caused riffles to predominate, especially for downstream reaches, where pools could be constructed to add more habitat. In the upstream reaches, pools are deeper and the underlying bedrock significantly influences bedform, as well as restoration potential. Constructed weirs and culverts also impact bedform, leading to silt deposition on the bottom of the channel. In general, most assessment reaches fell into functioning-at-risk or not functioning for all three bedform diversity measurements (shelter for fish, pool-to-pool spacing, and pool depth variability). There is potential for increased bedform diversity in these assessment reaches with increased pool placement and in some cases an increase in pool depth.

Geomorphology Assessment Parameter (Measurement Method)	Functioning Assessment Reaches	Functioning-at-Risk Assessment Reaches	Not Functioning Assessment Reaches
Riparian Vegetation (FWS Rapid Assessment)	None	1, 7, 9 – 11, 14, 15, 17 – 19, 25	2 – 6, 8, 12 – 13, 16, 20 – 24, 26, 27
Lateral Stability (Dominant Bank Erosion Rate)	1, 3 – 7, 10, 14 – 16, 18, 22 – 25	2, 8, 9, 11 – 13, 19 – 21, 26, 27	17
Lateral Stability (Lateral Stability Extent)	3, 5, 7, 8, 14, 16, 18, 22	2, 4, 6, 9 – 13, 15, 17, 19 – 21, 23 – 27	1
Bedform Diversity (Shelter for fish)	1	2 – 6, 9 – 15, 17 – 19, 21 – 27	7, 8, 16, 20
Bedform Diversity (Pool-to-pool spacing)	1, 19	2, 5, 6, 11, 13, 17, 18, 21, 22	3, 4, 7 – 10, 12, 14 – 16, 20, 23 – 27
Bedform Diversity (Pool Depth Variability)	1, 3, 12 – 15	2, 4 – 6, 9 – 11, 17 – 24, 27	7, 8, 16, 25, 26

Table 6. Geomorphology Function-Based Assessment of Reaches

3.2.1.4 – Physiochemical (Level 4)

Physiochemical factors, as described by the Stream Functions Pyramid, include water quality parameters necessary for aquatic life and processing of organic matter and nutrients. This level of the pyramid was assessed using water quality appearance and detritus. The U.S. Fish and Wildlife Service's (USFWS) (Starr et al., 2015) rapid assessment for water quality evaluates the approximate turbidity, presence of oil sheens or foams, odors, and potential algal growth in the stream. When present, these criteria are signs of untreated runoff entering the stream that can impair water quality. The assessment of detritus determines the presence of decomposing organic matter in the stream, which promote nutrient cycling and the basis for an aquatic food web.

Hamilton Run is impacted by poor watershed health and the water quality and nutrient characteristics of all reaches except for assessment reach 8 are described as functioning-at-risk (Table 7 - Physicochemical). This condition was mainly a result of high sediment loading and the potential of stormwater runoff from the urban area to transport sediment, oil and other debris into the stream which impairs water quality. Furthermore, straightening of the channel has led to an increase in energy, which prevents the build-up of detritus that enables cycling of organic materials. The detritus conditions of two reaches were characterized as not-functioning, and the rest were characterized as functioning-at-risk. Therefore, overall water quality would be improved by uplift of the hydrologic and hydraulic stream functions through the management runoff before it enters the stream. Furthermore, stream restoration strategies promoting dissipation of the stream flow energy would also allow detritus to accumulate.

Physiochemical Assessment Parameter (Measurement Method)	Functioning Assessment Reaches	Functioning-at-Risk Assessment Reaches	Not Functioning Assessment Reaches
Water Quality and Nutrients (FWS Rapid Assessment)	None	1 – 7, 9 – 27	8
Detritus (FWS Rapid Assessment)	None	1, 2, 4 – 7, 9 – 27	3, 8

Table 7. Physiochemical Function-Based Assessment of Reaches

3.2.1.5 – Biology (Level 5)

Biology, as described by the Stream Functions Pyramid, is the biodiversity and life histories of aquatic and riparian life. This level was assessed by the presence or absence of fish and macroinvertebrates in the stream. The presence of species known to be intolerant to poor water quality is a further assessment parameter that can be used in concert with water quality assessments. These species include the Mayfly, Stonefly and Caddisfly, all of which are sensitive to water quality and will not be present when water quality is impaired. The presence of macroinvertebrates and fish were mainly characterized as functioning-at-risk, meaning they were present but rare across most reaches (Table 8 - Biology). On the downstream side, there were five assessment reaches (4,495 ft.) where intolerant macroinvertebrates were found; however, they were rare in number, so these reaches were characterized as functioning-at-risk. Intolerant

macroinvertebrates were not present in the other reaches, so these reaches were characterized as not functioning. Improvement in habitat for fish and macroinvertebrates, through an increase in bedform diversity, may allow partial uplift to improve the biology of the stream. However, improvement of water quality will result in the most biological uplift.

Biology Assessment Parameter (Measurement Method)	Functioning Assessment Reaches	Functioning-at-Risk Assessment Reaches	Not Functioning Assessment Reaches
Macroinvertebrate (Presence)	None	1 – 4, 6 – 27	5
Intolerant Macroinvertebrates (Presence)	None	1 – 4, 7	5, 6, 8 – 27
Fish (Presence)	None	1 – 27	None

Table 8. Biology Function-Based Assessment of Reaches

2. Channel Evolution

The 27 assessment reaches that make up Hamilton Run fall into different channel evolution patterns depending on existing and past influences acting on the reach (Table 9 – Channel Evaluation). Before human development, Hamilton Run was most likely a C4 Rosgen stream type based on watershed and valley conditions. However, anthropogenic influences such as channel straightening, floodplain encroachment from development and other land uses, increased impervious surfaces, and stream piping created unstable stream conditions, primary F4 Rosgen stream types. Currently, there are three distinct channel evolution trends: 1) unstable F4 Rosgen stream type channels or F4 channels moving towards B4c channels, 2) stable B4c Rosgen stream type channels, and 3) incised C4 Rosgen stream type channels.

The greatest length of the stream is currently the Rosgen stream type F4 that is evolving towards a B4c type stream. The geomorphic functions are still undergoing significant adjustments. The streams are entrenched, but are no longer adjusting vertically. This is evident by the grade control throughout Hamilton Run provided by road crossings and bedrock. However, there is active lateral erosion occurring that will continue to occur until new, stable flood prone areas are developed at a lower elevation and with less steep banks. However, adjustments to the channel could take years if not decades to occur naturally.

The B4c Rosgen stream type channels are currently at an evolutional end point. They evolved from a F4 Rosgen stream type and should have evolved into a C4. However, because of floodplain encroachment from development, there is not enough available floodplain width to allow the stream to develop the channel meanders and sinuosity required to be classified as a C4. The B4 stream reaches will likely remain fairly stable over time as long as the established

riparian vegetation remains intact, no channel alterations are made, and the watershed characteristics remain generally the same.

The majority of the C4 Rosgen stream type channels are straight or nearly straight, most likely because they were physically straightened sometime in the past. The difference between the C4 and B4c stream channels is that the C4, in most cases, have adequate floodplain width to meander. Additionally, they typically have some type of downstream grade control (e.g., road crossings and/or bedrock) that keeps these reaches connected to the floodplain. Where riparian vegetation is not well established, bank erosion is occurring as the stream tries to create meanders in order to dissipate energy. While these stream reaches are further in the evolution trend than the F4 stream reaches, it still will likely take years for them to fully recover.

Channel Evolution	Assessment Reaches	Length (ft)
F4 → B4c	4, 6, 16, 17, 20, 21, 24, 26	3740
B4c	2, 3	1800
Straight C4	7, 25	1660
Straight C4/6	9, 11	1610
Slightly incised and laterally eroding C4	1	1125
F4/6 → B4c	15	930
Straight and incised C4/6	12	980
Hardened F4	5, 8	540
High width-to-depth ratio C4	22	660
Straight and slightly incised C4	23	630
Slightly incised and straight C5/6	14	550
Low sinuosity and slightly incised C4/1	19	680
Hardened F4/6	10	450
Incised and nearly straight C4	27	340
Low sinuosity E4	18	120
F4/1 → B4c	13	350

Table 9. Hamilton Run Channel Evolution

IV. WATERSHED ACTION PLAN

This section presents the project constraints, restoration potential, design objectives, proposed restoration projects and project prioritization for the Hamilton Run Watershed. The development of restoration projects focused on stream restoration opportunities, but did include BMP opportunities identified as part of this project and from past reports completed by the City.

A.   CONSTRAINTS

Constraints are man-made features that may influence the restoration potential of a stream restoration project. There were four general project constraints identified across the reaches: 1) bridge / road crossings, 2) undersized culverts, 3) piped sections, and 4) encroachment by development (Table 10 - Constraints) (Figure 7 – Undersized Culverts and Piped Sections). These constraints are located throughout Hamilton Run and must be considered when evaluating the maximum potential functional uplift expected from a stream restoration project.
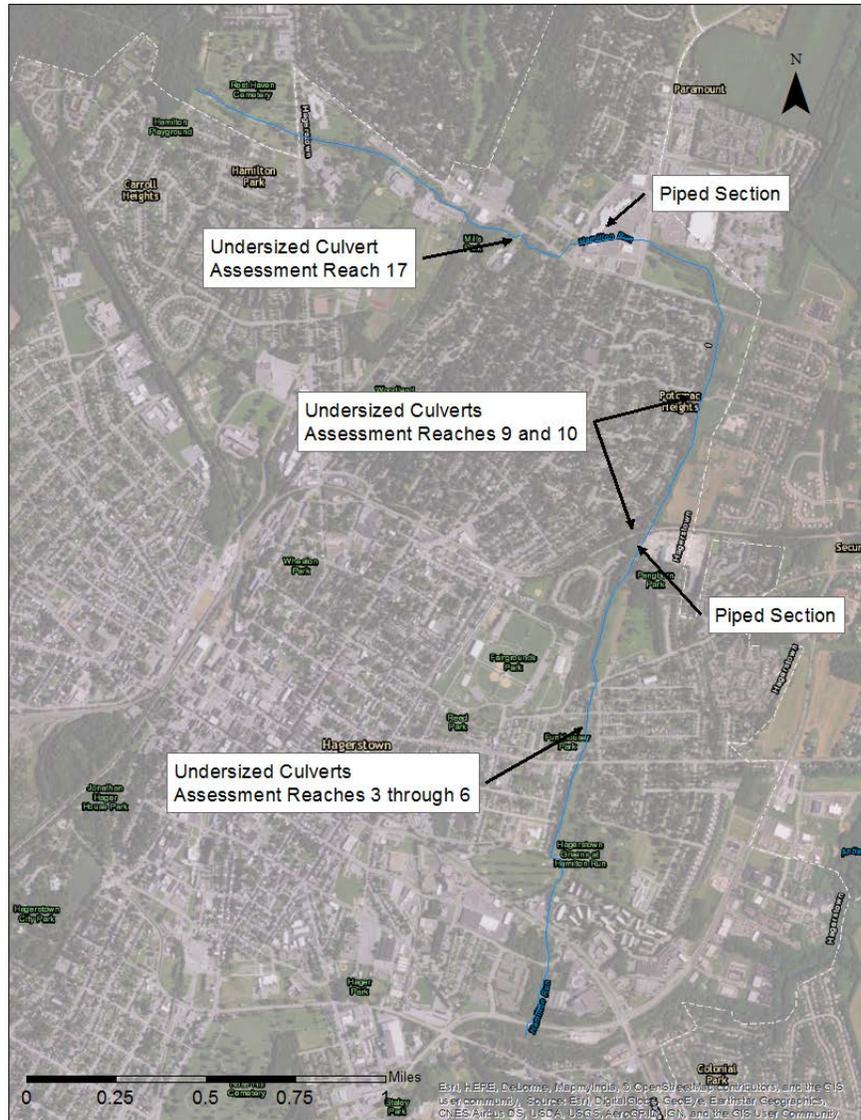
Figure 7. Project Constraints

Bridges and culverts from road crossings are the most common constraints impacting 23 of the 27 reaches. Bridges and culverts impact the stream by altering flow dynamics and aquatic species movement. Flow dynamics are altered because bridges and culverts are typically undersized to pass stream flood flows. There are seven assessment reaches determined to be

impacted by culverts that cannot pass bankfull flows. These undersized culverts adversely impact stream conditions upstream and downstream. Upstream of undersized culverts, stream energy is reduced and causes a backwater build up that leads to stream bed aggradation and increased flooding. Downstream of undersized culverts stream energy is increased and causes stream bed and bank erosion. Aquatic species movement is adversely impacted either by significant bed elevation changes downstream of a culvert or because the culvert is too long.

Piping of streams is a common constraint. Three reaches are impacted by underground piping either upstream or downstream of the reach itself. Similar to the impact of culverts, stream reaches that are piped for a significant length strongly influence changes in flow regime and aquatic species movement. Additionally, functional uplift in the piped sections themselves requires acquiring land necessary to remove the piping and re-establish a natural stream channel.

The final common constraint impacting uplift potential is encroachment by development into the stream corridor. This encroachment limits increases in the width of the riparian buffer and any potential large changes in plan form in 22 of the 27 reaches. The lack of open space then limits the creation of floodplains that help manage floods and control runoff in the stream corridor. Together, these four constraints are typical of an urban stream and are often managed to a level that would result in partial functional uplift on most of the stream reaches.

Constraint	Assessment Reaches Impacted
Bridge / road crossing in reach	1 - 6, 9 - 14, 16 - 18, 20 - 27
Undersized culvert	3 - 6, 9, 10, 17
Piped sections	8, 15, 16
Encroachment by development	3 - 6, 8 - 13, 16 - 27
None	7

Table 10. Reach Restoration Constraints Summary

B.   RESTORATION POTENTIAL

Restoration potential is the highest level of restoration or functional uplift that can be achieved given the watershed health, reach-level function-based condition, stressors, and constraints (Harman et al., 2012). It was determined that all reaches except for assessment reach 8 could achieve fully functioning hydraulic (level 2) conditions. For Geomorphology (level 3), 12 of the 27 reaches could reach conditions considered fully functioning from restoration activities, and 14 reaches have the potential to achieve partial uplift through the geomorphology level (Table 11 – Restoration Potential). Restoration of Level 2 and 3 functions are typically the easiest to achieve since it involves direct, physical manipulation of stream channel dimension, pattern, and profile. Stream channel parameters such as bank heights, floodplain width, facet feature lengths, slopes, and depths can be constructed to specifications considered functioning. Constraints limiting

those reaches from achieving fully functioning status through level 3 are mainly due to a lack of available adjacent land required to create a sufficient riparian buffer.

There is a potential for partial uplift in the Physicochemical level (level 4). Sediment sources from eroding streambanks can be eliminated to improve water quality. Additionally, the establishment of a riparian buffer along the stream, where possible, would help to better control runoff. Improvements in water quality would then be translated to partial uplift for Biology (level 5). Aiding any partial uplift of biology would be the large increase of instream habitat from improvements in geomorphology. Significant physiochemical and biological uplift is limited due to poor watershed health adversely impacting the stream system.

Stream Functions Pyramid Level Uplift	Assessment Reaches	Description
Full Level 2 – Hydraulics	1 – 7, 9 – 27	Channel dimensions can be constructed to achieve conditions considered fully functioning.
Partial Level 3 - Geomorphology	2 – 6, 9, 12, 13, 16, 19 – 21, 26, 27	Limited extent of potential riparian vegetation width limits full uplift
Full Level 3 - Geomorphology	1, 7, 10, 11, 14, 15, 17, 18, 22 – 25	All geomorphology parameters could be constructed to conditions considered functioning.
Partial Level 4 – Physicochemical	1 – 27	Water quality is primarily influenced by watershed health and minimal uplift can be achieved from reach level restoration.
Partial Level 5 - Biology	1 – 27	Biology is adversely impacted by poor water quality and minimal uplift can be achieved from reach level restoration.
Other	8	Potential to add some limited vegetation on banks. Pond located in reach would have to be removed to increase any additional potential uplift.

Table 11. Reach Restoration Potential Summary

C.   DESIGN GOALS AND OBJECTIVES

Based on the maximum potential uplift possible for a given reach, design goals can be established for reach based projects. Design goals differ from potential uplift by taking into account realistic project scopes for restoration activity. Design goals of the various assessment reaches in Hamilton Run include reconnection of floodplain, improving lateral stability, enhancing the stream riparian buffer and reducing nutrient levels (Table 12 – Design Goals).

Design Goals	Assessment Reaches
1. Reconnect floodplain	1 – 7, 9 – 27
2. Improve lateral stability 3. Enhance stream riparian buffer	1 – 27 1 - 27
4. Reduce Nutrient Levels	1 – 7, 9 – 22, 24 – 27

Table 12. Design goals for Hamilton Run Assessment Reaches

Design objectives are then developed for each design goal. Design objectives reflect the project goals but state specifically how the project will be completed. Thus, design objectives are quantifiable and measurable (Table 13 – Design Objectives).

Level and Category	Parameters	Design Objectives
Level 2 – Hydraulics	1. Floodplain Connectivity	1. Create floodplain connection by decreasing bank-height ratio to 1.0 to 1.2 and increasing entrenchment ratio to greater than 2.2.
Level 3 – Geomorphology	2. Lateral Stability 3. Riparian Buffer	2. Reduce stream bank erosion rates to match reference erosion rates (bank migration / lateral stability) 3. Create a minimum 25 ft wide native riparian buffer
Level 4 – Physicochemical	4. Nutrient Levels	4. Reduce nutrient levels compared to existing conditions

Table 13. Design Objectives for Hamilton Run

D. PROPOSED RESTORATION PROJECTS

1. Proposed Project Feasibility Assessment

Proposed stream restoration recommendations were developed for each assessment reach based on the project feasibility assessment (Appendix B – Stream Restoration Feasibility Assessment). The results of the feasibility assessment were also used to prioritize the restoration recommendation. The feasibility assessment included the evaluation of ten parameters that influence the design and implementation of potential stream restoration projects. The parameters for the feasibly assessment included:

- potential restoration solution effort
- potential for ecological uplift from a restoration solution
- TMDL credits for sediment, nutrient and phosphorous reduction
- potential for BMP installation
- total stream length within a reach

The feasibility assessment also included project implementation focused parameters, which included:

- construction access
- environmental constraints
- project success / risk potential
- land ownership
- project implementation difficulty and cost

Additionally, the potential for BMPs to be incorporated into the proposed stream restoration project in areas adjacent to the stream corridor were evaluated and are described in Section IV.D.4. - BMPs and Additional Uplift. These BMPs could provide additional TMDL credits beyond the stream restoration recommendation. A broader study of BMP implementation in areas outside the stream corridor were studied and reported on in the Stormwater Management Retrofit Study (URS Corporation, 2013).

2. <u>Proposed Stream Restoration Recommendations</u>

Proposed stream restoration recommendations are based on the Natural Channel Design (NCD) Priority 1 – 3 restoration approaches (Rosgen 2006). The NCD Priority restoration approaches call for different levels of effort in adjusting channel and floodplain conditions to provide ecological uplift, while meeting design objectives.

NCD Priority Level 1 restoration creates a new stable channel that is re-connected to the previous (higher in elevation) floodplain. A new stream channel is excavated on the original floodplain by raising the stream bed elevation. This approach requires an abrupt change in bed elevation at the upstream end of the project, e.g. culvert outfall or knickpoint. The former incised channel is filled, converting it to a floodplain feature. This approach is used in areas where there are few lateral constraints and where flooding on the adjacent land can be increased. An example of the plan form and dimension improvements created by a Rosgen Priority 1 project is shown in Figure 8 - Priority Level 1.
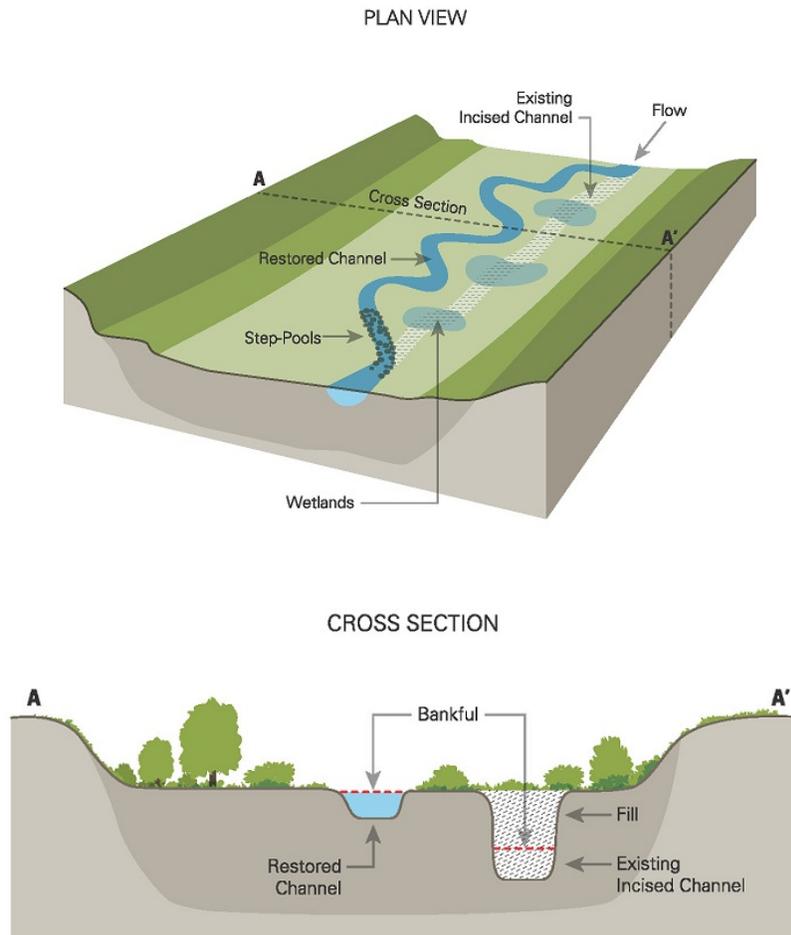
Figure 8. NCD Priority Level 1 Restoration Approach

A Priority Level 2 restoration also creates a new stable channel that is connected to the floodplain, but the floodplain is excavated at the existing bankfull elevation, i.e. the bed elevation of the stream remains nearly the same. The formerly channelized and incised stream is re-meandered through the excavated floodplain. This approach is typically used if there is not a knickpoint or other abrupt change in grade upstream of the project, in larger streams, or in cases where flooding cannot be increased on adjacent property. A plan view and cross section example is shown below in Figure 9 – Priority Level 2.

PLAN VIEW

CROSS SECTION
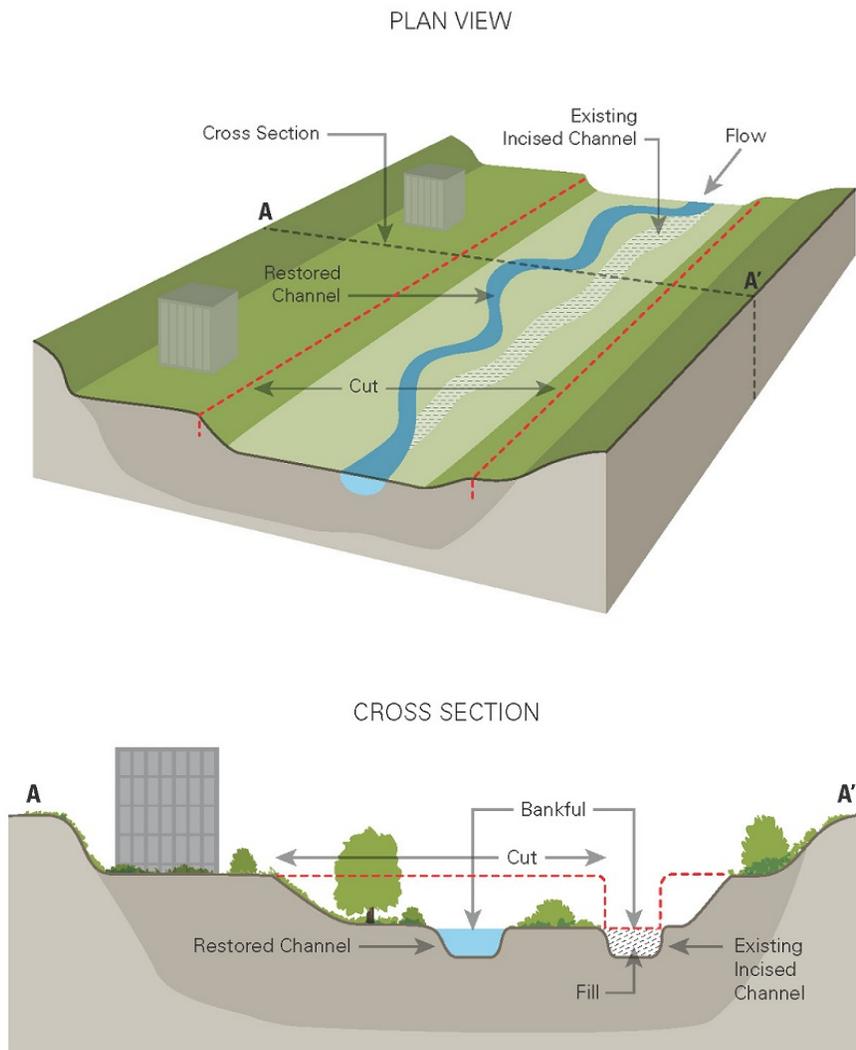
Figure 9. NCD Priority Level 2 Restoration Approach

NCD Priority Level 3 restoration also creates a new stable channel that is connected to the existing bankfull elevation, i.e. the bed elevation of the stream remains nearly the same. However, the newly excavated floodplain is much narrower than a floodplain associated with a Priority Level 2 and is commonly referred to as a floodplain bench. This approach is typically used if the floodplain has been encroached upon by development and there is limited space for a floodplain area. A plan view and cross section example is shown below in Figure 10 – Priority Level 3.

PLAN VIEW

CROSS SECTION
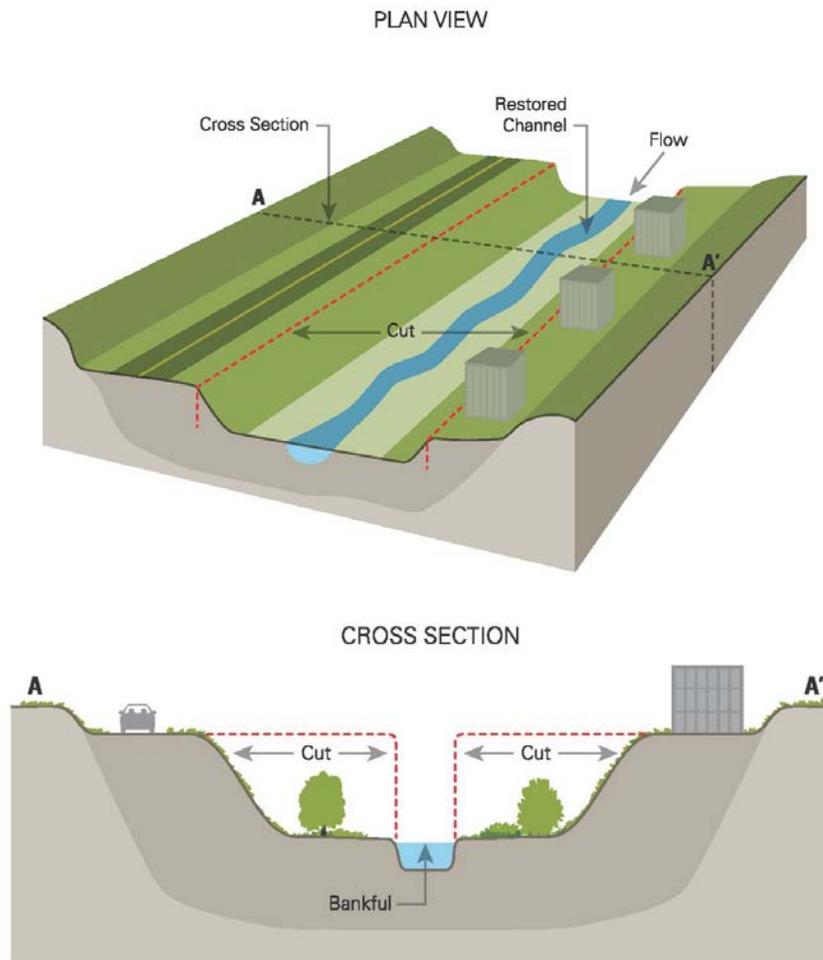
Figure 10. NCD Priority Level 3 Restoration Approach

Altogether, the project feasibility assessment led to the development of 18 proposed project areas that span the 27 assessment reaches across Hamilton Run (Figure 11 – Proposed Stream Restoration and BMP Recommendations), along with 10 BMP recommendations. Some assessment reaches were combined into one proposed project area to maximize potential TMDL credits and ecological uplift. To meet the design objectives for each proposed project area, restoration solutions were developed and are listed below (Table 14 – Proposed Restoration Reaches).

Project Locations
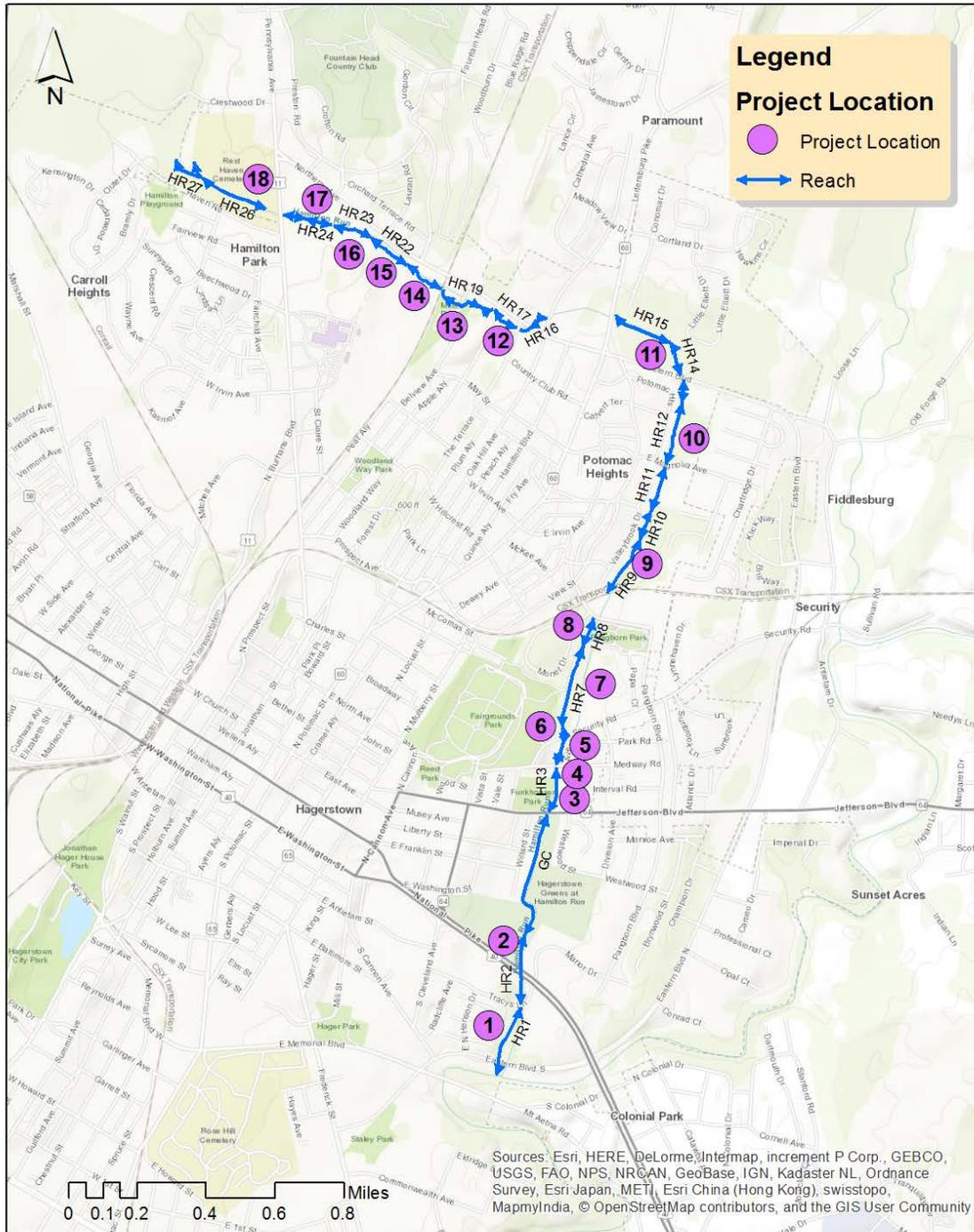
Figure 11. Proposed Stream Restoration and BMP Recommendations

Proposed Project Area	Assessment Reach	Project Reach Length (ft)	Proposed Stream Restoration Recommendation	Proposed BMP Recommendation
1	1	1125	NCD Priority 1 if raising streambed does not impact bridge, Priority 2 if it does impact the bridge	None
2	2	1100	NCD Priority 3	Install BMP to treat stormwater drainage from commercial parking lot
3	3	700	Localized bank stabilization	Replace concrete swale with grass swale BMP to better manage concentrated flow from alleyways
4	4	270	NCD Priority 3	None
5	5	70	NCD Priority 3 if landowners are willing to give up land	None
6	6	250	NCD Priority 3	None
7	7	1300	NCD Priority 1, Valley Restoration	Create large wetland BMP in floodplain that is frequently inundated from flood flows and effluent from Pangborn Park
8	8	470	Localized bank stabilization and some riparian plantings	None
9	9 10 11	2060	NCD Priority 1, Valley Restoration	Create large wetland BMP in floodplain that is frequently inundated from flood flows
10	12 13	1330	NCD Priority 3	None
11	14 15	1480	NCD Priority 3 for Assessment Reach 15	Create large wetland BMP in floodplain that is frequently inundated from flood flows
12	16 17	960	NCD Priority 3	None
13	18 19	800	NCD Priority 1, Valley Restoration	Create small wetland BMP in floodplain that is frequently inundated from flood flows
14	20 21	760	NCD Priority 3	BMP to treat stormwater runoff from the County maintenance yard parking lot and reduce concentrated flow
15	22	660	NCD Priority 1, Valley Restoration	Create small wetland BMP in floodplain that is frequently inundated from flood flows
16	23	630	NCD Priority 2	None
17	24 25	760	NCD Priority 1, Valley Restoration	Create small wetland BMP in floodplain that is frequently inundated from flood flows
18	26 27	1440	NCD Priority 3 for Assessment Reach 26 and NCD Priority 2 for Assessment Reach 27	Potential to turn current ponds into wetland BMPs

Table 14. Proposed Restoration Recommendations

3. Proposed Stream Restoration Function-based Condition

The proposed restoration recommendations have the potential to provide functional uplift and improve stream processes (Table 15 – Proposed Function-based Uplift). As previously mentioned, most functional uplift will be provided in the Stream Functions Pyramid Levels 2 and 3. Conditions considered functioning for floodplain connectivity in Level 2 (Hydraulics) can be constructed in 19 of the 27 assessment reaches. For Level 3 (Geomorphology), 21 assessment reaches have a proposed improvement in riparian vegetation conditions with 11 assessment reaches proposed to have a minimum 100 ft. riparian buffer. Conditions of functioning bedform diversity, including pool spacing and depth, can be reached in all but four reaches. Lateral stability can be provided from bank stabilization across all assessment reaches. Improvements to conditions beyond functioning-at-risk for both Level 4 (Physicochemical) and Level 5 (Biology), are limited primarily as a result of overall watershed health.

The proposed uplift score quantifies how much uplift will be provided in any one assessment reach. These proposed uplift scores are relative to the existing assessment reach condition. For example, if two assessment reaches have the same proposed functional condition, an assessment reach characterized with not functioning existing conditions will have a higher proposed uplift score than an assessment reach with a functioning-at-risk existing condition. The proposed uplift scores for the assessment reaches within Hamilton Run were ranked and grouped into thirds with the top third proposed uplift scores greater than 45 (High), middle third uplift scores were between 44 and 35 (Moderate) and bottom third uplift scores were below 34 (Low) noted in the table below (Table 15 Proposed Function-based Uplift). Of the eight assessment reaches with an existing condition of not-functioning (see Table 3), seven were brought to a functioning-at-risk condition based on proposed function-based conditions. The remaining 19 assessment reaches persisted in a functioning-at-risk condition in the proposed assessment, although partial functional uplift can still be achieved as shown in Table 15. Greater increases to overall restoration functional potential is inhibited due to the existing watershed health that impairs water quality.

Assessment Reach	Level 1 - Hydrology	Level 2 - Hydraulics	Level 3 - Geomorphology			Level 4 - Physico-chemical	Level 5 - Biology	Overall Proposed Function-Based Condition	Proposed Uplift (Score)
	Runoff	Floodplain Connectivity	Riparian Vegetation	Lateral Stability	Bedform Diversity	Water Quality and Nutrients	Presence		
	Proposed (Score)	Proposed (Score)	Proposed (Score)	Proposed (Score)	Proposed (Score)	Proposed (Score)	Proposed (Score)		
1	FAR* (12)	F (40)	F (9)	F (18)	F (27)	FAR* (15)	FAR* (19)	FAR* (140)	High (52)
2	FAR (10)	FAR* (33)	FAR (6)	F (18)	F (26)	FAR* (16)	FAR* (18)	FAR* (127)	Moderate (40)
3	FAR* (9)	F (34)	FAR (6)	F (18)	F (26)	FAR* (15)	FAR* (16)	FAR* (124)	Low (31)
4	FAR* (9)	F (35)	FAR (7)	F (18)	F (26)	FAR* (15)	FAR* (16)	FAR* (126)	High (46)
5	FAR* (9)	NF (20)	NF (3)	F (16)	FAR (14)	FAR* (8)	FAR* (13)	FAR* (83)	Low (4)
6	FAR* (9)	F (35)	NF (3)	F (17)	F (27)	FAR* (12)	FAR* (15)	FAR* (118)	Low (23)
7	FAR* (16)	F (37)	F (8)	F (17)	F (27)	FAR* (16)	FAR* (18)	FAR* (139)	Moderate (44)
8	FAR* (13)	NF (21)	NF (3)	F (17)	NF (13)	NF (10)	FAR* (13)	NF* (90)	Low (16)
9	FAR* (14)	F (40)	FAR* (7)	F (18)	F (27)	FAR* (15)	FAR* (18)	FAR* (139)	Moderate (44)
10	FAR* (15)	F (36)	F (9)	F (18)	F (27)	FAR* (16)	FAR* (18)	FAR* (139)	High (59)
11	FAR* (12)	F (36)	F (8)	F (18)	F (27)	FAR* (16)	FAR* (18)	FAR* (135)	Moderate (38)
12	FAR* (11)	F (36)	FAR (6)	F (18)	F (26)	FAR* (15)	FAR* (18)	FAR* (130)	Moderate (35)
13	FAR* (11)	F (33)	FAR (6)	F (18)	FAR* (21)	FAR* (13)	FAR* (13)	FAR* (115)	Low (24)
14	FAR* (10)	F (34)	F (9)	F (18)	FAR* (21)	FAR* (14)	FAR* (15)	FAR* (121)	Low (22)
15	FAR* (10)	F (32)	FAR* (9)	F (18)	F (24)	FAR* (15)	FAR* (17)	FAR* (125)	Moderate (42)
16	FAR* (10)	FAR* (32)	FAR (6)	F (18)	F (24)	FAR* (14)	FAR* (13)	FAR* (117)	High (47)
17	FAR* (8)	FAR* (31)	F (8)	F (17)	F (25)	FAR* (14)	FAR* (11)	FAR* (114)	Moderate (41)
18	FAR* (11)	F (37)	F (8)	F (17)	F (26)	FAR* (14)	FAR* (11)	FAR* (124)	Low (24)
19	FAR* (11)	FAR* (34)	FAR* (7)	F (17)	F (26)	FAR* (14)	FAR* (11)	FAR* (120)	Low (24)
20	FAR* (9)	FAR* (30)	FAR (5)	F (16)	F (24)	FAR* (13)	FAR* (11)	FAR* (108)	Moderate (44)
21	FAR* (10)	FAR* (32)	FAR (6)	F (17)	F (24)	FAR* (14)	FAR* (11)	FAR* (114)	Low (31)
22	FAR (14)	F (36)	F (8)	F (17)	F (27)	FAR* (16)	FAR* (17)	FAR* (135)	Moderate (41)
23	FAR (13)	F (36)	F (8)	F (18)	F (27)	FAR* (16)	FAR* (17)	FAR* (135)	High (47)
24	FAR (14)	F (36)	F (8)	F (18)	F (27)	FAR* (16)	FAR* (17)	FAR* (136)	High (62)
25	FAR* (13)	F (36)	F (8)	F (18)	F (27)	FAR* (16)	FAR* (17)	FAR* (135)	Moderate (39)
26	FAR* (13)	F (35)	FAR (6)	F (18)	F (24)	FAR* (14)	FAR* (15)	FAR* (125)	High (53)
27	FAR* (15)	F (35)	F (9)	F (18)	F (27)	F (17)	FAR* (18)	FAR* (136)	High (46)

Table 15. Proposed Function Based-Assessment Ratings and Overall Uplift. * means partial uplift

4.   **Proposed BMP Recommendations**

The implementation of BMPs along the stream corridor would provide opportunity for the City to obtain additional TMDL credits and treatment of impervious surfaces either separately or in conjunction with stream restoration work. This study identified potential BMP opportunities along the Hamilton Run stream corridor through both an independent assessment and through review of BMP opportunities identified in the Stormwater Management Retrofit Study (URS Corporation, 2013).

The Stormwater Management Retrofit Study (URS Corporation, 2013) evaluated the feasibility of BMPs both along the Hamilton Run stream corridor and throughout the City. In reviewing this report, it was determined that three of the URS proposed BMP locations are along the stream corridor. One of these URS proposed BMPs (URS Site 35) is in the same local area as EPR Project Area 7. Two further URS proposed BMP opportunities are within the area of The Greens at Hamilton Run Golf Course. A sixth BMP proposed by the URS report was identified immediately adjacent to the stream corridor. The priority rankings for the proposed URS BMP recommendations were provided by the City (Table 16 – Previously Proposed BMP Recommendation).

The feasibility assessment study conducted by EPR identified potential BMP opportunities for 10 of the 18 proposed project areas (Table 14 – Proposed Restoration Recommendations). Some of these proposed BMPs are recommended in large, undeveloped lands adjacent to Hamilton Run that could be used to create wetland BMPs that are frequently inundated by flood flows, while other recommendations include smaller stormwater treatment BMPs that could help manage and treat concentrated stormwater runoff. Below is a brief description of priority areas identified where BMPs have potential to be implemented dependent upon land owner approval (Figure 11 Proposed Stream Restoration and BMP Recommendations):

1. **Proposed Project Area 2**: There is potential for a stormwater treatment BMP to be installed and treat runoff from a parking lot along the right bank in this proposed project reach. The BMP would be on private commercial property.
2. **Proposed Project Area 3**: Two concrete swales that drain nearby residential homes and alleyways create concentrated runoff point sources that drain into Hamilton Run in this proposed project reach. The removal of these concrete swales and replacement with a grass swale BMP with riparian planting would help decrease concentrated flow.
3. **Proposed Project Area 7:** This reach of Hamilton Run moves between two private property parcels. Currently, open space exists to create an expanded floodplain and wetland BMP along the left bank approximately four and a half acres in size. This land is currently empty and zoned for future moderate density residential development.

EPR Proposed Project Area	URS Report Site Number	Proposed Project from URS Stormwater Management Retrofit Study	City Priority Ranking
7	URS Site 35	To improve the treatment provided at this site, excavation is proposed to provide extended detention for water quality. The potential retrofit would consistent of adding forebays at the inlets and micro pool at the riser to settle sediment and other pollutants before being discharged into the downstream channel.	Medium
8	URS Site 15	Improvement recommendations at this site include modifying the concrete ditch to a bio-swale that would filter pollutants from runoff.	Medium / High
16	URS Site 12	Proposed recommendations at the site include the addition of a diversion structure to the storm drain system to divert the water volume to the open parcel where a bioretention system could be implemented. Higher flows would be diverted to the storm drain system which would be discharged to the stream on the other side of Northern Avenue. Modification of the existing storm drain system would be required to implement this project.	Medium / High
Adjacent to stream corridor	URS Site 36	The proposed recommendations at the site include converting the facility to a bioretention system as the facility currently receives runoff as sheet flow.	Low
The Greens at Hamilton Run	URS Site 17	Improvement options at the site include modifying the concrete ditch to a water quality swale to promote the uptake of pollutants from the stormwater runoff.	Medium / High
The Greens at Hamilton Run Maintenance Facility	URS Site 18	Project recommendations at this site include converting the facility to a bioretention system by adding a flow splitter/diversion structure at the two inlets to divert the water quality volume to the facility. Higher flows would be diverted to exiting outlet pipe. Modification of existing storm drain system would be required to implement this project.	Low / Medium

Table 16. Previously Proposed BMP Recommendations

4. **Proposed Project Area 9**: This section of Hamilton Run separates the backyards of private homes and a large parcel of land occupied by an elementary school that is part of Washington County Public Schools (WCPS). Along the left bank, on land owned by WCPS, there is a long corridor approximately four and a half acres in size of open field that could be used to build a large wetland BMP complex.

5. **Proposed Project Area 11**: This area of Hamilton Run moves through an open space where approximately two and a half acres of undeveloped land exists that could be

turned into a large wetland BMP complex. The land is privately owned and may potentially require coordination with two separate land owners. There is also a forest conservation easement currently on this project that may influence the BMP potential.

6. **Proposed Project Area 13**: This proposed project area is where Hamilton Run moves through the City owned Mills Park and there is approximately a quarter-acre of open space available to create a small wetland BMP. This reach is immediately upstream of the American Legion Drive crossing and the City has already developed stream restoration concept plans, in September 2014, that extend into this Project Area.

7. **Proposed Project Area 14:** This reach of Hamilton Run flows between the Washington County Highway Maintenance Yard and several private commercial businesses. A stormwater treatment BMP could be installed on the downstream end of where Hamilton Run parallels the maintenance yard to provide runoff treatment from the maintenance yard parking lot.

8. **Proposed Project Area 15:** This section of Hamilton Run meanders through the WCPS middle school. At the downstream end of this proposed project reach, there is approximately a quarter-acre of open space where a wetland BMP could be constructed on either bank of Hamilton Run.

9. **Proposed Project Area 17**: This section of Hamilton Run meanders through a WCPS elementary school on the left bank and Western Maryland Hospital Center on the right bank. There is open space approximately a half-acre in size on school property where a potential wetland BMP could be constructed.

10. **Proposed Project Area 18**: Hamilton Run flows through the Rest Haven Cemetery in these reaches. There is the potential for two small ponds along these reaches to be converted into wetland BMPs.

E.   PROJECT PRIORITIZATION

1.   Prioritization Criteria

Criteria to prioritize the proposed project area recommendations were developed based on the proposed project feasibility assessment and discussions with the City (Appendix F – Proposed Project Prioritization Matrix). Prioritization criteria were weighted to reflect the City's priorities and the top three criteria for consideration were: 1) estimated design and construction costs, 2) potential for TMDL credits through bank restoration, and 3) land ownership. These considerations allow the City to focus on projects that are most likely to be cost effective and provide the most TMDL credits and impervious surface treatment along Hamilton Run. Additional criteria also contributed to creating a prioritization score (Table 17 – Project Prioritization Criteria).

Prioritization Criteria	Weighted contribution to prioritization score
Ownership Score	25%
Potential sediment reduction through bank restoration	25%
Proposed restoration costs per linear foot	25%
Potential Restoration Solution Approach	3%
Potential Restoration Solution Uplift	3%
TMDL Restoration Potential for Sediment, Nutrient and Phosphorous Reduction	3%
Construction Access	3%
Constraints	3%
Potential Success/Risk	3%
BMP Restoration Potential	3%
Stream Length	3%

Table 17. Project Prioritization Criteria

Projected TMDL reduction credits where determined for both stream restoration and BMP recommendations, separately. Projected TMDL reduction credits (Total Suspended Solids (TSS), Total Nitrogen (TN) and Total Phosphorus (TP)) associated with proposed stream restoration recommendations were calculated following the approved Chesapeake Bay Program Protocol 1 - Credit for Prevented Sediment during Storm Flow using the collected BANCs erosion data (Berg et al., 2013). Proposed stream restoration project area potential TMDL credits were then rated by separating the estimated potential TMDL credits into thirds (Table 18 – Estimated Range of TMDL Reduction Credits). Final scope and design of each restoration project, which is not part of this project effort, will determine the actual extent of TMDL credits that may be obtained. Projects that are designed with considerations for increased riparian nutrient processing may provide additional TN TMDL credits under Protocol 2 of the Expert Panel Report.

TMDL credits were determined for two types of proposed BMP projects: wetland BMPs and stormwater treatment BMPs. Determination of wetland BMP TMDL credits was based on the estimated floodplain storage volume (Protocol 3) and floodplain elevation of the proposed wetland BMP areas associated with a 1 inch storm event (Berg et al., 2013). Proposed wetland BMPs with an approximate area of four and a half acres were determined to have high TMDL credit potential and proposed wetland BMPs with areas less than a half-acre were determined to have low TMDL credit potential. Actual achievable TMDL credits associated with the proposed wetland BMPs is dependent upon the designed size of the floodplain /wetland BMP area and the frequency inundation of flood flows, which is not part of this project effort. Additionally, landowner acceptance will influence actual TMDL credits.

Stormwater treatment BMPs are able to provide TMDL credits relative to the drainage areas they treat. Three stormwater treatment BMPs are proposed: two that treat parking lot areas (Project Areas 3 and 14) and one that treats concentrated flows (Project Area 2). The recommended stormwater treatment BMP in Project Area 14 was determined to have medium TMDL credit potential and Project Areas 2 and 3 were evaluated to have low TMDL credit potential.

Potential to Obtain TMDL Credits	Estimated Range of TMDL Reduction Credit		
	TN (lbs / year)	TP (lbs / year)	TSS (tons / year)
Low	0 - 7	0 - 3	0 - 0.6
Medium	7 - 50	3 - 20	0.6 - 4
High	> 50	> 20	> 4

Table 18. Estimated Range of Project TMDL Reduction Credits

Finally, estimated Implementation Costs were developed based on current stream restoration and BMP costs and included assessment, design and construction.

Based on all of the prioritization criteria, the proposed project area prioritization scores were split into thirds and categorically ranked into high, medium and low priorities. Finally, best professional judgment was used to assess rankings and determine if adjustments were required for final priority rankings. For example, the project area farthest upstream (Project Area 18), on the property of Rest Haven Cemetery, was initially ranked high because it is owned by one landowner and eroding banks would allow a high amount of TMDL credits to be obtained from stream restoration. However, the sensitivity of doing construction work within cemetery limits reduces the likelihood of project implementation. Therefore, the priority ranking of Project Area 18 was lowered. In general, priority ranking adjustments were associated with projects that contained highly eroding banks and were either publicly owned or had less than two private landowners. After adjustment, a final project priority list was formed (Table 19 - Proposed project area Prioritization) (Figure 12 – Proposed Restoration Recommendations Ranking)

2. **Project Prioritization**

Proposed Project Areas Ranked as High Priority

1. **Proposed Project Area 1:** Hamilton Run flows through this reach immediately before its confluence with Antietam Creek. This area contains the second most highly eroding banks of all the project areas and stream restoration work has the potential to provide TMDL credits. The majority of the land is owned by a Homeowners Association. The City owns a small portion at the upstream end and a private entity owns a small portion on the farthest downstream end.
2. **Proposed Project Area 9**: Hamilton Run flows between several private residential parcels on the right bank and an open field exists on the left bank that is owned by Washington County Public Schools. Stream restoration of highly eroding banks in this section of Hamilton Run and the creation of a large wetland BMP complex within the left bank floodplain would provide significant TMDL reduction credits, but would require coordination with property owners.
3. **Proposed Project Area 12 and 13:** These proposed project areas include portions of Hamilton Run where it passes through a culvert under American Legion Drive and through Mills Park. Proposed Project Area 12 has the highest rate of bank erosion along Hamilton Run and a concept plan for stream restoration has already been developed for

the City in September 2014. In addition, this project area is prone to flooding where flood flows are constricted from undersized culverts under American Legion Drive, as described in the watershed assessment, and stream restoration work may help to alleviate some of this flooding. This area also has a potential for a small wetland BMP, but would only provide low TMDL credits.

Proposed Project Areas Ranked as Medium Priority

1. **Proposed Project Area 2**: This proposed project area has moderate bank erosion that could be addressed through stream bank restoration. Work in this proposed project area would require coordination with two landowners. Installation of a stormwater treatment BMP could provide additional, but low TMDL credits.

2. **Proposed Project Area 7:** This reach of Hamilton Run flows between two private property parcels. The reach has very few eroding banks and thus would not result in significant TMDL credits. However, the open space on the left bank could be used to create a wetland BMP and obtain TMDL credits, as described above in Section IV.D.4. BMP and Additional Uplift Opportunities, but permission would be required from the landowner. Additionally, the riparian vegetation and in-stream habitat could be improved.

3. **Proposed Project Area 8**: Hamilton Run flows adjacent to the pond at Pangborn Park in this proposed project area. Stream restoration work is confined due to limitations from the pond and a paved walking path, but restoration work on the eroding banks could provide some TMDL credits. Additionally, there is a potential to reroute Pangborn Park Pond return water flows from its current location into the proposed wetland BMP proposed as part of Project Area 7.

4. **Proposed Project Area 10**: There are highly eroding banks in this proposed project area; however, private property along both sides of the stream corridor establish barriers for successful implementation of stream restoration work. Therefore, while this project reach contains potential for significant TMDL credits to be obtained from stream bank restoration, lower project success potential limits higher prioritization.

5. **Proposed Project Area 11**: This proposed project area covers Hamilton Run above Eastern Blvd and before Hamilton Run becomes piped under the shopping center at Leitersburg Pike. This project reach has moderate bank erosion and a large open area that a wetland BMP or bioretention area could be created for TMDL credits. Work at this site would require coordination with one or two property owners depending on exact scope of the project. Additionally, there is an existing forest conservation easement that would have to be addressed during the development of a proposed BMP design.

6. **Proposed Project Area 14**: Moderate bank erosion exists in this proposed project area that could be stabilized to obtain TMDL credits. There is also potential for a stormwater treatment BMP to be installed to manage parking lot stormwater runoff. Space constraints from urban encroachment prevented higher prioritization.

7. **Proposed Project Area 17**: This proposed project area has low bank erosion and contains small open areas that could be used to create a wetland BMP. However, TMDL credits would be low for this project area. Permission would have to be required to work on land belonging to the hospital and the Washington County Public Schools. Additionally, there the riparian vegetation and in-stream habitat could be improved.

Hamilton Run Project Ranking
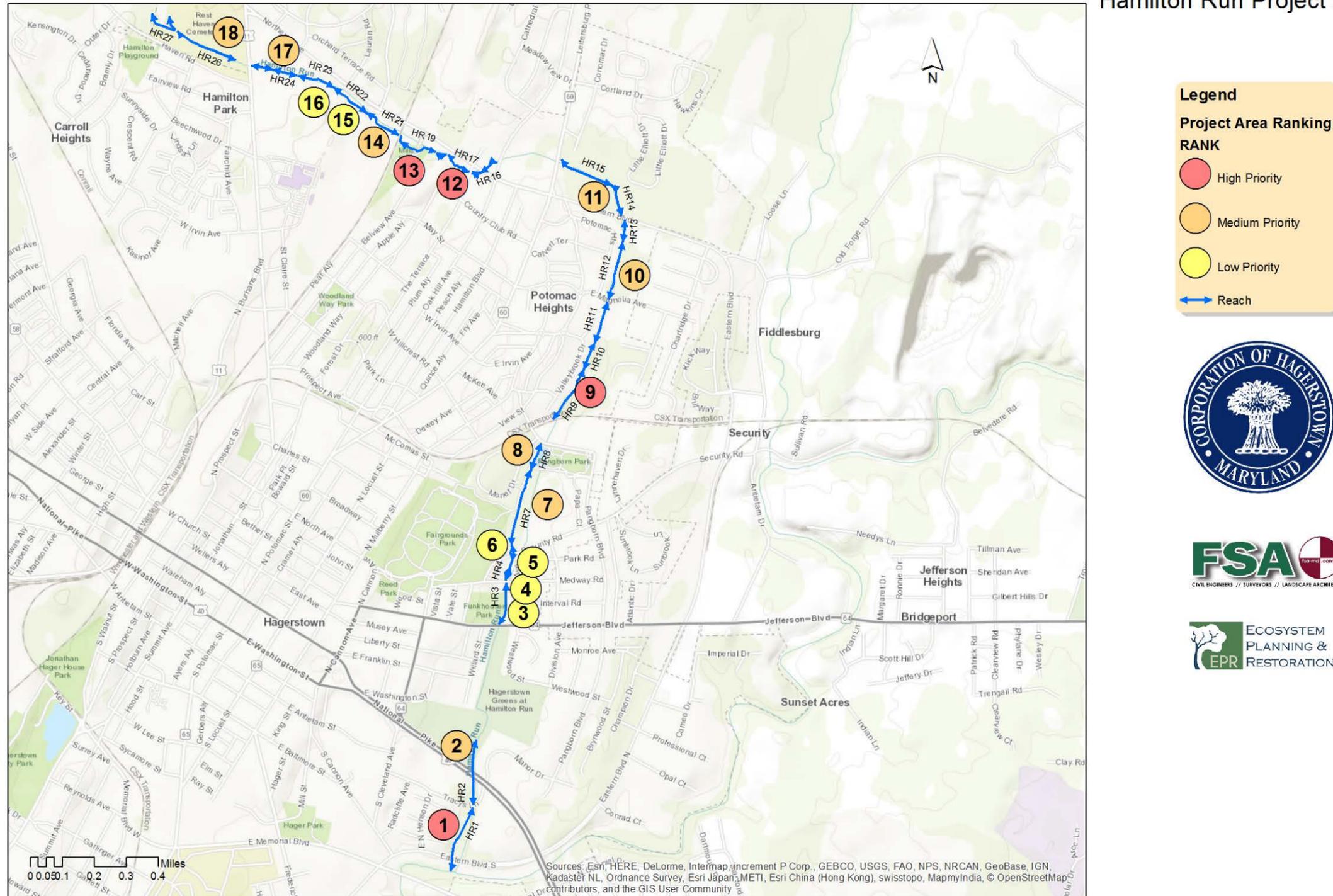
Figure 12. Proposed Restoration Recommendation Ranking

Proposed Project Area	Assessment Reach	Priority Ranking	Estimated Stream Restoration Implementation Costs	Stream Restoration Potential for TMDL Credits	Impervious Acres Treatment Credit from Stream Restoration	BMP Potential to obtain TMDL credits	Estimated BMP Implementation Costs
1	1	High	**$540,000**	High	11	NA	NA
2	2	Medium	**$330,000**	Medium	11	Low	$150,000 - $250,000
3	3	Low	**$84,000**	Medium	7	Low	$75,000 - $150,000
4	4	Low	**$81,000**	Low	3	NA	NA
5	5	Low	**$42,000**	Low	1	NA	NA
6	6	Low	**$75,000**	Low	3	NA	NA
7	7	Medium	**$156000**	Low	13	High	$220,000
8	8	Medium	**$85,00**	Medium	5	NA	NA
9	9 10 11	High	**$989,000**	High	21	High	$225,000
10	12 13	Medium	**$538,000**	High	13	NA	NA
11	14 15	Medium	**$723,000**	Medium	15	Medium	$130,000
12	16 17	High	**$630,000**	High	10	NA	NA
13	18 19	High	**$206,000**	Medium	8	Low	$9,000
14	20 21	Medium	**$365,000**	High	8	Medium	$150,000 - $250,000
15	22	Low	**$79,000**	Low	7	Low	$17,000
16	23	Low	**$265,000**	Low	6	NA	NA
17	24 25	Medium	**$154,000**	Medium	8	Low	$26,000
18	26 27	Medium	**$605,000**	High	14	Low	$23,000

Table 19. Proposed Project Area Prioritization

8. **Proposed Project Area 18**: This proposed project area has moderate bank erosion that could be addressed through stream bank restoration and potential for conversion of ponds to wetland BMPs for TMDL credits. However, the project is located on cemetery property, which would be less tolerant of construction impacts.

Proposed Project Areas Ranked as Low Priority

1. **Proposed Project Areas 3 – 6**: There are few eroding stream banks in these project reaches where bank restoration would have the potential to provide TMDL credits. Furthermore, significant constraints exist due to encroachment of private property along the stream corridor. Additionally, the riparian vegetation and in-stream habitat could be improved.
2. **Proposed Project Areas 15 and 16**: These two proposed project areas have minimally eroding banks and therefore few TMDL credits would be achieved through stream bank restoration. Most TMDL credits would instead be obtained through the creation of a wetland BMP in proposed Project Area 15. Additionally, the riparian vegetation and in-stream habitat could be improved.

V. FUTURE LAND USE AND LAND MANAGEMENT PRACTICE RECOMMENDATIONS

As part of a comprehensive Watershed Action Plan, it is important to also identify potential measures the City can take on a policy level to further watershed stream health. The following recommendations address both water quality (sediment, phosphorus, and nitrogen loads) and water quantity (increased velocities) issues on public and private lands, and provide input on changes in land use that could positively affect these same issues.

A. LAND MANAGEMENT PRACTICE RECOMMENDATIONS

5.1.1 Public Lands

Both the City and Washington County own and/or maintain a number of properties in the Hamilton Run watershed, ranging from parks and recreation facilities, schools, municipal buildings, highway maintenance facilities, and a nine-hole golf course. To address non-point source pollution and water quantity concerns from these properties, it is recommended that the City, in partnership with the County, develop a unifying Riparian Area Management Plan (RAMP). RAMP's provide explicit guidance in how to consider streams and stream buffers during the management, design, and maintenance of City and County properties. It can be used for the planning and design of new infrastructure and facilities, improving existing facilities, or during the maintenance of water and sanitary sewer lines and easements, parks and recreation facilities, stormwater and flood-control projects, roads, and public works facilities. The RAMP could eventually be applied to all public properties within the City limits. Potential components include:

- Requiring the maintenance of <u>existing</u> forested riparian buffers on intermittent and perennial streams and encouraging the re-planting of woody vegetation along those streams with no or turf-only riparian buffers, where practicable.

- Utilization of a natural turf management strategy, tenets of which include:
    o Use of compost instead of fertilizer, or a combination of compost, compost tea and slow-release synthetic fertilizers
    o Integrated pest management techniques
    o Use of cultural practices like over-seeding and aeration to improve soil health and its ability to absorb nutrients

- Developing further concept plans for existing stormwater BMP retrofits and new facilities identified on public property in the URS Stormwater Management Retrofit Study (2013) written for the City with a grant from the Chesapeake Bay Trust.

- Use of permeable pavement when replacing or expanding parking lots and other areas traditionally designed as impervious surface.

5.1.2 <u>Private Lands</u>

There are generally three pathways to influence the quality and quantity of water flowing off private property: 1) regulation or fees mandated through City code or ordinance; 2) public education/outreach; and 3) incentive programs.

Regulation
As part of its subdivision ordinance, Washington County requires that new development maintain riparian buffers on intermittent and perennial streams, where the width required varies based on slope. Similarly, the City could enact this type of regulation on new development within the City limits (including the Hamilton Run watershed).

Many municipalities that require National Pollutant Discharge Elimination System (NPDES) permits for their stormwater drainage systems, as the City does, have enacted stormwater utility fee systems to help fund their compliance with the law. Stormwater fees can be levied as a flat rate or tiered based on the amount of impervious surface found on a property. The latter method is preferred, as it encourages the wise use of impervious surfaces, especially in larger developments.

Public Education
Regulatory options are a useful tool to protect and improve water quality; however, an effective public education campaign can also help to achieve many of the same outcomes, especially when used in concert with regulation and/or incentive programs. Providing outreach to local professionals, such as landscape architects, designers, and nursery staff, can further spread the word about City water quality initiatives and incentives. Elements of a public education campaign focused on water quality could include:

- Tips for stream-friendly lawn care. Promote the use of compost or slow-release synthetic fertilizer and emphasize the proper disposal of grass clippings and other yard waste, including fall leaves.

- Promoting the use of rain gardens or other similar bioretention facilities that can contribute to attractive aesthetics and provide wildlife habitat. There are many educational resources already available to help in this effort.

- Composting City-collected yard waste and making it available to homeowners and businesses as an alternative to fertilizer.

Incentive Programs

Incentive programs to encourage the use of facilities that improve water quality and decrease the amount of runoff entering streams can be used for both private developers and homeowners. Examples include:

- Allowing developers to use higher residential densities in exchange for using low impact development stormwater BMPs, which are designed to minimize impacts by reducing impervious surface and by treating stormwater runoff on-site.

- Providing tax rebates to home and commercial land-owners that install facilities to treat stormwater on-site. These facilities could include rain gardens or constructed wetlands, permeable pavement, cisterns/rain barrels, or green roofs.

B.   FUTURE LAND USE RECOMMENDATIONS

The Hamilton Run watershed is a mix of residential and commercial development, light industrial development (Volvo Powertrain plant), transitional agricultural lands, and undeveloped property, mainly in the northwestern part of the watershed. However, within the current City limits, much of the Hamilton Run watershed is built-out, which may make it more difficult to change or influence land use patterns. There are still pockets of privately-owned, undeveloped land in the City portion of the watershed that could be targeted for preservation as open space, either through fee simple acquisition (whole or partial) or conservation easement.

Two larger undeveloped areas stand out. The first is a section of Hamilton Run that flows through Project Area 11 that is partially forested, vacant land (Figure 12 – Proposed Restoration Recommendations). This area is currently comprised of land zoned for high density residential development, professional office-mixed, as well as some areas set aside for forest conservation easements associated with the Cortland Apartments. Remaining land in this area is in the Hamilton Run floodplain. With landowner support, it has been determined that this area could be converted into a large wetland BMP to provide functional uplift and TMDL credits, as described above in Section IV.D.4. BMP and Additional Uplift Opportunities.

The second area that stands out is the mostly forested headwaters of Hamilton Run west of its beginning in Rest Haven Cemetery, at the end of Haven Rd. This area is zoned for high density residential development and industrial-general, due to the association with the Volvo plant. It is currently connected to a larger forested segment that extends outside the City limits into Washington County, but is still within the Hamilton Run watershed. The City could work with the County and the landowner on future uses for the forested section of this tract that would help limit development of impervious cover.

Where preservation is not practicable, compact higher density development should be encouraged, both within the Hamilton Run watershed and in other areas as the City grows outwards. Development of this kind decreases impervious surface, leaves natural areas that can serve to promote pollutant infiltration and reduce runoff, and reduces sprawl. The RAMP, mentioned above, can also act as a guide in land use planning, to further integrate water quality and quantity concerns into the planning and zoning process. For areas outside the City limits that have not yet developed but are zoned as residential and residential-transitional, consider working with the County to the extent possible to implement these practices. Particular areas of concern include an agricultural property just north of the Volvo plant zoned as residential-suburban, and an undeveloped area just northeast of the Cortland Apartments zoned as residential-transitional.

Redevelopment of land can also reduce sprawl and could present opportunities to improve stormwater conditions on-site, particularly if facilities are aging or no longer needed. One instance in the Hamilton Run watershed is the old Pangborn factory property just north of Pangborn Park. While most structures have been removed, all the building slabs remain and much of the property is covered in impervious surface, with Hamilton Run piped along the western parcel boundary. In all likelihood, new tenants will not use the parcel as intensively and will not require the vast amounts of impervious surface currently present. The City may consider working with the owner and tenant to possibly remove unneeded pavement and daylight the stream as part of an incentive program and/or in exchange for a reduction of fees, should a stormwater fee program be implemented.

VI.   STREAM RESTORATION CONCEPT PLANS

The City selected three project areas for concept plan development: Project Areas 7, 9, and 10. The concept plans include: plan view schematic, brief project design description, potential functional uplift, preliminary cost estimate and estimated TMDL reductions.

A.   PROPOSED PROJECT AREAS 7 AND 9

The design approach for Project Areas 7 and 9 is to create emergent wetlands that can store and filter diverted water from Hamilton Run (Figures 13 – 16 - Photo Examples of Constructed Wetlands, Figures 17 and 18 – Concept Plans). This approach proposes inundation the floodplain with a steady flow of water moving through the constructed emergent wetlands. Flows for Project Area 9 will enter from a diversion channel that is accessed during flood flows when the water level in Hamilton Run reaches a specified stream stage. In contrast, flows for Project Area 7 could be diverted from the outflow discharge

of the Pangborn Park Pond. The emergent wetlands themselves are characterized by frequent inundation of water which maintains saturated or semi-saturated conditions (Figure 13 – 16 – Photos of Constructed Wetlands). Vegetation is dominated by herbaceous plant species typically rooted underwater and emerging into air. Natural soil processes that are undergone in emergent wetlands help reduce pollutant and sediment loads into receiving streams and wetland treatment is recognized to improve water quality.

The main project constraint is land ownership. A majority of the land for Proposed Project Area 7 is currently owned by a single private landowner. Therefore, project implementation would require this landowner's permission. Proposed Project Area 9 is mostly on land owned by Washington County Public Schools, however, permission from the school system will still be required. Additionally, the right streambank of Project Area 9 is in private ownership by several separate landowners. Therefore, homeowner permission from various individuals would be required if the project were to expand to include stream stabilization work. Additionally, there are two potential minor constraints, which could be managed during project design. The first potential constraint involves creation of the diversion channel from Pangborn Park. The diversion flow rate and channel location would have to be coordinated with the City to ensure that any diversion still allows the City to maintain the existing operation or future construction plans that the City has for Pangborn Park as an existing recreational facility. The second minor constraint is a sewer line that runs near the railroad tracks on the downstream end of Project Area 9. However, the location of the sewer line is at the edge of the proposed constructed wetlands and therefore, its impact on the potential extent for constructed wetlands will be minimal.

Functional uplift to Hamilton will be mostly related to improvements in Level 4 – Physiochemical. Water quality improves will occur from Hamilton Run flood flows filtering through the created wetlands and then being discharges back into Hamilton Run. Sufficient flow rates of water into the constructed emergent wetlands allow time and conditions for microorganisms to remove nutrients from water, thereby improving the quality of water leaving the wetland. Potential partial uplift in Level 5 – Biology could then be expected as a response to improved water quality. Wetlands play host to a variety plant and animal species. Furthermore, the construction of new riparian habitat areas create opportunities for those riparian species to recolonize the area. One common concern centered around constructed wetlands is the creation of habitat for mosquitoes to breed and become a nuisance. To appropriately deal with this issue, design criteria that minimize areas where mosquitoes can effectively breed should be considered. This can include incorporation of proper wetland depths and flow rates, planned colonization of mosquito predators, and effective vegetation design and management that limits buildup of standing water. After construction, surveillance of mosquito populations would allow the City to be proactive in managing the wetland through vegetation trimming or altering controllable flow rates of water through the wetland before mosquito populations become a nuisance. Finally, application of safe and approved insecticides can be used to limit any unmanaged mosquito population.

The proposed projects will result in TMDL nutrient and sediment reduction credits from floodplain inundation. Estimates of credits are shown in Table 20 - Estimated TMDL Reduction Credits from Floodplain Inundation. Estimated TMDL reduction credits for Proposed Project 7 will vary depending on conditions of how constant flow is maintained from Pangborn Park discharge. Additional treatment of the constant discharge may provide additional TMDL credits while decreased storage volume due to maintained inundation will decrease TMDL credits from treated flood flows.

The total estimated project cost is $376,000.00 (stream restoration - $156,00.00 and wetland creation - $220.000.00). This cost includes design costs which are based on 20 percent of the implementation costs.

Estimated TMDL Credits from Floodplain Inundation[1]				
Project Area	Wetland Area (Acres)	TSS (tons / yr)	TN (lbs / yr)	TP (lbs / yr)
7	4.4	5	251	27
9	4.5	5	263	28

Table 20. Project Area 7 and 9 Estimated TMDL Reduction Credits from Floodplain Inundation. Credits were calculated following Protocol 3 in Berg et al., (2014) Expert Panel Report. Floodplain access was assumed to occur at a 1" storm event and the wetland BMP was assumed to be designed to allow for 1' of inundation.

Figure 13. Wetland Under Construction

Figure 14. Constructed Wetland

Figure 15. Constructed Wetland

Figure 16. Constructed Wetland

PANGBORN PARK

Pedestrian Connection to North End Walk

Proposed Constructed Low Flow Stream Channel

Pedestrian Connection to Pangborn Park

Proposed Constructed Wetlands

HAMILTON RUN

Proposed Pedestrian Nature Trail

Pedestrian Connection to North End Walk

Proposed Constructed Wetlands

Proposed Constructed Low Flow Stream Channel

SECURITY ROAD
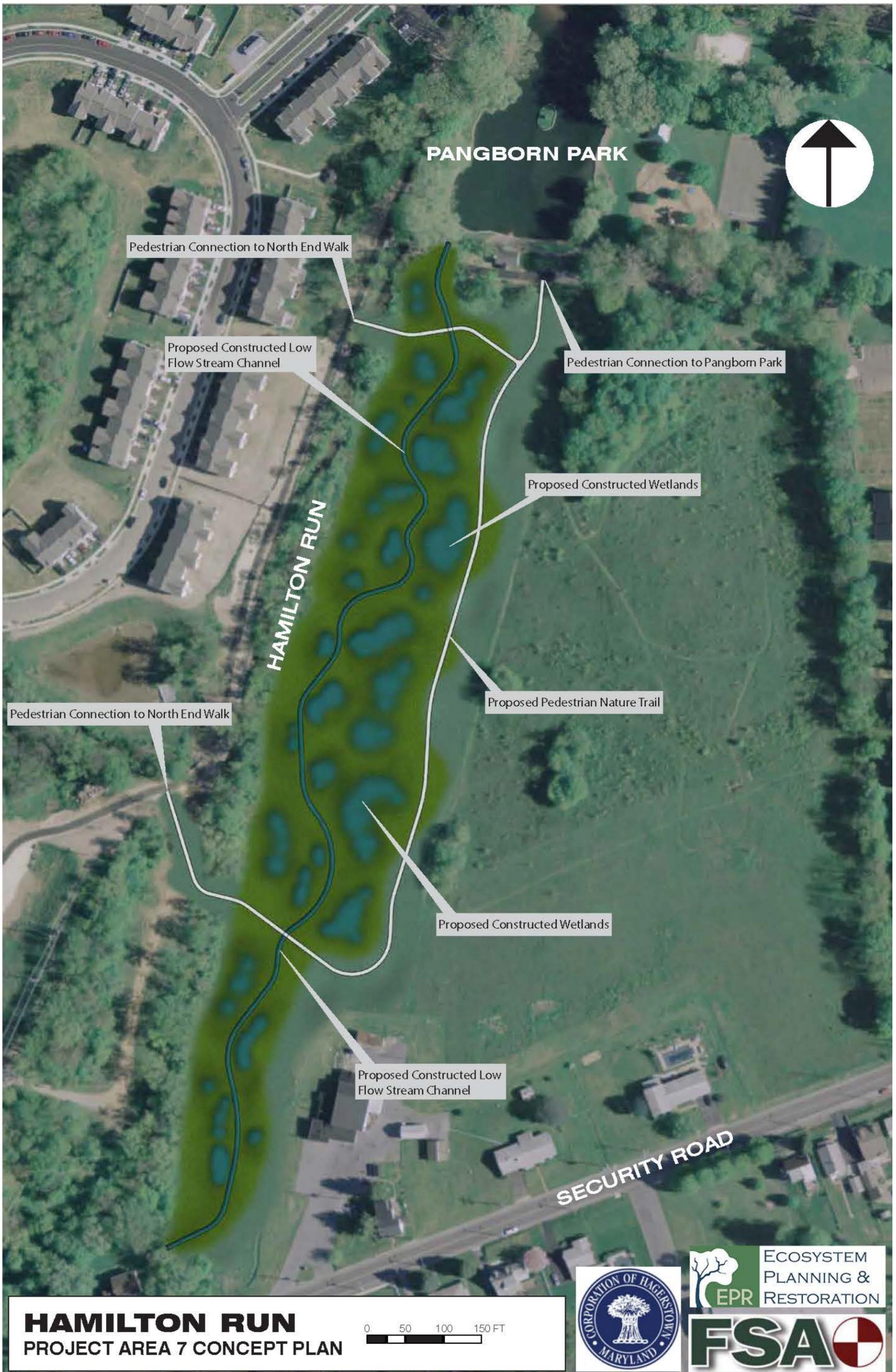
HAMILTON RUN
PROJECT AREA 7 CONCEPT PLAN

0   50   100   150 FT

CORPORATION OF HAGERSTOWN MARYLAND

ECOSYSTEM PLANNING & RESTORATION
EPR

FSA

Figure 17. Concept Plan for Proposed Project Area 7
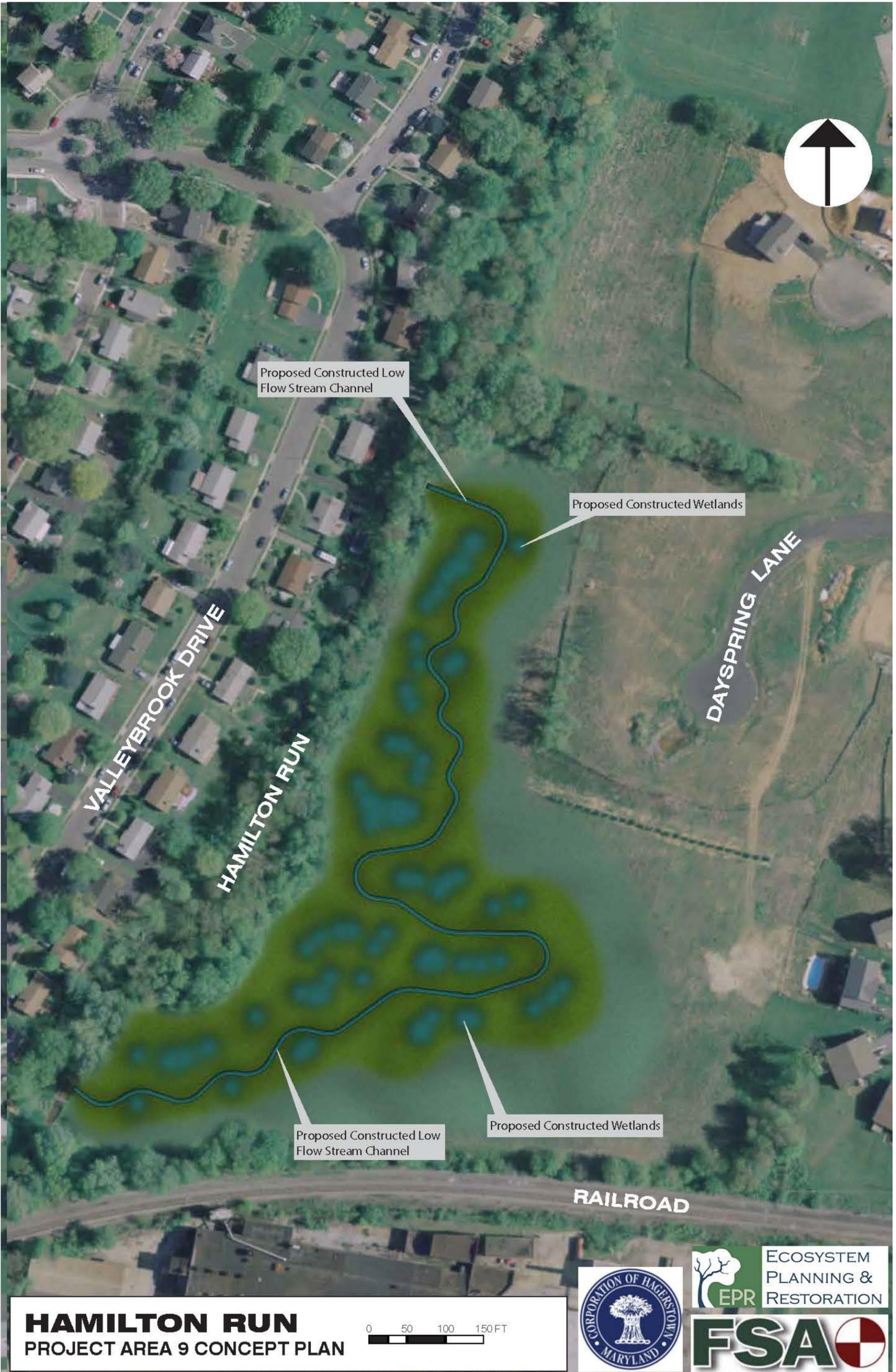
Figure 18. Concept Plan for Proposed Project Area 9

B.   PROPOSED PROJECT AREA 10

The proposed design stream type for Project Area 10 is a Rosgen B4c (Figures 19 – 22 - Photo Examples of Restored B4c channel). This approach involves minor channel realignment adjustments and the construction of a bankfull bench to create a flood prone area (Figure 23 – Typical B4c Channel Cross Section). Lateral and vertical grade control structures, consisting mostly of rock, will be required to dissipate energy adequately along this relatively straight channel. Typically, a meandering stream would naturally form given the characteristics of the Hamilton Run watershed and its valley type. However, the restoration of a meandering stream is constrained by adjacent private properties. Therefore, lateral and vertical grade control structures will be required to maintain a straight channel alignment (Figure 24 – Concept Plan).

Constraints that influence project implementation include adjacent private property and existing infrastructure. There are road crossings that require the stream to pass through a culvert both upstream and downstream of the project area that influences how flows move through the project area. In addition, the right bank of the stream is adjacent to the back of several residential properties. Therefore, any extensive stream restoration work will require receiving permission from several private landowners, which could influence the ultimate success of the project.

Implementation of the project will result in partial uplift to the stream in Level 1 – Hydrology, full uplift in Level 2 – Hydraulics and partial uplift in Level 3 – Geomorphology. Partial uplift in conditions of Level 1 – Hydrology would improve through partial elimination or improved management of concentrated and flashy water flows that currently enter the stream during storm events. Full uplift is prevented as a result of overall watershed conditions. The creation of fully functioning conditions in Level 2 – Hydraulics would result from the construction of channel dimensions that allow Hamilton Run to adequately dissipate energy along the bankfull bench to help alleviate the buildup of shear stress in the channel and limit potential for bank erosion.

Partial functional uplift in Level 3 – Geomorphology will be achieved through the installation of the in-stream structures, such as rock vanes, that concentrate the higher velocity flows into the center of the channel and away from the banks where they would be more erosive, thereby improving lateral stability. The rock vane's ability to concentrate the higher flow velocities into the center of the channel also create scour pools that would improve instream habitat. Additionally, the construction of riffle habitat from constructed gravel riffles or log rollers and the establishment of scour pools from rock vanes promotes a healthy balance between riffle and pool habitat. Complete uplift in Level 3 – Geomorphology is limited due to bed rock in the stream channel in the upper portion of the project area that would prevent development of pool habitat. Finally, the proposal would include riparian plantings along the stream bank that would provide functional uplift by promoting the establishment of a wider riparian buffer along the project area over existing conditions. However, the buffer width will be constricted on the right bank due to private property constraints.

Level 4 – Physicochemical design objectives of reducing nutrient loads will be met primarily through the bank stabilization which will reduce the sediment load entering the stream. Level 5 – Biology design objectives of increasing macroinvertebrate and fish population diversity and densities will be minimally met primarily through improvements in bedform diversity and the balance between riffle and pool habitat. However, watershed conditions limit any significant biological uplift.

The proposed project will result in TMDL nutrient and sediment reduction credits from streambank stabilization. Estimates of credits are shown in Table 21 - Project Area 10 Estimated TMDL Reduction Credits from Bank Stabilization.

Project Area 10 Estimated TMDL Reduction Credits from Bank Stabilization		
TSS (tons / yr)	TN (lbs / yr)	TP (lbs / yr)
9	117	54

Table 21. Project Area 10 Estimated TMDL Reduction Credits from Bank Stabilization

The total estimated project cost is $538,000.00. This cost includes design costs which are based on 20 percent of the implementation costs.

Figure 19. Existing Stream Condition

Figure 20. B4c Stream Under Construction

Figure 21. B4c Stream After Construction

Figure 22. B4c Stream 1-yr After Construction
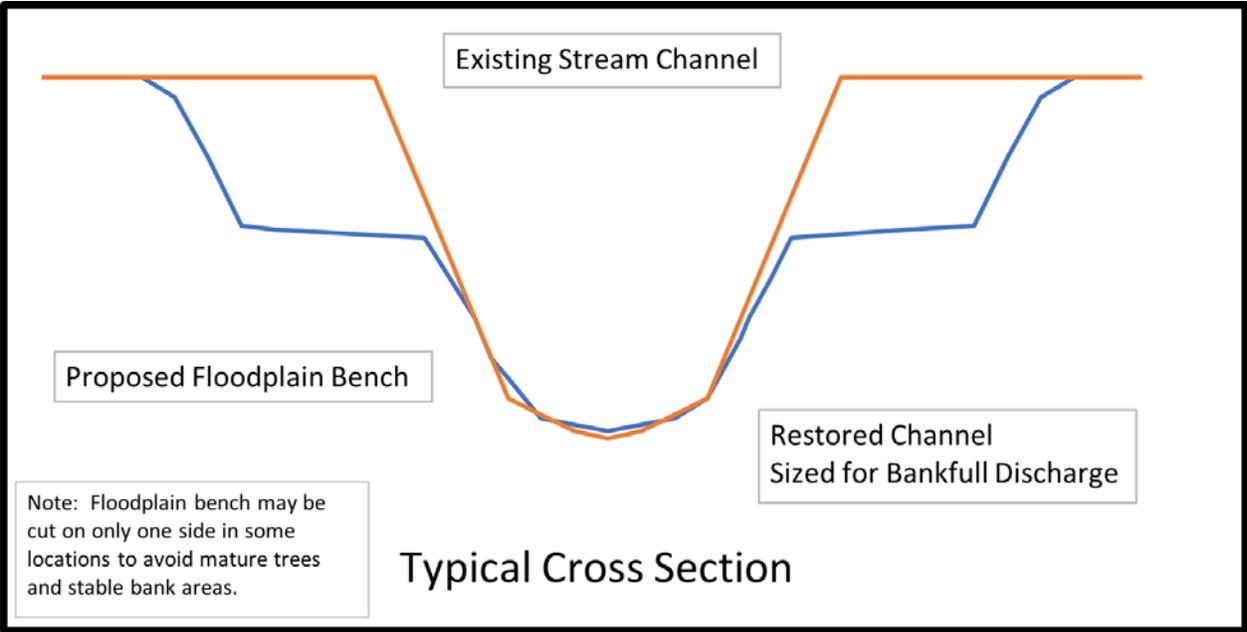
Figure 23. Typical B4c Channel Cross Section

Figure 24. Concept Plan for Proposed Project Area 10

1.   **Description of Proposed In-Stream Structures**

      a. **Cross Vane**

The cross vane (Figure 25 – Plan View of a Cross Vane) will establish grade control, reduce bank erosion, create a stable width/depth ratio, and maintain channel capacity, while maintaining sediment transport capacity, and sediment competence. The cross-vane also provides for the proper natural conditions of secondary circulation patterns commensurate with channel pattern, but with high velocity gradients and boundary stress shifted from the near-bank region. The cross-vane is also a stream habitat improvement structure due to: 1) an increase in bank cover as a result of a differential raise of the water surface in the bank region; 2) the creation of holding and refuge cover during both high and low flow periods in the deep pool; 3) the development of feeding lanes in the flow separation zones (the interface between fast and slow water) due to the strong down welling and upwelling forces in the center of the channel; and 4) the creation of spawning habitat in the tail-out or glide portion of the pool (Rosgen, D.R., 2010). The figure below shows the cross vane structure consisting of large boulders while habitat logs are installed underneath the vane arm for improved habitat in the scour pool.

      b. **Constructed Riffles and Riffle Log Rollers**

The constructed riffle and riffle log rollers are two options to develop riffle habitat in stream restoration projects. The log roller consists of alternatively angled and sloped logs that are placed at low grades in an effort to "roll" water back and forth while still concentrating energy towards the center of the channel (Figure 26A – Plan View of Riffle Log Roller). The structure is typically used in straight portions of the channel as they are effective in generating aeration and increased dissolved oxygen concentration by creating hydraulic rises and falls while still directing stream energy towards the center of the channel. These structures also add woody debris into the stream system promoting increased habitat for aquatic species.

Constructed Riffles (Figure 26B – Plan View of Constructed Riffle) are installed to provide immediate grade control for the project area using natural stone as a substrate. These structures remain stable while the pavement and sub-pavement layers develop in the restored stream providing long term grade control. The stone in the constructed riffle is placed in such a way as to mimic the action of a natural riffle by producing turbulent flow.
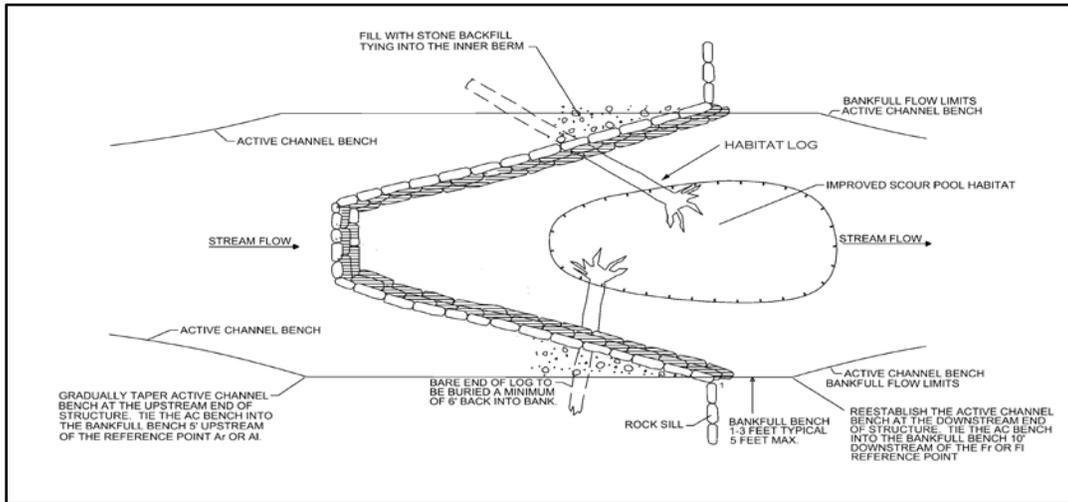
Figure 25. Cross Vane in Plan View
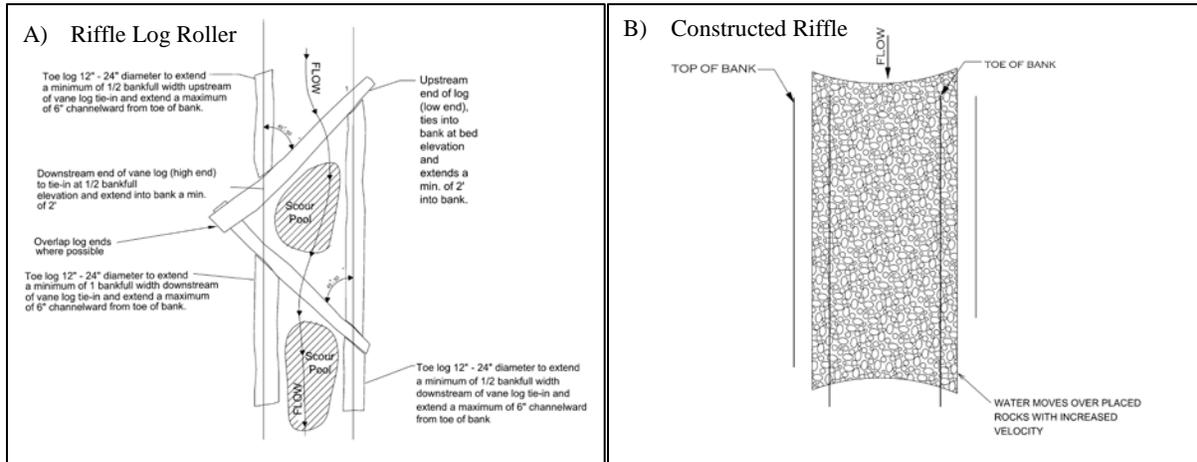
Figure 26. Plan views of A) Riffle Log Roller and B) Constructed Riffle

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APPENDIX A
Function-Based Rapid Assessment Form

Watershed:		Rater(s):	RRS
Stream:		Date:	
Reach Length:		Latitude:	
Photo(s):		Longitude:	

Reach ID:

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category			
		Functioning	Functioning-at-Risk		Not Functioning

Stream Function Pyramid Level 1 Hydrology

Runoff	1. Concentrated Flow	No potential for concentrated flow/impairments from adjacent land use	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources				Potential for concentrated flow/impairments to reach restoration site and no treatments are in place		
	Existing Condition	10 9 8	7	6	5	4	3	2	1
	Restoration Potential	10 9 8	7	6	5	4	3	2	1
	Proposed Condition	10 9 8	7	6	5	4	3	2	1
	2. Flashiness	Non-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover less than 6%	Semi-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover 7 - 15%				Flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover greater than 15%		
	Existing Condition	10 9 8	7	6	5	4	3	2	1
	Restoration Potential	10 9 8	7	6	5	4	3	2	1
	Proposed Condition	10 9 8	7	6	5	4	3	2	1
	If existing runoff is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason								

	Runoff Overall EXISTING Condition	F FAR NF	Score:	
	Runoff Overall Restoration Potential	F FAR NF	Score:	
	Runoff Overall PROPOSED Condition	F FAR NF	Score:	

Stream Function Pyramid Level 1 Hydrology Overall EXISTING Condition F FAR NF	**Score:**
Stream Function Pyramid Level 1 Hydrology Overall Restoration Potential F FAR NF	**Score:**
Stream Function Pyramid Level 1 Hydrology Overall PROPOSED Condition F FAR NF	**Score:**

Stream Function Pyramid Level 2 Hydraulics

Floodplain Connectivity (Vertical Stability)	3. Bank Height Ratio (BHR)	<1.20	1.21 - 1.50				>1.50		
	Existing Condition	10 9 8	7	6	5	4	3	2	1
	Restoration Potential	10 9 8	7	6	5	4	3	2	1
	Proposed Condition	10 9 8	7	6	5	4	3	2	1
	4a. Entrenchment (Meandering streams in alluvial valleys or Rosgen C, E, DA Streams)	>2.2	2.1 - 1.4				<1.4		
	Existing Condition	10 9 8	7	6	5	4	3	2	1
	Restoration Potential	10 9 8	7	6	5	4	3	2	1
	Proposed Condition	10 9 8	7	6	5	4	3	2	1
	4b. Entrenchment (Non meandering streams in colluvial valleys or Rosgen B Streams)	>1.4	1.3 - 1.1				<1.1		
	Existing Condition	10 9 8	7	6	5	4	3	2	1
	Restoration Potential	10 9 8	7	6	5	4	3	2	1
	Proposed Condition	10 9 8	7	6	5	4	3	2	1
	5. Floodplain Drainage	no concentrated flow; runoff is primarily sheet flow; hillslopes < 10%; hillslopes >200 ft from stream; ponding or wetland areas and litter or debris jams are well represented	runoff is equally sheet and concentrated flow (minor gully and rill erosion occurring); hillslopes 10 - 40%; hillslopes 50 - 200 ft from stream; ponding or wetland areas and litter or debris jams are minimally represented				concentrated flows present (extensive gully and rill erosion); hillslopes >40%; hillslopes <50 ft from stream; ponding or wetland areas and litter or debris jams are not well represented or absent		
	Existing Condition	10 9 8	7	6	5	4	3	2	1
	Restoration Potential	10 9 8	7	6	5	4	3	2	1
	Proposed Condition	10 9 8	7	6	5	4	3	2	1

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category									
		Functioning			Functioning-at-Risk				Not Functioning		
Floodplain Connectivity (Vertical Stability)	6. Vertical Stability Extent	Stable			Localized Instability				Widespread Instability		
	Existing Condition	10	9	8	7	6	5	4	3	2	1
	Restoration Potential	10	9	8	7	6	5	4	3	2	1
	Proposed Condition	10	9	8	7	6	5	4	3	2	1
	If existing floodplain connectivity is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason										
	Floodplain Connectivity Overall EXISTING Condition				F	FAR	NF		Score:		
	Floodplain Connectivity Overall Restoration Potential				F	FAR	NF		Score:		
	Floodplain Connectivity Overall PROPOSED Condition				F	FAR	NF		Score:		

Stream Function Pyramid Level 2 Hydraulics Overall EXISTING Condition	F	FAR	NF	**Score:**			
Stream Function Pyramid Level 2 Hydraulics Overall Restoration Potential	F	FAR	NF	**Score:**			
Stream Function Pyramid Level 2 Hydraulics Overall PROPOSED Condition	F	FAR	NF	**Score:**			

Stream Function Pyramid Level 3 Geomorphology

Assessment Parameter	Measurement Method	Category									
Riparian Vegetation	7. Riparian Vegetation Zone (EPA, 1999, modified)	Riparian zone extends to a width of >100 feet; good vegetation community diversity and density; human activities do not impact zone; invasive species not present or sparse			Riparian zone extends to a width of 25-100 feet; species composition is dominated by 2 or 3 species; human activities greatly impact zone; invasive species well represented and alter the community				Riparian zone extends to a width of <25 feet; little or no riparian vegetation due to human activities; majority of vegetation is invasive		
	Left Bank Existing	10	9	8	7	6	5	4	3	2	1
	Left Bank Restoration Potential	10	9	8	7	6	5	4	3	2	1
	Left Bank Proposed	10	9	8	7	6	5	4	3	2	1
	Right Bank Existing	10	9	8	7	6	5	4	3	2	1
	Right Bank Restoration Potential	10	9	8	7	6	5	4	3	2	1
	Right Bank Proposed	10	9	8	7	6	5	4	3	2	1
	If existing riparian vegetation is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason										
	Riparian Vegetation Overall EXISTING Condition				F	FAR	NF		Score:		
	Riparian Vegetation Overall Restoration Potential				F	FAR	NF		Score:		
	Riparian Vegetation Overall PROPOSED Condition				F	FAR	NF		Score:		

Assessment Parameter	Measurement Method	Category									
Lateral Stability	8. Dominant Bank Erosion Rate Potential	Dominate bank erosion rate potential is low or BEHI/NBS Rating: L/VL, L/L, L/M, L/H, L/VH, M/VL			Dominate bank erosion rate potential is moderate or BEHI/NBS Rating: M/L, M/M, M/H, L/Ex, H/L, M/VH, M/Ex, H/L, H/M, VH/VL, Ex/VL				Dominate bank erosion rate potential is high or BEHI/NBS Rating: H/H, H/Ex, VH/H, Ex/M, Ex/H, Ex/VH, VH/VH, Ex/Ex		
	Existing Condition (Right bank)	10	9	8	7	6	5	4	3	2	1
	Restoration Potential (Right Bank)	10	9	8	7	6	5	4	3	2	1
	Proposed Condition (Right Bank)	10	9	8	7	6	5	4	3	2	1
	Existing Condition (Left bank)	10	9	8	7	6	5	4	3	2	1
	Restoration Potential (Left Bank)	10	9	8	7	6	5	4	3	2	1
	Proposed Condition (Left Bank)	10	9	8	7	6	5	4	3	2	1
	9. Lateral Stability Extent	Stable			Localized Instability				Widespread Instability		
	Existing Condition	10	9	8	7	6	5	4	3	2	1
	Restoration Potential	10	9	8	7	6	5	4	3	2	1
	Proposed Condition	10	9	8	7	6	5	4	3	2	1

| Reach ID: | |

Assessment Parameter	Measurement Method	Category		
		Functioning	**Functioning-at-Risk**	**Not Functioning**

Lateral Stability

Measurement Method				
If existing lateral stability is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason				

	F	FAR	NF	
Lateral Stability Overall EXISTING Condition	F	FAR	NF	Score:
Lateral Stability Overall Restoration Potential	F	FAR	NF	Score:
Lateral Stability Overall PROPOSED Condition	F	FAR	NF	Score:

Bedform Diversity (Do not complete if stream is ephemeral)

Measurement Method	Functioning	Functioning-at-Risk	Not Functioning
10. Shelter for Fish and Macroinvertebrates (EPA 1999)	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, rubble, gravel, cobble and large rocks, or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	20-70% mix of stable habitat; suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale)	Less than 20% mix of stable habitat; lack of habitat availability less than desirables obvious; substrate unstable or lacking

	Functioning			Functioning-at-Risk				Not Functioning		
Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1

11a. Pool-to-Pool Spacing Ratio (Watersheds < 10 mi^2)	4.0 - 5.0	3.0 - 4.0 *or* 5.0 - 7.0	< 3.0 *or* >7.0

	Functioning			Functioning-at-Risk				Not Functioning		
Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1

11b. Pool-to-Pool Spacing Ratio (Watersheds > 10 mi^2)	5.0 - 7.0	3.5 - 5.0 *or* 7.0 - 8.0	<3.5 *or* >8.0

	Functioning			Functioning-at-Risk				Not Functioning		
Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1

12a. Pool Max Depth Ratio/Depth Variability (Gravel Bed Streams)	>1.5	1.2 - 1.5	<1.2

	Functioning			Functioning-at-Risk				Not Functioning		
Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1

12b. Pool Max Depth Ratio/Depth Variability (Sand Bed Streams)	>1.2	1.1 - 1.2	<1.1

	Functioning			Functioning-at-Risk				Not Functioning		
Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1

Moderate Gradient Perennial Streams in Colluvial Valleys

11. Pool-to-Pool Spacing Ratio (3-5% Slope)	2.0 - 4.0	4.0 - 6.0	>6.0

	Functioning			Functioning-at-Risk				Not Functioning		
Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1

12. Pool Max Depth Ratio/Depth Variability	>1.5	1.2 - 1.5	<1.2

	Functioning			Functioning-at-Risk				Not Functioning		
Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1

Reach ID:	

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	Functioning-at-Risk	Not Functioning
Bedform Diversity	If existing bedform diversity is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason			

Bedform Diversity Overall EXISTING Condition		F	FAR	NF	Score:
Bedform Diversity Overall Restoration Potential		F	FAR	NF	Score:
Bedform Diversity Overall PROPOSED Condition		F	FAR	NF	Score:

Stream Function Pyramid Level 3 Geomorphology Overall EXISTING Condition	**F**	**FAR**	**NF**	**Score:**
Stream Function Pyramid Level 3 Geomorphology Overall Restoration Potential	**F**	**FAR**	**NF**	**Score:**
Stream Function Pyramid Level 3 Geomorphology Overall PROPOSED Condition	**F**	**FAR**	**NF**	**Score:**

Stream Function Pyramid Level 4 Physicochemical

Water Quality and Nutrients   (Do not complete if stream is ephemeral)

Measurement Method	Functioning	Functioning-at-Risk	Not Functioning
13. Water Appearance and Nutrient Enrichment (USDA 1999)	Very clear, or clear but tea-colored; objects visible at depth 3 to 6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks. Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present	Frequent cloudiness especially after storm events; objects visible to depth 0.5 to 3.0 ft; may have slight green color; no oil sheen on water surface. Fairly clear or slightly greenish water along entire reach; moderate algal growth on stream substrate	Very turbid or muddy appearance most of the time; objects visible at depth< 0.5 ft; slow moving water maybe bright green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface; or strong odor of chemicals, oil, sewage, or other pollutants. Pea-green, gray, or brown water along entire reach; dense stands of macrophytes clogging stream; severe algal blooms creating thick algal mats in stream

Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1

Measurement Method	Functioning	Functioning-at-Risk	Not Functioning
14. Detritus (Petersen, 1992)	Mainly consisting of leaves and wood without sediment covering it	Leaves and wood scarce; fine organic debris without sediment	Fine organic sediment - black in color and foul odor (anaerobic) or detritus absent

Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1

If existing water quality is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason	

Stream Function Pyramid Level 4 Physicochemical Overall EXISTING Condition	**F**	**FAR**	**NF**	**Score:**
Stream Function Pyramid Level 4 Physicochemical Overall Restoration Potential	**F**	**FAR**	**NF**	**Score:**
Stream Function Pyramid Level 4 Physicochemical Overall PROPOSED Condition	**F**	**FAR**	**NF**	**Score:**

Stream Function Pyramid Level 5 Biology

Biology (Do not complete if stream is ephemeral)

15. Macroinvertebrate	Abundant			Rare				Not present		
Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1
16. Macroinvertebrate Tolerance	Abundant intolerant species			Limited intolerant species				Only tolerant species		
Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1
17. Fish Presence	Abundant			Rare				Not present		
Existing Condition	10	9	8	7	6	5	4	3	2	1
Restoration Potential	10	9	8	7	6	5	4	3	2	1
Proposed Condition	10	9	8	7	6	5	4	3	2	1

Reach ID:	

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	**Functioning-at-Risk**	**Not Functioning**
Biology	If existing biology is FAR or NF, provide description of cause (s) and stability trend and if F can not be potentially achieved, provide reason			

Stream Function Pyramid Level 5 Biology Overall EXISTING Condition F FAR NF	**Score:**	
Stream Function Pyramid Level 5 Biology Overall Restoration Potential F FAR NF	**Score:**	
Stream Function Pyramid Level 5 Biology Overall PROPOSED Condition F FAR NF	**Score:**	

Bankfull Determination and Rosgen Stream Classification

Rosgen Stream Type (Observation)	
Regional Curve (circle one): Piedmont Coastal Plain Allegheny Plateau/Ridge and Valley Urban Karst	

DA (sqmi)		Rosgen Valley Type	
BF Width (ft)		BF Area (sqft)	
BF Depth (ft)		Percent Impervious (%)	

Field Measurements

Parameter	Measurements and Ratios		
Water surface to geomorphic feature elevation difference			
Riffle Mean Depth at Bankfull Stage (dbkf)			
Riffle Width at Bankfull Stage (Wbkf)			
Riffle XS Area at Bankfull Stage (Abkf = dbkf*Wbkf)			
Floodprone Area Width (Wfpa) (Wfpa=Width at elevation determined by 2xDmax)			
Entrenchment Ratio (ER) (ER=Wfpa/Wbkf)			
Low Bank Height (LBH)			
Riffle Maximum Depth at Bankfull Stage (Dmax)			
Bank Height Ratio (BHR) (BHR=LBH/Dmax)			
BEHI/NBS Ratings and Lengths			
Pool to Pool Spacing (P-P)			
Pool to Pool Spacing Ratio (P-P Ratio) (P-P Ratio=P-P/Wbkf)			
Pool Maximum Depth at Bankfull Stage (Dmbkfp)			
Pool Depth Ratio (Dmbkfp Ratio) (Dmbkfp Ratio=Dmbkfp/dbkf)			
Macroinvertebrate Species Observed			

APPENDIX B
Stream Restoration Feasibility Assessment Form

STREAM RESTORATION FEASIBILITY ASSESSMENT FIELD DATA SHEET

Watershed: ___Hamilton Run___

Stream: Hamitlon Run _____   Rater(s): __RRS_____

Reach ID: _____   Date: _____

STREAM RESTORATION POTENTIAL SOLUTION, COST, and FEASIBILITY				
Parameter	**Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Potential Restoration Solution Approach	Localized Restoration - bioengineering and/or minor bank grading. Less than 50 % of reach requires localized restoration.	Localized Restoration - bioengineering and/or minor bank grading and some localized placement of instream structures. Greater than 50 % of reach requires localized restoration.	Widespread Restoration - in-channel adjustments, instream structures, and bioengineering throughout entire project area.	Widespread Restoration - new channel and/or channel realignment, in-channel adjustments, instream structures, and bioengineering throughout entire project area.
SCORE _____	10 9	8 7 6	5 4 3	2 1
2. Potential Restoration Solution Uplift	**Existing Condition** - All parameters in Pyramid Levels 2 and 3 have Not Functioning scores. Parameters in Levels 4 and 5 are Not Functioning or Functioning-at-Risk. **Potential Condition** - Functioning scores for Levels 1-5.	**Existing Condition** - Mix of Not-Functioning and Functioning-at-Risk scores for parameter Levels 2 through 5. **Potential Condition** - Functioning scores for Levels 1-5.	**Existing Condition** -Mix of Not-Functioning, Functioning-at-Risk and Functioning scores for parameter Levels 2 through 5. **Potential Condition** - Functioning scores for Levels 1-5.	
		or	or	
		Existing Condition - All parameters in Pyramid Levels 2 and 3 have Not Functioning scores. **Potential Condition** - Functioning scores for Levels 1-3.	**Existing Condition** - Mostly Functioning-at-Risk and Functioning scores for parameter Levels 2 through 3. May include some Not-Functioning scores. **Potential Condition** - Functioning scores for Levels 1-3.	
SCORE _____	10 9 8	7 6 5 4	3 2 1	
3. TMDL Restoration Potential for Sediment Nutrient and Phosporous Reduction	Potential for all 3	Potential for 2	Potential for 1	No Potential
SCORE _____	10 9	8 7 6	5 4 3	2 1
4. Stream Length	>2,000 LF	1,500 to 2,000 LF	1,000 to 1,500 LF	<1,000 LF
SCORE _____	10 9	8 7 6	5 4 3	2 1
Parameter	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
5. Construction Access	Access location relatively flat, open, dry, and within 100 feet of a road	Access location relatively flat, open, dry, over 100 feet of a road, and requires special construction road treatments	Access location has some steep slopes, some vegetation clearing required, some wet areas, and is within 100 feet of a road, and requires special construction road treatments	Access location has steep slopes, wet areas, heavily vegetated, is over 100 feet of a road, and requires special construction road treatments
SCORE _____	10 9	8 7 6	5 4 3	2 1
6. Constraints	No Constraints or impacts to existing healthy habitat and no infrastructure	Slight vegetation clearing required and minor impacts to existing healthy habitat and no infrastructure	Moderate vegetation clearing required, infrastructure crossing and/or potential repair or relocation required, impacts to healthy habitat and/or potential impact of T & E species	Vegetation clearing required, infrastructure repair or relocation required, special access treatments required, impacts to healthy habitat, impacts to T & E species
SCORE _____	10 9	8 7 6	5 4 3	2 1

STREAM RESTORATION POTENTIAL SOLUTION, COST, and FEASIBILITY

Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7. Potential Success/Risk	Shallow gradient slope < 0.5 %, cohesive bed and banks, incision ratio 1.00 - 1.10, entrenchment ratio > 2.2, meander width ratio of 3.0 to 8.0 for Rosgen E and C stream types, design complexity low, minimum restoration construction, no infrastructure, upstream and downstream conditions stable	Shallow gradient slope 0.6 - 1.0 %, cohesive bed and banks, incision ratio 1.10 - 1.30, entrenchment ratio > 2.2, meander width ratio of 3.0 to 4.0 for Rosgen E and C stream types, design complexity moderate, moderate restoration construction, infrastructure crossing, upstream and/or downstream conditions have localized stablity issues	Moderate gradient slope 1.1 - 2.0 %, cohesive bed, non-cohesive banks, incision ratio 1.31 - 1.50, entrenchment ratio 1.4 - 2.2, meander width ratio of 2.5 to 3.0 for Rosgen E and C stream types, design complexity moderate to high, moderate to high restoration construction, infrastructure crossing and potential repair and/or protection, upstream and/or downstream conditions have localized to widespread stablity issues	Steep gradient slope > 2.0 %, non-cohesive bed and banks, incision ratio >1.51, entrenchment ratio > 2.3, meander width ratio of < 2.5 for Rosgen E and C stream types, design complexity high, high restoration construction, infrastructure crossing repair and/or /orprotection, upstream and downstream conditions have widespread stablity issues
SCORE _____	10 9	8 7 6	5 4 3	2 1
8.BMP Restoration Potential	Potential for 3-4 BMPs	Potential for 2 BMPs	Potential for 1 BMP	No Potential for BMPs
SCORE _____	10 9	8 7 6	5 4 3	2 1
9.Ownership	Public or 1 Private Landower	1-2 Private Landowner(s)	3-4 Private Landowners	5 or more Private Landowners
SCORE _____	10 9	8 7 6	5 4 3	2 1
Restoration Potential Solution Approach Description				

Stream Restoration Total Score   _____

RESTORATION ESTIMATED COST

Parameter	Category and cost			
Project difficulty	Minor localized bank grading (< 50% of reach), localized bank plantings (< 50% of reach), low cost bio-engineering (i.e.,…….),	Moderate localized bank grading (> 50% of reach), localized bank plantings (> 50% of reach), moderate cost bio-engineering, instream structures to address localized instability problem (i.e.,…….),	In-channel adjustments, bank grading, instream structures (i.e., vanes, cross vanes, W weirs, sills, etc.) reach-wide plantings and/or bio-engineering, repair of infrastructure,	In-channel adjustments and new channel construction, bank grading, instream structures (i.e., vanes, cross vanes, W weirs, sills, etc.) reach-wide plantings and/or bio engineering, protections and repair of infrastructure
Cost Per Linear Foot	$100 - $200	$200 - $300	$300 - $400	$400 - $600

Cost/foot: $_____   Area to be treated: _____ feet   Total cost: $_____

Note: If there are site constraints or access is poor, move up one cost category.

APPENDIX C

BANCS Assessment Data

Sequential Bank I.D.	Assessment Reach	Length, ft (Bank or deposition)	Height, ft (Bank or Headcut)	BEHI Rating	NBS Rating	Predicted Rate of Bank Erosion (ft/year)	Predicted Erosion Amount (ft³/year)	Predicted Erosion Amount (tons/year)	Predicted Erosion Rate (tons/year/ft)
					Hamilton Run, Hagerstown, MD - Rapid BANCs Assessment				
1	1	18	4.0	Moderate	Moderate	0.30	22	1	0.08
2	1	27	3.0	Moderate	Moderate	0.30	24	2	0.06
3	1	35	3.0	Moderate	Moderate	0.30	31	2	0.06
4	1	33	3.0	Moderate	Moderate	0.30	30	2	0.06
5	1	76	4.0	High	Moderate	0.64	194	12	0.16
6	1	43	3.0	Moderate	Moderate	0.30	39	2	0.06
7	1	82	3.0	Moderate	Moderate	0.30	74	5	0.06
8	1	25	3.0	Moderate	Moderate	0.30	23	1	0.06
9	1	69	3.0	Moderate	Moderate	0.30	62	4	0.06
10	1	159	4.0	High	Moderate	0.64	408	26	0.16
11	1	72	3.5	High	High	1.00	252	16	0.22
12	1	78	4.0	High	High	1.00	312	19	0.25
13	1	29	8.0	Moderate	Moderate	0.30	68	4	0.15
14	1	16	8.0	High	High	1.00	131	8	0.50
15	1	8	7.0	Moderate	Moderate	0.30	16	1	0.13
Assessment Reach 1 Sub Total		**770**	**N/A**	**N/A**	**N/A**	**N/A**	**1686**	**105**	**N/A**
16	2	19	3.0	Moderate	Moderate	0.30	17	1	0.06
17	2	21	8.0	Moderate	Moderate	0.30	51	3	0.15
18	2	15	8.0	Moderate	Moderate	0.30	35	2	0.15
19	2	39	8.0	Moderate	Moderate	0.30	93	6	0.15
20	2	57	8.0	Moderate	Moderate	0.30	136	9	0.15
21	2	16	3.0	Moderate	Moderate	0.30	14	1	0.06
22	2	11	4.0	Moderate	Moderate	0.30	13	1	0.08
23	2	20	8.0	Moderate	Very High	1.00	161	10	0.50
24	2	25	7.0	High	Moderate	0.64	111	7	0.28
25	2	14	3.0	High	Moderate	0.64	26	2	0.12
Assessment Reach 2 Sub Total		**236**	**N/A**	**N/A**	**N/A**	**N/A**	**659**	**41**	**N/A**
26	Golf Course	77	3.1	Moderate	High	0.80	191	12	0.16
27	Golf Course	113	2.4	Moderate	High	0.80	217	14	0.12
28	Golf Course	13	3.2	Moderate	High	0.80	33	2	0.16
29	Golf Course	74	6.5	Low	Moderate	0.07	34	2	0.03
30	Golf Course	77	5.5	Moderate	Moderate	0.30	127	8	0.10
31	Golf Course	30	3.7	Low	Moderate	0.07	8	0	0.02
32	Golf Course	37	2.3	Moderate	Moderate	0.30	26	2	0.04
33	Golf Course	30	3.0	High	Moderate	0.64	58	4	0.12
34	Golf Course	32	2.6	High	Low	0.40	33	2	0.07
35	Golf Course	15	2.3	Low	Moderate	0.07	2	0	0.01
36	Golf Course	30	3.2	Low	Moderate	0.07	7	0	0.01
37	Golf Course	30	1.8	Moderate	Low	0.13	7	0	0.01
38	Golf Course	24	1.7	Low	Moderate	0.07	3	0	0.01
39	Golf Course	18	2.8	Low	Moderate	0.07	4	0	0.01
Golf Course Sub Total		**600**	**N/A**	**N/A**	**N/A**	**N/A**	**748**	**47**	**N/A**
40	3	10	3.0	Moderate	Moderate	0.30	9	1	0.06
41	3	21	3.0	Moderate	Moderate	0.30	19	1	0.06
42	3	17	4.0	Moderate	Moderate	0.30	20	1	0.08
43	3	16	3.0	Moderate	Moderate	0.30	14	1	0.06
44	3	16	3.0	Moderate	Moderate	0.30	15	1	0.06
45	3	9	4.5	Moderate	Moderate	0.30	12	1	0.08
46	3	28	3.0	Moderate	Moderate	0.30	25	2	0.06
Assessment Reach 3 Sub Total		**116**	**N/A**	**N/A**	**N/A**	**N/A**	**114**	**7**	**N/A**
47	4	16	4.0	Moderate	Moderate	0.30	19	1	0.08
Assessment Reach 4 Sub Total		**16**	**N/A**	**N/A**	**N/A**	**N/A**	**19**	**1**	**N/A**
Assessment Reach 5 Sub Total		**0**	**N/A**	**N/A**	**N/A**	**N/A**	**0**	**0**	**N/A**
48	6	22	3.5	Moderate	Moderate	0.30	24	1	0.07
Assessment Reach 6 Sub Total		**22**	**N/A**	**N/A**	**N/A**	**N/A**	**24**	**1**	**N/A**
49	7	16	2.5	Moderate	Moderate	0.30	12	1	0.05
50	7	19	2.0	Moderate	Moderate	0.30	12	1	0.04
51	7	12	2.5	Moderate	Moderate	0.30	9	1	0.05
Assessment Reach 7 Sub Total		**48**	**N/A**	**N/A**	**N/A**	**N/A**	**33**	**2**	**N/A**
52	8	70	5.0	High	Moderate	0.64	224	14	0.20
53	8	31	5.5	Very High	Moderate	0.64	109	7	0.22
Assessment Reach 8 Sub Total		**101**	**N/A**	**N/A**	**N/A**	**N/A**	**333**	**21**	**N/A**

54	9	303	3.5	Moderate	Low	0.13	132	8	0.03
55	9	445	3.0	Moderate	Low	0.13	167	10	0.02
56	9	76	7.0	Moderate	Low	0.13	67	4	0.05
57	9	193	3.5	Moderate	Low	0.13	84	5	0.03
58	9	398	3.5	High	Low	0.40	558	35	0.09
Assessment Reach 9 Sub Total		**1415**	**N/A**	**N/A**	**N/A**	**N/A**	**1008**	**63**	**N/A**
59	10	231	4.0	Moderate	Low	0.13	115	7	0.03
60	10	43	4.0	High	Low	0.40	68	4	0.10
Assessment Reach 10 Sub Total		**273**	**N/A**	**N/A**	**N/A**	**N/A**	**184**	**11**	**N/A**
61	11	33	2.5	Moderate	Low	0.13	10	1	0.02
62	11	74	3.5	Moderate	Low	0.13	33	2	0.03
63	11	44	4.0	Moderate	Low	0.13	22	1	0.03
64	11	28	3.0	Moderate	Low	0.13	11	1	0.02
65	11	44	3.0	Moderate	Moderate	0.30	40	2	0.06
Assessment Reach 11 Sub Total		**224**	**N/A**	**N/A**	**N/A**	**N/A**	**115**	**7**	**N/A**
66	12	74	4.5	Moderate	Low	0.13	41	3	0.04
67	12	116	4.5	Moderate	Low	0.13	65	4	0.04
68	12	86	4.5	Moderate	Low	0.13	48	3	0.04
69	12	79	4.0	Moderate	Low	0.13	39	2	0.03
70	12	78	8.0	High	Moderate	0.64	399	25	0.32
71	12	90	6.0	Low	High	0.15	81	5	0.06
Assessment Reach 12 Sub Total		**522**	**N/A**	**N/A**	**N/A**	**N/A**	**674**	**42**	**N/A**
72	13	75	7.5	Moderate	Moderate	0.30	168	11	0.14
73	13	96	7.5	High	Moderate	0.64	463	29	0.30
74	13	95	7.0	Moderate	Moderate	0.30	199	12	0.13
75	13	15	4.5	Moderate	High	0.80	54	3	0.23
76	13	17	4.5	High	High	1.00	77	5	0.28
Assessment Reach 13 Sub Total		**298**	**N/A**	**N/A**	**N/A**	**N/A**	**961**	**60**	**N/A**
77	14	41	3.0	Moderate	Low	0.13	15	1	0.02
78	14	24	3.5	Moderate	Low	0.13	11	1	0.03
79	14	31	4.5	Moderate	Moderate	0.30	42	3	0.08
Assessment Reach 14 Sub Total		**96**	**N/A**	**N/A**	**N/A**	**N/A**	**68**	**4**	**N/A**
80	15	76	5.0	Moderate	Low	0.13	48	3	0.04
81	15	110	4.5	Moderate	Low	0.13	62	4	0.04
82	15	129	4.5	Moderate	Moderate	0.30	175	11	0.08
83	15	50	8.5	Very High	Moderate	0.64	273	17	0.34
Assessment Reach 15 Sub Total		**366**	**N/A**	**N/A**	**N/A**	**N/A**	**557**	**35**	**N/A**
84	16	55	4.5	Moderate	High	0.80	200	12	0.23
85	16	61	7.5	Very High	High	1.00	458	29	0.47
Assessment Reach 16 Sub Total		**117**	**N/A**	**N/A**	**N/A**	**N/A**	**658**	**41**	**N/A**
86	17	90	7.2	Very High	Moderate	0.64	413	26	0.29
87	17	89	5.0	High	Moderate	0.64	285	18	0.20
88	17	63	6.0	Very High	Very High	1.75	657	41	0.66
89	17	28	5.5	Very High	High	1.00	154	10	0.34
90	17	27	3.8	Moderate	Very High	1.00	102	6	0.24
91	17	46	7.2	Very High	Very High	1.75	579	36	0.79
92	17	30	4.7	High	High	1.00	143	9	0.29
93	17	92	4.0	Moderate	Moderate	0.30	110	7	0.08
94	17	37	4.7	High	Very High	1.75	305	19	0.51
95	17	23	3.0	Moderate	Moderate	0.30	21	1	0.06
Assessment Reach 17 Sub Total		**525**	**N/A**	**N/A**	**N/A**	**N/A**	**2769**	**173**	**N/A**
96	18	30	4.3	Moderate	High	0.80	103	6	0.22
Assessment Reach 18 Sub Total		**30**	**N/A**	**N/A**	**N/A**	**N/A**	**103**	**6**	**N/A**
97	19	25	3.5	Moderate	Moderate	0.30	26	2	0.07
98	19	40	2.5	Moderate	Moderate	0.30	30	2	0.05
99	19	22	3.0	Moderate	Moderate	0.30	19	1	0.06
100	19	31	4.0	High	Extreme	2.50	312	20	0.63
101	19	12	4.2	Moderate	Moderate	0.30	15	1	0.08
102	19	32	2.5	Moderate	Moderate	0.30	24	2	0.05
Assessment Reach 19 Sub Total		**162**	**N/A**	**N/A**	**N/A**	**N/A**	**427**	**27**	**N/A**
103	20	27	8.0	Very High	High	1.00	217	14	0.50
Assessment Reach 20 Sub Total		**27**	**N/A**	**N/A**	**N/A**	**N/A**	**217**	**14**	**N/A**
104	21	27	1.5	High	Very High	1.75	70	4	0.16
105	21	19	6.2	Moderate	High	0.80	94	6	0.31
106	21	62	5.8	Moderate	High	0.80	288	18	0.29
107	21	17	5.5	High	High	1.00	94	6	0.34

108	21	20	4.3	Moderate	Very High	1.00	87	5	0.27
Assessment Reach 21 Sub Total		**145**	**N/A**	**N/A**	**N/A**	**N/A**	**634**	**40**	**N/A**
109	22	23	3.8	Moderate	High	0.80	70	4	0.19
Assessment Reach 22 Sub Total		**23**	**N/A**	**N/A**	**N/A**	**N/A**	**70**	**4**	**N/A**
110	23	82	3.2	Moderate	Low	0.13	33	2	0.03
Assessment Reach 23 Sub Total		**82**	**N/A**	**N/A**	**N/A**	**N/A**	**33**	**2**	**N/A**
111	24	55	4.1	Moderate	Moderate	0.30	68	4	0.08
Assessment Reach 24 Sub Total		**55**	**N/A**	**N/A**	**N/A**	**N/A**	**68**	**4**	**N/A**
112	25	22	4.1	Moderate	High	0.80	73	5	0.20
Assessment Reach 25 Sub Total		**22**	**N/A**	**N/A**	**N/A**	**N/A**	**73**	**5**	**N/A**
113	26	35	2.7	Moderate	High	0.80	76	5	0.14
114	26	58	2.7	Moderate	High	0.80	125	8	0.14
115	26	98	2.6	Moderate	Moderate	0.30	76	5	0.05
116	26	53	4.6	High	Low	0.40	98	6	0.11
117	26	17	4.4	High	High	1.00	73	5	0.28
118	26	27	4.5	High	Moderate	0.64	77	5	0.18
119	26	39	4.5	High	Moderate	0.64	112	7	0.18
120	26	138	3.1	Moderate	Low	0.13	53	3	0.02
121	26	13	3.8	High	Low	0.40	19	1	0.10
Assessment Reach 26 Sub Total		**477**	**N/A**	**N/A**	**N/A**	**N/A**	**711**	**44**	**N/A**
122	27	157	2.0	Moderate	Low	0.13	39	2	0.02
123	27	20	2.8	Moderate	Moderate	0.30	17	1	0.05
124	27	22	3.1	High	High	1.00	70	4	0.19
125	27	58	2.2	High	Moderate	0.64	82	5	0.09
Assessment Reach 27 Sub Total		**257**	**N/A**	**N/A**	**N/A**	**N/A**	**207**	**13**	**N/A**
ASSESSMENT TOTAL		**7027**	**N/A**	**N/A**	**N/A**	**N/A**	**13152**	**822**	**N/A**

APPENDIX D
Water Quality Laboratory Reports

Fredericktowne Labs Inc.

ENVIRONMENTAL TESTING

3020 Ventrie Court ● P.O. BOX 245 ● Myersville, MD 21773 ● 800-332-3340 ● FAX 301-293-2366
www.fredericktownelabs.com ● info@fredericktownelabs.com

Certificate of Analysis

Acct. No. 10482 - 1-1

Field Record

Site visit performed on: Thursday, September 29, 2016   9:00 AM
                by: Doug Hutzell
          Affiliation: FSA
Property Owner: Frederick, Seibert & Associates, Inc.
          Project: Washington County Stream Project
Property Address: 128 South Potomac Street
            Hagerstown, MD 21740
Sample Source: Stream Hamilton Run Golf Crs Lwr Bridg

Field pH: 8.5

Temp: 17.1° C

Laboratory Report

Sample Received at laboratory: 9/29/2016   10:36 AM

Bacteriological results:

Total Colif. (/100ml)	E.coli.(/100ml)	Start Date	Time	End Date	Time	Method	Analyst
	>2400	09/29/16	11:09	09/30/16	11:26	9223B	JD

**Bacteriological analysis of this sample indicates the water is unsafe for human consumption.
Analysis was performed according to the 20th edition of Standard Methods**

Inorganic Chemical results:

Parameter	Result	Units	MCL	Date of Analysis	Method	Analyst
Nitrate-Nitrogen	0.8	mg/l	10	9/29/2016	300.0	PH
Nitrite Nitrogen	<0.2	mg/l		9/29/2016	300.0	PH
Phosphorous-Total	0.220	mg/l		10/3/2016	SM4500P BE*	VVK
Solids - Total Suspend	56	mg/l		9/29/2016	2540D	JD
Total Kjeldahl Nitrogen	0.748	mg/l		10/6/2016	4500NH3-D*	RMT
Total Nitrogen	1.5	mg/l		10/7/2016	Calculation	PH
Turbidity	39	NTU'		9/29/2016	180.1	KMW

Reported by: _Curty Phelps_   10/11/16
        Name   Date

SUMMIT
ENVIRONMENTAL TECHNOLOGIES, INC.
Analytical Laboratories

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

Analytical Report
(base report)

WO#:	**16091817**
Date Reported:	**10/6/2016**

CLIENT:	Fredericktowne Labs, Inc	**Tag Number:**	
Matrix:	NON-POTABLE WATER	**Collection Date:**	9/29/2016 9:00:00 AM
Lab ID:	16091817-001A		
Project:	10482-1-1		
Client Sample ID	10482-1-1-1		

Analyses	Result	RL	Qual	Units		DF	Date Analyzed
PHOSPHORUS (EPA 200.7)				E200.7	E200.2		Analyst: **VVK**
Phosphorus(P)	0.220	0.0500		mg/L		1	10/3/2016 5:23:25 PM
TOTAL KJELDAHL NITROGEN (4500-NH3-D)				A4500-NH3-D	A4500-NOR		Analyst: **RMT**
TKN	0.748	0.500		mg/L		1	10/6/2016 8:00:00 AM

Chain of Custody Form

Fredericktowne Labs, Inc.

3020 Ventrie Ct.   P. O. Box 245
Myersville , MD 21773-
(301) 293-3340 / FAX (301) 293-2366

Acct. No.: 10482-1-1

Project:	Frederick, Seibert & Associates, Inc.	Collected by:	DOUG HUTZELL + KEVIN PERKINS
	Washington County Stream Project	Affiliation:	FSA
	128 South Potomac Street		
	Hagerstown, MD 21740		

Sample Description / Sample Number	Date of Collection	Time of Collection	Analysis to be Performed	Field Observations	Preservation	Verif. By:
Source: Describe Source			STREAM HAMILTON RUN RAIN	ICE		
Matrix: Water			GOLF COURSE AT LOWER BRIDGE	TEMP. 17.1		
Grab/Comp: Grab				pH 8.5		
10482-1-1-**1**	9/28/16 1330		Phosphorous-Total		H2SO4 pH < 2	90
	9/29/16	0900	Total Kjeldahl Nitrogen			
			Total Nitrogen			
Source: Describe Source						
Matrix: Water						
Grab/Comp: Grab						
10482-1-1-**2**	9/29/16	0900	Bacteria - Colilert 2000 E.Coli Only		Na2S2O3	
Source: Describe Source						
Matrix: Water						
Grab/Comp: Grab						
10482-1-1-**3**	9/29/16	0900	Nitrate-Nitrogen		4 degrees C	
			Nitrite Nitrogen			
			Solids - Total Suspended			
			Turbidity			

If lead or copper are sample collection forms attached?					
Yes [ ] No [ ]		Water last used: _____ (Date) _____ (Time)			
Relinquished by: _____ 9/29/16 1074			Received by: Ellen Mellott 9/29/16 10:34		
Relinquished by:			Received by:		
Relinquished by:			Received by:		
Method of Shipment:	Iced: Yes [✓] No [ ] Temp 4.0		Treatment:		

Certificate of Analysis

Acct. No. 10482 - 2-1

Field Record

Site visit performed on: Thursday, September 29, 2016   9:30 AM

by: Doug Hutzell

Affiliation: FSA

Property Owner: Frederick, Seibert & Associates, Inc.

Project: Washington County Stream Project

Property Address: 128 South Potomac Street

Hagerstown, MD 21740

Sample Source: Stream Hamilton Run Magnolia St Cross

Field pH: 8.0

Temp: 17° C

Laboratory Report

Sample Received at laboratory: 9/29/2016   10:36 AM

Inorganic Chemical results:

Parameter	Result	Units	MCL	Date of Analysis	Method	Analyst
Nitrate-Nitrogen	1.3	mg/l	10	9/29/2016	300.0	PH
Nitrite Nitrogen	<0.2	mg/l		9/29/2016	300.0	PH
Phosphorous-Total	0.210	mg/l		10/3/2016	200.7*	VVK
Solids - Total Suspend	140	mg/l		9/29/2016	2540D	JD
Total Kjeldahl Nitrogen	0.921	mg/l		10/6/2016	4500NH3-D*	RMT
Total Nitrogen	2.2	mg/l		10/17/2016	Calculation	PH
Turbidity	60	NTU'		9/29/2016	180.1	KMW

Reported by: _____

Name   Date

Fredericktowne Labs, Inc. is a State Certified Water Quality Laboratory

Maryland Cert. No. 116   Virginia Cert. No. 00444

MDOT WBE Cert. No.: 91-158

Fredericktowne Labs Inc.
ENVIRONMENTAL TESTING

Analysis Results

REVISED
11/15/16 CP

Account No.: 10482 - 2-1

Washington County Stream Project
Frederick, Seibert & Associates, Inc.
128 South Potomac Street
Hagerstown, MD 21740

Date Received: Thursday, September 29, 2016
Collected By: Doug Hutzell
FSA
Date Reported: Monday, October 10, 2016

Matrix: Water

Lab#	Parameter	Result	Limit of Detection	Method	Start Date Time	End Date Time	Analyst
Source: -	Stream Hamilton Run Magnolia St Cross	Type: Grab	Collection Date: 9/29/2016 - 09:30				
10482-2-1-1	Phosphorous-Total	0.210 mg/l	0.05 mg/l	200.7*	10/03/16-17:23	10/03/16	VVK
10482-2-1-1	Total Kjeldahl Nitrogen	0.921 mg/l	0.5 mg/l	4500NH3-D*	10/06/16-08:00	10/06/16	RMT
10482-2-1-1	Total Nitrogen	2.2 mg/l	mg/l	Calculation	10/17/16-16:20	10/17/16-16:20	PH
10482-2-1-2	E. Coli	>2400 /100ml	1 /100ml	9223B	09/29/16-11:09	09/30/16-11:26	JD
10482-2-1-3	Nitrate-Nitrogen	1.3 mg/l	0.2 mg/l	300.0	09/29/16-15:14	09/29/16-15:29	PH
10482-2-1-3	Nitrite Nitrogen	<0.2 mg/l	0.2 mg/l	300.0	09/29/16-15:14	09/29/16-15:29	PH
10482-2-1-3	Solids - Total Suspended	140 mg/l	1 mg/l	2540D	09/29/16-15:00	09/30/16-11:30	JD
10482-2-1-3	Turbidity	60 NTU's	0.1 NTU's	180.1	09/29/16-12:35	09/29/16	KMW

Notes:
1. mg/l stands for milligrams per liter and is nearly synonymous with parts per million
   ug/l stands for micrograms per liter and is nearly synonymous with parts per billion
2. < stands for "less than" and indicates that the component in question was not detected (i.e. was less than the detection limit)
3. All analyses performed using EPA accepted methods per: (1) Methods for the Chemical Analysis of Water & Wastewater EPA-600/4-79-020, (2) Standard Methods for the Examination of Water & Wastewater – AWWA 19th/20th eds., (3) Test Methods for Evaluating Solid Waste – EPA SW-8⁄
4. "*" denotes an analysis that was subcontracted to a State of Maryland approved lab.

Verified by: Custy Phelps 11/15/16
M. L. Miller, Ph.D.
Laboratory Director

SUMMIT
ENVIRONMENTAL TECHNOLOGIES, INC.
Analytical Laboratories

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

Analytical Report
(base report)

WO#: **16091815**

Date Reported: **10/6/2016**

CLIENT:	Fredericktowne Labs, Inc	**Tag Number:**
Matrix:	NON-POTABLE WATER	**Collection Date:** 9/29/2016 9:30:00 AM
Lab ID:	16091815-001A	
Project:	10482-2-1	
Client Sample ID	10482-2-1-1	

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
PHOSPHORUS (EPA 200.7)				E200.7	E200.2	Analyst: **VVK**
Phosphorus(P)	0.210	0.0500		mg/L	1	10/3/2016 5:23:25 PM
TOTAL KJELDAHL NITROGEN (4500-NH3-D)				A4500-NH3-D	A4500-NOR	Analyst: **RMT**
TKN	0.921	0.500		mg/L	1	10/6/2016 8:00:00 AM

Qualifiers:	H	Holding times for preparation or analysis exceeded	M	Manual Integration used to determine area response
	ND	Not Detected at the Reporting Limit	PL	Permit Limit
	RL	Reporting Detection Limit	W	Sample container temperature is out of limit as specified at testcode

Chain of Custody Form

Fredericktowne Labs, Inc.

3020 Ventrie Ct.   P. O. Box 245
Myersville , MD 21773-
(301) 293-3340 / FAX (301) 293-2366

Acct. No.: 10482-2-1

Project:	Frederick, Seibert & Associates, Inc.	Collected by:	DOUG HUTZELL & KEVIN PERKINS
	Washington County Stream Project		
	128 South Potomac Street	Affiliation:	FSA
	Hagerstown, MD 21740		

Sample Description / Sample Number	Date of Collection	Time of Collection	Analysis to be Performed	Field Observations	Preservation	Verif. By:
Source: Describe Source Matrix: Water Grab/Comp: Grab			STREAM, HAMILTON RUN MAGNOLIA ST. CROSSING	RAIN ± 1.75 IN	ICE TEMP. 17 C pH 8.0	
10482-2-1-**1**	9/29/16	0930	Phosphorous-Total		H2SO4 pH < 2	M
			Total Kjeldahl Nitrogen			
			Total Nitrogen			
Source: Describe Source Matrix: Water Grab/Comp: Grab						
10482-2-1-**2**	9/29/16	0930	Bacteria - Colilert 2000 E.Coli Only		Na2S2O3	
Source: Describe Source Matrix: Water Grab/Comp: Grab						
10482-2-1-**3**	9/29/16	0930	Nitrate-Nitrogen		4 degrees C	
			Nitrite Nitrogen			
			Solids - Total Suspended			
			Turbidity			

If lead or copper are sample collection forms attached?

Yes ☐   No ☐

Water last used: _____ (Date) _____ (Time)

Relinquished by: A.W. Hill 9/29/16 1034	Received by: Ellen Mellott 9/29/16 10:36
Relinquished by:	Received by:
Relinquished by:	Received by:

Method of Shipment: Iced: Yes ✓ No ☐   Temp 1.2   Treatment:

Fredericktowne Labs Inc.

ENVIRONMENTAL TESTING

3020 Ventrie Court ● P.O. BOX 245 ● Myersville, MD 21773 ● 800-332-3340 ● FAX 301-293-2366
www.fredericktownelabs.com ● info@fredericktownelabs.com

Certificate of Analysis

Acct. No. 10482 - 3-1

Field Record

Site visit performed on: Thursday, September 29, 2016   10:00 AM

by: Doug Hutzell

Affiliation: FSA

Property Owner: Frederick, Seibert & Associates, Inc.

Project: Washington County Stream Project

Property Address: 128 South Potomac Street

Hagerstown, MD 21740

Sample Source: Stream Hamilton Run MillsPk atTrib Con

Field pH: 7.8

Temp: 16.4° C

Laboratory Report

Sample Received at laboratory: 9/29/2016   10:36 AM

Inorganic Chemical results:

Parameter	Result Units	MCL	Date of Analysis	Method	Analyst
Nitrate-Nitrogen	0.8 mg/l	10	9/29/2016	300.0	PH
Nitrite Nitrogen	<0.2 mg/l		9/29/2016	300.0	PH
Phosphorous-Total	0.150 mg/l		10/3/2016	SM4500P BE*	VVK
Solids - Total Suspend	30 mg/l		9/29/2016	2540D	JD
Total Kjeldahl Nitrogen	0.608 mg/l		10/6/2016	4500NH3-D*	RMT
Total Nitrogen	1.4 mg/l		10/7/2016	Calculation	PH
Turbidity	23 NTU'		9/29/2016	180.1	KMW

Reported by: _Cathy Phelps_ 10/11/16

Name   Date

Fredericktowne Labs, Inc. is a State Certified Water Quality Laboratory
Maryland Cert. No. 116   Virginia Cert. No. 00444
MDOT WBE Cert. No.: 91-158

10/11/2016 9:23:06 AM

Page 1 of 1

No Regulatory Reports Required

Fredericktowne Labs Inc.

ENVIRONMENTAL TESTING

Analysis Results

REVISED
11/15/16 CP

Account No.: 10482 - 3-1

Washington County Stream Project
Frederick, Seibert & Associates, Inc.
128 South Potomac Street
Hagerstown, MD 21740

Date Received: Thursday, September 29, 2016
Collected By: Doug Hutzell
FSA
Date Reported: Friday, October 07, 2016

Matrix: Water

Lab#	Parameter	Result	Limit of Detection	Method	Start Date Time	End Date Time	Analyst
Source: -	**Stream Hamilton Run MillsPk atTrib Con**	Type: Grab	Collection Date: 9/29/2016 - 10:00				
10482-3-1-1	Phosphorous-Total	0.150 mg/l	0.05 mg/l	SM4500P BE*	10/03/16-17:23	10/03/16	VVK
10482-3-1-1	Total Kjeldahl Nitrogen	0.608 mg/l	0.5 mg/l	4500NH3-D*	10/06/16-08:00	10/06/16	RMT
10482-3-1-1	Total Nitrogen	1.4 mg/l	mg/l	Calculation	10/07/16-15:00	10/07/16-15:00	PH
10482-3-1-2	E. Coli	>2400 /100ml	1 /100ml	9223B	09/29/16-11:09	09/30/16-11:27	JD
Source: -	**Stream Hamilton RunMillsPk atTrib Conf**	Type: Grab	Collection Date: 9/29/2016 - 10:00				
10482-3-1-3	Nitrate-Nitrogen	0.8 mg/l	0.2 mg/l	300.0	09/29/16-15:30	09/29/16-15:45	PH
10482-3-1-3	Nitrite Nitrogen	<0.2 mg/l	0.2 mg/l	300.0	09/29/16-15:30	09/29/16-15:45	PH
10482-3-1-3	Solids - Total Suspended	30 mg/l	1 mg/l	2540D	09/29/16-15:00	09/30/16-11:30	JD
10482-3-1-3	Turbidity	23 NTU's	0.1 NTU's	180.1	09/29/16-12:35	09/29/16	KMW

Notes:
1. mg/l stands for milligrams per liter and is nearly synonymous with parts per million
    ug/l stands for micrograms per liter and is nearly synonymous with parts per billion
2. < stands for "less than" and indicates that the component in question was not detected (i.e. was less than the detection limit)
3. All analyses performed using EPA accepted methods per: (1) Methods for the Chemical Analysis of Water & Wastewater EPA-600/4-79-020, (2) Standard Methods for the Examination of Water & Wastewater – AWWA 19th /20th eds., (3) Test Methods for Evaluating Solid Waste – EPA SW-84
4. "*" denotes an analysis that was subcontracted to a State of Maryland approved lab.

Verified by: _Curtis Phelps_ 11/15/16
for
M. L. Miller, Ph.D.
Laboratory Director

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

SUMMIT
ENVIRONMENTAL TECHNOLOGIES, INC.
Analytical Laboratories

CLIENT:	Fredericktowne Labs, Inc	**Tag Number:**	
Matrix:	NON-POTABLE WATER	**Collection Date:**	9/29/2016 10:00:00 AM
Lab ID:	16091816-001A		
Project:	10482-3-1		
Client Sample ID	10482-3-1-1		

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
PHOSPHORUS (EPA 200.7)				E200.7	E200.2	Analyst: **VVK**
Phosphorus(P)	0.150	0.0500		mg/L	1	10/3/2016 5:23:25 PM
TOTAL KJELDAHL NITROGEN (4500-NH3-D)				A4500-NH3-D	A4500-NOR	Analyst: **RMT**
TKN	0.608	0.500		mg/L	1	10/6/2016 8:00:00 AM

Qualifiers:	H	Holding times for preparation or analysis exceeded	M	Manual Integration used to determine area response
	ND	Not Detected at the Reporting Limit	PL	Permit Limit
	RL	Reporting Detection Limit	W	Sample container temperature is out of limit as specified at testcode

Original

Chain of Custody Form

Fredericktowne Labs, Inc.

3020 Ventrie Ct.   P. O. Box 245
Myersville , MD 21773-
(301) 293-3340 / FAX (301) 293-2366

Acct. No.: 10482-3-1

Project:	Frederick, Seibert & Associates, Inc.	Collected by:	DOUG HUTZELL + KEVIN PERKINS
	Washington County Stream Project	Affiliation:	FSA
	128 South Potomac Street		
	Hagerstown, MD 21740		

Sample Description / Sample Number	Date of Collection	Time of Collection	Analysis to be Performed	Field Observations	Preservation	Verif. By:
Source: Describe Source			STREAM; HAMILTON RUN MILLS PARK AT TRIB. CONFL.	RAIN TEMP. 16.4 pH 8.5 7:8	ICE	
Matrix: Water						
Grab/Comp: Grab						
10482-3-1-1	9/29/16	0900	Phosphorous-Total		H2SO4 pH < 2	
		1000	Total Kjeldahl Nitrogen			
			Total Nitrogen			
Source: Describe Source						
Matrix: Water						
Grab/Comp: Grab						
10482-3-1-2	9/29/16	0900	Bacteria - Colilert 2000 E.Coli Only		Na2S2O3	
Source: Describe Source		1000				
Matrix: Water						
Grab/Comp: Grab						
10482-3-1-3	9/29/16	0900	Nitrate-Nitrogen		4 degrees C	
		1000	Nitrite Nitrogen			
			Solids - Total Suspended			
			Turbidity			

If lead or copper are sample collection forms attached?				
Yes ☐ No ☐	Water last used: _____ (Date) _____ (Time)			
Relinquished by: A.W. Kastill 9/29/16 10:36	Received by: Ellen Millott 9/29/16 10:36			
Relinquished by:	Received by:			
Relinquished by:	Received by:			
Method of Shipment:	Iced: Yes ☑ No ☐ Temp 8.0	Treatment:		

FREDERICKTOWNE Labs Inc.

ENVIRONMENTAL TESTING

3020 Ventrie Court ● P.O. BOX 245 ● Myersville, MD 21773 ● 800-332-3340 ● FAX 301-293-2366
www.fredericktownelabs.com ● info@fredericktownelabs.com

Certificate of Analysis

Acct. No. 10482 - 4-1

Field Record

Site visit performed on: Wednesday, September 28, 2016 1:30 PM

by: Doug Hutzell

Affiliation: FSA

Property Owner: Frederick, Seibert & Associates, Inc.

Project: Washington County Stream Project

Property Address: 128 South Potomac Street

Hagerstown, MD 21740

Sample Source: Stream, Hamilton Run Golf C. Bridge

Laboratory Report

Sample Received at laboratory: 9/28/2016   3:04 PM

Bacteriological results:

Total Colif. (/100ml)	E.coli.(/100ml)	Start Date	Time	End Date	Time	Method	Analyst
	410	09/28/16	15:25	09/29/16	15:27	9223B	JD

Bacteriological analysis of this sample indicates the water is unsafe for human consumption. Analysis was performed according to the 20th edition of Standard Methods

Inorganic Chemical results:

Parameter	Result Units	MCL	Date of Analysis	Method	Analyst
Nitrate-Nitrogen	3.2 mg/l	10	9/29/2016	300.0	PH
Nitrite Nitrogen	<0.2 mg/l		9/29/2016	300.0	PH
Phosphorous-Total	<0.05 mg/l		9/29/2016	200.7*	VVK
Solids - Total Suspend	7 mg/l		9/29/2016	2540D	JD
Total Kjeldahl Nitrogen	<0.5 mg/l		10/4/2016	4500NH3-D*	RMT
Total Nitrogen	3.2 mg/l		10/5/2016	Calculation	PH
Turbidity	4.8 NTU'		9/28/2016	180.1	KB

Reported by: *Cutty Phelps* 10/5/16

Name   Date

Fredericktowne Labs, Inc. is a State Certified Water Quality Laboratory

Maryland Cert. No. 116   Virginia Cert. No. 00444

MDOT WBE Cert. No.: 91-158

10/5/2016 2:30:44 PM

Page 1 of 1

No Regulatory Reports Required

SUMMIT ENVIRONMENTAL TECHNOLOGIES, INC. Analytical Laboratories

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

CLIENT:	Fredericktowne Labs, Inc
Matrix:	NON-POTABLE WATER
Lab ID:	16091729-001A
Project:	10482-4-1
Client Sample ID	10482-4-1-1

Tag Number:
Collection Date: 9/28/2016 1:30:00 PM

Analyses	Result	RL	Qual	Units		DF	Date Analyzed
PHOSPHORUS (EPA 200.7)				E200.7	E200.2		Analyst: **VVK**
Phosphorus(P)	ND	0.0500		mg/L		1	9/29/2016 5:25:33 PM
TOTAL KJELDAHL NITROGEN (4500-NH3-D)				A4500-NH3-D	A4500-NOR		Analyst: **RMT**
TKN	ND	0.500		mg/L		1	10/4/2016 12:17:00 PM

Qualifiers:	H	Holding times for preparation or analysis exceeded	M	Manual Integration used to determine area response
	ND	Not Detected at the Reporting Limit	PL	Permit Limit
	RL	Reporting Detection Limit	W	Sample container temperature is out of limit as specified at testcode

Original

Page 6 of 6

Chain of Custody Form

Fredericktowne Labs, Inc.

3020 Ventrie Ct.   P. O. Box 245
Myersville , MD 21773-
(301) 293-3340 / FAX (301) 293-2366

Acct. No.: 10482-4-1

Project:	Frederick, Seibert & Associates, Inc.	Collected by: DOUG HUTZELL
	Washington County Stream Project	
	128 South Potomac Street	Affiliation:
	Hagerstown, MD 21740	FSA

Sample Description / Sample Number	Date of Collection	Time of Collection	Analysis to be Performed	Field Observations	Preservation	Verif. By:
Source: Describe Source Matrix: Water Grab/Comp: Grab			STREAM, HAMILTON RUN GOLF C. BRIDGE	BASE FLOW BEFOR RAIN 8.5 PH? 17.6 C	ICE	
10482-4-1-1	9/28/16	1330	Phosphorous-Total		H2SO4 pH < 2	
			Total Kjeldahl Nitrogen			
			Total Nitrogen			
Source: Describe Source Matrix: Water Grab/Comp: Grab						
10482-4-1-2	9/28/16	1330	Bacteria - Colilert 2000 E.Coli Only		Na2S2O3	
Source: Describe Source Matrix: Water Grab/Comp: Grab						
10482-4-1-3	9/28/16	1330	Nitrate-Nitrogen		4 degrees C	
			Nitrite Nitrogen			
			Solids - Total Suspended			
			Turbidity			

If lead or copper are sample collection forms attached?

Yes ☐   No ☐

Water last used: _____ (Date) _____ (Time)

Relinquished by: _____ 9/28/16 1504	Received by: Ellen Mellott 9/28/16 15:04
Relinquished by: Ellen Mellott 9/28/16	Received by:
Relinquished by:	Received by:

| Method of Shipment: | Iced: Yes ☑ No ☐ Temp ☐ | Treatment: |

SET 9/28

Fredericktowne Labs Inc.

ENVIRONMENTAL TESTING

3020 Ventrie Court ● P.O. BOX 245 ● Myersville, MD 21773 ● 800-332-3340 ● FAX 301-293-2366
www.fredericktownelabs.com ● info@fredericktownelabs.com

Certificate of Analysis

Acct. No. 10482 - 5-1

Field Record

Site visit performed on: Wednesday, September 28, 2016 2:00 PM

by: Doug Hutzell

Affiliation: FSA

Property Owner: Frederick, Seibert & Associates, Inc.

Project: Washington County Stream Project

Property Address: 128 South Potomac Street

Hagerstown, MD 21740

Sample Source: Stream, Hamilton Run Magnolia St Cross

Laboratory Report

Sample Received at laboratory: 9/28/2016   3:04 PM

Bacteriological results:

Total Colif. (/100ml)	E.coli.(/100ml)	Start Date	Time	End Date	Time	Method	Analyst
	730	09/28/16	15:25	09/29/16	15:27	9223B	JD

Bacteriological analysis of this sample indicates the water is unsafe for human consumption. Analysis was performed according to the 20th edition of Standard Methods

Inorganic Chemical results:

Parameter	Result Units	MCL	Date of Analysis	Method	Analyst
Nitrate-Nitrogen	3.8 mg/l	10	9/29/2016	300.0	PH
Nitrite Nitrogen	<0.2 mg/l		9/29/2016	300.0	PH
Phosphorous-Total	0.110 mg/l		9/29/2016	200.7*	VVK
Solids - Total Suspend	11 mg/l		9/29/2016	2540D	JD
Total Kjeldahl Nitrogen	<0.5 mg/l		10/4/2016	4500NH3-D*	RMT
Total Nitrogen	3.9 mg/l		10/5/2016	Calculation	PH
Turbidity	7.6 NTU'		9/28/2016	180.1	KB

Reported by: _Cutty Phelps_   10/5/16
Name   Date

Fredericktowne Labs, Inc. is a State Certified Water Quality Laboratory
Maryland Cert. No. 116   Virginia Cert. No. 00444
MDOT WBE Cert. No.: 91-158

10/5/2016 2:30:46 PM

Page 1 of 1
No Regulatory Reports Required

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

Analytical Report
(base report)

WO#:	**16091730**
Date Reported:	**10/5/2016**

CLIENT:	Fredericktowne Labs, Inc	**Tag Number:**	
Matrix:	NON-POTABLE WATER	**Collection Date:**	9/28/2016 2:00:00 PM
Lab ID:	16091730-001A		
Project:	10482-5-1		
Client Sample ID	10482-5-1-1		

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
PHOSPHORUS (EPA 200.7)				E200.7	E200.2	Analyst: **VVK**
Phosphorus(P)	0.110	0.0500		mg/L	1	9/29/2016 5:25:33 PM
TOTAL KJELDAHL NITROGEN (4500-NH3-D)				A4500-NH3-D	A4500-NOR	Analyst: **RMT**
TKN	ND	0.500		mg/L	1	10/4/2016 12:17:00 PM

Qualifiers:				
	H	Holding times for preparation or analysis exceeded	M	Manual Integration used to determine area response
	ND	Not Detected at the Reporting Limit	PL	Permit Limit
	RL	Reporting Detection Limit	W	Sample container temperature is out of limit as specified at testcode

Original

Page 6 of 6

Chain of Custody Form

Fredericktowne Labs, Inc.

3020 Ventrie Ct.   P. O. Box 245
Myersville , MD 21773-
(301) 293-3340 / FAX (301) 293-2366

Acct. No.: 10482-5-1

Project:	Frederick, Seibert & Associates, Inc.	Collected by:	DOUG HOTZELL
	Washington County Stream Project	Affiliation:	FSA
	128 South Potomac Street		
	Hagerstown, MD 21740		

Sample Description / Sample Number	Date of Collection	Time of Collection	Analysis to be Performed	Field Observations	Preservation	Verif. By:
Source: Describe Source **Matrix:** Water **Grab/Comp:** Grab			STREAM, HAMILTON RUN MAGNOLIA St. CROSSING	BASE FLOW BEFOR RAIN	ICE 8.4 PH 16.1 C	
10482-5-1-**1**	9/28/16	1400	Phosphorous-Total		H2SO4 pH < 2	M
			Total Kjeldahl Nitrogen			
			Total Nitrogen			
Source: Describe Source **Matrix:** Water **Grab/Comp:** Grab						
10482-5-1-**2**	9/28/16	1400	Bacteria - Colilert 2000 E.Coli Only		Na2S2O3	
Source: Describe Source **Matrix:** Water **Grab/Comp:** Grab						
10482-5-1-**3**	9/28/16	1400	Nitrate-Nitrogen		4 degrees C	
			Nitrite Nitrogen			
			Solids - Total Suspended			
			Turbidity			

If lead or copper are sample collection forms attached?
Yes [ ]   No [ ]

Water last used: _____ (Date) _____ (Time)

Relinquished by: _DW. Hotzell_ 9/28/16 1504	Received by: _Edlen Mellott_ 9/28/16 15:04
Relinquished by: _Edlen Mellott_ 9/28/16	Received by:
Relinquished by:	Received by:

Method of Shipment:	Iced: Yes [✓] No [ ] Temp [ ]	Treatment:

Fredericktowne Labs Inc.

ENVIRONMENTAL TESTING

3020 Ventrie Court ● P.O. BOX 245 ● Myersville, MD 21773 ● 800-332-3340 ● FAX 301-293-2366
www.fredericktownelabs.com ● info@fredericktownelabs.com

Certificate of Analysis

Acct. No. 10482 - 6-1
Field Record

Site visit performed on: Wednesday, September 28, 2016 2:30 PM
by: Doug Hutzell
Affiliation: FSA
Property Owner: Frederick, Seibert & Associates, Inc.
Project: Washington County Stream Project
Property Address: 128 South Potomac Street
Hagerstown, MD 21740
Sample Source: Stream, Hamilton Run Mills Pk @ Confl

Laboratory Report

Sample Received at laboratory: 9/28/2016   3:04 PM

Bacteriological results:

Total Colif. (/100ml)	E.coli.(/100ml)	Start Date	Start Time	End Date	End Time	Method	Analyst
	>2400	09/28/16	15:25	09/29/16	15:27	9223B	JD

Bacteriological analysis of this sample indicates the water is unsafe for human consumption. Analysis was performed according to the 20th edition of Standard Methods

Inorganic Chemical results:

Parameter	Result Units	MCL	Date of Analysis	Method	Analyst
Nitrate-Nitrogen	3.1 mg/l	10	9/29/2016	300.0	PH
Nitrite Nitrogen	<0.2 mg/l		9/29/2016	300.0	PH
Phosphorous-Total	<0.05 mg/l		9/29/2016	200.7*	VVK
Solids - Total Suspend	22 mg/l		9/29/2016	2540D	JD
Total Kjeldahl Nitrogen	0.516 mg/l		10/4/2016	4500NH3-D*	RMT
Total Nitrogen	3.6 mg/l		10/5/2016	Calculation	PH
Turbidity	17 NTU'		9/28/2016	180.1	KB

Reported by: _Curtis Phelps_   10/5/16
Name   Date

SUMMIT
ENVIRONMENTAL TECHNOLOGIES, INC.
Analytical Laboratories

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

Analytical Report
(base report)

WO#: **16091731**

Date Reported: **10/5/2016**

CLIENT:	Fredericktowne Labs, Inc	**Tag Number:**
Matrix:	NON-POTABLE WATER	**Collection Date:** 9/28/2016 2:30:00 PM
Lab ID:	16091731-001A	
Project:	10482-5-1	
Client Sample ID 10482-6-1-1		

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
PHOSPHORUS (EPA 200.7)				E200.7	E200.2	Analyst: **VVK**
Phosphorus(P)	ND	0.0500		mg/L	1	9/29/2016 5:25:33 PM
TOTAL KJELDAHL NITROGEN (4500-NH3-D)				A4500-NH3-D	A4500-NOR	Analyst: **RMT**
TKN	0.516	0.500		mg/L	1	10/4/2016 12:17:00 PM

Qualifiers:	H	Holding times for preparation or analysis exceeded	M	Manual Integration used to determine area response
	ND	Not Detected at the Reporting Limit	PL	Permit Limit
	RL	Reporting Detection Limit	W	Sample container temperature is out of limit as specified at testcode

Original

Page 6 of 6

Chain of Custody Form

Fredericktowne Labs, Inc.

3020 Ventrie Ct.   P. O. Box 245
Myersville , MD 21773-
(301) 293-3340 / FAX (301) 293-2366

Acct. No.: 10482-6-1

Project:	Frederick, Seibert & Associates, Inc.	Collected by:	DOUG HUTZELL
	Washington County Stream Project		
	128 South Potomac Street	Affiliation:	FSA
	Hagerstown, MD 21740		

Sample Description / Sample Number	Date of Collection	Time of Collection	Analysis to be Performed	Field Observations	Preservation	Verif. By:
Source: Describe Source Matrix: Water Grab/Comp: Grab			STREAM, HAMILTON RUN MILLS PARK AT CONFL. OF TRIB.	CLOUDY BASE FLOW	ICE 8.2 PH 16.4 C	
10482-6-1-1	9/28/16	1430	Phosphorous-Total		H2SO4 pH < 2	
			Total Kjeldahl Nitrogen			
			Total Nitrogen			
Source: Describe Source Matrix: Water Grab/Comp: Grab						
10482-6-1-2	9/28/16	1430	Bacteria - Colilert 2000 E.Coli Only		Na2S2O3	
Source: Describe Source Matrix: Water Grab/Comp: Grab						
10482-6-1-3	9/28/16	1430	Nitrate-Nitrogen		4 degrees C	
			Nitrite Nitrogen			
			Solids - Total Suspended			
			Turbidity			

If lead or copper are sample collection forms attached?
Yes ☐   No ☐

Water last used: _____ (Date) _____ (Time)

Relinquished by: H.W. ____ 9/28/16 1504	Received by: Ellen Mellott 9/28/16 15:04
Relinquished by: Ellen Mellott 9/28/16	Received by:
Relinquished by:	Received by:

| Method of Shipment: | Iced: Yes ☑ No ☐ Temp ☐ | Treatment: |

TC & FC limits for natural waters
(Ref.: EPA Water Quality Standards for Coastal and Great
Lakes Recreation Waters, 1986)

Acceptable swimming-associated gastroenteritis rate per 1000 swimmers	Steady state geometric mean indicator density	Designated beach area (upper 75% C.L.)	Moderate full body contact recreation (upper 82% C.L.)	Lightly used full body contact recreation (upper 82% C.L.)	Infrequently used full body contact recreation (upper 95% C.L.)
Freshwater-**Enterococci** (8)	33/100ml	61	78	107	151
Freshwater-**E. Coli** (8)	126/100ml	235	298	409	575
Marine Water-**Enterococci** (19)	35/100ml	104	158	276	501

	Desirable	Permissible
Primary contact water (swimming)		
Total coliforms / 100 ml	<1000	<2400
Fecal coliforms / 100 ml	<200	<1000
Secondary contact (boating, fishing)		
Total coliforms / 100 ml	<5000	<10000
Fecal coliforms / 100 ml	<1000	<5000

APPENDIX E
Reach Level Function-Based Assessments

ECOSYSTEM
PLANNING &
RESTORATION

Hamilton Run, Hagerstown, MD: HR-R1													
			Pre-Restoration Condition						**Proposed Condition**				
Level and Category	**Parameter**	**Measurement Method**	**Rating**	**Score**	**Overall by Level**	**Score**	**Overall Reach**	**Score**	**Rating**	**Score**	**Overall by Level**	**Score**	**Overall Reach**	**Score**
1 - Hydrology	Runoff	Concentrated Flow	FAR	6	FAR	9			F	9	FAR*	12		
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	6	FAR	29			F	10	F	40		
		Entrenchment Ratio	F	10					F	10				
	Floodplain Drainage	FWS Rapid Assessment	FAR	6					F	10				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	7					F	10				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	7	FAR	28	FAR	88	F	9	F	54	FAR*	140
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	5					F	9				
		Lateral Stabity Extent	NF	3					F	9				
	Bedform Diversity	Shelter for Fish	FAR	4					F	9				
		Pool-to-pool Spacing	FAR	4					F	9				
		Pool Depth Variability	FAR	5					F	9				
4 - Phisicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	5	FAR	9			FAR*	7	FAR*	15		
	Detritus	FWS Rapid Assessment	FAR	4					FAR*	8				
5 - Biology	Macro	Presence	FAR	4	FAR	13			FAR*	7	FAR*	19		
		Tolerance	FAR	5					FAR	5				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	**Channel Evolution**
Channel Evolution	FAR	Slightly incised, laterally eroding C4. Trending toward functioning- downcutting done. Outside meanders eroding. Most likely decades before equilibrium reached
		Constraints
Constraints		Bridge at upstream end.
		Restoration Potential
Restoration Potential		Full Lvl 3 and partial Lvls 4 and 5

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R2

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	NF	3	NF	6			FAR*	7	FAR*	10		
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	6	FAR	23			F	9	FAR*	33		
		Entrenchment Ratio	FAR	7					F	8				
	Floodplain Drainage	FWS Rapid Assessment	NF	3					FAR*	7				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	7					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	3	FAR	36	FAR	87	FAR*	6	FAR*	50	FAR*	127
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	7					F	9				
		Lateral Stabity Extent	FAR	7					F	9				
	Bedform Diversity	Shelter for Fish	FAR	5					F	8				
		Pool-to-pool Spacing	FAR	7					F	9				
		Pool Depth Variability	FAR	7					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	5	FAR	10			FAR*	7	FAR*	16		
	Detritus	FWS Rapid Assessment	FAR	5					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	12			FAR*	7	FAR*	18		
		Tolerance	FAR	4					FAR	4				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	Channel Evolution
Channel Evolution	FAR	B4c because of floodplain encroachment from development. Reach is mostly stable because of dense vegetation.
		Constraints
Constraints		Bridge at downstream end.
		Restoration Potential
Restoration Potential		Nearly full Lvl 3 and partial Lvls 4 and 5

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R3														
			Pre-Restoration Condition						**Proposed Condition**					
Level and Category	**Parameter**	**Measurement Method**	**Rating**	**Score**	**Overall by Level**	**Score**	**Overall Reach**	**Score**	**Rating**	**Score**	**Overall by Level**	**Score**	**Overall Reach**	**Score**
1 - Hydrology	Runoff	Concentrated Flow	FAR	5	FAR	8			FAR*	6	FAR*	9		
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	F	8	FAR	31			F	9	F	34		
		Entrenchment Ratio	F	8					F	8				
	Floodplain Drainage	FWS Rapid Assessment	FAR	6					F	8				
	Vertical Stability Extent	FWS Rapid Assessment	F	9					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	3	FAR	35	FAR	93	FAR*	6	FAR*	50	FAR*	124
	Lateral Stability	Dominant Bank Ersoion Rate	F	8					F	9				
		Lateral Stabity Extent	F	8					F	9				
	Bedform Diversity	Shelter for Fish	FAR	5					F	8				
		Pool-to-pool Spacing	NF	2					F	9				
		Pool Depth Variability	F	9					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	7			FAR*	7	FAR*	15		
	Detritus	FWS Rapid Assessment	NF	3					F	8				
5 - Biology	Macro	Presence	FAR	4	FAR	12			FAR*	6	FAR*	16		
		Tolerance	FAR	4					FAR	4				
	Fish	Presence	FAR	4					FAR*	6				

	Rating	Channel Evolution
Channel Evolution	FAR	Evolved into a B4c. Should be a C4 but has been straightened. Reach is mostly stable because of dense vegetation

	Constraints
Constraints	Bridge at upstream and downstream end, neither of which can pass BF flows. Encroachment from development on both sides of the stream.

	Restoration Potential
Restoration Potential	Nearly full Lvl 3 and partial Lvls 4 and 5

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R4

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	6	FAR	9	NF	80	FAR	6	FAR*	9	FAR*	126
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	NF	3	NF	19			F	9	F	35		
		Entrenchment Ratio	NF	2					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					F	8				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	7					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	3	FAR	32			FAR*	7	FAR*	51		
	Lateral Stability	Dominant Bank Ersoion Rate	F	9					F	9				
		Lateral Stabity Extent	FAR	6					F	9				
	Bedform Diversity	Shelter for Fish	FAR	4					F	8				
		Pool-to-pool Spacing	NF	3					F	9				
		Pool Depth Variability	FAR	7					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	8			FAR*	7	FAR*	15		
	Detritus	FWS Rapid Assessment	FAR	4					F	8				
5 - Biology	Macro	Presence	FAR	4	FAR	12			FAR*	6	FAR*	16		
		Tolerance	FAR	4					FAR	4				
	Fish	Presence	FAR	4					FAR*	6				

	Rating	Channel Evolution
Channel Evolution	NF	F4 trying to evovle into a B4c. Right bank fairly stable but left banl eroding at a low to moderate rate. Vegetation is helping slow rate.
		Constraints
Constraints		Bridge at downstream end, neither of which can pass BF flows. Encroachment from development on both sides of the stream.
		Restoration Potential
Restoration Potential		Nearly full Lvl 3 and partial Lvls 4 and 5

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R5													
			Pre-Restoration Condition						**Proposed Condition**				
Level and Category	**Parameter**	**Measurement Method**	**Rating**	**Score**	**Overall by Level**	**Score**	**Overall Reach**	**Score**	**Rating**	**Score**	**Overall by Level**	**Score**	**Overall Reach**	**Score**
1 - Hydrology	Runoff	Concentrated Flow	FAR	6	FAR	9	NF	79	FAR	6	FAR	9	FAR*	83
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	NF	3	NF	20			NF	3	NF	20		
		Entrenchment Ratio	NF	3					NF	3				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					FAR	7				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	7					FAR	7				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	2	FAR	32			NF	3	FAR*	33		
	Lateral Stability	Dominant Bank Ersoion Rate	F	8					F	8				
		Lateral Stabity Extent	F	8					F	8				
	Bedform Diversity	Shelter for Fish	FAR	4					FAR	4				
		Pool-to-pool Spacing	FAR	5					FAR	5				
		Pool Depth Variability	FAR	5					FAR	5				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	8			FAR	4	FAR	8		
	Detritus	FWS Rapid Assessment	FAR	4					FAR	4				
5 - Biology	Macro	Presence	NF	3	FAR	10			FAR*	5	FAR*	13		
		Tolerance	NF	3					FAR	3				
	Fish	Presence	FAR	4					FAR*	5				

	Rating	Channel Evolution
Channel Evolution	NF	Hardened F4 because of rock and concrete walls on both banks. It is entrencheded. Bed is controlled by bedrock. Residental development encroaching on both sides of stream.
		Constraints
Constraints		Bridge at downstream end, neither of which cannot pass BF flows. Encroachment from development on both sides of the stream.
		Restoration Potential
Restoration Potential		Partial Lvl 3 only, if walls can be removed and Priority 3 completed.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R6

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	6	FAR	9			FAR	6	FAR	9		
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	7	FAR	31			F	9	F	35		
		Entrenchment Ratio	F	9					F	9				
	Floodplain Drainage	FWS Rapid Assessment	F	8					F	8				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	7					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	2	FAR	36	FAR	95	NF	3	FAR*	47	FAR*	118
	Lateral Stability	Dominant Bank Ersoion Rate	F	9					F	9				
		Lateral Stabity Extent	FAR	7					F	8				
	Bedform Diversity	Shelter for Fish	FAR	6					F	9				
		Pool-to-pool Spacing	FAR	6					F	9				
		Pool Depth Variability	FAR	6					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	8			FAR*	5	FAR*	12		
	Detritus	FWS Rapid Assessment	FAR	4					FAR*	7				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR	6	FAR*	15		
		Tolerance	NF	3					NF	3				
	Fish	Presence	FAR	4					FAR	6				

	Rating	Channel Evolution
Channel Evolution	FAR	Moving towards a B4c because of residental development encroachment on both sides of stream.
		Constraints
Constraints		Bridge in middle of reach but can pass BF flows. Encroachment from development on both sides of the stream.
		Restoration Potential
Restoration Potential		Nearly full Lvl 3 only, if walls can be removed and Priority 3 completed.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R7														
			Pre-Restoration Condition						**Proposed Condition**					
Level and Category	**Parameter**	**Measurement Method**	**Rating**	**Score**	**Overall by Level**	**Score**	**Overall Reach**	**Score**	**Rating**	**Score**	**Overall by Level**	**Score**	**Overall Reach**	**Score**
1 - Hydrology	Runoff	Concentrated Flow	FAR	7	FAR	10			F	9	FAR*	16		
		Flashniess	NF	3					FAR	7				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	F	8	FAR	32			F	9	F	37		
		Entrenchment Ratio	F	9					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					F	10				
	Vertical Stability Extent	FWS Rapid Assessment	F	8					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	6	FAR	34	FAR	95	F	8	F	52	FAR*	139
	Lateral Stability	Dominant Bank Ersoion Rate	F	9					F	9				
		Lateral Stabity Extent	F	9					F	8				
	Bedform Diversity	Shelter for Fish	NF	4					F	9				
		Pool-to-pool Spacing	NF	3					F	9				
		Pool Depth Variability	NF	3					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	8			FAR*	7	FAR*	16		
	Detritus	FWS Rapid Assessment	FAR	4					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	7	FAR*	18		
		Tolerance	FAR	3					FAR	4				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	**Channel Evolution**
Channel Evolution	FAR	Straight C4
		Constraints
Constraints		None
		Restoration Potential
Restoration Potential		Full Lvl 3 only, if walls can be removed and Priority 3 completed.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R8

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	4	FAR	7	NF	74	FAR*	6	FAR*	13	NF*	90
		Flashniess	NF	3					FAR	7				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	NF	3	NF	21			NF	3	NF	21		
		Entrenchment Ratio	NF	3					NF	3				
	Floodplain Drainage	FWS Rapid Assessment	FAR	8					F	8				
	Vertical Stability Extent	FWS Rapid Assessment	F	7					FAR	7				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	2	NF	27			NF	3	NF	33		
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	7					F	9				
		Lateral Stabity Extent	F	8					F	8				
	Bedform Diversity	Shelter for Fish	NF	4					NF	5				
		Pool-to-pool Spacing	NF	3					NF	4				
		Pool Depth Variability	NF	3					NF	4				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	NF	4	NF	8			NF	5	NF	10		
	Detritus	FWS Rapid Assessment	NF	4					NF	5				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	5	FAR*	13		
		Tolerance	NF	3					NF	3				
	Fish	Presence	FAR	4					FAR*	5				

	Rating	Channel Evolution
Channel Evolution	NF	F4 - Harden on right bank by concrete/rock wall. Encroached on left bank by Pangborn Pond and homes on the right. U/S of reach is piped
		Constraints
Constraints		Homes, Pangborn Pond and piped section u/s of reach.
		Restoration Potential
Restoration Potential		Potential only add some limited veg on banks. Pond would have to be removed to increase any additional potential uplift.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R9

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	6	FAR	9	FAR	95	F	8	FAR*	14	FAR*	139
		Flashniess	NF	3					FAR	6				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	F	9	FAR	34			F	10	F	40		
		Entrenchment Ratio	F	9					F	10				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					F	10				
	Vertical Stability Extent	FWS Rapid Assessment	F	9					F	10				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	6	FAR	30			FAR*	7	FAR*	52		
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	7					F	9				
		Lateral Stabity Extent	FAR	5					F	9				
	Bedform Diversity	Shelter for Fish	FAR	5					F	9				
		Pool-to-pool Spacing	NF	3					F	9				
		Pool Depth Variability	FAR	4					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	6	FAR	11			FAR*	7	FAR*	15		
	Detritus	FWS Rapid Assessment	FAR	5					F	8				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	7	FAR*	18		
		Tolerance	NF	3					FAR	4				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	Channel Evolution
Channel Evolution	FAR	Straight C4/6. Very silty channel bottom because of d/s undersized culvert causing back water.
		Constraints
Constraints		D/s culvert undersided, homes on right bank and mowed lawn on left bank.
		Restoration Potential
Restoration Potential		Nearly full Lvl 3 and partial Lvls 4 and 5. There is potential to build a large wetland complex within the leftbank floodplain because the land is owned by the City.

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	6	FAR	9			F	9	FAR*	15		
		Flashniess	NF	3					FAR	6				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	NF	3	NF	19			F	9	F	36		
		Entrenchment Ratio	NF	3					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					F	9				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	6					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	4	FAR	30	NF	80	F	9	F	54	FAR*	139
	Lateral Stability	Dominant Bank Ersoion Rate	F	8					F	9				
		Lateral Stabity Extent	FAR	6					F	9				
	Bedform Diversity	Shelter for Fish	FAR	5					F	9				
		Pool-to-pool Spacing	NF	3					F	9				
		Pool Depth Variability	FAR	4					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	6	FAR	11			FAR*	7	FAR*	16		
	Detritus	FWS Rapid Assessment	FAR	5					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	7	FAR*	18		
		Tolerance	NF	3					FAR	4				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	Channel Evolution
Channel Evolution	NF	Hardened F4/6. Harden on right bank from placed rocks. Entrenched because of artifical berm on left bank. Very silty channel bottom because of d/s undersized culvert causing back water.
		Constraints
Constraints		D/s culvert undersided and homes on right bank.
		Restoration Potential
Restoration Potential		Full Lvl 3 and partial Lvls 4 and 5. There is potential to build a large wetland complex within the leftbank floodplain because the land is owned by the City.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R11

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	6	FAR	9			FAR	6	FAR*	12		
		Flashniess	NF	3					FAR	6				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	6	FAR	30			F	9	F	36		
		Entrenchment Ratio	F	9					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					F	9				
	Vertical Stability Extent	FWS Rapid Assessment	F	8					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	6	FAR	36	FAR	97	F	8	F	53	FAR*	135
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	7					F	9				
		Lateral Stabity Extent	FAR	7					F	9				
	Bedform Diversity	Shelter for Fish	FAR	5					F	9				
		Pool-to-pool Spacing	FAR	4					F	9				
		Pool Depth Variability	FAR	7					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	5	FAR	11			FAR*	7	FAR*	16		
	Detritus	FWS Rapid Assessment	FAR	6					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	7	FAR*	18		
		Tolerance	NF	3					FAR	4				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	Channel Evolution
Channel Evolution	FAR	Straight C4/6. Very silty channel bottom because of slightly high w/d ratio. A lot of hardening on right bank from landowners. Left bank stable from vegetation.
		Constraints
Constraints		Homes on right bank, school on left bank and bridge at u/s end of reach.
		Restoration Potential
Restoration Potential		Full Lvl 3 and partial Lvls 4 and 5.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R12

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	5	FAR	8			F	8	FAR*	11		
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	6	FAR	29			F	9	F	36		
		Entrenchment Ratio	F	9					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					F	9				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	7					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	2	FAR	35	FAR	95	FAR	6	FAR*	50	FAR*	130
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	7					F	9				
		Lateral Stabity Extent	FAR	7					F	9				
	Bedform Diversity	Shelter for Fish	FAR	6					F	9				
		Pool-to-pool Spacing	NF	4					F	8				
		Pool Depth Variability	F	9					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	6	FAR	12			FAR*	7	FAR*	15		
	Detritus	FWS Rapid Assessment	FAR	6					F	8				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	7	FAR*	18		
		Tolerance	NF	3					FAR	4				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	Channel Evolution
Channel Evolution	FAR	Straight and incised C4/6. Very silty channel bottom because of slightly high w/d ratio. Channel is slight incised because of artifical berm on left bank. Vegetation is helping keep the banks stable. Plus there is a backwater effect from d/s bridge/road crossing
		Constraints
Constraints		Homes on left bank and bridge/road at d/s end of reach.
		Restoration Potential
Restoration Potential		Nearly full Lvl 3 and partial Lvls 4 and 5.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R13

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	7	FAR	10			F	8	FAR*	11		
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	NF	3	FAR	20			F	8	F	33		
		Entrenchment Ratio	NF	3					F	8				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					F	8				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	7					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	2	FAR	36	FAR	91	FAR	6	FAR*	45	FAR*	115
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	7					F	9				
		Lateral Stabity Extent	FAR	6					F	9				
	Bedform Diversity	Shelter for Fish	FAR	6					FAR*	6				
		Pool-to-pool Spacing	FAR	7					FAR*	7				
		Pool Depth Variability	F	8					F	8				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	6	FAR	12			FAR*	7	FAR*	13		
	Detritus	FWS Rapid Assessment	FAR	6					FAR	6				
5 - Biology	Macro	Presence	FAR	5	FAR	13			FAR	5	FAR	13		
		Tolerance	NF	3					NF	3				
	Fish	Presence	FAR	5					FAR	5				

	Rating	Channel Evolution
Channel Evolution	NF	F4/1 → B4c. This reach is like a nick point. It is dominated by bedrock grade control and much steeper than other reaches within the project area. It is an F channel because of placed fill by adjacent landowners
		Constraints
Constraints		Homes on both banks and bridge/road at u/s end of reach.
		Restoration Potential
Restoration Potential		Nearly full Lvl 3. Can only really improve floodplain connectivity and riparian veg because of existing bedrock grade control.

Note: "*" means partial uplift

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
Hamilton Run, Hagerstown, MD: HR-R14			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	NF	3	FAR	6			FAR	7	FAR*	10		
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	7	FAR	30			F	8	F	34		
		Entrenchment Ratio	F	9					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					F	8				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	7					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	7	FAR	41	FAR	99	F	9	FAR*	48	FAR*	121
	Lateral Stability	Dominant Bank Ersoion Rate	F	9					F	9				
		Lateral Stabity Extent	F	9					F	9				
	Bedform Diversity	Shelter for Fish	FAR	4					FAR*	7				
		Pool-to-pool Spacing	NF	3					FAR	6				
		Pool Depth Variability	F	9					F	8				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	5	FAR	11			FAR*	6	FAR*	14		
	Detritus	FWS Rapid Assessment	FAR	6					F	8				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	6	FAR*	15		
		Tolerance	NF	3					NF	3				
	Fish	Presence	FAR	4					FAR*	6				

	Rating	Channel Evolution
Channel Evolution	FAR	Slightly incised and straight C5/6. This reach has a silt channel bottom because of a high w/d ratio and is very flat as a result of the bedrock grade control and bridge/road crossing d/s.
		Constraints
Constraints		Bridge/road at u/s end of reach.
		Restoration Potential
Restoration Potential		Possibably Full Lvl 3, bedform diversity could be improved if backwater is addressed.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R15

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	5	FAR	8			FAR*	7	FAR*	10		
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	NF	3	FAR	16			F	8	F	32		
		Entrenchment Ratio	NF	3					F	8				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					F	8				
	Vertical Stability Extent	FWS Rapid Assessment	NF	3					F	8				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	6	FAR	38	FAR	83	F	9	F	51	FAR*	125
	Lateral Stability	Dominant Bank Ersoion Rate	F	8					F	9				
		Lateral Stabity Extent	FAR	7					F	9				
	Bedform Diversity	Shelter for Fish	FAR	6					F	8				
		Pool-to-pool Spacing	NF	3					F	8				
		Pool Depth Variability	F	8					F	8				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	10			FAR*	7	FAR*	15		
	Detritus	FWS Rapid Assessment	FAR	6					F	8				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	7	FAR*	17		
		Tolerance	NF	3					NF	3				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	Channel Evolution
		Channel Evolution
Channel Evolution	NF	F4/6 → B4c. This reach has a silt channel bottom because of a high w/d ratio.
		Constraints
Constraints		Stream piped at u/s end of reach.
		Restoration Potential
Restoration Potential		Full Lvl 3 and partial Lvls 4 and 5.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R16

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	5	FAR	8	NF	70	FAR*	7	FAR*	10	FAR*	117
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	NF	3	NF	18			F	9	FAR*	32		
		Entrenchment Ratio	NF	3					F	8				
	Floodplain Drainage	FWS Rapid Assessment	FAR	6					FAR*	7				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	6					F	8				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	3	FAR	26			FAR	6	FAR*	48		
	Lateral Stability	Dominant Bank Ersoion Rate	F	8					F	9				
		Lateral Stabity Extent	F	8					F	9				
	Bedform Diversity	Shelter for Fish	NF	3					F	8				
		Pool-to-pool Spacing	NF	2					F	8				
		Pool Depth Variability	NF	2					F	8				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	9			FAR*	7	FAR*	14		
	Detritus	FWS Rapid Assessment	FAR	5					FAR*	7				
5 - Biology	Macro	Presence	FAR	4	FAR	9			FAR*	6	FAR*	13		
		Tolerance	NF	1					NF	1				
	Fish	Presence	FAR	4					FAR*	6				

	Rating	Channel Evolution
		Channel Evolution
Channel Evolution	NF	F4 moving to a B4c with some bedrock grade control.
		Constraints
Constraints		Stream piped at d/s end of reach. Three road crossings and landowners on both sides of stream
		Restoration Potential
Restoration Potential		Nearly full Lvl 3 and partial Lvls 4 and 5.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R17

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	NF	3	FAR	6	NF	73	FAR*	5	FAR*	8	FAR*	114
		Flashniess	NF	3					NF	3				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	NF	2	NF	15			F	8	FAR*	31		
		Entrenchment Ratio	NF	2					F	8				
	Floodplain Drainage	FWS Rapid Assessment	FAR	5					FAR*	7				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	6					F	8				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	6	FAR	34			F	8	F	50		
	Lateral Stability	Dominant Bank Ersoion Rate	NF	3					F	9				
		Lateral Stabity Extent	FAR	6					F	8				
	Bedform Diversity	Shelter for Fish	FAR	6					F	8				
		Pool-to-pool Spacing	FAR	6					F	8				
		Pool Depth Variability	FAR	7					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	9			FAR*	5	FAR*	14		
	Detritus	FWS Rapid Assessment	FAR	5					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	9			FAR*	5	FAR*	11		
		Tolerance	NF	1					NF	1				
	Fish	Presence	FAR	4					FAR*	5				

Channel Evolution	Rating	Channel Evolution
		Channel Evolution
Channel Evolution	NF	F4 moving to a B4c in some areas.
		Constraints
Constraints		Two road crossings and landowners on both sides of stream
		Restoration Potential
Restoration Potential		Full Lvl 3 and partial Lvls 4 and 5.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R18														
			Pre-Restoration Condition						**Proposed Condition**					
Level and Category	**Parameter**	**Measurement Method**	**Rating**	**Score**	**Overall by Level**	**Score**	**Overall Reach**	**Score**	**Rating**	**Score**	**Overall by Level**	**Score**	**Overall Reach**	**Score**
1 - Hydrology	Runoff	Concentrated Flow	FAR	5	FAR	9			FAR*	7	FAR*	11		
		Flashniess	FAR	4					FAR	4				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	F	10	FAR	34			F	10	F	37		
		Entrenchment Ratio	F	8					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					F	9				
	Vertical Stability Extent	FWS Rapid Assessment	F	9					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	6	FAR	38	FAR	100	F	8	F	51	FAR*	124
	Lateral Stability	Dominant Bank Ersoion Rate	F	8					F	9				
		Lateral Stabity Extent	F	8					F	8				
	Bedform Diversity	Shelter for Fish	FAR	7					F	9				
		Pool-to-pool Spacing	FAR	4					F	8				
		Pool Depth Variability	FAR	5					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	10			FAR*	5	FAR*	14		
	Detritus	FWS Rapid Assessment	FAR	6					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	9			FAR*	5	FAR*	11		
		Tolerance	NF	1					NF	1				
	Fish	Presence	FAR	4					FAR*	5				

	Rating	Channel Evolution
Channel Evolution	FAR	Low sinuosity E4 near stable condition.
		Constraints
Constraints		One road crossings and limited space for vegetation on left bank.
		Restoration Potential
Restoration Potential		Full Lvl 3 and partial Lvls 4 and 5.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R19														
Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	4	FAR	8			FAR*	7	FAR*	11		
		Flashniess	FAR	4					FAR	4				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	7	FAR	30			F	9	FAR*	34		
		Entrenchment Ratio	F	9					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	6					FAR*	7				
	Vertical Stability Extent	FWS Rapid Assessment	F	8					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	6	FAR	39	FAR	96	FAR*	7	FAR*	50	FAR*	120
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	6					F	9				
		Lateral Stabity Extent	FAR	6					F	8				
	Bedform Diversity	Shelter for Fish	FAR	7					F	9				
		Pool-to-pool Spacing	F	9					F	9				
		Pool Depth Variability	FAR	5					F	8				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	10			FAR*	5	FAR*	14		
	Detritus	FWS Rapid Assessment	FAR	6					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	9			FAR*	5	FAR*	11		
		Tolerance	NF	1					NF	1				
	Fish	Presence	FAR	4					FAR*	5				

Channel Evolution	Rating	Channel Evolution
	FAR	Low sinuosity and slightly incised C4/1 with some localized bank erosion. Vegetation and bedrock grade control is providing system wide stability.
		Constraints
Constraints		Buildings and parking lots encroaching on the left bank.
		Restoration Potential
Restoration Potential		Nearly full Lvl 3 and partial Lvls 4 and 5. Riparian vegetation width is limited because of encroachment.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R20

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	NF	3	FAR	7	NF	64	FAR	5	FAR*	9	FAR*	108
		Flashniess	FAR	4					FAR	4				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	NF	3	NF	13			F	8	FAR*	30		
		Entrenchment Ratio	NF	3					F	8				
	Floodplain Drainage	FWS Rapid Assessment	NF	3					FAR	6				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	4					F	8				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	2	NF	25			FAR*	5	FAR*	45		
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	6					F	8				
		Lateral Stabity Extent	FAR	6					F	8				
	Bedform Diversity	Shelter for Fish	NF	3					F	8				
		Pool-to-pool Spacing	NF	3					F	8				
		Pool Depth Variability	FAR	5					F	8				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	10			FAR*	5	FAR*	13		
	Detritus	FWS Rapid Assessment	FAR	6					F	8				
5 - Biology	Macro	Presence	FAR	4	FAR	9			FAR*	5	FAR*	11		
		Tolerance	NF	1					NF	1				
	Fish	Presence	FAR	4					FAR*	5				

	Rating	Channel Evolution
Channel Evolution	NF	F4 channel evolving to a B4c with RR track on right bank and parking lot on left bank, although left bank has a thin strip of riparian vegetation helping stabilize the banks.
		Constraints
Constraints		RR track on right bank, parking lot on left bank and culvert at u/s end.
		Restoration Potential
Restoration Potential		Nearly full Lvl 3 and partial Lvls 4 and 5. Riparian vegetation width is limited because of encroachment.

Note: "*" means partial uplift

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	3	FAR	7			FAR*	6	FAR*	10		
		Flashniess	FAR	4					FAR	4				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	5	FAR	24			F	8	FAR*	32		
		Entrenchment Ratio	FAR	6					F	8				
	Floodplain Drainage	FWS Rapid Assessment	FAR	6					FAR*	7				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	7					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	3	FAR	33	FAR	83	FAR*	6	FAR*	47	FAR*	114
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	7					F	9				
		Lateral Stabity Extent	FAR	6					F	8				
	Bedform Diversity	Shelter for Fish	FAR	4					F	8				
		Pool-to-pool Spacing	FAR	6					F	8				
		Pool Depth Variability	FAR	7					F	8				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	4	FAR	10			FAR*	5	FAR*	14		
	Detritus	FWS Rapid Assessment	FAR	6					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	9			FAR*	5	FAR*	11		
		Tolerance	NF	1					NF	1				
	Fish	Presence	FAR	4					FAR*	5				

Hamilton Run, Hagerstown, MD: HR-R21

	Rating	Channel Evolution
Channel Evolution	NF	F4 moving to a B4c in some areas with d/s end being a C4 because of backwater from RR crossing.
		Constraints
Constraints		Buildings and parking lots encroaching on the left bank and DOT encroaching on right bank. RR culvert at d/s end opf reach.
		Restoration Potential
Restoration Potential		Nearly full Lvl 3 and partial Lvls 4 and 5. Riparian vegetation width is limited because of encroachment.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R22

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	NF	3	NF	6	FAR	94	F	9	FAR*	14	FAR*	135
		Flashniess	NF	3					FAR	5				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	F	8	FAR	31			F	9	F	36		
		Entrenchment Ratio	F	8					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	6					F	9				
	Vertical Stability Extent	FWS Rapid Assessment	F	9					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	2	FAR	34			F	8	F	52		
	Lateral Stability	Dominant Bank Ersoion Rate	F	9					F	9				
		Lateral Stabity Extent	F	9					F	8				
	Bedform Diversity	Shelter for Fish	FAR	6					F	9				
		Pool-to-pool Spacing	FAR	4					F	9				
		Pool Depth Variability	FAR	4					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	6	FAR	12			FAR*	7	FAR*	16		
	Detritus	FWS Rapid Assessment	FAR	6					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	7	FAR*	17		
		Tolerance	NF	3					NF	3				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	Channel Evolution
Channel Evolution	FAR	High w/d C4/wetland BMP in stable condition.
		Constraints
Constraints		One road crossings and school property on both sides of stream.
		Restoration Potential
Restoration Potential		Full Lvl 3 and partial Lvls 4 and 5.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R23

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	NF	3	NF	6			F	8	FAR*	13		
		Flashniess	NF	3					FAR	5				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	6	FAR	27			F	9	F	36		
		Entrenchment Ratio	F	8					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	6					F	9				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	7					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	3	FAR	33	FAR	88	F	8	F	53	FAR*	135
	Lateral Stability	Dominant Bank Ersoion Rate	F	8					F	9				
		Lateral Stabity Extent	FAR	6					F	9				
	Bedform Diversity	Shelter for Fish	FAR	6					F	9				
		Pool-to-pool Spacing	NF	3					F	9				
		Pool Depth Variability	FAR	7					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	5	FAR	11			FAR*	7	FAR*	16		
	Detritus	FWS Rapid Assessment	FAR	6					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	7	FAR*	17		
		Tolerance	NF	3					NF	3				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	Channel Evolution
Channel Evolution	FAR	Straight and slightly incised C4 with localized bank erosion. Vegetation helping to stablize the banks
		Constraints
Constraints		Road crossings at u/s and d/s end of reach. Parking losts and buildings on the left bank.
		Restoration Potential
Restoration Potential		Full Lvl 3 and partial Lvls 4 and 5.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R24

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	NF	3	NF	6	NF	74	F	9	FAR*	14	FAR*	136
		Flashniess	NF	3					FAR	5				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	NF	3	NF	19			F	9	F	36		
		Entrenchment Ratio	NF	3					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	7					F	9				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	6					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	3	NF	28			F	8	F	53		
	Lateral Stability	Dominant Bank Ersoion Rate	F	8					F	9				
		Lateral Stabity Extent	FAR	6					F	9				
	Bedform Diversity	Shelter for Fish	FAR	5					F	9				
		Pool-to-pool Spacing	NF	3					F	9				
		Pool Depth Variability	NF	3					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	5	FAR	10			FAR*	7	FAR*	16		
	Detritus	FWS Rapid Assessment	FAR	5					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	7	FAR*	17		
		Tolerance	NF	3					NF	3				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	Channel Evolution
Channel Evolution	NF	F4 evolving into a B4c, dense vegetation on banks is prevented some erosion
		Constraints
Constraints		Road crossings at d/s end of reach. Stream on school property. This will influence riparian buffer width and potential BMP creation.
		Restoration Potential
Restoration Potential		Full Lvl 3 and partial Lvls 4 and 5.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R25

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	FAR	6	FAR	9	FAR	96	F	8	FAR*	13	FAR*	135
		Flashniess	NF	3					FAR	5				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	F	9	F	36			F	9	F	36		
		Entrenchment Ratio	F	9					F	9				
	Floodplain Drainage	FWS Rapid Assessment	F	9					F	9				
	Vertical Stability Extent	FWS Rapid Assessment	F	9					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	FAR	5	FAR	30			F	8	F	53		
	Lateral Stability	Dominant Bank Ersoion Rate	F	8					F	9				
		Lateral Stabity Extent	FAR	7					F	9				
	Bedform Diversity	Shelter for Fish	FAR	4					F	9				
		Pool-to-pool Spacing	NF	3					F	9				
		Pool Depth Variability	NF	3					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	5	FAR	10			FAR*	7	FAR*	16		
	Detritus	FWS Rapid Assessment	FAR	5					F	9				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	7	FAR*	17		
		Tolerance	NF	3					NF	3				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	Channel Evolution
Channel Evolution	FAR	Straight C4 with backwater from large debris jam and old concrete weir at d/s end of reach.
		Constraints
Constraints		Road crossings at u/s end of reach. Stream on school property. This will influence riparian buffer width and potential BMP creation.
		Restoration Potential
Restoration Potential		Full Lvl 3 and partial Lvls 4 and 5.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R26															
Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	F	8	FAR	11			F	9	FAR*	13		
		Flashniess	NF	3					FAR	4				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	4	FAR	21			F	9	F	35		
		Entrenchment Ratio	FAR	4					F	9				
	Floodplain Drainage	FWS Rapid Assessment	FAR	6					F	8				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	7					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	1	FAR	19	FAR	72	FAR	6	FAR*	48	FAR*	125
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	5					F	9				
		Lateral Stabity Extent	FAR	5					F	9				
	Bedform Diversity	Shelter for Fish	FAR	4					F	8				
		Pool-to-pool Spacing	NF	2					F	8				
		Pool Depth Variability	NF	2					F	8				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	5	FAR	10			FAR*	6	FAR*	14		
	Detritus	FWS Rapid Assessment	FAR	5					F	8				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	6	FAR*	15		
		Tolerance	NF	3					NF	3				
	Fish	Presence	FAR	4					FAR*	6				

	Rating	Channel Evolution
Channel Evolution	NF	F4 moving to a B4c in some areas.
		Constraints
Constraints		Ponds at u/s and d/s end of reach. Four road crossings throughout the reach. Stream on cemetary property. This will influence riparian buffer width.
		Restoration Potential
Restoration Potential		Nearly full Lvl 3 and partial Lvls 4 and 5. Riparian vegetation width is limited because of encroachment.

Note: "*" means partial uplift

Hamilton Run, Hagerstown, MD: HR-R27

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition						Proposed Condition					
			Rating	Score	Overall by Level	Score	Overall Reach	Score	Rating	Score	Overall by Level	Score	Overall Reach	Score
1 - Hydrology	Runoff	Concentrated Flow	F	8	FAR	11			F	9	FAR*	15		
		Flashniess	NF	3					FAR	6				
2 - Hydraulics	Floodplain Connectivity	Bank Height Ratio	FAR	4	FAR	23			F	9	F	35		
		Entrenchment Ratio	FAR	5					F	9				
	Floodplain Drainage	FWS Rapid Assessment	F	8					F	8				
	Vertical Stability Extent	FWS Rapid Assessment	FAR	6					F	9				
3 - Geomorphology	Riparain Vegetation	FWS Rapid Assessment	NF	3	FAR	31	FAR	90	FAR	6	FAR*	51	FAR*	136
	Lateral Stability	Dominant Bank Ersoion Rate	FAR	6					F	9				
		Lateral Stabity Extent	FAR	6					F	9				
	Bedform Diversity	Shelter for Fish	FAR	7					F	9				
		Pool-to-pool Spacing	NF	3					F	9				
		Pool Depth Variability	FAR	6					F	9				
4 - Physicochemical	Water Appearance and Nutrients	FWS Rapid Assessment	FAR	7	FAR	14			F	9	F	17		
	Detritus	FWS Rapid Assessment	FAR	7					F	8				
5 - Biology	Macro	Presence	FAR	4	FAR	11			FAR*	7	FAR*	18		
		Tolerance	NF	3					FAR	4				
	Fish	Presence	FAR	4					FAR*	7				

	Rating	Channel Evolution
Channel Evolution	FAR	Incised and nearly straight C4 with a moderate level of bank erosion. Bank erosion occurring to build correct sinuocity.
		Constraints
Constraints		Road crossing at d/s end of reach. Stream on cemetary property. This will influence riparian buffer width. This reach is the beginning of Hamilton Run and is spring fed by several springs.
		Restoration Potential
Restoration Potential		Nearly full Lvl 4 and partial Lvl 5. Riparian vegetation width is limited because of encroachment.

Note: "*" means partial uplift

APPENDIX F
Proposed Project Prioritization Matrix

Proposed Project Reach	Potential Restoration Solution Approach	Potential Restoration Solution Uplift	TMDL Restoration Potential for Sediment, Nutrient and Phosporous Reduction	Stream Length	Construction Access	Constraints	Potential Success/Risk	BMP Restoration Potential	Ownership Score	Potential sediment reduction through bank stabilization	Proposed restoration costs per linear foot	Weighted Prioritization Score	Ranking by Prioritization Score	Categorical Ranking	Adjusted Final Categorical Ranking	Ranking adjustment justification
1	6	10	8	9	9	5	8	5	8	9	6	7.6	1	High	High	
2	8	7	6	3	5	5	6	6	4	5	7	5.4	9	Medium	Medium	
3	9	5	2	2	8	4	8	3	9	1	10	6.3	4	High	Low	Lack of eroding banks
4	8	8	3	1	7	5	7	2	5	0	7	4.3	17	Low	Low	
5	3	1	1	1	7	3	5	2	8	0	2	3.2	18	Low	Low	
6	8	3	3	1	6	8	8	2	6	0	7	4.5	15	Low	Low	
7	5	8	9	4	8	6	8	8	8	0	4	4.8	13	Low	Medium	Lack of eroding banks, large open parcel with one land owner may create opportunity to obtain TMDL credits from large wetland creation
8	9	2	1	1	7	8	3	1	10	3	9	6.5	3	High	Medium	Lack of eroding banks, very limited space for restoration
9	5.6	9	4	9	7	5	7.3	7.3	3	9	3	5.4	8	Medium	High	Increased ranking because potential to a create large wetland BMP and achieve high TMDL credits
10	5.5	4	4	4	6.5	5	5	2	3	9	4	5.1	11	Medium	Medium	
11	5.3	5	5.6	6	8	6.5	7	5	7	5	7	6.3	5	High	Medium	This area contains a forest conservation easement that may create difficulty in doing stream stabilization work
12	4.5	8	4.5	2	7.5	5	4.5	2.5	3	10	2	5.0	12	Medium	High	Highly eroding banks
13	6.3	3	5	2	8	6	3.5	3	6	4	8	5.7	7	Medium	High	Moderately eroding banks, work is just upstream of the American Legion, concept plan for area is already in place
14	4.7	4	3.7	1.7	7.7	6	5	2	3	8	3	4.6	14	Low	Medium	Moderately eroding banks
15	6	8	9	2	8	6	7	6	9	0	6	5.4	10	Medium	Low	Lack of eroding banks, limited area for BMP wetland limits potential TMDL reduction credits
16	5	9	6	2	9	6	6	3	8	0	4	4.4	16	Low	Low	
17	5	10	5	1	9	6	5	2	9	1	8	5.8	6	High	Medium	Low bank erosion amounts and floodplain connectivity potential results in low TMDL crediting
18	5	9	7.5	6	9	5.5	6	3	9	8	4	6.8	2	High	Medium	Highly eroding banks but sensitivity of cemetery property will be large constraint to construction

* Shaded cells have had their final prioritization changed from what was determined in the priority matrix