Little Gunpowder Falls Watershed Water Quality Management Plan

Submitted to:

Baltimore County
Dept. of Environmental Protection
and Resource Management

BALTIMORE COUNTY MARYLAND

Executive Summary

October 1, 2001

Biohabitats

EXECUTIVE SUMMARY DOCUMENT

ES-1 INTRODUCTION

Purpose of the Study

The Baltimore County Department of Environmental Protection and Resource Management is requesting consultant services to develop a comprehensive water quality management plan for the Little Gunpowder River Watershed. The purposes of the plan is to:

1. assist Baltimore County in identification and evaluation of non-point source stormwater pollution and stream degradation,
2. determine management measures for the reduction of nonpoint source pollution and reestablishment of stream stability, and
3. provide a watershed restoration framework for the Department's Capital Improvement Program.

This plan will be used as a component for satisfying Federal mandates under the National Pollutant Discharge Elimination System (NPDES) – Municipal Stormwater Discharge Permit and obligations for the MD Tributary Strategy Agreement. This study and the plan development were conducted by Biohabitats, Inc., in cooperation with Center for Watershed Protection, and Michael J. Baker, Jr., Inc. for the Baltimore County Department of Environmental Protection and Resource Management (DEPRM).

Study Elements

The major components of the study and the watershed plan development include:

- watershed characterization, involving comprehensive collection and review of available information of this watershed to assess the natural resources, and develop the subwatershed delineation for modeling and field assessment;
- hydrologic and water quality modeling of existing land use conditions and future conditions (based on zoning) for nutrient, heavy metal and sediment pollution

using U.S. Environmental Protection Agency's Storm Water Management Model (SWMM);

- detailed field assessments including a fluvial geomorphic assessment of stream channels and an assessment of the riparian conditions;
- description of the findings from both the modeling and field assessment was developed on a subwatershed basis;
- water quality problem identification including stream channel and riparian conditions; and
- management strategies, action items and restoration projects were identified and prioritized.

ES-2 WATERSHED CHARACTERIZATION

Introduction

The Little Gunpowder Falls watershed is located along the eastern edge of Baltimore County. The Little Gunpowder Falls mainstem channel forms the boundary between Baltimore County and Harford County. The watershed is long and narrow in shape, with the widest part only 2.5 miles across and extending more than 23 miles from north to south. The watershed begins near the intersection of Troyer Road and Hunter's Mill Road extending southeast along the Baltimore-Harford County border through Jacksonville, Sweet Air, Baldwin, Fork, Kingsville, Franklinville, and Bradshaw, and emptying into the Gunpowder River upstream of Day's Cove. The total watershed size is 36,986 acres or 57.8 mi^2. The Baltimore County portion is 17,145 acres or 26.8 mi^2. Harford County's portion of the Little Gunpowder watershed is 19,841 acres or 31.0 mi^2.

Land Use and Zoning

Maryland Office of Planning 1997 land use/land cover data obtained from Baltimore and Harford County indicates the predominant existing land uses in the Little Gunpowder Falls watershed are agriculture and forest (see Figure ES.1 and Table ES.1). The upper portion of the watershed is predominantly agriculture with the lower portion having an increased density of development including low density residential, industrial, and commercial land use.

Table ES.1. Current land use coverage in square feet, acres and percentage of total coverage for both Baltimore and Harford Counties.

Baltimore County			Harford County		
Type	**Acres**	**Percentage**	**Type**	**Acres**	**Percentage**
Agriculture			**Agriculture**		
Agric. feeding operations	54.9	0.3	Agric. feeding operations	44.3	0.2
Agricultural building	202.2	1.2	Agricultural building	114.2	0.6
Cropland	5544.9	32.3	Cropland	7425.6	37.4
Pasture	1715.5	10.0	Pasture	951.4	4.8
Orchards, vineyards, horticulture	85.8	0.5	Orchards, vineyards,	135.1	0.7
			Row and garden crops	15.3	0.1
Subtotal	**7603.4**	**44.4**	**Subtotal**	**8685.9**	**43.8**
Forest			**Forest**		
Deciduous forest	5449.2	31.8	Deciduous forest	5804.4	29.3
Evergreen forest	26.2	0.2	Evergreen forest	121.5	0.6
Mixed forest	81.2	0.5	Mixed forest	81.0	0.4
Brush	37.0	0.2	Brush	154.4	0.8
Subtotal	**5593.7**	**32.6**	**Subtotal**	**6161.3**	**31.1**
Commercial			**Commercial**		
Commercial	99.7	0.6	Commercial	337.6	1.7
Government institutional	72.2	0.4	Governmental institutional	117.5	0.6
Industrial	16.5	0.1	Industrial		0.0
			Extractive	38.9	0.2
Subtotal	**188.4**	**1.1**	**Subtotal**	**494.0**	**2.5**
Residential			**Residential**		
Low-density residential	3500.9	20.4	Low-density residential	4050.7	20.4
Medium-density residential	64.7	0.4	Medium-density	368.3	1.9
			High-density residential	40.8	0.2
Subtotal	**3565.6**	**20.8**	**Subtotal**	**4459.8**	**22.5**
Open Space			**Open Space**		
Open urban land	29.6	0.2	Open urban land	39.7	0.2
Bare ground	13.4	0.1			
Subtotal	**43.0**	**0.3**	**Subtotal**	**39.7**	**0.2**
Water	0.0	0.0	**Water**	39.75	0.2
Wetlands	150.6	0.9	**Wetlands**	53.9	0.27
TOTAL	**17144.6**	**100.0**		**19840.7**	**100.0**

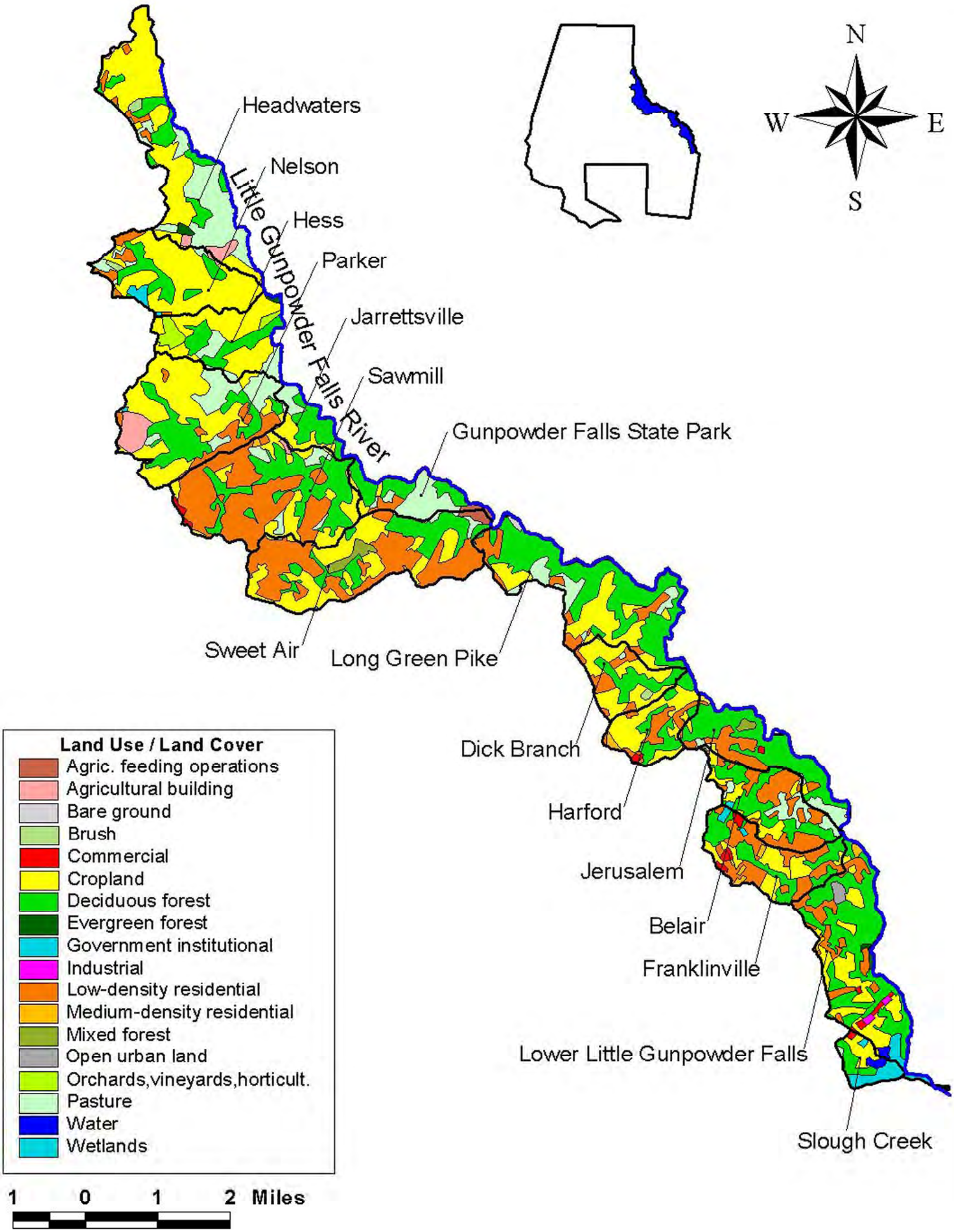


Figure ES.1. Existing land use for the Little Gunpowder Falls watershed in Baltimore County.

For Baltimore County, the current zoning of predominantly agriculture and rural residential combined with the lack of service for water and sewer for the Little Gunpowder Falls watershed has allowed this area to maintain its rural character. Figure ES.2 provides an overview of the existing zoning for the Little Gunpowder Falls watershed in Baltimore County. The majority of the watershed is zoned for agriculture and rural residential (77%), with only the lower portion of the watershed (Lower Piedmont and Coastal Plain) having zoning for commercial, industrial, and higher density residential areas.

Geology, Soils, Streams and Forest Cover

The Little Gunpowder Watershed extends across two major physiographic provinces within Maryland: the Piedmont and the Coastal Plain. The Piedmont areas of the watershed are primarily underlain by bedrock composed of crystalline rock types with varying susceptibility to erosion and weathering. Layers of loosely consolidated or unconsolidated sediments, nearly horizontal and susceptible to erosion, underlie the Coastal Plain portion of the watershed.

The mainstem of Little Gunpowder Falls is a fourth-order stream and is approximately 23 miles in length. Within the Baltimore County portion of the watershed, there are approximately 72 miles of first-order stream channels, 34 miles of second-order stream channels, and 47 miles of third-order stream channels. The percentage of first-order tributaries is 47% of the total length of tributaries, with 22% percent of the total length of the tributaries as second-order, and 31% as third- or fourth-order. Figure ES.3 depicts the drainage network for the Baltimore County portion of the watershed.

A distinctive, and consistent, landscape pattern of hydrologic soil groups exists in this watershed. In the Upper Piedmont portion of the watershed, soils are predominantly B, with C soils concentrated primarily along streams. In the Lower Piedmont and Coastal Plain area, are predominant C soils, with B soils distributed throughout the terrain, and concentrated areas of D soils. Because soils in Lower Piedmont and Coastal areas have

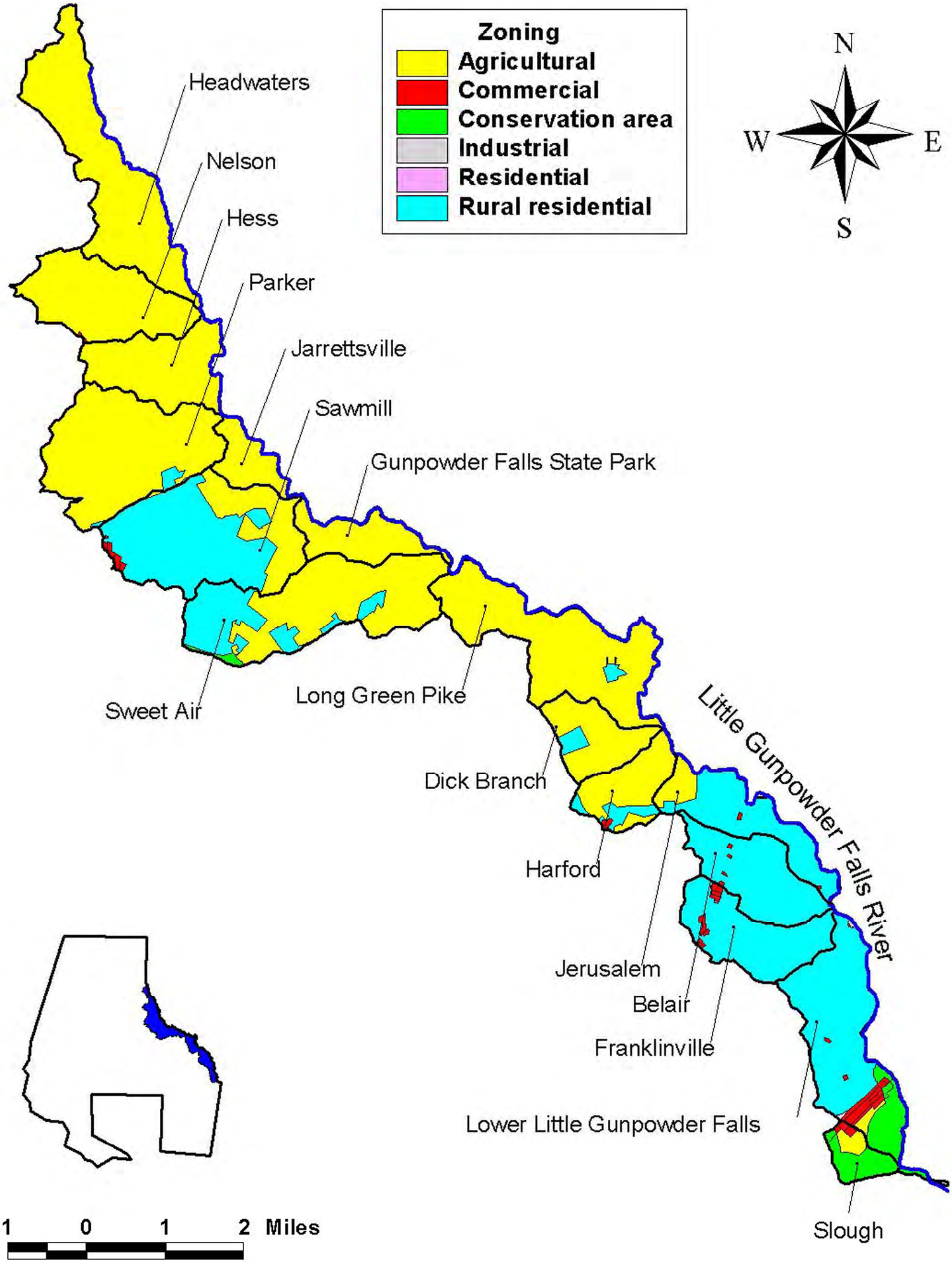


Figure ES.2. Existing zoning of the Little Gunpowder Falls watershed in Baltimore County.

Figure ES.3. Major tributaries of the Little Gunpowder Falls watershed.

lower infiltration rates (C and D soils), it follows that storm runoff may pose relatively greater flooding risks along tributaries than in the Upper Piedmont subwatersheds.

Despite dramatic changes in land use that likely altered downstream hydrology and sediment supply, many upland channels have not adjusted vertically in response. This may be explained in part by the underlying bedrock geology, which acts as one major control of stream channel evolution. As is the case for most Piedmont streams, tributaries to the Little Gunpowder have moderate slopes locally controlled by bedrock outcrops at the surface. In many upland, low-order streams of the watershed, the stream profile intersects the underlying bedrock to form steeply-sloped reaches and small (<5 ft high) knickpoints. This shallow soil depth to erosion-resistant bedrock probably has limited historical channel incision in upland tributaries. Most streams with metamorphic rocks exposed along the bed have bottoms consisting of flat, schistose gravels. The Coastal Plain includes flat areas underlain by unconsolidated sediment, primarily sand and gravel. In these higher-order channels in broader valley lowlands, the depth to bedrock is greater and stream channels are able to adjust themselves downward through the alluvial deposits.

In the Baltimore County portion of the watershed, approximately 32% of the watershed is forested. Throughout the headwater subwatersheds, agriculture is the predominant land use, and forest cover is present only in small tracts. The largest contiguous areas of forested land follow the mainstem of Little Gunpowder Falls, and cover much of the Parker Branch and Sawmill Branch subwatersheds. The majority of this forested area extends south from Jarrettsville Pike to Jerusalem Road, covering both upland areas and stream valley slopes. The Little Gunpowder Falls State Park (extends beyond the Gunpowder Falls State Park subwatershed) encompasses approximately 4,000 acres of this watershed, much of which is forested. The parkland follows the mainstem along the eastern boundary through the lower two-thirds of the watershed.

ES-3 HYDROLOGY AND WATER QUALITY ANALYSES

Introduction

As part of this study, hydrologic and water quality modeling is required to estimate storm event flows and pollutant loadings and long-term pollutant loadings in the watershed for existing land use conditions and for future, built-out conditions. The United States Environmental Protection Agency's Storm Water Management Model (SWMM), Version 4.31, was selected to perform these analyses. The SWMM model uses several modules to model the hydrologic and water quality processes within a watershed.

Land Use

Several parameters were derived based on the land use in each subwatershed. Therefore, existing land use conditions and future land use conditions must be quantified. Because the SWMM model is limited to 10 land use classifications, these 10 categories include cropland, pastureland, barren land and open space, low density residential, medium-density residential, high-density residential, open urban land, commercial and industrial, and water. Future conditions land use information was extrapolated from current Baltimore and Harford County GIS zoning data coverage, and guidelines taking into account forest conservation regulations and preserved land areas, public land areas and land under special protection.

Water Quality Modeling

The model was used to perform the water quality analysis for 10 parameters including biochemical oxygen demand, chemical oxygen demand, total suspended solids, total nitrogen, total kjeldahl nitrogen, total phosphorus, copper, cadmium, zinc and lead. The model predicted storm event pollutant concentration and pollutant annual loadings for existing land use conditions and future conditions based on zoning as described above. The water quality model was used to simulate pollutant buildup and washoff for the dry, average, and wet precipitation years. The dry year is 1989, the average year is 1990, and the wet year is 1991.

Event Mean Concentration Determination

Using the water quality modeling, pollutant event mean concentrations (EMCs) were determined for the 10 constituents for the dry, average, and wet precipitation years, in each of Baltimore County modeled subwatersheds. The pollutant EMCs for each of the modeled subwatersheds for existing and future are presented in Appendix BAKER16.

EMC Frequency Exceedance Curves

Frequency-exceedance curves were prepared for the heavy metal constituents, Pb, Cu, Zn, and Cd, for the average rainfall year. For the average rainfall year, the EMCs were tabulated and ranked in descending order. The percent chance of exceedance for each event was computed and plotted. These curves were then compared to the State of Maryland's acute and chronic water quality criteria.

Annual Pollutant Load Determination

Annual pollutant loads resulting from storm events were determined for the 10 parameters for the dry, average, and wet precipitation years, in each of the subwatersheds. The loadings for TN, TP, ZN and TSS for an average rainfall year are presented in Tables ES.2 – ES.5, including the total loadings in lbs/year for existing and future conditions.

Table ES.2. Annual Pollutant Load & Load Intensity for the Average Rainfall Year - Total Nitrogen

Total Nitrogen			Load (lbs)		Load Intensity (lbs/acre)	
Subwatershed Name	**No.**	**Area (ac)**	**Existing**	**Future**	**Existing**	**Future**
Headwaters	**32**	1762	7510	7610	4.26	4.32
Nelson	**45**	1089	5370	5470	4.93	5.02
Hess	**49a**	926	3540	3530	3.82	3.81
Parker	**54**	1768	7250	7410	4.10	4.19
Jarrettsville	**49b**	309	903	941	2.92	3.05
Sawmill	**57**	1879	8650	9690	4.60	5.16
Gunpowder Falls State Park	**49c**	486	1970	1990	4.05	4.09
Sweet Air	**49d**	1922	9430	10100	4.91	5.25
Long Green Pike	**49e**	504	1620	1650	3.21	3.27

Total Nitrogen			**Load (lbs)**		**Load Intensity (lbs/acre)**	
Subwatershed Name	**No.**	**Area (ac)**	**Existing**	**Future**	**Existing**	**Future**
Long Green Pike	**49f**	527	1880	1920	3.57	3.64
Long Green Pike	**49g**	591	1940	2010	3.28	3.40
Dick	**77**	577	2800	2970	4.85	5.15
Harford	**86a**	574	2760	3110	4.81	5.42
Jerusalem	**86b**	562	2720	2850	4.84	5.07
Jerusalem	**86c**	288	1420	1470	4.92	5.10
Belair	**86d**	824	4840	5290	5.87	6.42
Franklinville	**135**	868	5290	5580	6.09	6.43
Lower Little Gunpowder Falls	**143a**	265	1240	1330	4.68	5.02
Lower Little Gunpowder Falls	**143b**	323	1590	1810	4.92	5.60
Lower Little Gunpowder Falls	**143c**	149	803	899	5.41	6.05
Lower Little Gunpowder Falls	**143d**	90	392	478	4.34	5.29
Lower Little Gunpowder Falls	**143e**	58	307	362	5.27	6.21
Lower Little Gunpowder Falls	**143f**	347	2060	2170	5.94	6.26
Lower Little Gunpowder Falls	**143g**	55	228	259	4.12	4.68
Lower Little Gunpowder Falls	**143h**	256	1380	1390	5.38	5.42
Slough	**192**	288	1380	1390	4.79	4.82
Runoff Total		17287	79273	83679	4.59	4.84
Baseflow Total			58477	61610	3.38	3.56
Total (Baltimore County)			137750	145289	7.97	8.40
Percent of Total – Runoff			58%	58%	58%	58%
Percent of Total – Baseflow			42%	42%	42%	42%

Table ES.3. Annual Pollutant Load & Load Intensity for the Average Rainfall Year - Total Phosphorus

Total Phosphorus			**Load (lbs)**		**Load Intensity (lbs/acre)**	
Subwatershed Name	**No.**	**Area (ac)**	**Existing**	**Future**	**Existing**	**Future**
Headwaters	**32**	1762	689	707	0.39	0.40
Nelson	**45**	1089	522	546	0.48	0.50
Hess	**49a**	926	343	341	0.37	0.37
Parker	**54**	1768	651	710	0.37	0.40
Jarrettsville	**49b**	309	56	72	0.18	0.23
Sawmill	**57**	1879	711	829	0.38	0.44
Gunpowder Falls State Park	**49c**	486	112	122	0.23	0.25
Sweet Air	**49d**	1922	856	939	0.45	0.49
Long Green Pike	**49e**	504	100	114	0.20	0.23
Long Green Pike	**49f**	527	136	147	0.26	0.28
Long Green Pike	**49g**	591	124	143	0.21	0.24

Total Phosphorus			**Load (lbs)**		**Load Intensity (lbs/acre)**	
Subwatershed Name	**No.**	**Area (ac)**	**Existing**	**Future**	**Existing**	**Future**
Harford	**86a**	574	254	299	0.44	0.52
Jerusalem	**86b**	562	134	154	0.24	0.27
Jerusalem	**86c**	288	51	77	0.18	0.27
Belair	**86d**	824	320	404	0.39	0.49
Franklinville	**135**	868	392	460	0.45	0.53
Lower Little Gunpowder Falls	**143a**	265	67	81	0.25	0.31
Lower Little Gunpowder Falls	**143b**	323	76	113	0.24	0.35
Lower Little Gunpowder Falls	**143c**	149	42	65	0.29	0.44
Lower Little Gunpowder Falls	**143d**	90	23	36	0.26	0.40
Lower Little Gunpowder Falls	**143e**	58	26	31	0.45	0.53
Lower Little Gunpowder Falls	**143f**	347	149	183	0.43	0.53
Lower Little Gunpowder Falls	**143g**	55	8	13	0.15	0.24
Lower Little Gunpowder Falls	**143h**	256	90	89	0.35	0.35
Slough	**192**	288	101	106	0.35	0.37
Runoff Total		17287	6300	7076	0.36	0.41
Baseflow Total			1164	909	0.07	0.05
Total (Baltimore County)			7464	7985	0.43	0.46
Percent of Total – Runoff			84%	89%	84%	89%
Percent of Total – Baseflow			16%	11%	16%	11%

Table ES.4. Annual Pollutant Load & Load Intensity for the Average Rainfall Year - Total Zn

Total Zinc			**Load (lbs)**		**Load Intensity (lbs/acre)**	
Subwatershed Name	**No.**	**Area (ac)**	**Existing**	**Future**	**Existing**	**Future**
Headwaters	32	1762	67	68	0.038	0.038
Nelson	45	1089	47	47	0.043	0.043
Hess	49a	926	31	31	0.034	0.034
Parker	54	1768	67	69	0.038	0.039
Jarrettsville	49b	309	7	8	0.023	0.026
Sawmill	57	1879	89	109	0.047	0.058
Gunpowder Falls State Park	49c	486	16	16	0.032	0.033
Sweet Air	49d	1922	92	103	0.048	0.054
Long Green Pike	49e	504	13	15	0.027	0.029
Long Green Pike	49f	527	15	16	0.028	0.030
Long Green Pike	49g	591	15	16	0.025	0.028
Dick	77	577	23	25	0.040	0.043
Harford	86a	574	24	30	0.041	0.052
Jerusalem	86b	562	20	23	0.035	0.041

Total Zinc			**Load (lbs)**		**Load Intensity (lbs/acre)**	
Subwatershed Name	**No.**	**Area (ac)**	**Existing**	**Future**	**Existing**	**Future**
Belair	86d	824	39	55	0.048	0.066
Franklinville	135	868	61	79	0.071	0.090
Lower Little Gunpowder Falls	143a	265	9	11	0.035	0.041
Lower Little Gunpowder Falls	143b	323	10	15	0.032	0.046
Lower Little Gunpowder Falls	143c	149	5	9	0.036	0.062
Lower Little Gunpowder Falls	143d	90	3	4	0.032	0.049
Lower Little Gunpowder Falls	143e	58	2	3	0.032	0.053
Lower Little Gunpowder Falls	143f	347	24	50	0.068	0.143
Lower Little Gunpowder Falls	143g	55	1	3	0.020	0.059
Lower Little Gunpowder Falls	143h	256	7	8	0.029	0.032
Slough	192	288	13	23	0.046	0.081
Runoff Total		17287	708	847	0.041	0.049
Baseflow Total			600	550	0.035	0.032
Total (Baltimore County)			1309	1396	0.076	0.081
Percent of Total – Runoff			54%	61%	54%	61%
Percent of Total – Baseflow			46%	39%	46%	39%

Table ES.5. Annual Pollutant Load & Load Intensity for the Average Rainfall Year - Total TSS

Total Suspended Solids			**Load (lbs)**		**Load Intensity (lbs/acre)**	
Subwatershed Name	**No.**	**Area (ac)**	**Existing**	**Future**	**Existing**	**Future**
Headwaters	32	1762	125000	126000	70.93	71.50
Nelson	45	1089	98200	97900	90.14	89.87
Hess	49a	926	61000	61700	65.86	66.61
Parker	54	1768	135000	132000	76.36	74.66
Jarrettsville	49b	309	19100	18600	61.86	60.24
Sawmill	57	1879	214000	256000	113.91	136.26
Gunpowder Falls State Park	49c	486	39300	39500	80.79	81.20
Sweet Air	49d	1922	221000	245000	114.96	127.44
Long Green Pike	49e	504	38400	38600	76.20	76.60
Long Green Pike	49f	527	39500	39100	74.92	74.16
Long Green Pike	49g	591	43900	42200	74.24	71.37
Dick	77	577	57000	59700	98.83	103.52

Harford	86a	574	59100	67100	102.99	116.94
Jerusalem	86b	562	71400	76200	127.01	135.55
Jerusalem	86c	288	32500	38700	112.70	134.21
Belair	86d	824	118000	144000	143.15	174.69
Franklinville	135	868	128000	148000	147.46	170.51
Lower Little Gunpowder Falls	143a	265	32100	34700	121.10	130.91
Lower Little Gunpowder Falls	143b	323	41900	48800	129.59	150.94
Lower Little Gunpowder Falls	143c	149	20700	25400	139.35	170.98
Lower Little Gunpowder Falls	143d	90	9940	12400	110.08	137.33
Lower Little Gunpowder Falls	143e	58	5960	8620	102.31	147.97
Lower Little Gunpowder Falls	143f	347	42600	50800	122.90	146.56
Lower Little Gunpowder Falls	143g	55	5780	6200	104.44	112.03
Lower Little Gunpowder Falls	143h	256	26200	27200	102.21	106.12
Slough	192	288	22900	22000	79.41	76.29
Total from Runoff		17287	1708480	1866420	98.83	107.97
Total from Erosion			5463758	4998008	316.06	289.12
Baseflow Total			374882	264577	21.69	15.30
Total			7547120	7129005	436.58	412.39
Percent of Total - Runoff			23%	26%	23%	26%
Percent of Total - Erosion			72%	70%	72%	70%
Percent of Total - Baseflow			5%	4%	5%	4%

ES-4 STREAM CHANNEL ASSESSMENT

Overview

Two tiers of stream channel assessment were conducted within the sixteen subwatersheds and along the mainstem channel of the Little Gunpowder watershed. This stream channel assessment was part of the overall effort of determining existing and potential watershed problems. This information was also used in the development of management measures for the Little Gunpowder watershed and as an assessment tool for identifying and prioritizing stream restoration projects.

Cruised Reach Assessment

The first level of stream channel assessment, termed the "*cruised reach assessment*," involved walking all the stream channels within the Baltimore County portion of the watershed and recording key information. This information included a geomorphic characterization and assessment of channel morphology (modified Rosgen Level I and II methodology). In addition, specific observations were made related to channel stability, riparian and aquatic habitat, sediment supply, and sources of impact to the stream channels, all components of the Rosgen Level III methodology (Rosgen, 1996). The modified approach specifically included assessment of the following stream characteristics: (1) presence of woody debris, (2) sediment supply, (3) reach bed stability, (4) degree of bank erosion, (5) extent of vertical raw bank, (6) evidence of altered hydrology, (7) direct human channel impacts, (8) culverts, (9) utilities, (10) fish barriers, (11) riparian composition, (12) riparian width, (13) canopy cover, and (14) reference reach potential. These parameters all influence the current stream condition and potential for recovery to an optimum condition. As such, the Rosgen Level III analysis helps describe channel conditions as they relate to stream stability, potential, and function.

Measured Reach Assessment

The second level of channel assessment, termed "*measured reach assessment*," involved identifying a subset of the total stream channel miles, approximately 25 miles of stream, and further evaluating the channel morphology (Rosgen Level II methodology). Stream stability assessments were also performed using the Rosgen Bank Erodibility Hazard Index Rating tool.

Overview of Stormwater Survey

Finally, stormwater management facilities in the watershed were evaluated for their condition and any opportunities for retrofit. Currently, there are eighteen stormwater facilities located in the Little Gunpowder Falls Watershed, as indicated by the Baltimore County GIS database. Nine of the eighteen are public facilities, and nine of the facilities are privately owned and maintained. As a component of the field investigation for this watershed study, the type of facility, its present condition, the type of outlet and its present condition, the location of the facility relative to the nearest stream, and the condition of the channel downstream of the outlet were evaluated. Opportunities to retrofit the facilities for either water quality improvement or channel protection measures were also assessed.

Stream Assessment Findings

The stream channel assessments provided the foundation for identifying existing and potential stream problem areas, general findings are presented in the following section. The stream assessment findings were also used for the identification of reference reach areas to be used as model areas during the development of restoration projects within the Little Gunpowder Falls watershed. When used in combination with the SWMM modeling results, assessment data was used to develop management measures that will ameliorate water quality within the Little Gunpowder watershed.

ES-5 IDENTIFICATION OF WATER QUALITY PROBLEMS

Introduction

The assessment parameters from the field and modeling efforts can be presented in four general categories including water quality, hydrology, channel stability and habitat.

Water Quality

Water quality modeling indicates that the water quality within the subwatersheds of the Little Gunpowder is good overall. In general, the subwatersheds had low nutrient and sediment loads and were similar to loading rates typical of forest or pasture areas. Model results also indicate that metals are not problematic in the Little Gunpowder. This result is not surprising, given the relatively low density of development (i.e., rural residential versus industrial) within the Baltimore County portion of the Little Gunpowder watershed.

Although some of these concentrations and loads are predicted to increase with future growth, most loads and concentrations will remain within the same general categories on the screening matrix (e.g., low, moderate, high). Subwatersheds with the highest pollutant loads include Sawmill, Sweet Air, Harford, and Franklinville. In general, pollutant loading is highly correlated with the level of development in each subwatershed. With agriculture, forest and residential areas as the predominant land use, pollutant loadings are almost entirely the result of nonpoint source inputs from agricultural activities and low density residential development.

One important note regarding this analysis is that many potential sources are not included in the modeling, such as possible septic system failures. In addition, the model is unable to distinguish between agricultural lands with management practices versus lands without practices in place. Finally, the impact of some of these pollutants on the system may be difficult to determine even with the most accurate modeling results.

Hydrology

Briefly, this effort included using the SWMM program to model hydrology for both existing land use conditions and future conditions using Baltimore County zoning information to simulate future build-out land use scenarios. The comparison of the increases in discharge from existing condition to future build-out condition was performed for each subwatershed. The percent increase between the existing and future conditions for both the two-year (Q2) and ten-year (Q10) peak flow discharges was calculated.

One important index of the hydrologic effects on a watershed is the amount of imperviousness on a given site. Imperviousness is the percent, or decimal fraction, of the total watershed area covered by roads, parking lots, sidewalks, rooftops, and other impermeable surfaces of a developed landscape. Imperviousness is a useful indicator for measuring the varying effects of land development on receiving waters; therefore, it can be viewed as providing a unifying theme in urban watershed protection.

In general, this watershed shows low percent increases for both the Q2 and Q10 under future discharge conditions. Much of this watershed is currently zoned for agriculture and agriculture is predicted to remain as the predominant land use condition under the future build-out scenario using existing zoning conditions. With little increases watershed-wide in residential, commercial, and industrial land uses predicted in the future built-out scenario, the increase in impervious area is very low overall. The primary growth areas is expected to occur in sub-watersheds that currently have a greater percentage of land areas of residential and commercial land uses.

Most of the concentrated growth in residential areas is in the lower portion of the watershed with the exception of Sawmill and Sweet Air watersheds which lie in the central portion of the watershed. Under future built-out scenario with existing zoning conditions, there are some portions of the watershed that show a decrease in forest area as land area is cleared for limited rural residential development under the agricultural land use categories RC2 and RC5. This occurs primarily in the northernmost portion of the watershed.

Channel Stability

Channel bank erosion throughout the watershed was primarily assessed as low to moderate. Lack of riparian buffer, livestock access resulting in stream bank trampling, lateral scour causing bank erosion and channel widening due to hydrologic alterations from development were observed as the primary causes for the moderate and high ratings of channel bank erosion. Channel bed conditions were primarily categorized as indeterminate, no visible evidence of bed aggradation or bed degradation. Localized, not widespread, areas of channel bed degradation and aggradation were identified, with aggradation occurring primarily where increased areas of sediment supply from upstream sources and a significant lowering of channel slope conditions. Overall, sediment supply from upstream sources was generally low to moderate with few instances of high sediment supply impacting reaches.

The Rosgen stream classification application resulted in predominantly stable stream types of B and E channel in the headwater areas of most of the sub-watersheds. There were areas of C, F and G stream types throughout portions of the watershed, with F and G stream types inherent less stable than C stream types. Sensitivity to disturbance ranging from low to very high depending on the stream classification and the bed and bank material. Recovery potential ranges from excellent to poor, as based on the Rosgen classification.

In summary, this watershed does not exhibit widespread channel instability. Areas of moderate and high bank erosion were typically localized and due to upstream alterations in hydrology (increases in impervious area and reduction in forest), lack of riparian buffer and livestock access. Local bed degradation and aggradation are generally minor and not representative of a watershed-wide problem or anticipated factors for extensive future channel instability.

Habitat

Aquatic and riparian habitat parameters were assessed during field investigations. These parameters included riparian width, riparian composition, canopy cover, woody debris, fish blockages and direct human channel impacts (i.e., livestock, channel straightening, road crossings, etc.).

Of all the habitat parameters assessed, the presence and width of riparian buffer appeared to have the most dramatic effect on the channel stability. There are many reasons behind the importance of this parameter in the overall health of the stream channel. These include woody root mass providing channel bank stability, riparian canopy providing stream channel shading thus maintaining ambient water temperatures, adequate riparian width for habitat and buffering from surrounding land uses, the presence of woody material and leaf litter in-channel which is important for cover and food source. Species composition was also noted. In areas where the riparian canopy cover was non-existence or minimal, the presence of invasive and exotic species was typically much higher.

ES-6 RANKING OF WATER QUALITY PROBLEMS

Overview

Field and modeling results were used to rank water quality problems on a subwatershed basis to determine where problems were most common and, therefore, in which subwatersheds restoration efforts should be focused. Subwatersheds were ranked on a relative basis to assess the probable origin, type, and magnitude of water quality problems. Separate rankings were established for existing and future conditions, as appropriate, for each subwatershed.

Primary factors used to rank water quality problems by subwatershed were categorized into five broad categories: 1) land use, 2) hydrology, 3) channel stability, 4) riparian condition, and 5) water quality. The category structure allows for some generalization across factors based on the categories.

Existing conditions data originated as field observations, available GIS coverages, and SWMM modeling results. Some of these data sets are based on watershed area, specific locations in the watershed, or channel length. Where appropriate, future conditions were also assessed for comparison. A preliminary step in the ranking process was to review data for each evaluated parameter to establish the range of values measured for that parameter. For some parameters, this procedure was repeated for both 1) total channel length and 2) percentage of channel length, to assess two separate aspects of subwatershed condition. The total degraded channel length helps establish the magnitude of the problem relative to the entire watershed, while the percentage of stream length helps establish the extent of the problem on a subwatershed basis. Although magnitude was of primary importance in the ranking, an understanding of the extent was relevant to establish if local applications of stream restoration or retrofitting techniques could fix larger problems in a subwatershed.

Next, based on the existing range, a four- or five-part relative ranking system was imposed for each parameter. This involved the assignment of a qualitative description (e.g., poor, fair, good, very good) to each subwatershed based on the measured value for an individual subwatershed relative to the range observed for all subwatersheds. For example, Long Green Pike subwatershed has the greatest length of degraded channel (23,900 feet) and so was rated as “High” with respect to bed instability while with 1,800 ft of degradation; Sweet Air is near the low end and was therefore considered to exhibit “Minor” degradation.

It should be noted that the cutoffs for some of the stream assessment parameters are subjective and suit the purposes of this study in that they serve to emphasize the differences between subwatersheds. This approach helped develop a relative prioritization of problems on a subwatershed basis, as was an important project goal. While the ranges for the water quality parameters, including nutrients and other pollutants are not subjective but rather based on expected loadings rates based on various land use categories including forest, pasture and mixed agriculture. Metals ranges are based on state water quality acute and chronic criteria standards.

In interpreting the parameter rankings to establish overall subwatershed rankings, several working principles were applied. Not all parameters were considered to be of equal weight. First, some factors (e.g., sediment supply) were considered to be more directly linked to water quality than others (e.g., increase in 2-year discharge). Second, in most cases greater consideration was given to field observations (e.g., bank erosion) than to generic qualifiers associated with Rosgen channel type (e.g., Rosgen sensitivity to disturbance), since the former provided first-hand observations rather than hypothetical generalizations.

In the process of developing threshold values for ranking categories, information was inevitably simplified, since the full distribution of values for any parameter was not included for each subwatershed. Of course, while an attempt was made to extract the most salient information and consider the broader distribution, the reader may wish to refer to the complete data set for more information as provided in Appendix B in Volume

II of this report. General qualitative rankings were compared for all parameters across-the-board to "tell the story" of each subwatershed as shown in Table ES.6.

Results of Ranking

Results from ranking of all parameters are shown in Table ES.6. Colors have been superimposed on the ranking categories to improve the ease of comparison.

Prioritization of Subwatersheds Based on Ranking

A matrix, shown in Table ES.6, was developed to summarize all of the existing and future conditions in Table ES.7 and associate these results with general management approaches. First, each subwatershed was characterized by generalizing all of the results in Table ES.8 for future and existing conditions of the subwatershed as "very good," "good to fair," "poor," and "very poor." Three broad categories were used ("Protect," "Minimize," and "Prevent") to characterize management approaches for subwatersheds showing any combination of conditions for existing versus future conditions. For each subwatershed a restoration prioritization was then assigned. Restoration of subwatersheds was prioritized from A to D, with A being the highest priority. This means that while subwatersheds rated "A" in this Watershed Management Plan are high priority for restoration relative to others in the Little Gunpowder Falls watershed, they may be in good condition relative to other streams in the region.

Table ES.6 Rankings of Parameters by Subwatersheds (Part 1)

SUB-WATERSHED	LAND USE			HYDROLOGY		CHANNEL STABILITY																		RIPARIAN CONDITIONS	
	Land Use: Agriculture, Forest, Developed % Existing %Future	TIA		Increase in Q2 Flow (%cfs)	Increase in Q10 Flow (%cfs)	Field Sediment Supply Rating		Bank Erosion		BEHI Rank by Sum Area (Total Yield Score)	BEHI Rank by Weighted Area (Proportion Yield)	Vertical Raw Bank		Bed Instability		Erosion Ratio		Rosgen Sensitivity to Disturbance		Rosgen Predicted Recovery				Riparian Width	
		% Existing	% Future			By Length	%	By Length	%			By Length	%	By Length	%	Existing	Future	By Length	%	By Length	%			By Length	%
Headwaters	83.0, 15.0, 0.0 83.0, 14.2, 2.8	2.7, Sensitive	2.7, Sensitive	2.1%	1.9%	High	High	Mod.	Low	NDC	NDC	NDC	NDC	Mod.	High	1.01	1.02	Mod.	High	Good	Good			Very Poor	Very Poor
Nelson	70.3, 18.8, 10.9 74.8, 15.9, 9.3	3.8, Sensitive	3.9, Sensitive	2.0%	1.7%	Mod.	Low	High	Mod.	NDC	NDC	NDC	NDC	Mod.	Mod.	1.01	1.02	High	Mod.	Fair	Good			Poor	Poor
Hess	76.0, 24.0, 0.0 74.0, 25.1, 0.9	1.9, Sensitive	1.9, Sensitive	0.0%	0.0%	Mod.	Mod.	High	Mod.	NDC	NDC	NDC	NDC	Minor	Mod.	1.01	1.01	Mod.	Mod.	Fair	Fair			Poor	Poor
Parker	67.0, 22.0, 11.0 73.5, 15.4, 11.0	4.4, Sensitive	4.5, Sensitive	1.8%	1.6%	High	Mod.	High	High	7	8	NDC	NDC	Mod.	Mod.	1.01	1.02	V. High	V. High	Poor	Fair			Very Poor	Very Poor
Jarrettsville	42.0, 58.0, 0.0 52.9, 47.1, 0.0	1.7, Sensitive	1.7, Sensitive	5.0%	3.5%	Low	Low	Low	Mod.	NDC	NDC	NDC	NDC	None	None	1.01	1.03	Low	Low	Excellent	Excellent			Good	Good
Sawmill	20.0, 30.0, 50.1 11.4, 18.4, 70.2	8.9, Sensitive	11.6, Impacted	10.5%	8.0%	V. High	Mod.	V. High	V. High	1	3	High	High	High	Mod.	1.04	1.08	Extreme	High	V. Poor	Fair			Poor	Fair
Gunpowder Falls S.P.	57.0, 38.0, 5.0 58.0, 35.8, 6.2	2.5, Sensitive	2.4, Sensitive	1.4%	1.3%	Mod.	Mod.	Mod.	V. High	NDC	NDC	Mod.	High	Minor	Mod.	1.01	1.01	Low	Mod.	Good	Good			Good	Good
Sweet Air	33.3, 23.2, 43.5 29.6, 16.4, 54.0	7.4, Sensitive	8.9, Sensitive	5.6%	4.5%	High	Low	V. High	V. High	3	6	High	Mod.	Minor	Minor	1.02	1.05	Extreme	V. High	Poor	Fair			Very Poor	Very Poor
Long Green Pike	33.8, 56.3, 9.3 38.6, 49.6, 10.8	2.8, Sensitive	3.0, Sensitive	1.7–2.2%	1.5–1.6%	V. High	Mod.	V. High	High	2	2	High	High	High	High	1.01	1.01-1.02	V. High	High	Poor	Poor			Fair	Good
Dick	56.0, 27.0, 17.0 59.2, 20.4, 20.4	3.9, Sensitive	4.4, Sensitive	2.9%	2.0%	Low	Low	Mod.	Mod.	8	5	Mod.	Mod.	None	None	1.01	1.02	Mod.	High	Good	Good			Good	Good
Harford	48.5, 29.7, 21.8 48.9, 16.3, 34.8	5.7, Sensitive	7.6, Sensitive	6.1%	4.4%	Mod.	Low	Mod.	Mod.	6	1	Low	Low	None	None	1.02	1.04	Mod.	V. High	Fair	Poor			Fair	Very Poor
Jerusalem	13.7, 66.4, 19.9 4.4, 57.4, 38.2	4.3, Sensitive	6.8, Sensitive	5.3–9.6%	4.1–6.6%	Low	V. Low	Low	Low	NDC	NDC	Low	Low	None	None	1.00	1.04	Mod.	High	Excellent	Excellent			Good	Fair
Belair	27.0, 32.0, 41.0 7.7, 12.1, 80.2	6.8, Sensitive	12.6, Impacted	14.4%	11.2%	Low	V. Low	Low	Low	NDC	NDC	Low	Low	None	None	1.02	1.08	High	Extreme	Poor	Poor			Fair	Good
Franklinville	21.8, 31.7, 46.5 6.6, 10.1, 83.2	10.7, Impacted	16.1, Impacted	13.0%	9.5%	High	High	High	High	5	7	High	High	Mod.	Mod.	1.03	1.09	High	High	Fair	Good			Poor	Very Poor
Lower LGF	22.0, 56.3, 17.8 13.4, 37.2, 45.9	8.1, Sensitive	12.7, Impacted	3.4–25.8%	2.8–19.6%	V. High	High	V. High	V. High	4	4	High	High	Mod.	Mod.	1.01-1.05	1.02-1.16	V. High	Extreme	V. Poor	V. Poor			Fair	Fair
Slough	24.2, 22.2, 6.1 23.5, 20.6, 9.9	4.6, Sensitive	4.6, Sensitive	5.5%	3.9%	Mod.	High	Low	Low	NDC	NDC	Low	Low	None	None	1.03	1.05	Low	Extreme	Excellent	Excellent			Good	Good
Main	See Table 2.1	NDC	NDC	NDC	NDC	V. High	High	V. High	V. High	NDC	NDC	High	High	None	None			Extreme	Mod.	V. Poor	Good			Very Poor	Fair

Table ES.6 Rankings of Parameters by Subwatersheds (Part 2)

Subwatershed	Annual Loads (lbs/acre/year)						Total Metals Concentrations (µg/L), Median Values							
	TN		TP		TSS		Copper		Zinc		Cadmium		Lead	
	Existing	Future	Existing	Future	Existing	Future	Ex	Future	Ex	Future	Ex	Future	Ex	Future
Headwaters	7.49	7.55	0.47	0.48	293	293	7.5	7.6	20.0	20.2	1.55	1.56	10.3	10.3
Nelson	8.16	8.25	0.55	0.58	278	310	8.2	8.4	23.1	23.1	1.69	1.71	12.6	12.6
Hess	7.06	7.05	0.44	0.44	289	296	6.7	6.6	17.3	17.3	1.30	1.29	9.5	9.6
Parker	7.32	7.41	0.44	0.48	462	409	8.1	8.6	22.8	23.5	1.60	1.71	11.9	11.7
Jarrettsville	6.11	6.23	0.26	0.31	630	628	4.6	5.6	13.6	15.5	0.77	1.00	9.3	9.5
Sawmill	8.69	8.89	0.42	0.47	372	265	10.3	11.7	33.4	38.9	1.74	1.99	18.6	19.9
Gunpowder Falls S.P.	7.24	7.29	0.30	0.32	315	321	5.2	5.4	16.0	16.3	1.06	1.09	9.7	9.7
Sweet Air	8.14	9.35	0.52	0.53	506	487	9.7	10.7	29.7	33.1	1.68	1.85	16.0	16.6
Long Green Pike	6.58	6.66	0.30	0.32	654	751	4.6-5.4	5.5-6.1	14.0-17.0	16.2-18.6	0.69-0.90	0.87-1.01	10.1-11.1	10.3-11.3
Dick	8.09	8.38	0.53	0.58	692	700	7.6	8.4	20.8	22.9	1.35	1.52	11.4	12.2
Harford	8.06	9.53	0.52	0.56	751	729	8.3	9.2	24.3	28.0	1.53	1.77	14.4	15.2
Jerusalem	8.09	9.16	0.29	0.31	467	453	2.3-3.6	4.0-4.3	7.7-12.7	13.6-15.3	0.37-0.48	0.57-0.60	6.4-9.5	9.2-10.3
Belair	9.14	10.19	0.46	0.52	456	314	5.1	6.8	16.5	23.0	0.89	1.15	9.4	11.1
Franklinville	10.17	10.15	0.49	0.55	420	301	6.6	6.9	25.3	27.1	1.18	1.18	12.9	11.6
Lower LGF	8.59	9.47	0.38	0.44	359	330	2.5-7.0	3.6-8.6	8.4-27.3	12.0-44.3	0.3-1.2	0.5-1.3	6.3-14.3	7.7-19.6
Slough	8.02	8.56	0.42	0.39	150	127	2.7	3.6	12.4	20.9	0.36	0.40	6.4	6.7
NOTE: All water quality parameter values are based on an average rainfall year.	Very Low: Loads less than forest (nutrients) Low: Loads between forest and pasture (nutrients) or loads less than forest (sediment) Moderate: Loads between pasture and mixed agriculture (nutrients) or loads between forest and row crops (sediment) High: Loads greater than mixed agriculture (nutrients) or loads greater than row crops (sediment)						Very Low: Median metals concentrations less than half of chronic values Low: Median metals concentration lower than chronic values Moderate: Median metals concentration between chronic and acute values High: Median metals concentration greater than acute values							

Table ES.7. Matrix Showing Approach of Watershed Plan Based on Existing versus Future Conditions Observed in Subwatersheds.

		Future Conditions			
		Very Good	**Good to Fair**	**Poor**	**Very Poor**
Existing Conditions	**Very Good**	PROTECT	PROTECT	n/a	n/a
	Good to Fair		MINIMIZE	MINIMIZE	n/a
	Poor			PREVENT	PREVENT
	Very Poor				PREVENT

n/a = not applicable

Protect

Where the matrix requires "Protect," the intent is to protect existing water quality conditions in the subwatershed. Existing conditions for these subwatersheds are very good, and given projected future conditions, major water quality changes are not anticipated in the subwatershed. Therefore, detailed restoration techniques are not proposed. Instead, emphasis is placed on controlling development and placing restrictions in the use of streamside zones.

Minimize

Where the matrix requires "Minimize," the intent is to minimize the likelihood of those events or chronic circumstances identified in the Watershed Plan that have a potential for material, adverse impacts to existing fair to good water quality characteristics. Future conditions are anticipated to remain either remain fair to good or to become poor with time. This means focusing on improving land management techniques with in the subwatershed and along streamside zones.

Where local problems exist and/or the likelihood of adverse future impacts is high (e.g., in the Belair subwatershed), some restoration techniques may be warranted. However, restoration techniques in other subwatersheds, such as those classified as “Prevent” below, may yield greater advantages to water quality conditions.

Table ES.8. Summary Matrix of Existing versus Future Conditions and Restoration Prioritization by Subwatershed.

		Future Conditions			
		Very Good	**Good to Fair**	**Poor**	**Very Poor**
Existing Conditions	**Very Good**	Jarrettsville (D) Dick (D)	Jerusalem (D)		
	Good to Fair		Headwaters (C) Nelson (C) Hess (C) GF State Park (C) Harford (C)	Belair (C)	
	Poor			Parker (C) Long Green Pike (B)	Franklinville (B) Lower (B)
	Very Poor				Sweet Air (A) Sawmill (A) Main (D)

Note: A= Highest priority for stream restoration approaches; D= Lowest priority for stream restoration approaches.

Prevent (& Restore Locally)

Where the matrix requires “prevent,” the intent is to prevent or avoid events or chronic circumstances identified in the report that have the potential for material, adverse effects to existing poor to very poor water quality and stream stability. One of the approaches should be to avoid or defer activities that may contribute to the problems identified in the Watershed Plan. This can include control of hydrologic regime, removal of pollutants, restoration of stream habitats, and augmentation of riparian cover. Additional approaches could include technological solutions that prevent or avoid the effects of land management.

ES-7 GOALS AND RESTORATION MANAGEMENT STRATEGIES

Watershed-wide Goals for Water Quality Management

Baltimore County's approach toward the Little Gunpowder Falls Watershed as developed through this watershed plan include the evaluation and identification of nonpoint source stormwater pollution, stream channel instability and areas of habitat loss. County watershed-wide goals include mitigating identified water quality problems, stream channel instability and habitat loss.

Through discussion with County personnel and review of the study data, specific management strategies toward accomplishing watershed-wide goals were identified, evaluated and prioritized. For example, habitat enhancement in areas identified as having a significant or potential loss of habitat may be accomplished through such efforts as stabilizing stream channels, enhancing riparian buffers, removing fish migration barriers, and establishing wildlife corridors.

To date, new nutrient and sediment load reduction goals have not been established for this watershed as a component of the Chesapeake Bay restoration and Tributary Strategies efforts. Water quality management strategies include efforts such as continuing and improving County operations such as the street sweeping program, inlet cleaning program, and the public education program. Other approaches toward meeting this goal may include changes in zoning and development techniques such as "down-zoning" and low impact development, agricultural best management practices, and nutrient management plans for all cropland.

Maintaining and enhancing stream channel stability is a watershed-wide goal for the Little Gunpowder watershed. This goal may be accomplished a number of ways including stream channel restoration, riparian buffer enhancement, and the protection of sensitive areas through changes in zoning, alternative approaches to development, and improved stormwater management practices.

Other goals and associated management strategies specific to individual subwatersheds have also been identified. For example, with the extensive agricultural land use and the current forest areas in the Little Gunpowder watershed, certain subwatersheds become important candidates for agricultural preservation through the Rural Legacy Program and meeting the County-wide goal to preserve the rural character. These subwatershed specific goals and management strategies are presented below and are based on information collected and evaluated throughout this study and the results of the ranking procedure, in addition to specific County needs.

Identification of the Potential Management Strategies

Narrowing the broad range of potential management strategies through a preliminary screening process was a necessary step in identifying those strategies that are feasible for this watershed. Consideration of the potential for management strategies to mitigate the observed water quality and stream channel problem areas and habitat loss, and/or anticipated problem areas with regard to future built-out scenarios using existing zoning, occurred in light of the following factors:

- ✓ identification of mitigation opportunities and prioritization including publicly owned land especially park land, available open space, and natural resources (connectivity of buffered stream corridors, habitat areas, etc.);
- ✓ broad scale application potential;
- ✓ existing County programs, other available resources and funding opportunities; and
- ✓ potential retrofit opportunities.

ES-8 WATERSHED MANAGEMENT PLAN

Introduction

This section presents the recommended watershed plan. First, management restoration strategies have been prioritized for each of the Little Gunpowder subwatersheds. Second, specific action items supporting each of the priority management strategies have been identified for implementation for each of the subwatersheds; these individual action items are presented in tables in Section 10.0 of the main report. The results of the prioritization of management strategies presented are based on the prioritization ranking methodology shown in Table ES.6. These measures along with the priority restoration areas identified in Figures ES.4 – ES.6 comprise the recommended watershed plan.

Watershed Management Plan

The objectives of this recommended watershed plan are to layout a series of management strategies with identified action items, and restoration projects that will serve to manage and mitigate the impacts of land use on water quality and stream channel condition including riparian condition in the Little Gunpowder Falls watershed. A combination of management strategies that work toward alleviating the impacts of existing and future stormwater runoff conditions on water quality and stream channel stability; habitat improvement and preservation; and protection and preservation of natural areas and open space have been developed. The management strategies are categorized by land use designation. These categories include public land strategies, developed land strategies, and agricultural land strategies.

Public land strategies include preservation of natural areas and open space through preservation of parkland, riparian buffer enhancement, and forest growth and harvest best management practices. Nonstructural developed land strategies include preservation of natural areas and open space, minimizing impacts of new development, public awareness and education, down-zoning to protect areas from further decline, and road maintenance. Structural developed land strategies include stream restoration, stormwater management practices (retrofitting existing ponds), and stormwater pond maintenance practices.

Retrofitting existing stormwater management facilities is not a priority strategy for this watershed because of the limited number of existing facilities, and the fact that very few are publicly owned facilities, most have small drainage areas and limited opportunity for improvement, and the cost versus benefit gained by improvements would be high. Agricultural land strategies include preservation of natural areas and open space, cropland best management practices and pastureland best management practices and forest growth and harvest best management strategies.

Ranking of Subwatershed Management Strategies

A prescreening of management strategies was done on a subwatershed basis prior to the ranking process to eliminate inappropriate strategies. For example, the public lands management strategies and the developed land management strategies were not included or ranked as viable strategies for the Hess subwatershed because this subwatershed has no developed or public lands. The ranking methodology included the following factors and point scale for scoring each relevant management strategy.

- ✓ Cost/Benefit - low (4) high (0)
- ✓ Available Funding – available (2) not available (1)
- ✓ Existing Program – existing program (2) no program (1)
- ✓ Scale of Application - watershed-wide (4) local (0)
- ✓ Consistent w/ Goals – yes (2) no (1)
- ✓ Existing and/or Future Benefit – both (2) existing only (1) future only (1)
- ✓ Minimizes increases in TIA/DCIA/Q2/Q10 yes (4) no (0)

The total possible score of the ranking process was 22 points. The process of ranking each subwatershed resulted in scores from a maximum of 22 points to a minimum of 9 points for individual management strategies across subwatersheds. The totals were then converted to a percentage of total possible points. For three of the ranking factors, a point value of 0 or 4 was applied while the remaining 5 ranking factors have a point value of 1 or 2. This weighting application was applied after reviewing the ranking factors and establishing their importance with regard to management strategy cost, implementation and benefits. The high ranking management strategies for which action items were identified were those with at least 80% of the total possible points resulting from the ranking process.

Process for Selecting Restoration Projects

Initially, a broad selection criterion was applied to the field data to determine viable site recommendations for stream channel restoration and riparian enhancement. The ranking analyses was used as a preliminary screening by subwatershed for areas most in need of and most benefited by stream channel and riparian restoration. This included areas with extensive lengths of impacted channels that have low recovery potential with regard to the Rosgen stream classification if left untouched. Sawmill and Sweet Air subwatersheds were both identified as high priority restoration areas based on these criteria. Lower Little Gunpowder Falls subwatershed was also identified as a priority restoration area.

Specific selection and prioritization criteria for stream restoration within the identified priority restoration subwatersheds included areas with many of the following primary factors:

- ✓ high field sediment supply rating,
- ✓ high BEHI ratings,
- ✓ high field bank erosion rating,
- ✓ presence and condition of riparian buffer,
- ✓ low stream order,
- ✓ field notes indicating problem areas, and
- ✓ photographs.

Riparian condition was considered when evaluating and prioritizing stream restoration potential on the basis of width on both sides of the channel, percent canopy cover, species composition and presence of invasive species. Other considerations included in the prioritization included future zoning with regard to increases in hydrology and sensitivity to disturbance with regard to the Rosgen stream classification.

Description of Restoration Projects and Mapping

Three subwatersheds have stream channel restoration as a priority management strategy. Specific restoration locations are identified and mapped for Sawmill, Sweet Air and Lower Little Gunpowder Falls subwatersheds (Figure ES.4, ES.5, and ES.6). The stream channel restoration areas are presented as high and moderate priority areas, with a separate category for riparian planting only when channel restoration was not a priority. Preliminary costs have been developed (Table ES.9).

Additional subwatersheds were identified as priority locations for riparian buffer enhancement, these include Headwaters, Nelson, Hess and Parker. Currently, these subwatersheds are predominantly in agricultural land use, often with encroachment and livestock access impacts evident along those areas with minimal riparian buffer widths.

Preliminary Cost Estimates of Restoration Projects

Preliminary cost estimates have been developed based on a unit cost per linear foot for stream channel restoration with riparian buffer enhancement costs for those areas included in the linear foot cost (Table ES.9). A unit cost per acre basis was used for determining costs for those areas identified for riparian buffer enhancement only.

Table ES.9. Preliminary cost estimates for potential channel restoration and riparian planting project sites in Sawmill, Sweet Air and Lower Little Gunpowder Falls subwatershed.

Subwatershed	Restoration Type	Unit of Measure	Cost per Unit (design and construction costs included)	Total Linear Feet	Total Cost
Sawmill	High priority channel restoration sites	Per Linear Foot	$250	11,700	$2,925,000
	Moderate priority channel restoration sites	Per Linear Foot	$200	17,400	$3,480,000
	Riparian Planting Only (assumes 50 foot buffer width on either side of channel)	Per Linear Foot	$30	5300	$159,000

Subwatershed	Restoration Type	Unit of Measure	Cost per Unit (design and construction costs included)	Total Linear Feet	Total Cost
Sweet Air	High priority channel restoration sites	Per Linear Foot	$250	4100	$1,025,000
	Moderate priority channel restoration sites	Per Linear Foot	$200	8300	$1,660,000
	Riparian Planting Only (assumes 50 foot buffer width on either side of channel)	Per Linear Foot	$30	17180	$515,400
Lower Little Gunpowder Falls	High priority channel restoration sites	Per Linear Foot	$250	4450	$1,112,500
	Moderate priority channel restoration sites	Per Linear Foot	$200	10050	$2,010,000
	Riparian Planting Only (assumes 50 foot buffer width on either side of channel)	Per Linear Foot	$30	5050	$151,500
All 3 Subwatersheds	Total High Priority				$5,062,500
	Total Moderate Priority				$7,150,000
	Riparian Planting Only				$825,900

Figure ES.4. Potential Channel Restoration and Riparian Planting Project Sites in the Sawmill Subwatershed

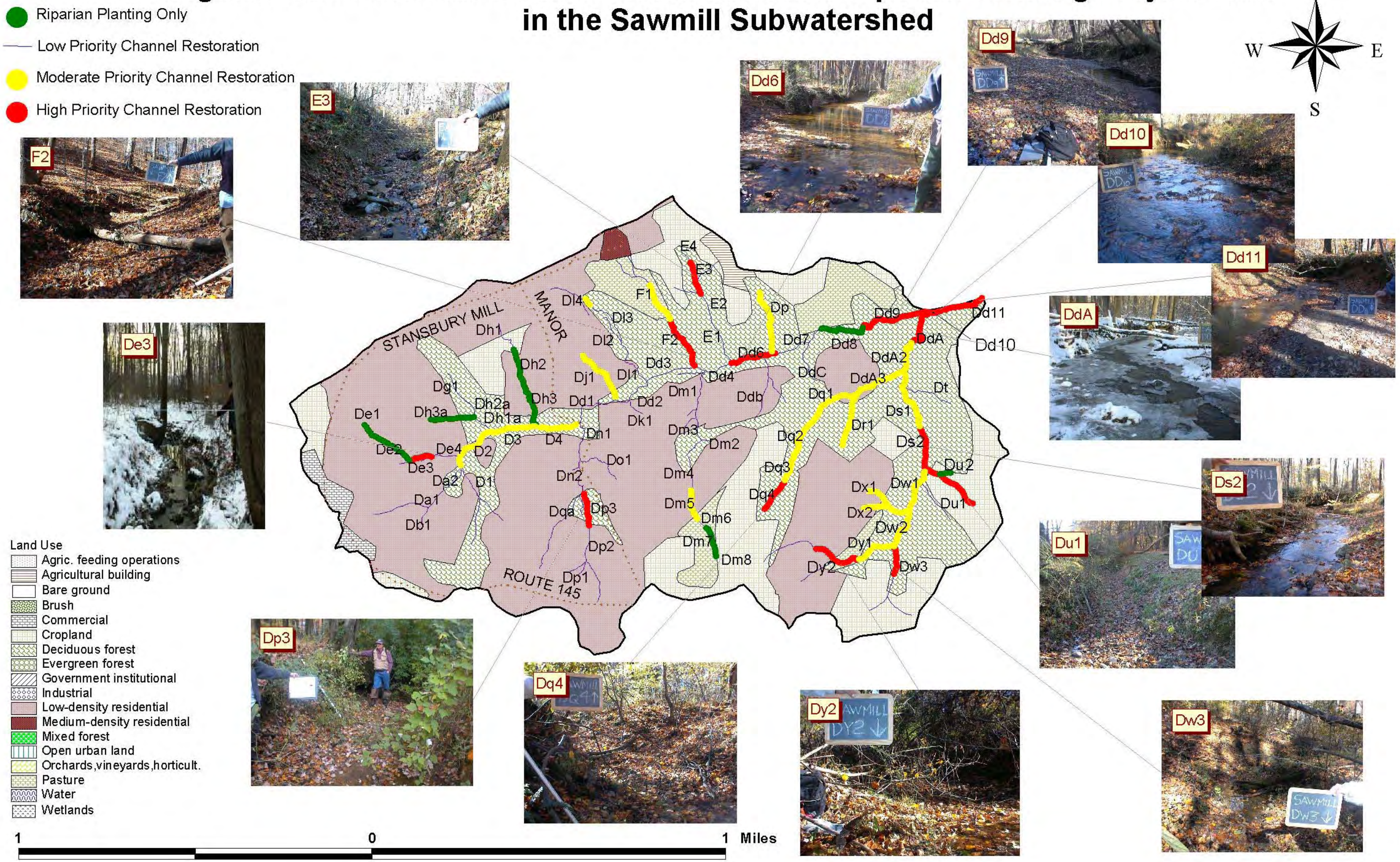


Figure ES.5. Potential Channel Restoration and Riparian Planting Project Sites in the Sweet Air Subwatershed

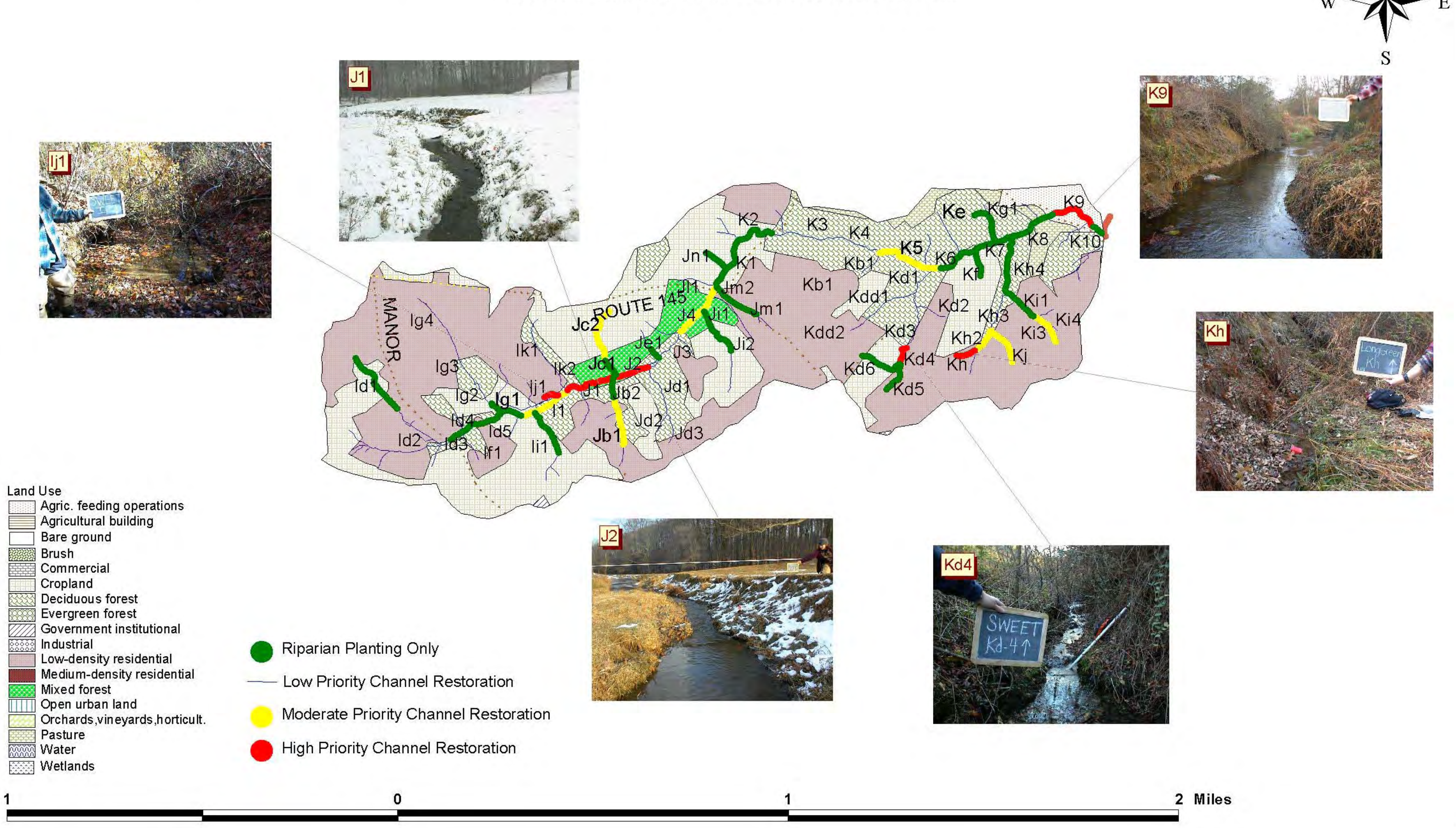
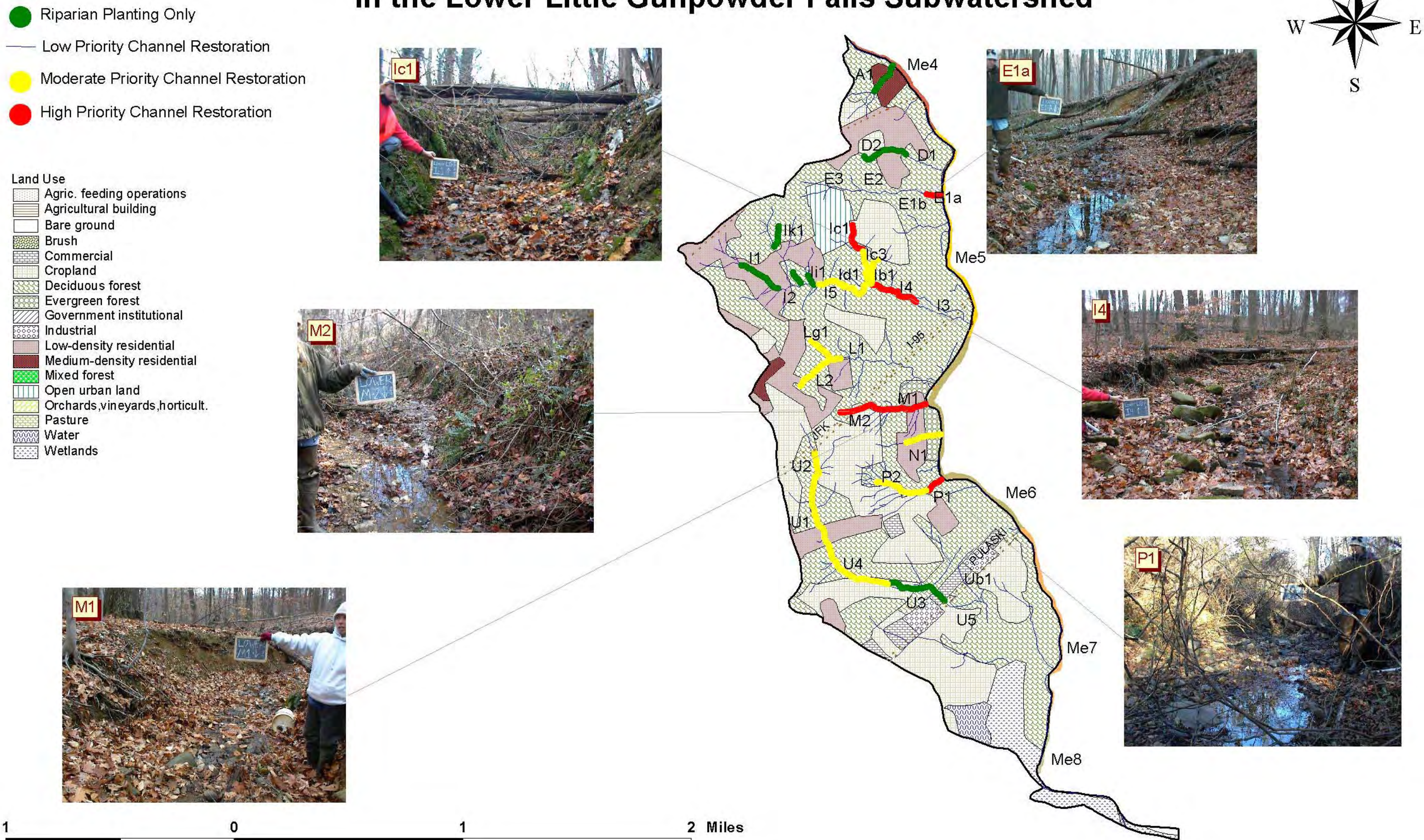


Figure ES.6. Potential Channel Restoration and Riparian Planting Project Sites in the Lower Little Gunpowder Falls Subwatershed



Approach for Implementing the Watershed Management Plan

In establishing an implementation approach for the watershed management plan, it is recommended that the County first undertake a broad scale implementation of a few priority management strategies. The high ranking priority management strategies (> 80% of total points) and their associated action items that were most commonly occurring across the subwatersheds were identified for the first tier of implementation. In addition to these commonly high ranking strategies, the high priority areas identified for stream restoration in the Sawmill, Sweet Air and Lower Little Gunpowder Falls subwatersheds has also been identified as first tier implementation items. Second tier management strategies and action items have also been identified. This tier is comprised of high ranking strategies (> 80% of total points) for each subwatershed and associated action items not already included in first tier implementation. In addition, the moderate priority areas identified for stream restoration and the riparian planting only areas in the Sawmill, Sweet Air and Lower Little Gunpowder Falls subwatersheds has also been identified as second tier implementation items. All remaining management strategies (< 80% of total points) and associated action items comprise the third tier of implementation.

First Tier Implementation

A broad watershed-wide view of the consistently highest ranking and most commonly occurring management strategies identify first tier items for implementing the watershed plan. The management strategies and associated action items listed below fall-out for broad scale implementation throughout the Little Gunpowder watershed. This selection was based on identifying the most commonly occurring strategies and action items, those occurring as high ranking (>80% of total points) in at least 75% (12) of the subwatersheds. In addition, the high priority stream restoration areas listed in Figures ES.4 – ES.6 are also included in this tier of implementation. Presented in Table ES.10 below is a summary of the ranking of the priority management strategies across the subwatersheds.

Table ES.10. Summary of the ranking of the priority management strategies across the subwatersheds.

First Tier - High ranking priority management strategies (> 80% of total points) that occur in at least 75% (12) of the subwatersheds **Second Tier** - High ranking priority management strategies (> 80% of total points) not included in the first tier implementation (occurring in less than 75% (12) of the subwatersheds **Third Tier** – Moderate ranking priority management strategies (=< 80% of total points) N/A = not an applicable management strategy for the subwatershed	**Headwaters**	**Nelson**	**Hess**	**Parker**	**Jarrettsville**	**Sawmill**	**Gunpowder Falls**	**Sweet Air**	**Long Green**	**Dick Branch**	**Harford**	**Jerusalem**	**Belair**	**Franklinville**	**Lower Little Gunpowder**	**Slough**	**Total # of Subwatersheds w/> 80% of Total Points**	**Percentage of Total**
Public Land Strategies																		
Preservation of natural areas and open space	N/A	N/A	N/A	N/A	100%	100%	100%	N/A	100%	100%	100%	100%	N/A	95%	100%	100%	10	**63%**
Riparian buffer enhancement	N/A	N/A	N/A	N/A	82%	82%	82%	N/A	82%	82%	82%	82%	N/A	77%	82%	82%	9	**56%**
Forest BMPs during growth and harvest	N/A	N/A	N/A	N/A	100%	100%	100%	N/A	100%	100%	100%	100%	N/A	95%	100%	100%	10	**63%**
Developed Land Strategies																		
Preservation of natural areas and open space	77%	100%	N/A	82%	N/A	100%	82%	100%	100%	82%	100%	100%	100%	95%	100%	82%	12	**75%**
Minimize impacts of new development	77%	N/A	N/A	N/A	N/A	96%	77%	95%	77%	77%	95%	95%	95%	91%	95%	77%	7	**44%**
Downing to prevent degradation of conditions	N/A	N/A	N/A	N/A	N/A	96%	N/A	95%	N/A	N/A	95%	95%	95%	91%	95%	N/A	7	**44%**
Public awareness and education	77%	100%	N/A	100%	N/A	100%	82%	100%	100%	82%	100%	100%	100%	95%	100%	82%	12	**75%**
Road maintenance	41%	41%	N/A	59%	N/A	60%	41%	59%	59%	41%	60%	59%	59%	55%	59%	41%	0	**0%**
Stream restoration	N/A	N/A	N/A	N/A	N/A	82%	N/A	82%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	**6%**
Stormwater pond maintenance	64%	N/A	N/A	N/A	N/A	64%	N/A	64%	N/A	N/A	77%	N/A	55%	77%	64%	N/A	0	**0%**
Agricultural Land Strategies																		
Preservation of natural areas and open space	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	95%	100%	82%	16	**100%**
Cropland best management practices	82%	82%	82%	82%	82%	82%	64%	82%	82%	82%	82%	64%	82%	91%	82%	64%	13	**81%**
Pastureland best management practices	82%	82%	82%	82%	82%	64%	82%	64%	82%	64%	N/A	64%	82%	N/A	N/A	N/A	8	**50%**

The following four management strategies fall-out as watershed-wide priorities as shown in Table ES.10. For each of the listed strategies, at least twelve (75%) of the subwatersheds resulted in a high ranking of these strategies (>80% of total points). Individual action items specific to each subwatershed are identified in Section 10.0 of the main report that supports the achievement of these strategies.

Developed Land Strategies

1. Preservation of natural areas and open space (i.e., protect natural areas through rezoning, conservation easements or voluntary protection of riparian buffer
2. Public awareness and education (i.e., .nutrient management, runoff reduction techniques, riparian buffer enhancement, wildlife habitat, native plants)

Agricultural Land Strategies

1. Preservation of natural areas and open space - (i.e., retain existing zoning classes, riparian buffer conservation easements, forest harvest BMPs during growth and harvest, ag. preservation (Rural Legacy)
2. Cropland best management strategies (i.e., nutrient management, buffer enhancement, no-till farming, winter cover crops)

Second Tier Implementation

The second tier items for implementing the watershed plan include tackling those high ranking management strategies (>80% of total points) and action items on a subwatershed basis that are not already covered under the first tier of implementation (watershed-wide) (Table ES.10). For example, for ten of the subwatersheds, public land is a component of the land use. Three management strategies are high ranking throughout almost every one of these ten subwatersheds and are listed below. Individual action items for each subwatershed are identified in Section 10.0 of the main report and support the achievement of these strategies.

Public Land Strategies:

1. Preservation of natural areas and open space (i.e., preservation of parkland - create a parkland zoning designation)
2. Riparian buffer enhancement (i.e., reforestation, afforestation, invasive species control, etc.)
3. Forest BMPs (i.e., management during growth and harvest)

In addition, the moderate priority areas identified for stream restoration and the riparian planting only areas in the Sawmill, Sweet Air and Lower Little Gunpowder Falls subwatersheds has also been identified as second tier implementation items.

Third Tier Implementation

All remaining management strategies (< 80% of total points) included in Table ES.10 comprises the third tier of implementation. These represent a lower priority for implementation based on the ranking procedure. The low rankings are based on many factors that vary by subwatershed and across management strategies. Although water quality improvement may be gained on a subwatershed basis by the implementation of these third tier strategies, factors such as high cost benefit ratio may be high and/or small scale of application resulted in a lower overall ranking.

ES-9 CONCLUSIONS

With current land use conditions, approximately 44% of the land in the watershed is in agricultural land use with 33% forested and 21% as residential development, with remaining areas in commercial, open space and wetlands. The residential development is almost exclusively low-density residential development. Future conditions as indicated by zoning will maintain the dominance of agricultural and low-density residential development throughout this watershed. In light of the existing land use, the current zoning, and the results of the study, the selected management strategies focus primarily on four main objectives toward meeting the watershed goals of improving water quality from stormwater runoff, stream and riparian condition, and areas of lost habitat. The four primary objectives are listed below:

1) preserving natural areas and open space (i.e., maintaining agricultural lands through preservation programs, protecting parkland, conservation set-asides in developing areas, preserving contiguous tracts of forest);
2) minimizing or reducing the impacts of new and existing development (i.e., public awareness and education, low impact development techniques, SWM credits to preserve forest cover, cluster dev. with conservation areas);
3) implementing agricultural best management practices (i.e., limiting livestock access to streams, nutrient management, restrict stream crossing, agricultural management plans); and
4) restoring areas of aquatic and riparian habitat loss, and channel instability (i.e., stream channel restoration, riparian buffer enhancement and forest management techniques).

Preservation of natural areas and open space is a priority management strategy applicable across the predominant land use types and for all of the subwatersheds. Implementing this strategy for agricultural areas, residential areas and public lands will serve many purposes. The most important of which are to reduce the impacts of future development, preserve vital habitat, and maintain the rural character of the watershed. The highest ranking management strategy across subwatersheds was preservation of natural areas and open space for agricultural lands (see Table ES.10). Specific action items supporting this management strategy are outlined in Section 10.0 of the main report for each subwatershed. To date, significant portions of Headwaters, Nelson, Hess and Parker subwatershed are currently preserved lands under Maryland's various land preservation programs (i.e., Rural Legacy). Concentrating future land preservation efforts on areas of agricultural land not currently under a preservation program for these subwatersheds would serve to establish large contiguous tracts of preserved rural land. Additional efforts should focus on agricultural lands adjacent to parkland and to other preserved tracts in Sawmill, Sweetair, Gunpowder Falls State Park, Long Green Pike and Dick Branch.

The effort to minimize or reduce the impacts of new and existing development comprises several priority management strategies applicable primarily to the residential areas throughout this watershed. For example, public awareness and education efforts will serve to change behavior and daily practices throughout the existing residential areas. These efforts focusing on minimizing runoff volume and improving water quality will serve to provide a very inexpensive and potential very effective tool in accomplishing the watershed goals. Again, specific action items for each subwatershed are outlined in Section 10.0 of the main report.

With the importance of agricultural activity in this watershed, promoting agricultural best management strategies is a certain and effective tool in achieving and maintaining improved conditions throughout this watershed. These strategies include a variety of action items specific to individual subwatersheds (see Section 10.0 of main report). They are specific to the type of agriculture activity, cropland or pastureland, and include such actions as riparian buffer enhancement, nutrient management, no-till farming, restriction of livestock access and many others. Restoring areas of aquatic and riparian habitat loss, and channel instability through techniques like stream channel restoration, riparian buffer enhancement and improved forest management techniques will serve to provide immediate local improvements to the conditions throughout the watershed.

In summary, this watershed has large tracts of agricultural land, forested land and a low density of development when compared to most of the other watersheds in Baltimore County. These attributes should be protected and preserved, maintaining the rural character and working toward the water quality based improvements recommended through many of the management strategies in this watershed plan. There are many miles of stream channel in stable condition surrounded by vital riparian habitat. Implementing the priority stream restoration and riparian enhancement projects identified in this plan will greatly improve the continuous lengths of stream corridors in good condition in this watershed serving as vital aquatic and terrestrial habitat.