9.0 Permit Requirements

F. <u>Watershed Assessment and Planning</u>

Baltimore County shall continue to update and revise watershed assessments that have been developed for its 10 urban watersheds (Baltimore Harbor, Bird River, Back River, Gwynns Falls, Jones Falls, Little Gunpowder, Loch Raven, Lower Gunpowder River, Middle River, and the Patapsco River). The overall goal is to ensure that each County watershed is thoroughly evaluated and has an action plan to maximize water quality improvements. Additionally, the County shall encourage the public to participate in the development and implementation of watershed restoration activities. At a minimum, the County shall:

1. Continue to perform and update detailed assessments in all of its urban watersheds. These watershed assessments shall include:
    a. Determining current water quality conditions;
    b. Identifying and ranking water quality problems;
    c. Identifying all structural and non-structural water quality improvements opportunities;
    d. Reporting the results of a visual watershed inspection;
    e. Specifying how the restoration efforts will be monitored; and
    f. Providing an estimated cost and a detailed implementation schedule for those improvement opportunities identified above.

H. <u>Assessment of Controls</u>

Assessment of controls is critical for determining the effectiveness of the NPDES stormwater management program and progress toward improving water quality. Therefore, Baltimore County shall use chemical, biological, and physical monitoring to document work toward meeting the watershed restoration goals identified above.

9.1 Introduction

In order to meet the permit requirements detailed in section F (1. a-e) and section H, Baltimore County has initiated chemical, biological, and geomorphological monitoring programs in addition to the specific monitoring required by the permit and detailed in Section 8. The chemical monitoring program (9.2) consists of two elements, stream baseflow monitoring and tidal water monitoring. The stream geomorphological monitoring program (9.3) includes monitoring of stream restoration projects and conducting stream assessments in support of the Small Watershed Action Plan preparation. The biological monitoring program (9.4) has four elements including probabilistic monitoring, CIP monitoring, reference site monitoring, and submerged aquatic vegetation monitoring. Baltimore County recently began monitoring brook trout populations in streams of the Prettyboy Reservoir watershed to support the Prettyboy Reservoir Watershed Restoration Action Strategy (9.5). The SCA survey (9.6) provides

descriptive and positional data for potential environmental problems along a watershed's non-tidal stream network.

9.2 Chemical Monitoring Program

In order to determine the chemical condition of Baltimore County waters two chemical monitoring programs have been implemented. The chemical monitoring program is intended to provide information on ambient chemical conditions and, over time, to assess trends in both chemical concentrations and chemical loads. The information will be used to better target restoration activities, to provide data for the calibration of pollutant load models, and to provide local data to assess the results of the Chesapeake Bay Program modeling efforts and TMDL modeling. The data will be used to assess water quality improvements that are the result of restoration efforts. It will also be used to determine progress in meeting the pollutant load reductions required by the Chesapeake Bay restoration efforts and as determined by the development of Total Maximum Daily Loads (TMDLs). These programs will partially fulfill the restoration effectiveness monitoring required under NPDES Permit section F.1 and H above.

The two current, chemically oriented programs, the Baseflow Monitoring Program and the Tidal Waters Monitoring Program are described in Sections 9.2.1 and 9.2.2, respectively.

9.2.1 Baseflow Monitoring

A baseflow monitoring program was initiated in 1999. The initial effort was targeted at watersheds that were undergoing or about to undergo the preparation of a Water Quality Management plan. The targeted watersheds included the Lower Gunpowder, the Little Gunpowder, the Middle River and the Baltimore Harbor watersheds. The limited data was used in the calibration of the SWMM pollutant load models that were included in the Water Quality Management plans. In the fall of 2000, the baseflow monitoring was shifted to the Back River, Jones Falls and Gwynns Falls watersheds. The shift was intended to address the lack of chemical monitoring information available for these watersheds. These watersheds were monitored until the spring of 2001. The data collected was presented in the NPDES – 2001 Annual Report. Staffing levels curtailed the continuance of the baseflow monitoring program until the spring of 2003.

The baseflow monitoring program, which resumed in 2003 was also redesigned. Baseflows were monitored in the Patapsco/Back River Basin in odd-numbered years, while the Gunpowder Basin/Deer Creek are monitored in the even-numbered years. In 2007, because of staff time constraints, we created Tier 1 and Tier 2 sites. The Tier 1 sites are our regular sampling sites. Tier 2 were sites that were removed from sampling, but were picked back up if we had a Small Watershed Action Plan (SWAP) or other project in that area. There were 32 Tier 1 and 9 Tier 2 sites in the Patapsco Back River Basin. There were 53 Tier 1 and 22 Tier 2 sites in the Gunpowder Basin/Deer Creek. The points were chosen to maximize the number of subwatersheds monitored. The monitoring points within the Patapsco/Back River Basin are displayed in Figure 9-1, while the Gunpowder Basin/Deer Creek monitoring points are displayed in Figure 9-2.

Due to the limited number of samples that were being collected for the Baseflow Program, the program is being discontinued. Baseflow synoptic surveys will still be completed in support of SWAPs. A new program called the Trend Monitoring Program will replace the Baseflow Program. The Trend Monitoring Program was initiated in January 2011. Forty sites were

selected throughout Baltimore County (Figure 9-3). Sites were primarily chosen where there are USGS gaged stations, to eliminate the time taken in measuring discharge. In watersheds where there was a lack of gages stations, sites were still selected but will be measured manually for discharge. All sites will be visited once a month approximately on the same day, regardless of weather. This will give us a better picture of the stream health and increase the number of samples per site to 12 per year. This sampling methodology will permit calculations of pollutant loads from each site. The standard set of monitored pollutants includes (TSS, TS, TKN, Nitrate/Nitrite, Total Phosphorus, Ortho-phosphorus, Cadmium, Copper, Lead, Zinc, BOD, COD, Chlorides, Sodium, Hardness, Magnesium and Calcium) as well as temperature and pH determined in *situ*.

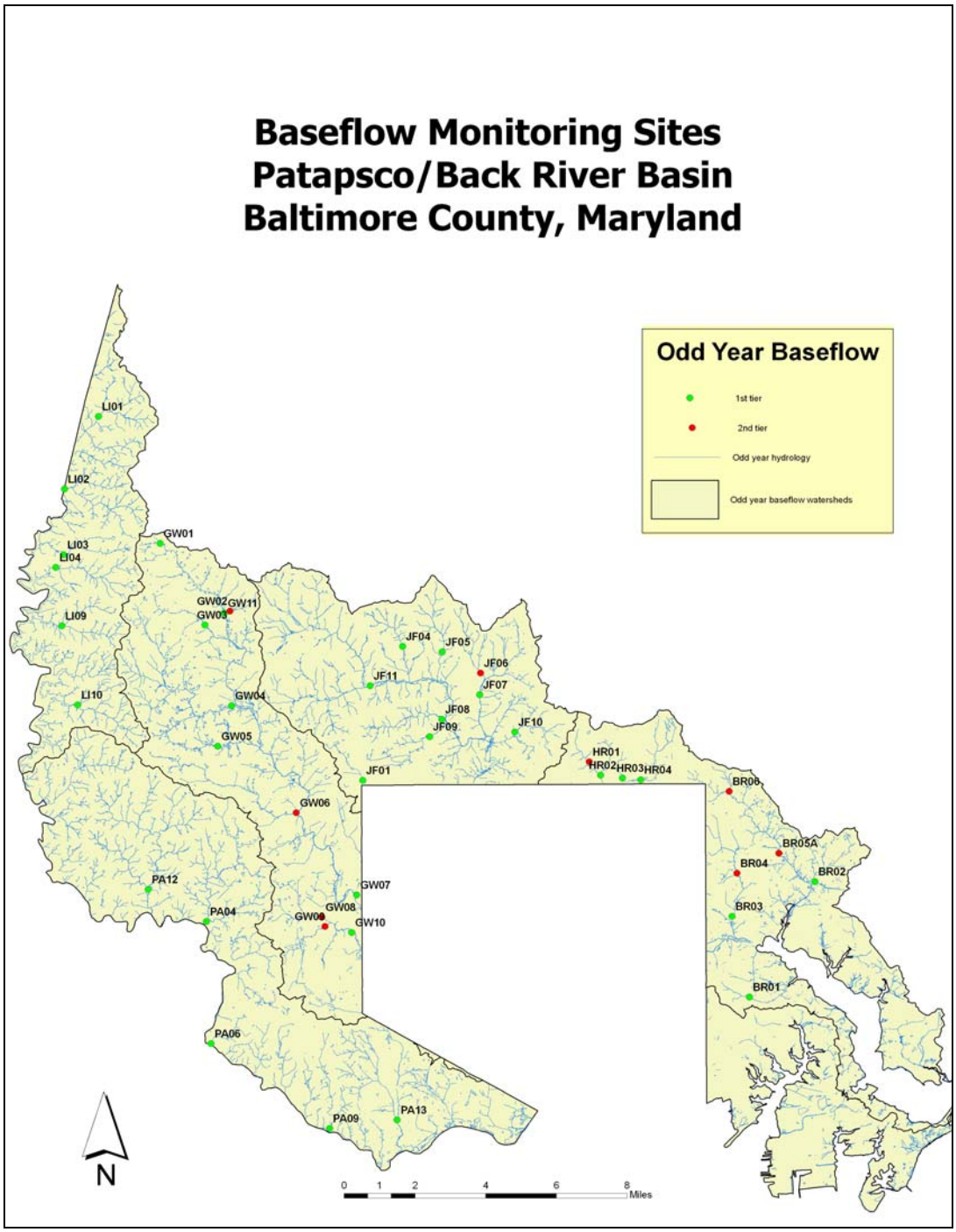


Figure 9-1: Patapsco/Back River Basin – Baseflow Monitoring Sites

Figure 9-2: Gunpowder Basin/Deer Creek – Baseflow Monitoring Sites

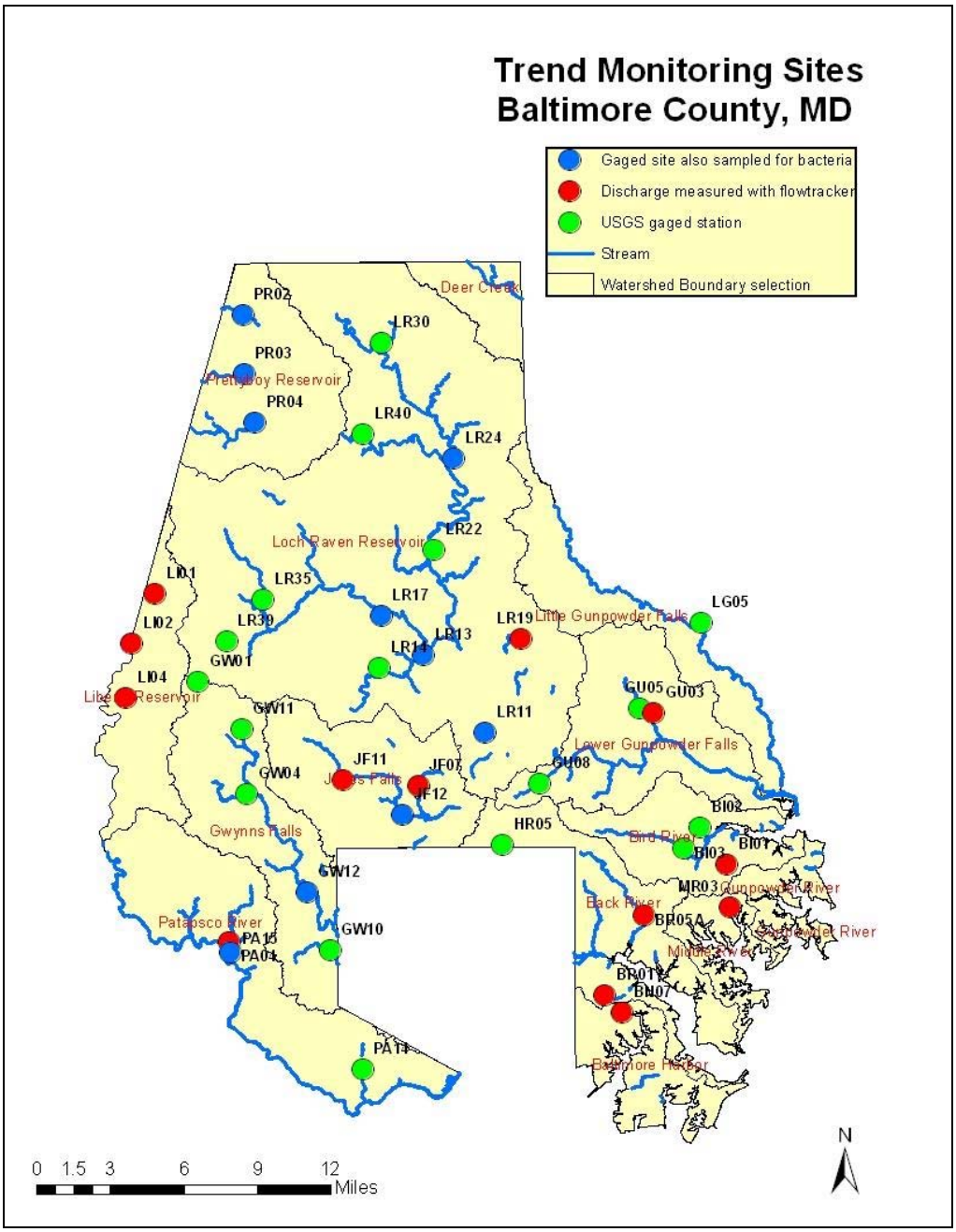
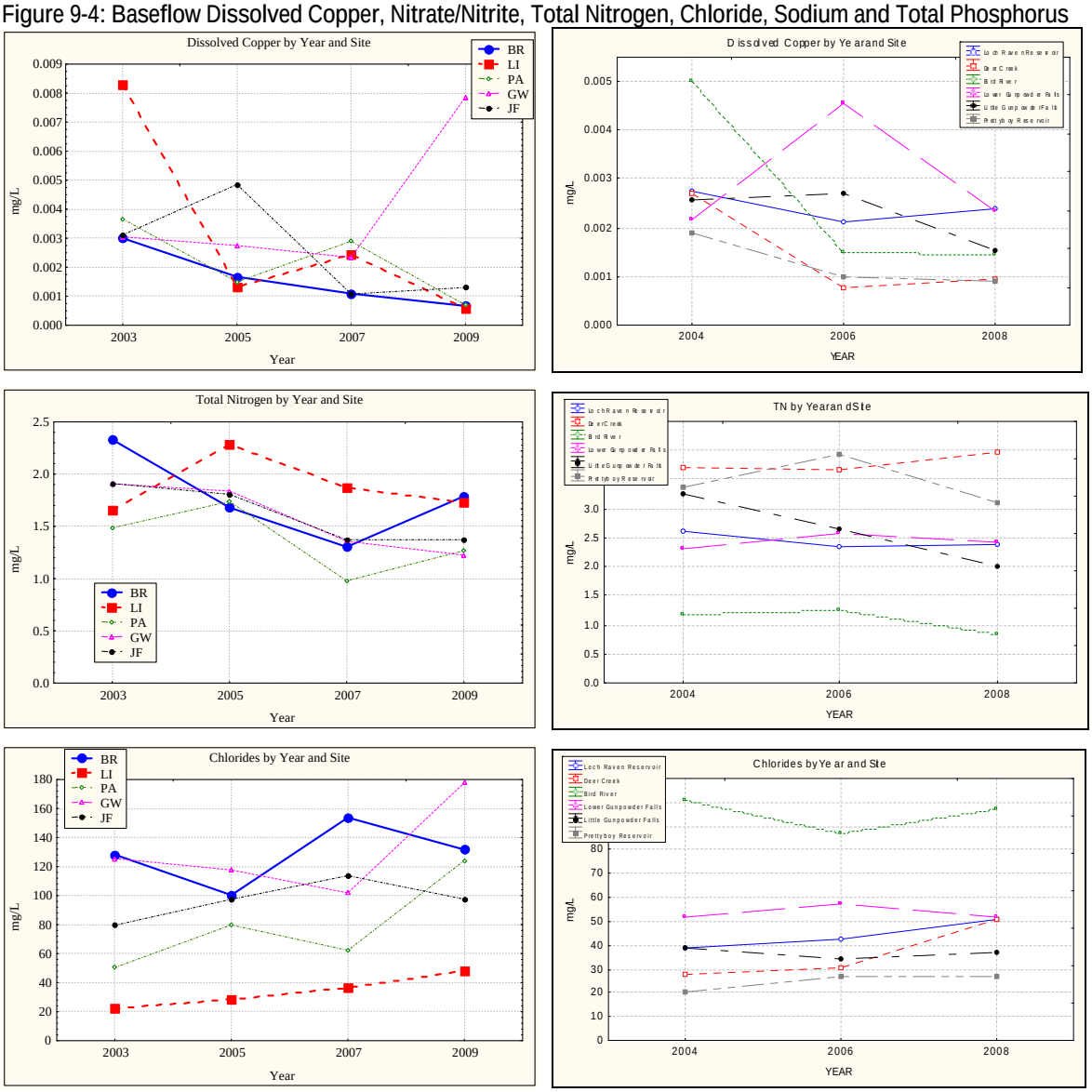


Figure 9-3: Trend Monitoring Sites

For 2010, most sites were sampled only once, with 8 not being sampled at all. For that reason, data presented in this years report will be summary of baseflow program data collected from 2003-2009 (figure 9-4).

Figure 9-4: Baseflow Dissolved Copper, Nitrate/Nitrite, Total Nitrogen, Chloride, Sodium and Total Phosphorus



Several interesting trends can be seen from the graphs in Figure 9-4.

For dissolved copper:

- Back River continues its declining trend.
- All Patapsco/Back River Basin Watersheds fell or stayed nearly the same, except for Gwynns Falls, which saw a dramatic increase from 0.002 mg/L to 0.007 mg/L.
- For the Patapsco/Back River Basin Watersheds, Patapsco had the greatest decline between 2007 and 2009 falling from 0.0024 mg/L to 0.0006 mg/L.
- Unlike the dramatic increases and decreases from 2004 to 2006, Loch Raven, Bird River, Prettyboy and Deer Creek only had slight changes between 2006 and 2008.
- The Lower Gunpowder had the largest change from 2006 to 2008, falling from 0.0046 mg/L to 0.0023 mg/L.

- The Little Gunpowder had the next largest change from 2006 to 2008 falling from 0.0027 mg/L to 0.0015 mg/L

For total nitrogen:

- Back River and Patapsco both increased from 2007 to 2009. Back River had the higher increase, from 1.30 mg/L to 1.79 mg/L. This is the first increase Back River has seen since 2003. Liberty increased as well in 2005 and has decreased since 2007.
- Gwynns Falls is the only watershed to show a steady decrease since 2003. Jones Falls has also decreased since 2003, but did have a slight increase from 2007 to 2009.
- Prettyboy, Little Gunpowder, Lower Gunpowder and Back River decreased from 2006 to 2008.
- Deer Creek and Loch Raven increased from 2006 to 2008.
- Little Gunpowder is the only Gunpowder Basin/Deer Creek watershed that has showed a steady trend, declining since 2004.

For chlorides:

- Liberty Reservoir has been increasing since 2003.
- Gwynns Falls had the most dramatic increase between 2007 and 2009 from 101.91 mg/L to 177.73 mg/L. It had been declining since 2003.
- Jones Falls saw a decrease for the first time since 2003. Back River and Patapsco have an up and down pattern with 2009 being a declining year for both.
- Bird River, Loch Raven, Deer Creek, and Little Gunpowder all increased from 2006 to 2008.
- Lower Gunpowder and Prettyboy were the only Gunpowder Basin/Deer Creek watersheds to show decreases.
- Bird River consistently has higher concentrations than the other Gunpowder Basin/Deer Creek watersheds.

Two map displays showing the Total Nitrogen and Total Phosphorus mean concentrations are shown in Figures 9-5 and 9-6 on the following two pages. As can be seen from Figure 9-5, the highest concentrations of Total Nitrogen predominate in the agricultural portions of the County. These increased Total Nitrogen concentrations may be the result of agricultural activities, septic system inputs, or a combination of both. Two of the urban areas, one in Back River and one in the Patapsco, show elevated Total Nitrogen concentrations.

The majority of Total Phosphorus is delivered during storm events, associated with sediment. Thus the concentrations measured in baseflow sampling are much lower than during storm event sampling. The elevated concentrations in the urban areas are likely the result of increases in orthophosphate, which occurs in a dissolved form. The source is currently not known, but may be associated with sewage and various industrial processes. The elevated and very high concentrations in rural areas may be associated with animal operations where livestock have access to the stream.

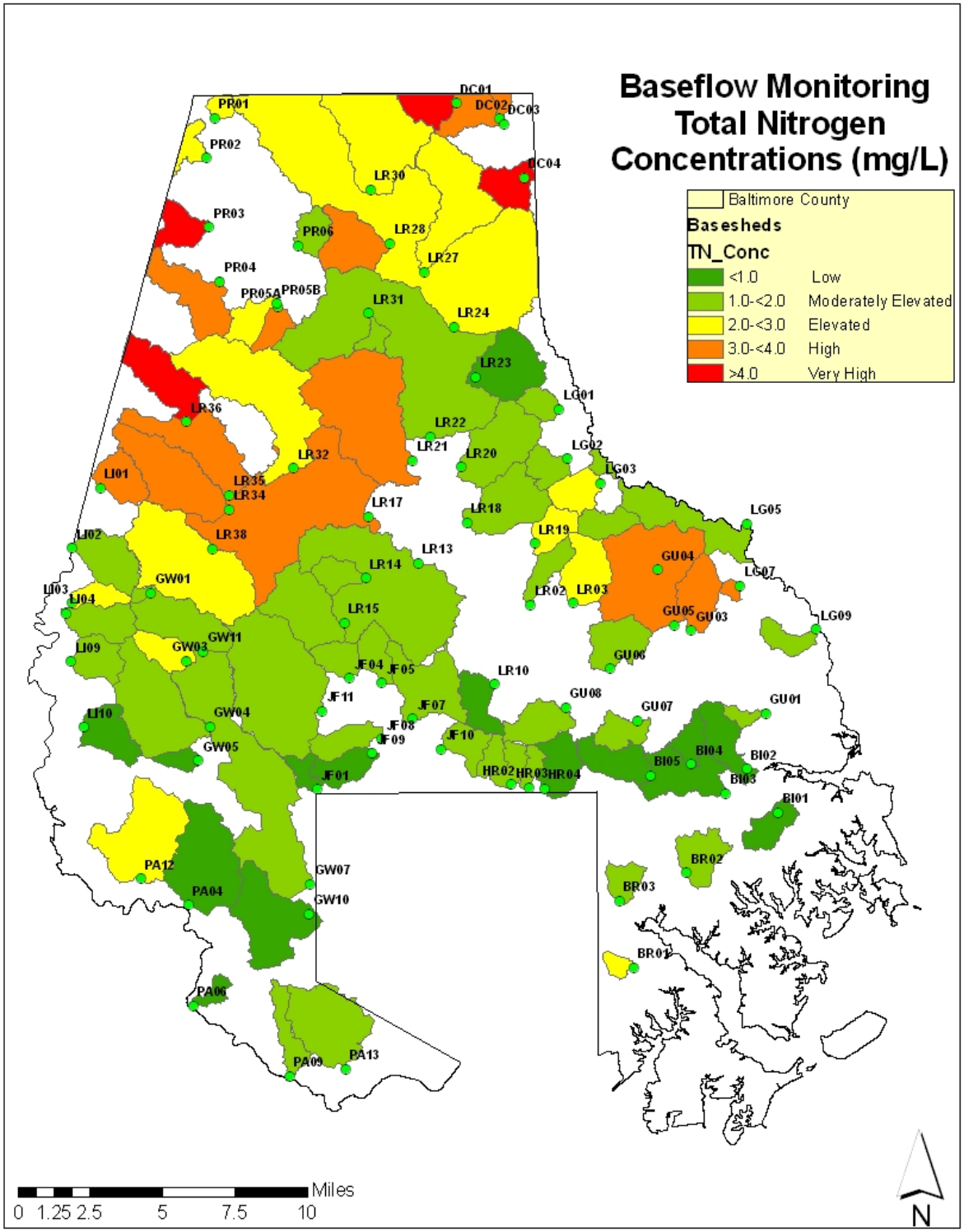


Figure 9-5: Baseflow Total Nitrogen Mean Concentrations for Monitoring Years 2008 (Gunpowder Basin) and 2009 (Patapsco/Back River Basin).

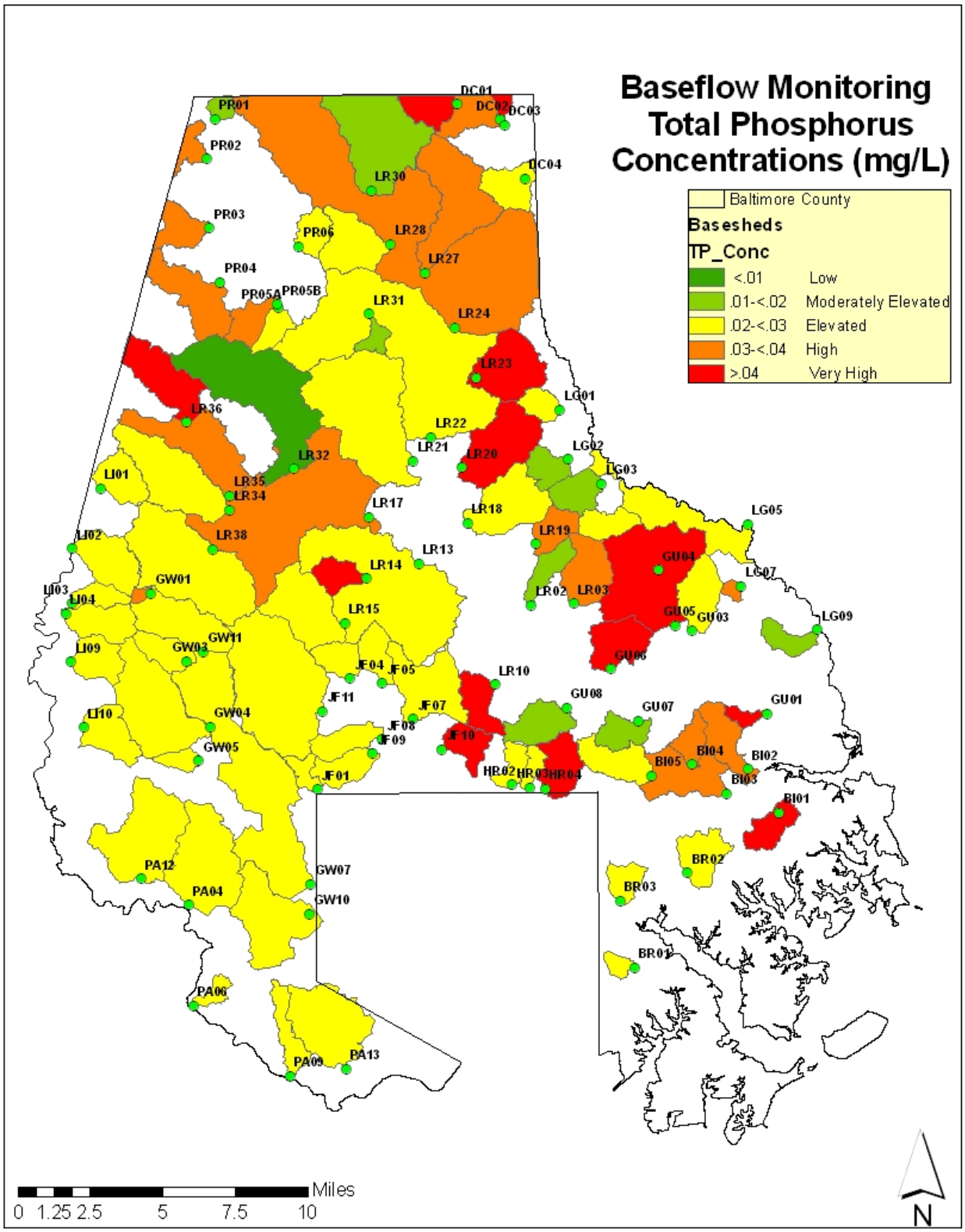


Figure 9-6: Baseflow Total Phosphorus Mean Concentrations for Monitoring Years 2008 (Gunpowder Basin) and 2009 (Patapsco/Back River Basin).

9.2.2 Tidal Waters Monitoring Program

Baltimore County has had a tidal recreational water-monitoring program since 1970. Early bacteriological sampling was conducted on a monthly basis between, Labor Day and Memorial Day, for fecal coliform. Since 2000, and the advent of the US EPA Beach Act, tidal water sampling has been conducted bi-weekly by boat for the indicator organism Enterococci. The sampling season has been extended to cover the period of April through November (weather permitting). Multiple bacteriological samples are taken in 10 zones representing areas of heavy recreational use with 4 single grab samples taken in less utilized areas. In addition, beach sampling also utilizing Enterococci is conducted at 3 permitted beach locations, on a basis alternate to recreational water sampling.

Individual sample results are recorded as well as the Geometric Mean of multiple sample zones. A value of 35 MPN (geomean) Enterococci is required to be utilized as a threshold for public safety and water contact only in association with a known or suspected sewage overflow. 35 MPN is otherwise used for comparison purposes to make general characterizations of open water. The results of the bacteriological sampling can be viewed on the Internet at: http://www.baltimorecountymd.gov/Agencies/environment/watersampling/results.html.

Special sampling is also conducted to support environmental/public health evaluations after severe storm events or sanitary sewage overflows.

Starting in 2002, chemical sampling of surface waters was initiated at locations designed to represent major county tidal basins. This sampling takes place during the recreational water-sampling run and was expanded to thirteen locations. The codes for those locations as noted on the "Beach, Beach Area, And Recreational Water Sampling Locations" map (Figure 9-7) and the tidal water basins they represent are found on Table 9-1.

This chemical sampling of surface waters program was discontinued in 2010, with only one sampling day taking place. Data presented in this report are a summary of 2002-2009. This will be the last time data from this program will be reported.

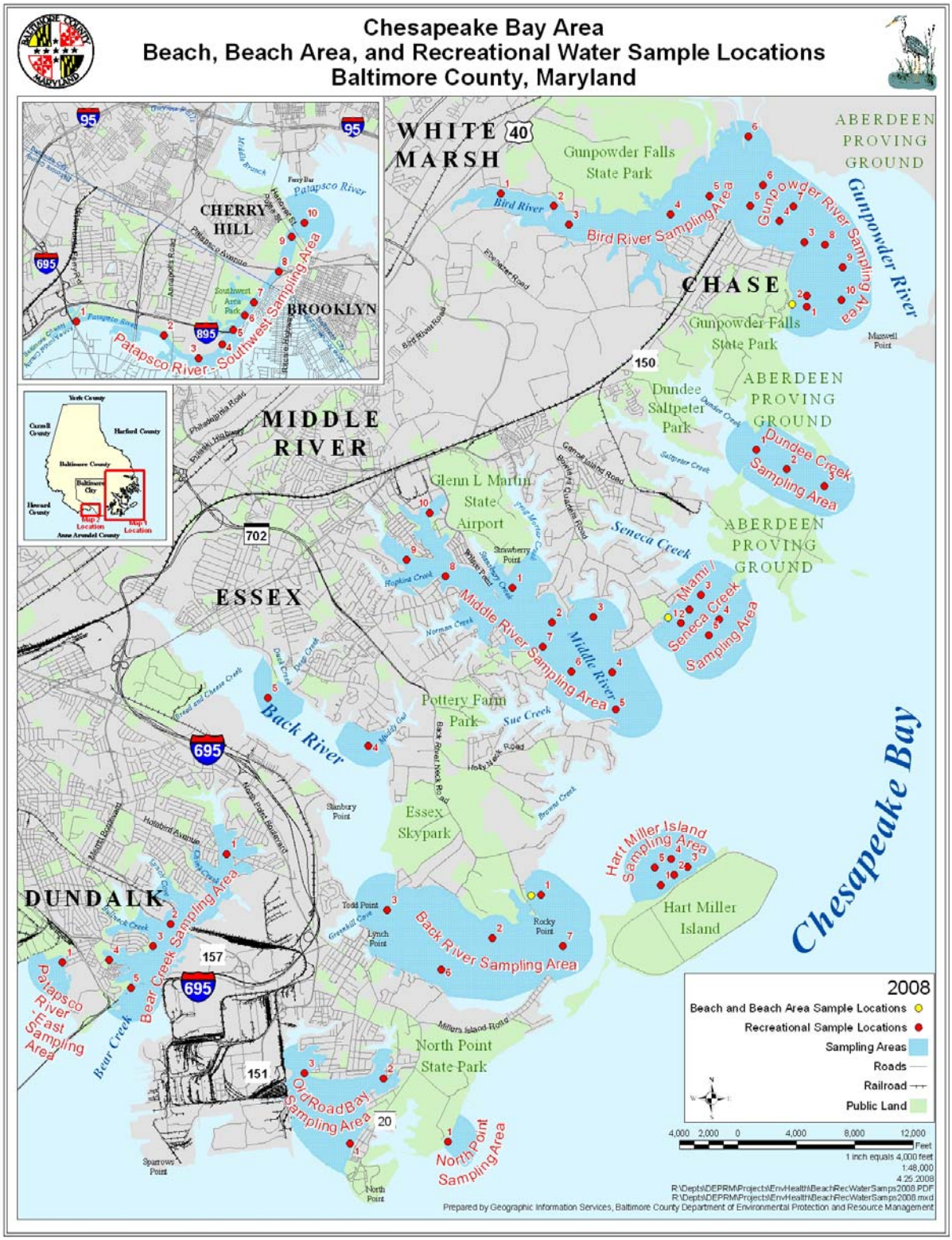


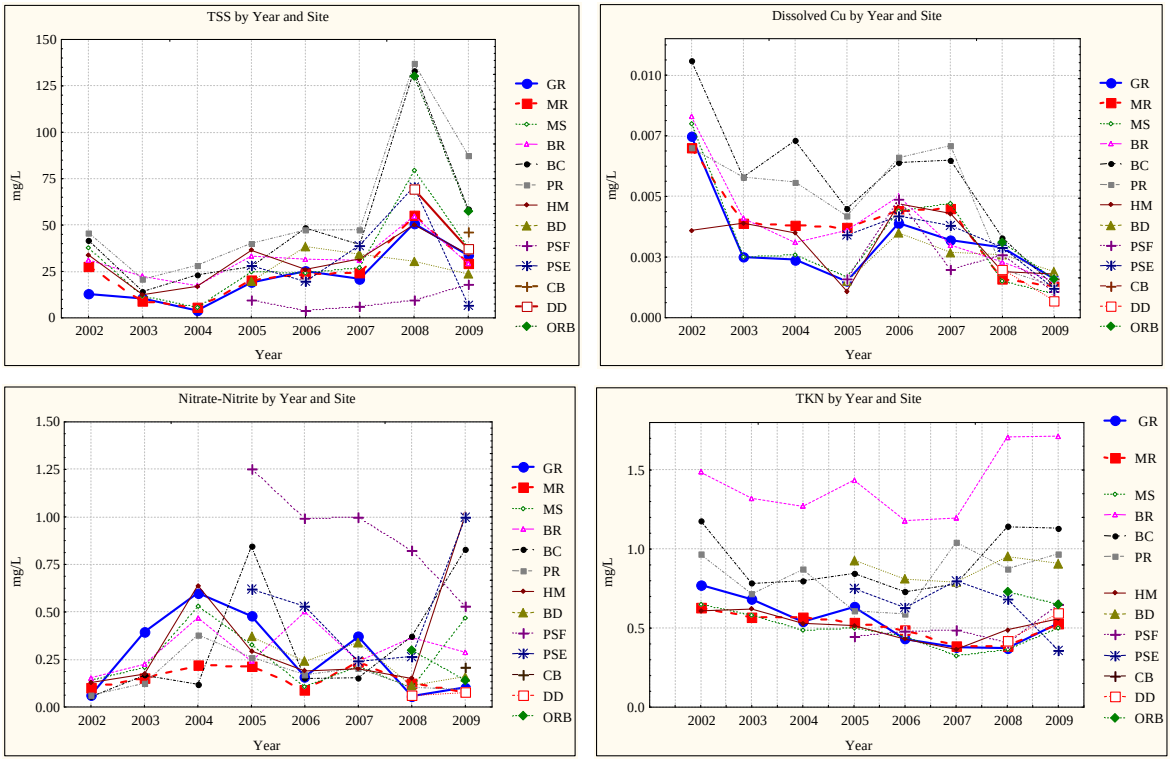
Figure 9-7: Tidal Waters Monitoring Site Locations.

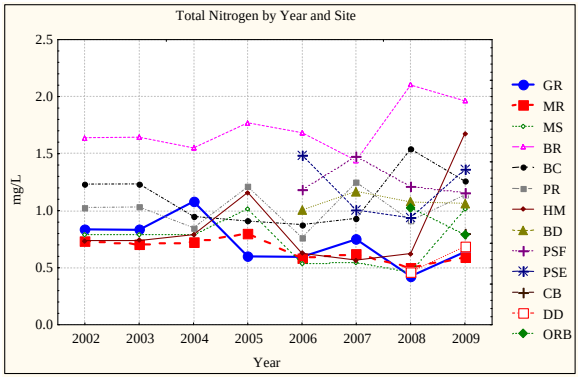
Table 9-1: Site Codes and the Associated Tidal Water body

Code	Water Body
BC	Bear Creek
PR	Patapsco River - Outer
GR	Gunpowder River
MS	Miami Beach/Seneca Creek
MR	Middle River
BR	Back River
HM	Hart Miller Island
BD	Bird River
PSF	Patapsco River – Fresh Water
PSE	Patapsco River – Estuarine
DD	Dundee Creek
ORB	Old Road Bay
CB	Chesapeake Bay North Point Park

A graphical comparison between years for site and select pollutants was conducted. Chesapeake Bay North Point Park (CB) has only one year of data, but is included in the graph so the relative ranking can be compared. Dundee Creek (DD) and Old Road Bay (ORB) have only two years of data. The results are presented in Figure 9-8. Two-year rolling averages were calculated for each site using the same water quality parameters as in Figure 9-8. The results are shown in Figure 9-9.

Figure 9-8: Pollutant Between Year Variation by Site.





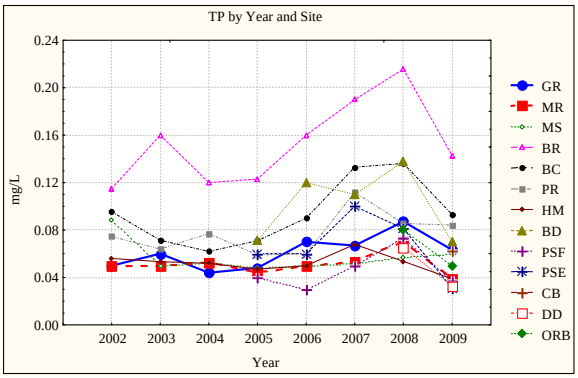
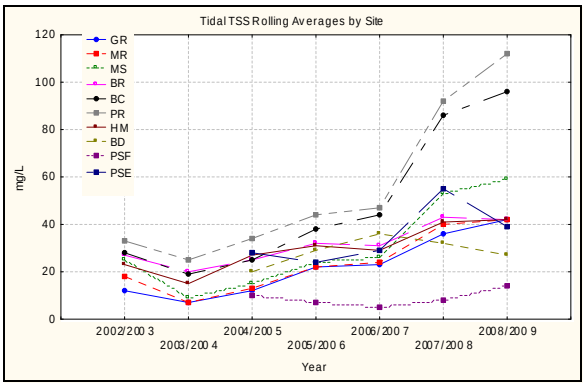
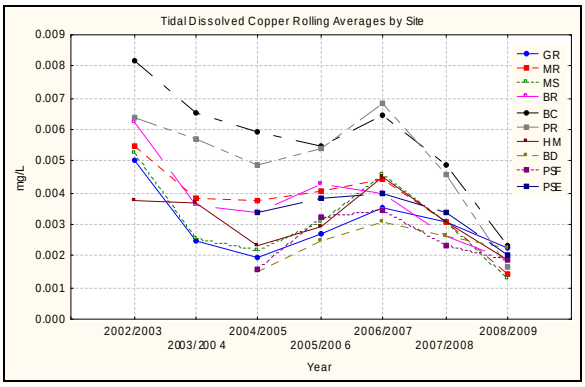
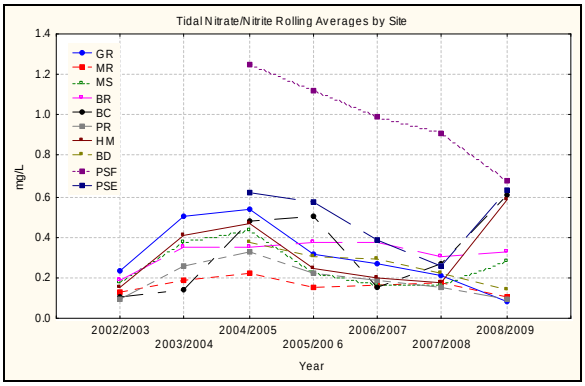
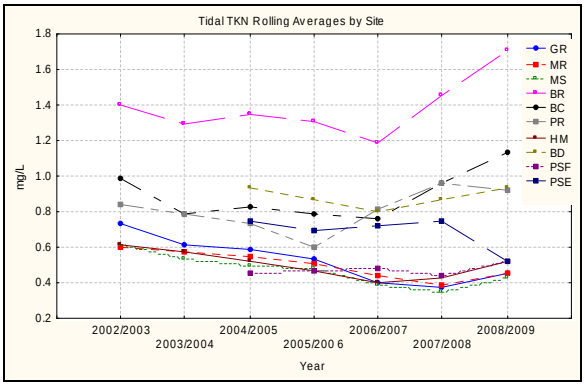


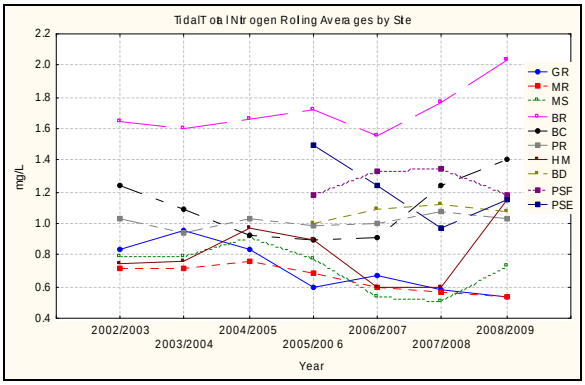
Figure 9-9: Tidal Monitoring Rolling Averages for TSS, Dissolved Copper, TKN, Nitrate/Nitrite, Total Nitrogen, and Total Phosphorus for sampling years 2002 through 2009.

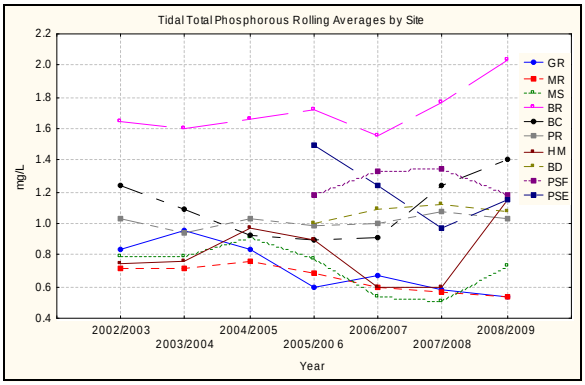












Several interesting trends can be seen from the graphs in Figure 9-8.

For Total Suspended Solids (TSS):

- A noted decrease in concentrations for all sites can be noted between 2002 and 2003.
- Until 2008, there has generally been an increasing trend, with the highest increases taking place between 2007 and 2008. 2009 is the first year to see a general decrease since 2004.
- All the sites are following the same trend except PSF (Patapsco River- Fresh), which had much lower levels than the other sites previous to 2009. PSF is the only site to have an increase and not a decrease for 2009.

For Dissolved Copper:

- Dissolved Copper continued to decrease in 2004 and 2005 for all sites followed by an increase in 2006.
- For 2007, Dissolved Copper decreased slightly in about half the sites including BD, GR, PSF, and BR while the remaining sites held steady.
- BC had the largest decrease for between 2008 and 2009, dropping 0.002 mg/L.
- Dissolved copper never exceeded the acute (0.0061 mg/L) Maryland Department of the Environment estuarine water quality standards for 2009.

For Nitrate/Nitrite:

- Concentrations saw a large decrease in 2006, with the exception of Back River (BR), which increased by 48%.
- HM had the greatest change from 2008 to 2009, rising from 0.15 mg/L to 1.01 mg/L.
- PSF, a fresh water site, generally had higher concentrations than the other sites until levels began falling in 2008.
- Data for May 15, 2007 is an outlier and was excluded. The concentration for that sampling event was 67.24 mg/L.

For Total Kjeldahl Nitrogen (TKN) and Total Nitrogen:

- BR continues to be higher than all the other sites for both TKN and TN.
- HM had the biggest change from 2008 to 2009 for TN, rising from 0.063 mg/L to 1.68 mg/L.
- PSE had the biggest change from 2008 to 2009 for TKN, falling from 0.68 mg/L to 0.36 mg/L.

For Total Phosphorus:

- All sites have been following the same general trend since 2002.
- Total Phosphorus in Back River (BR) which had consistently risen since 2006 fell in 2009 from 0.22 mg/L to 0.14 mg/L. The concentrations are always higher for BR than the other sites, probably due to the presence of the Back River WWTP.

The trends seen from the rolling averages in Figure 9-9 were mostly similar to the overall trends seen in Figure 9-11, with a few exceptions:

- Sites CB, DD, and ORB were not included in this analysis because of insufficient data.
- For TSS, all sites show an overall increase except for PSE and BD.
- All sites show an overall decline in dissolved copper since 2006/2007.
- For nitrate/nitrite, most sites showed a decline since 2004/2005 except for MS, HM, BC, and PSE, which have increased since 2007/2008. PSF remains the highest, although there has been a steady decline since 2004/2005.
- For total phosphorous, BR, BC, and PSF have increased since 2006/2007.

9.3 Stream Geomorphological Monitoring

Baltimore County EPS performs post-project monitoring of its completed stream restoration projects in accordance with applicable federal and state waterway construction permit requirements. The field monitoring and reports are either done completely in-house or by consulting firms competent in this work. These monitoring activities also provide compliance with the NPDES permit requirement to monitor effectiveness of restoration projects.

The U.S. Army Corps of Engineers authorization for stream restoration activity is generally required pursuant to Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act of 1899. Additionally, projects are normally eligible for authorization by the Maryland State Programmatic General Permit (MDSPGP) as published in the Special Public Notice 96-19 issued in June 1996. For these projects, the conditions of the (MDSPGP) authorization normally require the development of a monitoring plan that will be used to identify and evaluate changes in the completed stream restoration project and to take remedial measures as necessary in coordination with the regulatory agencies. For each project, specific elements of the monitoring plan are identified as determined by the regulatory agencies. See Exhibit 5-1 of the 2003 NPDES Report for an example of an authorization document/permit and monitoring criteria. Periodic field monitoring followed by a written report of findings and any proposed remedial measures are submitted to the Army Corps of Engineers, Maryland Section Northern and to the Maryland Department of the Environment (MDE) Non-Tidal Wetland and Waterways Division as called for in the monitoring plans. Monitoring is also utilized to determine if the capital project implementation meets the goals of the project. Further, the DEPRM believes that the post construction monitoring program provides valuable feed-back information that enables it to improve the effectiveness of its future project design and construction approaches.

The post construction monitoring plans require periodic collection of field data – usually annually for 2 to 5 years. Additional monitoring may be required after large storms. In most cases, monumented and surveyed channel cross-sections located at strategic points along the project are required. Occasionally, longitudinal profiles are required or elected to be done by EPS. Field data are collected using Standard Operating Procedures for pebble counts, cross sectional surveys, and longitudinal surveys. Data from the cross-sections and longitudinal surveys are entered into a computer program and plotted. For multi-year surveys these plots are overlayed (current over prior year(s)) to detect any changes in morphology that may have occurred between these periods. Bed material characterization via the Wolman pebble count procedure, inspection of the condition of any riparian plantings, visual inspection of the degree

of channel erosion or deposition etc., and photographing the channel and banks at key locations are other components that may be included in the monitoring plan and report.

Table 9-2 summarizes the streams and stream restoration projects monitored and/or reported to the regulatory agencies in 2010. Copies of the completed reports submitted and listed in Table 9-2 are on file at the Maryland Department of the Environment (MDE) Non-Tidal Wetland and Waterways Division and at the EPS CIP Section where they are available for inspection.

Table 9-2: Summary of Capital Improvements Projects Monitoring and Reports Submitted for 2010

Project	Submitted	Responsible Personnel
Gwynns Falls @ Chartley	2010	KCI
East Branch Honeygo	2010	Biohabitats

The stream restoration projects monitored through 2010 have been successful in achieving self-maintaining channel stability, reduction of bed and bank erosion, protection of private and public infrastructure, and habitat improvement. Improvements in aesthetics and public safety have been additional benefits. Most of the problems have been localized and minor, such as shifting of rock elements in grade control structures, bank scouring at the downstream end of bank protection structures, deposition in the vicinity of grade control structures, and channel erosion at intra-project segments that were not restored or modified during the project. The information gained from the monitoring has enabled DEPRM to improve its stream restoration approaches, such as increasing the size of the rock elements in grade control structures subject to high tractive forces, and more closely relating the height of bank protection structures to bank full elevation. The challenges of effective stream improvement in an urban setting are formidable. Through the knowledge and experience gained with its design, construction, and monitoring efforts, DEPRM continues to build upon a successful stream restoration program.

9.4 Biological Monitoring

In addition to the biological monitoring required at Scotts Level Branch under Baltimore County's NPDES permit, the County has four additional biological monitoring programs. These programs use the biological community to assess the ecological health of the streams within the County (Probabilistic Monitoring Program, Section 9.4.1), assess the effectiveness of stream restoration projects (CIP Monitoring Program, Section 9.4.2), provide data on the best streams in Baltimore County to serve as bench marks for other stream assessments (Reference Site Monitoring Program, Section 9.4.3), and assess Submerged Aquatic Vegetation (Submerged Aquatic Vegetation (SAV) Monitoring Program, Section 9.4.4). The first three programs use assessments based on the benthic macroinvertebrate community and, in some cases, the fish assemblage. It is widely accepted that the biological community of streams is sensitive to anthropogenic perturbations. By monitoring the biological community, the County can assess the amount of change due to anthropogenic activities and the benefit of stream restoration to stream organisms. The SAV Monitoring Program provides an assessment of the coverage of SAV and progress made in meeting the new water quality standards for water clarity and SAV coverage in Baltimore County tidal waters.

9.4.1 Probabilistic Monitoring

The County adopted Maryland Biological Stream Survey (MBSS) methodologies in 2003, which has allowed for direct comparisons with State generated data. This has expanded upon the available data for assessing County waters. Probabilistic monitoring (randomly selected monitoring sites) has allowed statistically valid statements regarding the state of the waters.

The County has contracted a consultant to perform the probabilistic monitoring. Each year a different basin is sampled, with the Patapsco/Back River Basin (Liberty Reservoir, Patapsco River, Gwynns Falls, Jones Falls, and Back River) monitored in odd years and the Gunpowder River Basin and Deer Creek watersheds (Deer Creek, Prettyboy Reservoir, Loch Raven Reservoir, Lower Gunpowder, Little Gunpowder, and Bird River) monitored in the even years. Three watersheds are not assessed using the Biological Probabilistic Monitoring Program (Baltimore Harbor, Middle River, and Gunpowder River) due to the limited miles of free flowing streams in the watersheds.

One hundred sites are randomly selected and macroinvertebrates are sampled during the spring index period, March 1 to April 30, using the MBSS protocols. These samples are sub-sampled to 100 organisms and identified to Genus or the lowest possible taxonomic level. A Benthic Index of Biotic Integrity (BIBI) is calculated. The BIBI describes the biological condition of the streams in the County. In 2006, a subset of previously sampled random sites was selected to serve as sentinel sites. The sites were located towards the base of major subwatersheds. Eighteen sentinel sites were selected in the Patapsco/Back River basin, and 13 sentinel sites were selected in the Gunpowder/Deer Creek basin. The sentinel sites will be used to monitor biological condition over a range of watershed and stream conditions.

The current BIBI uses six metrics. These six metrics, what they measure and the expected response to stressors are displayed in Table 9-3.

Table 9-3: BIBI Metrics

BIBI Metric	Metric Measure	Expected Response
Number of Taxa	Species Richness	Decrease
Number of EPT	Species Richness	Decrease
Number of Ephemeroptera	Species Richness	Decrease
Percent Intolerant to Urban	Tolerance/Intolerance	Decrease
Percent Chironomidae	Taxonomic Composition	Increase
Percent Clingers	Habit	Decrease

The raw BIBI scores for each site from the 2009 probabilistic monitoring are displayed in Appendix 9-4 at the end of this section. The sites are grouped by subwatershed and 12-digit watershed, along with their respective BIBI condition rating. The BIBI condition ratings are "Very Poor" (1.00 – 1.99), "Poor" (2.00 – 2.99), "Fair" (3.00 – 3.99), and "Good" (4.00 – 5.00).

Table 9-4 shows the results by watershed, as the percentage of sites within each BIBI range, for the entire seven-year probabilistic data set. In 2009, only 6% of sites were considered to have Good biological water quality, the second lowest percentage since 2003. Approximately two-thirds of sites were rated Very Poor or Poor. Since 2003, sampled sites have been distributed approximately evenly among the four condition categories.

Table 9-4: BIBI Score Distribution by Watershed (% by Category)

Watershed	N	1.00-1.99 Very Poor	2.00-2.99 Poor	3.00-3.99 Fair	4.00-5.00 Good
Patapsco/Back River Basin – Sampled in 2003					
Liberty Reservoir	10	10	50	30	10
Patapsco River	13	54	46	0	0
Gwynns Falls	30	43	53	3	0

Jones Falls	32	38	31	25	6
Back River	15	87	13	0	0
Total	**100**	**46**	**39**	**12**	**3**
Gunpowder River Basin/Deer Creek – Sampled in 2004					
Deer Creek	3	0	33	67	0
Prettyboy Res.	7	0	14	43	43
Loch Raven Res.	67	6	9	43	42
Lower Gunpowder	7	29	43	29	0
Little Gunpowder	6	0	0	50	50
Bird River	2	50	50	0	0
Total	**92**	**8**	**13**	**42**	**37**
Patapsco/Back River Basin – Sampled in 2005					
Liberty Reservoir	22	5	32	41	23
Patapsco River	21	29	43	24	4
Gwynns Falls	22	18	68	14	0
Jones Falls	23	17	30	48	4
Back River	12	58	42	0	0
Total	**100**	**22**	**43**	**28**	**7**
Gunpowder River Basin/Deer Creek – Sampled in 2006					
Deer Creek	13	8	8	31	53
Prettyboy Res.	17	0	30	35	35
Loch Raven Res.	44	7	16	57	20
Lower Gunpowder	17	30	35	35	0
Little Gunpowder	4	0	25	25	50
Bird River	5	80	20	0	0
Total	**100**	**13**	**21**	**42**	**24**
Patapsco/Back River Basin – Sampled in 2007					
Liberty Reservoir	20	0	0	30	70
Patapsco River	24	33	33	17	17
Gwynns Falls	26	12	54	19	15
Jones Falls	28	29	25	25	21
Back River	19	84	11	5	0
Total	**117**	**30**	**26**	**20**	**24**
Gunpowder River Basin/Deer Creek – Sampled in 2008					
Deer Creek	12	17	17	33	33
Prettyboy Res.	13	0	8	38	54
Loch Raven Res.	47	4	9	23	64
Lower Gunpowder	12	58	17	8	17
Little Gunpowder	11	0	0	64	36
Bird River	5	100	0	0	0
Total	**100**	**30**	**8**	**28**	**34**
Patapsco/Back River Basin – Sampled in 2009					
Liberty Reservoir	15	0	7	60	33
Patapsco River	23	22	30	43	4
Gwynns Falls	26	35	42	23	0
Jones Falls	20	35	50	15	0
Back River	16	69	31	0	0
Total	**100**	**32**	**34**	**28**	**6**
Gunpowder River Basin/Deer Creek – Sampled in 2010					
Deer Creek	3	0	0	100	0
Prettyboy Res.	11	0	27	64	9
Loch Raven Res.	59	7	15	68	10
Lower Gunpowder	13	8	38	54	0

Little Gunpowder	7	0	29	71	0
Bird River	7	57	43	0	0
Total	**100**	**9**	**22**	**62**	**7**
County Total	**809**	**22**	**26**	**32**	**20**

Figures 9-10 and 9-11 show the means and one standard deviation of the mean BIBI scores for each watershed between 2003 and 2010. Among Patapsco/Back River watersheds, Liberty Reservoir consistently has the highest biological integrity, while Back River has the lowest. Among Gunpowder River watersheds, the Lower Gunpowder and Bird River watersheds have the lowest biological integrity. In both the Patapsco and Gunpowder basins, the watersheds with the poorest biological condition coincide with the most populated and urbanized areas within Baltimore County.

The methodology developed by Maryland Department of the Environment and Maryland Department of Natural Resources to determine biological impairment of fresh water streams was used to determine the watershed condition for all five sampling years. The methodology is detailed in Part C.2.1 at the following web site:

http://www.mde.state.md.us/assets/document/2008_IR_Parts_A_thru_E(1).pdf

The method assesses watersheds at the Maryland 8-digit scale, and uses 90% confidence limits around the proportion of degraded stream miles to determine whether the proportion of degraded stream miles is significantly different than reference conditions. Watersheds are listed as "Attaining," "Impaired," or "Inconclusive." The results of the biological listing method are presented in Table 9-5. Figures 9-12 and 9-13 display site and watershed condition for sites sampled in 2009 and 2010, and 2007 and 2008, respectively. The sites, with color-coded condition, are overlain on their respective sub-watersheds.

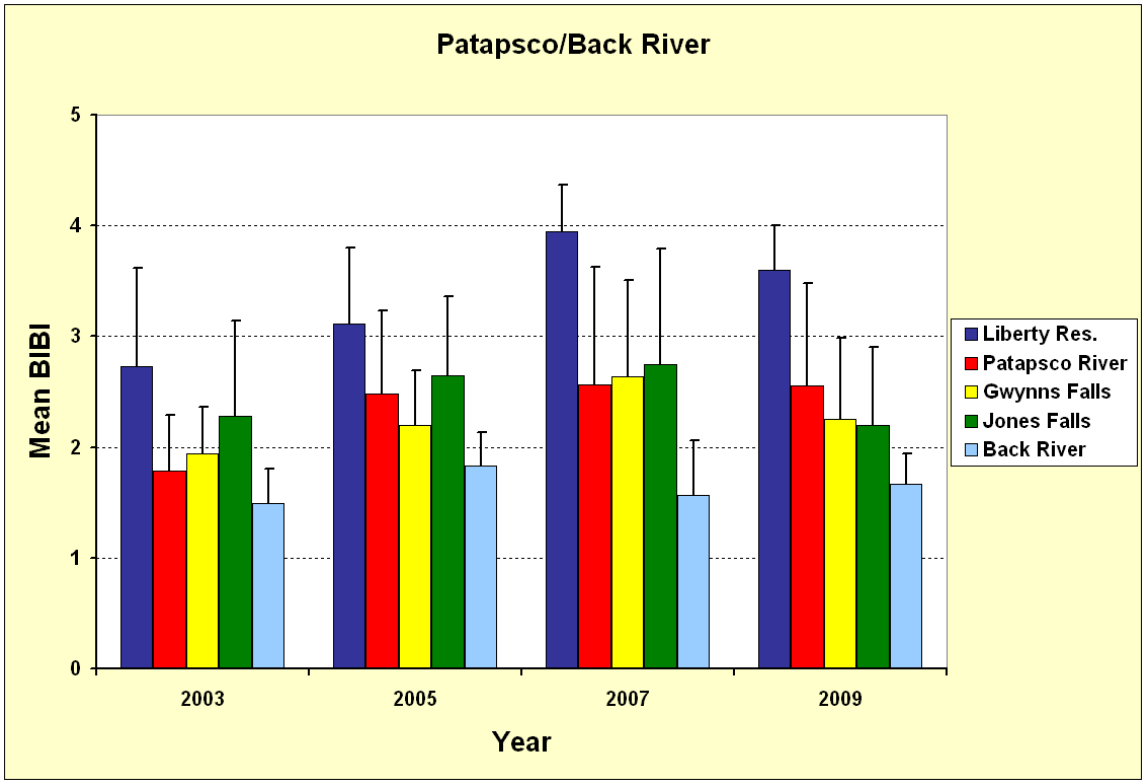


Figure 9-10: Means and one standard deviation of BIBI scores for Patapsco/Back River watersheds between 2003 and 2009.

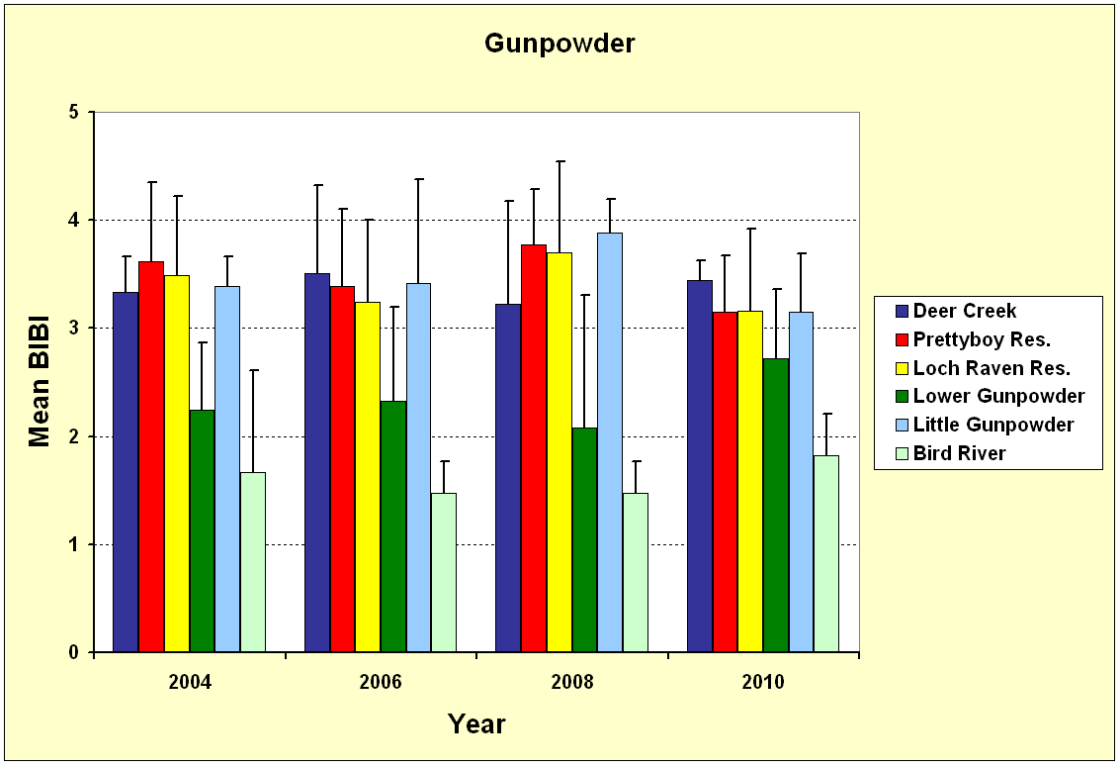


Figure 9-11: Means and one standard deviation of BIBI scores of Gunpowder Falls/Deer Creek watersheds between 2004 and 2010.

Table 9-5: Watershed Biological Condition Using Percent Stream Mile Method

Watershed	Sites Degraded	N	% Stream Miles With Possible Degradation	CL_{Lower} (%)	CL_{Upper} (%)	Category
2003 Sampling Year						
Liberty	6	10	60	35	81	Impaired
Patapsco River	13	13	100	84	100	Impaired
Gwynns Falls	29	30	97	88	99	Impaired
Jones Falls	22	32	69	56	80	Impaired
Back River	15	15	100	86	100	Impaired
2004 Sampling Year						
Deer Creek	1	3	33	3	80	Inconclusive
Prettyboy	1	7	14	1	45	Attaining
Loch Raven	10	67	15	9	22	Attaining
Lower Gunpowder	5	7	71	40	92	Impaired
Little Gunpowder	0	6	0	0	32	Attaining
Bird River	2	2	100	32	100	Impaired
2005 Sampling Year						
Liberty	8	22	36	22	52	Impaired
Patapsco River	15	21	71	55	84	Impaired
Gwynns Falls	19	22	86	72	95	Impaired
Jones Falls	11	23	48	33	63	Impaired
Back River	12	12	100	83	100	Impaired
2006 Sampling Year						
Deer Creek	2	13	15	4	36	Attaining
Prettyboy	5	17	29	15	48	Impaired
Loch Raven	10	44	23	15	33	Impaired
Lower Gunpowder	11	17	65	46	80	Impaired
Little Gunpowder	1	4	25	3	68	Inconclusive
Bird River	5	5	100	63	100	Impaired
2007 Sampling Year						
Liberty	0	20	0	0	11	Attaining
Patapsco River	16	24	67	52	80	Impaired
Gwynns Falls	17	26	65	51	78	Impaired
Jones Falls	15	28	54	40	67	Impaired
Back River	18	19	95	81	99	Impaired
2008 Sampling Year						
Deer Creek	4	12	33	15	56	Impaired
Prettyboy	1	13	8	1	27	Attaining
Loch Raven	6	47	13	7	21	Attaining
Lower Gunpowder	9	12	75	52	90	Impaired
Little Gunpowder	0	11	0	0	19	Attaining
Bird River	5	5	100	63	100	Impaired

Table 9-5 (continued): Watershed Biological Condition Using Percent Stream Mile Method

Watershed	Sites Degraded	N	% Stream Miles With Possible Degradation	CL_{Lower} (%)	CL_{Upper} (%)	Category
2009 Sampling Year						
Liberty	0	15	0	0	14	Attaining
Patapsco River	9	23	39	25	55	Impaired
Gwynns Falls	18	26	69	55	81	Impaired
Jones Falls	13	20	65	43	75	Impaired
Back River	16	16	100	87	100	Impaired
2010 Sampling Year						
Deer Creek	0	3	0	0	63	Attaining
Prettyboy	3	11	27	8	56	Impaired
Loch Raven	13	59	22	14	33	Impaired
Lower Gunpowder	6	13	46	22	71	Impaired
Little Gunpowder	2	7	29	5	66	Impaired
Bird River	7	7	100	65	100	Impaired

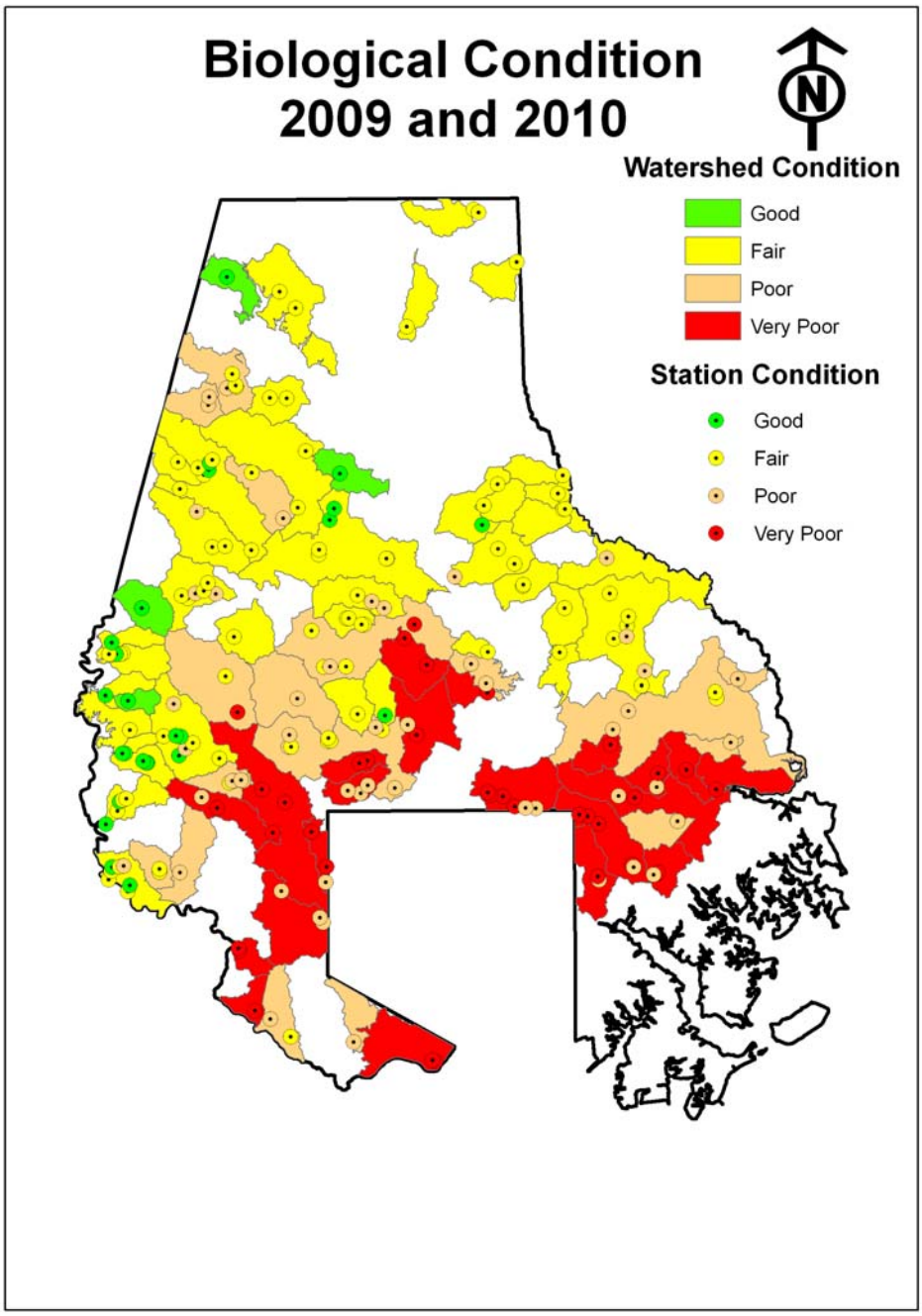


Figure 9-12: Probabilistic Biological Monitoring results for 2009 and 2010. Sample points are superimposed on named Baltimore County subwatersheds.

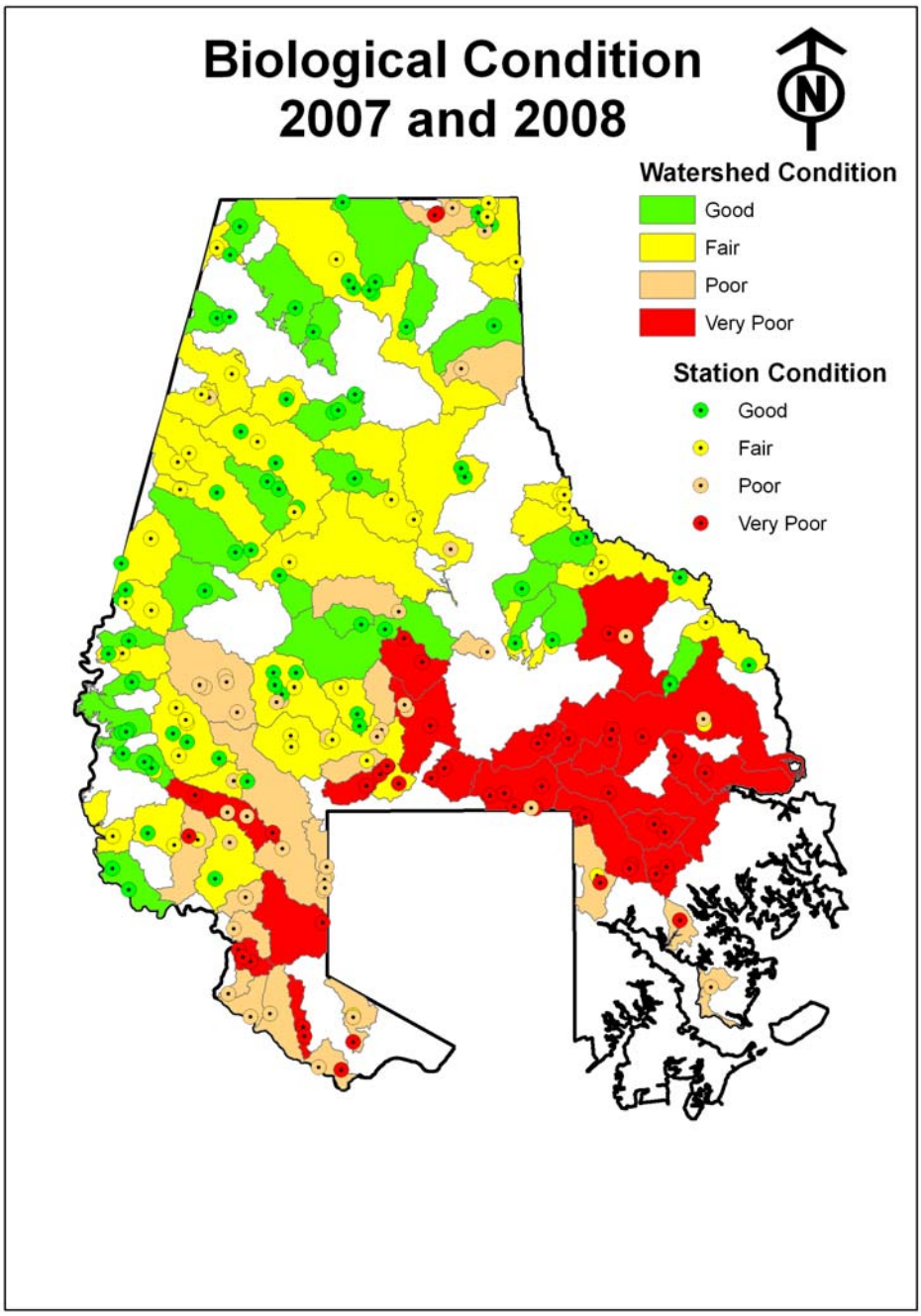


Figure 9-13: Probabilistic Biological Monitoring results for 2007 and 2008. Sample points are superimposed on named Baltimore County subwatersheds.

Based on the percent stream mile criteria, Deer Creek met biological criteria. Prettyboy Reservoir, Loch Raven Reservoir, Little Gunpowder Falls, Lower Gunpowder Falls, and Bird River did not meet biological criteria. The designation of Prettyboy as impaired in 2010 is an

artifact of the site distribution. Most of the sites sampled were in the southern part of the watershed in areas where agriculture was the primary land use. Figures 9-15 and 9-16 show that sites and sub-watersheds that are close to the population centers of Baltimore County are the most impaired. Rolling averages were calculated using the probabilistic data for the entire period of record. This simple, smoothing technique clarifies underlying patterns in data. Two-year rolling averages were calculated for sub-watersheds in the Gunpowder and Patapsco-Back River watersheds, and for the Gunpowder and Patapsco-Back River watersheds overall. The results are shown in Figure 9-14. Jones Falls and Patapsco River averages were almost identical to the Patapsco-Back River overall averages, which showed a slight increase followed by a slight decrease. Gwynns Falls increased over the period of record, to achieve an average BIBI similar to Jones Falls and the Patapsco River. Liberty Reservoir rolling averages were the highest in Patapsco-Back River, and also increased slightly. Back River rolling averages were the lowest, and were clearly separated from the other sub-watersheds. Sub-watersheds in the Gunpowder Falls showed slight changes. Little Gunpowder, Prettyboy, Loch Raven, and Deer Creek grouped together, slightly above the overall Gunpowder Falls average. The Lower Gunpowder and Bird River separated from the other sub-watershed rolling averages. For all watersheds, the rolling averages suggest stability in biological condition over this short period of record.

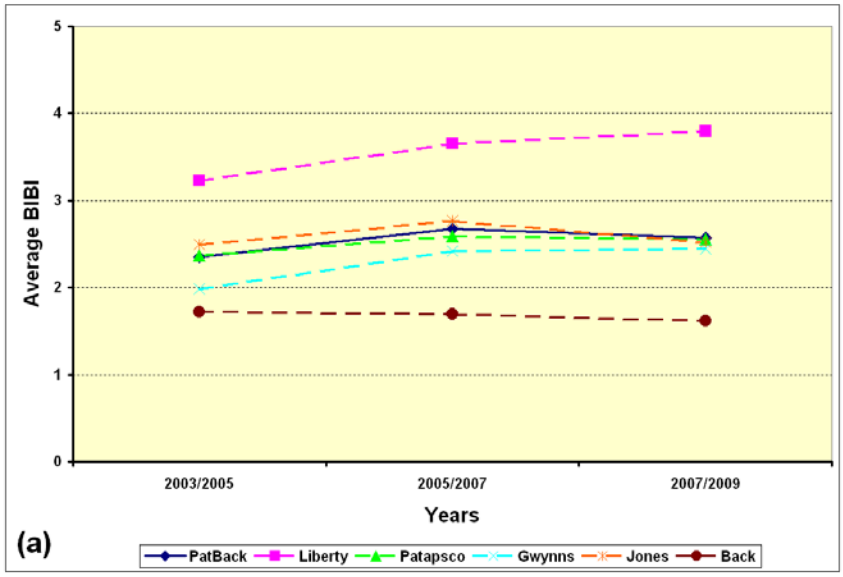


Figure 9-14a: BIBI rolling averages for Patapsco/Back River probabilistic monitoring sites between 2003 and 2009.

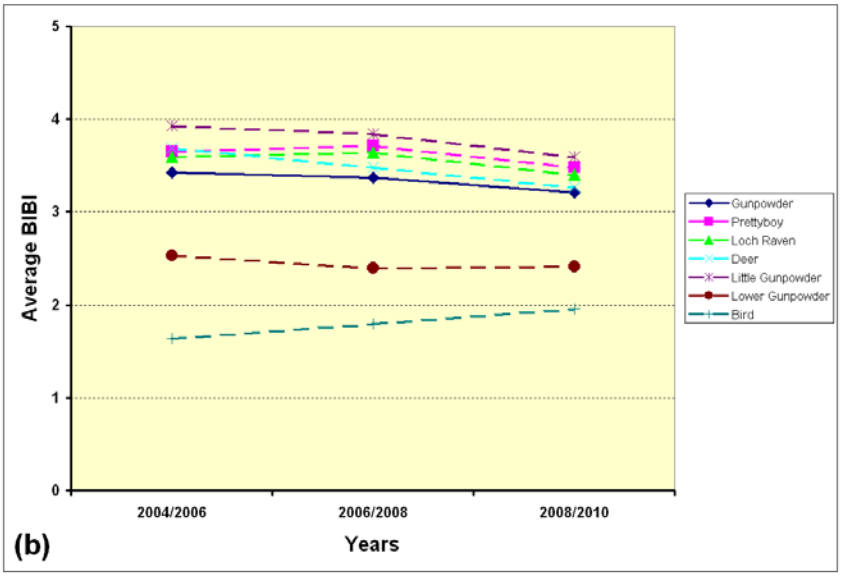


Figure 9-14b: BIBI rolling averages for Gunpowder/Deer Creek probabilistic monitoring sites between 2004 and 2010.

There are 17 sentinel sites in the Patapsco/Back River drainage and 13 sentinel sites in the Gunpowder River/Deer Creek drainage. The sentinel sites represent environmental variation over a range of watershed land use. Sentinel sites were sampled in 2003 and 2004, and 2006-2010. Figure 9-15 shows the mean BIBI scores for sentinel sites, by watershed, between 2003 and 2010. The biological condition of sentinel sites in the Patapsco/Back River drainage tended toward Poor and Very Poor ratings over the period of record. Liberty Reservoir sentinel sites were in the Fair category. The BIBI for Gunpowder River/Deer Creek sites were Fair to Good. Lower Gunpowder BIBI varied between Very Poor and Poor.

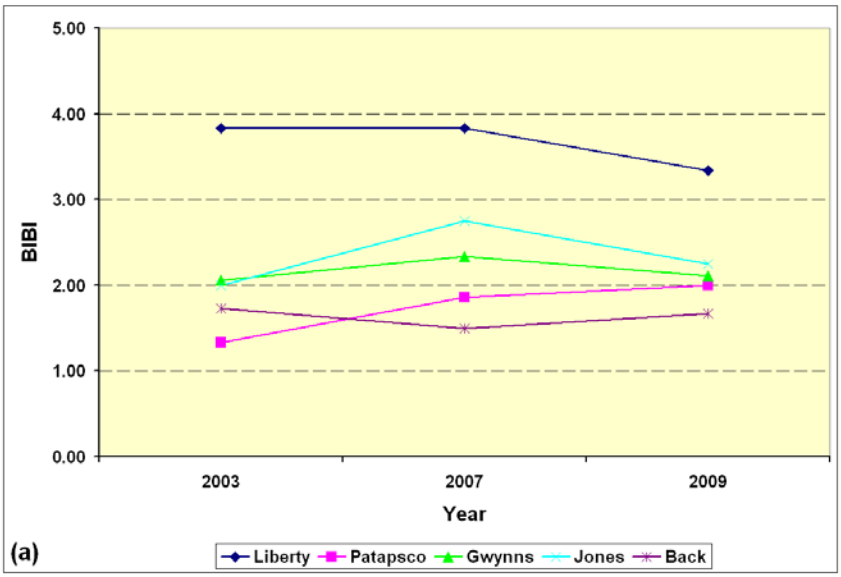


Figure 9-15a: Mean BIBI scores for Patapsco/Back River Sentinel Sites between 2003 and 2009.

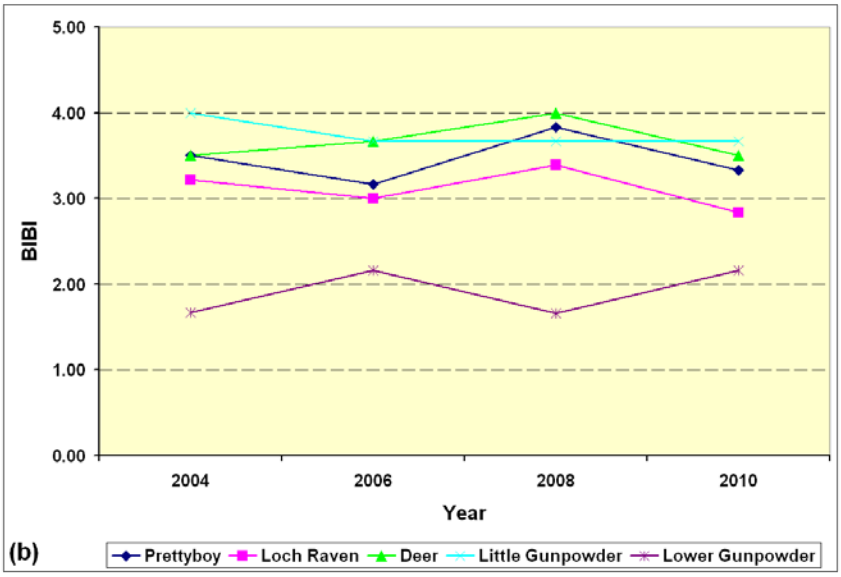


Figure 9-15b: Mean BIBI scores for Gunpowder/Deer Creek Sentinel Sites between 2004 and 2010.

9.4.2 Capital Improvement Projects Monitoring

Baltimore County monitors benthic macroinvertebrate and fish assemblages in conjunction with several capital improvement stream restoration projects. Stream segments are monitored pre- and post-construction to document any change in the biological community. As with the Probablistic Monitoring Program, MBSS methods are followed, including stream physical habitat assessments. Habitat assessments are based on visual ratings of instream and riparian zone characteristics that are important to stream biological communities. A physical habitat index (PHI) is calculated based on the visual ratings. The Minebank Run, Redhouse Run, Spring Branch, and Woodvalley projects are currently being monitored under the Capital Improvement Projects Monitoring Program. Their ADC map locations are displayed in Table 9-6.

Table 9-6: Stream Restoration Biological Monitoring Site Locations

Station	Stream and Location	ADC Map, Grid
Minebank Run II Stream Restoration		
MNBK-1	Minebank Run upstream of Gunpowder River	28 C2
MNBK-2	Minebank Run upstream of USGS gage	28 B3
MNBK-3	Minebank Run downstream of bridge @ park	28 A4
MNBK-4	Minebank Run upstream of bridge @ park	28 A4
MNBK-5	Minebank Run behind Loch Raven High School	27 K5
MNBK-6	Minebank Run upstream of Cowpens Road	27 J5
MNBK-7	Minebank Run upstream of Glen Eagles Court	27 H6
MNBK-8	Minebank Run upstream of MNBK-7	27 H6
MNBK-9	Minebank Run downstream of Cromwell ES	27 G6
JB-1	Jennifer Branch upstream of Gunpowder River	28 J2
JB-2	Jennifer Branch near archery range	28 J3
Woodvalley Stream Restoration		
WDVL-1	Unnamed Trib to Jones Falls at Michelle Way	25 F7
WDVL-2	Unnamed Trib to Jones Falls at Gardenview Way	25 G6
WDVL-3	Unnamed Trib to Jones Falls at Evan Way	25 F6
Redhouse Run Stream Restoration		
RH-1	Redhouse Run upstream of Twilight Court	36 G3
RH-2	Redhouse Run downstream of Home Road	36 F3

RH-3	Redhouse Run downstream of Raspe Avenue	36 F2
Spring Branch Stream Restoration		
MER-1	Merryman Branch at Old Bosley and Dulaney Valley Roads	19 F8
SB-1	Spring Branch downstream of Pot Spring Road	19 D12
SB-2	Spring Branch upstream of Pot Spring Road	19 C12
SB-7	Spring Branch downstream of Dulaney Valley Road	19 E12
SB-8	Spring Branch upstream of Dulaney Valley Road	19 E12

The Minebank Run stream restoration project has been monitored annually since April 2004, at eleven sampling stations (Figure 9-16). The stream restoration was completed in 2002 (Phase I) on the reach where MNBK-6, MNBK-7, MNBK-8, and MNBK-9 are located. The stream restoration was completed in 2005 (Phase II) where MNBK-2, MNBK-3, MNBK-4, and MNBK-5 are located. Stations MNBK-1, JB-1, and JB-2 are controls. As of 2010, DEPRM has collected seven years of post-restoration data at the Phase I stations, and two years of pre-restoration and six years of post-restoration data at the Phase II stations. While all eleven stations are sampled for macroinvertebrates, fish are sampled at a sub-set of the stations: MNBK-1, MNBK-2, MNBK-4, MNBK-7, and JB-1.

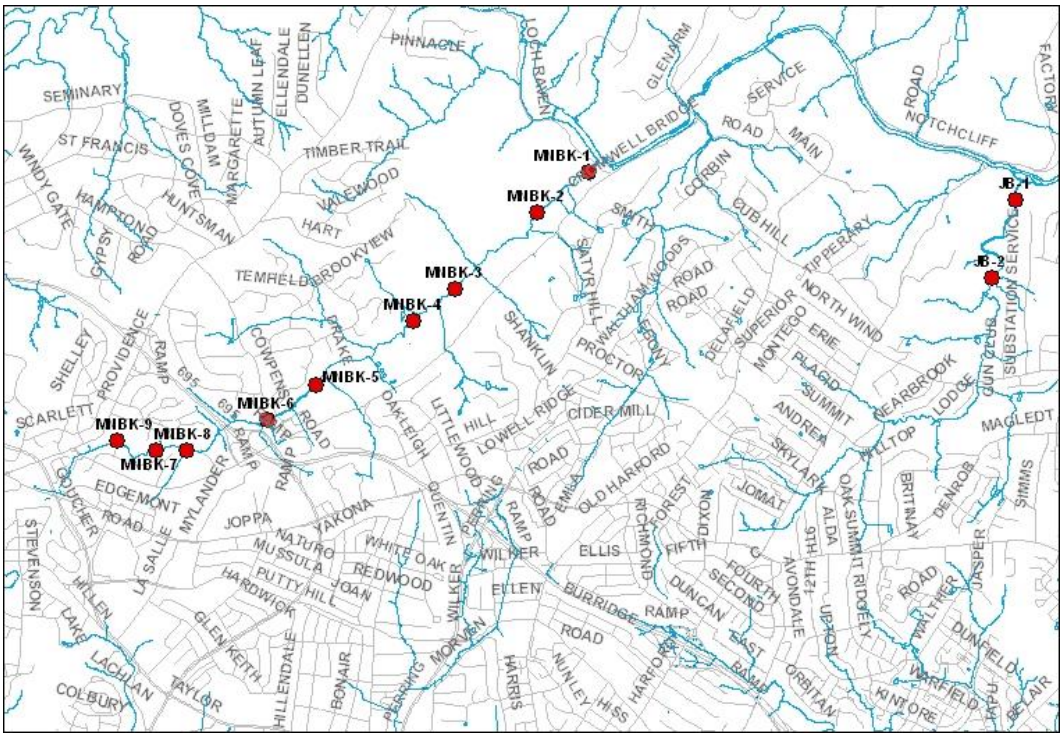


Figure 9-16: Minebank Run Biological Monitoring Stations.

BIBI scores across all treatments were Very Poor at restored stations (Table 9-7). The FIBI scores were either Fair or Poor. Figure 9-17 shows annual biological index values since the inception of monitoring for five of the eleven stations. BIBI values have been constant since the completion of the Phase II restoration, with a slight increase at MNBK-2 and MNBK-7, a pattern, which was also observed at both control stations. FIBI values have remained constant, also. Only one station, MNBK-4, has shown steady increase in FIBI the last two years. Physical habitat condition has generally increased since 2007. Benthic populations continue to be

depressed, likely due to the flashy hydrology of Minebank Run. Fish are more mobile and thus better able to find refugia during high flow events. Benthic macroinvertebrates are dependent on stable, diverse substrate, with ready access to the hyporheic zone during high flow events.

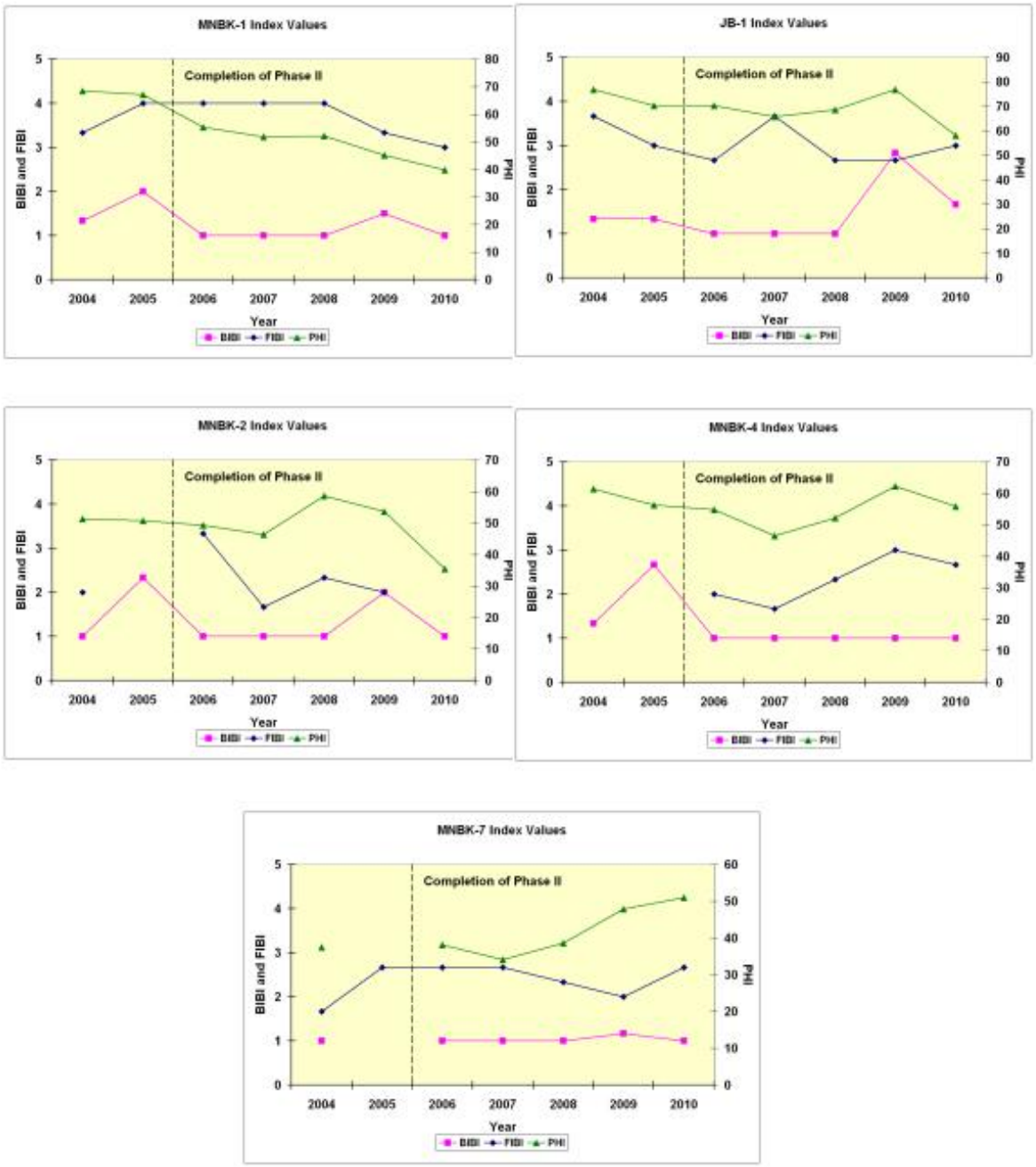


Figure 9-17: Biological index values at the downstream, unrestored control (MNBK-1); the unrestored control (JB-1); restored Phase II (MNBK-2 and MNBK-4); and restored Phase I (MNBK-7) stations from beginning of monitoring to present.

The Woodvalley stream restoration project was completed in 2005. Pre-restoration data were collected in 2004 at two stations: (1) WDVL-1, unnamed tributary to Jones Falls at Michelle Way (within the restored reach), and (2) WDVL-2, unnamed tributary to Jones Falls at Gardenview Way. WDVL-2 served as a control for the restored reach. Post-restoration data were collected beginning in 2005. A third station, WDVL-3, unnamed tributary to Jones Falls at Evan Way and Park Heights Avenue, was added as a control in 2005 because no fish were collected at WDVL-2 in 2004. See Figure 9-18 for station locations. Presently, biological sampling is done at WDVL-1 and WDVL-3.

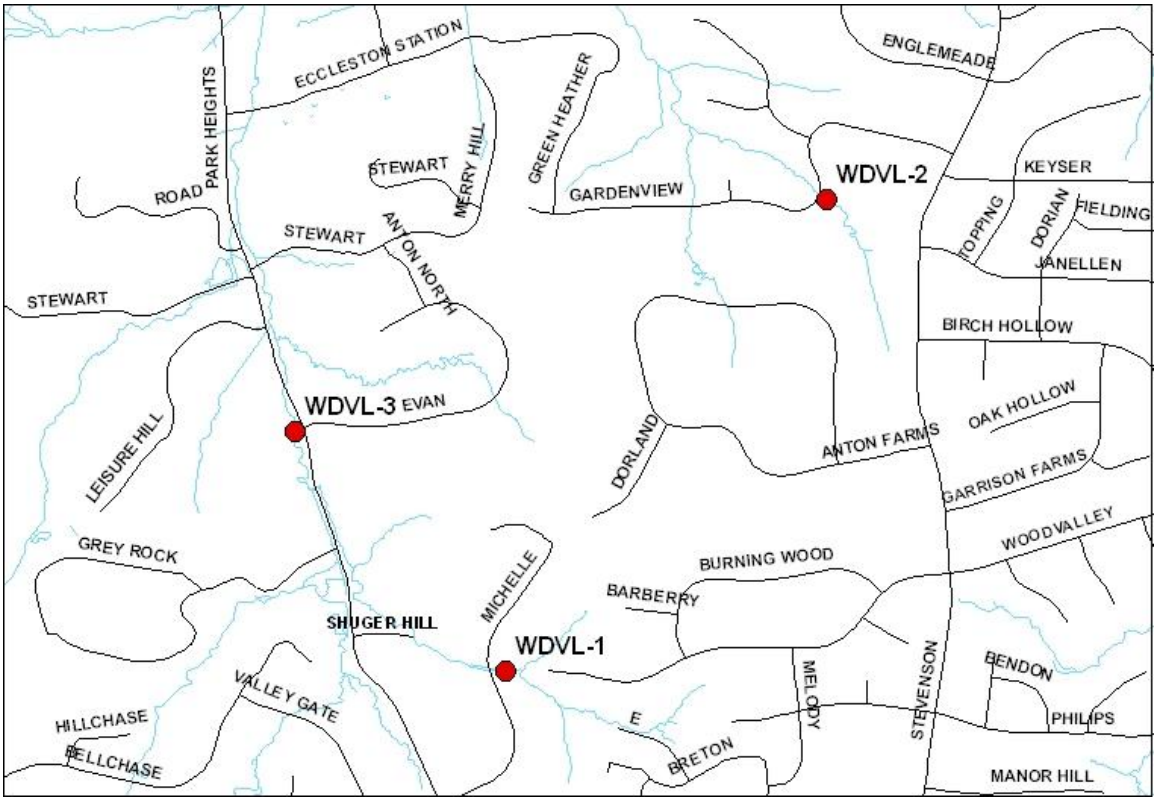


Figure 9-18: Woodvalley Biological Monitoring Station Locations.

The BIBI and FIBI scores at WDVL-1 and WDVL-3 rated Very Poor (Figure 9-19). The PHI at WDVL-1 was Degraded while the PHI at WDVL-3 was Partially Degraded. With the exception of fish at the restored station, both biological indices decreased since 2008. Physical habitat has improved at the restored site from Severely Degraded to Partially Degraded since completion of restoration. Based on biological index values, the restored station is performing similarly to the control.

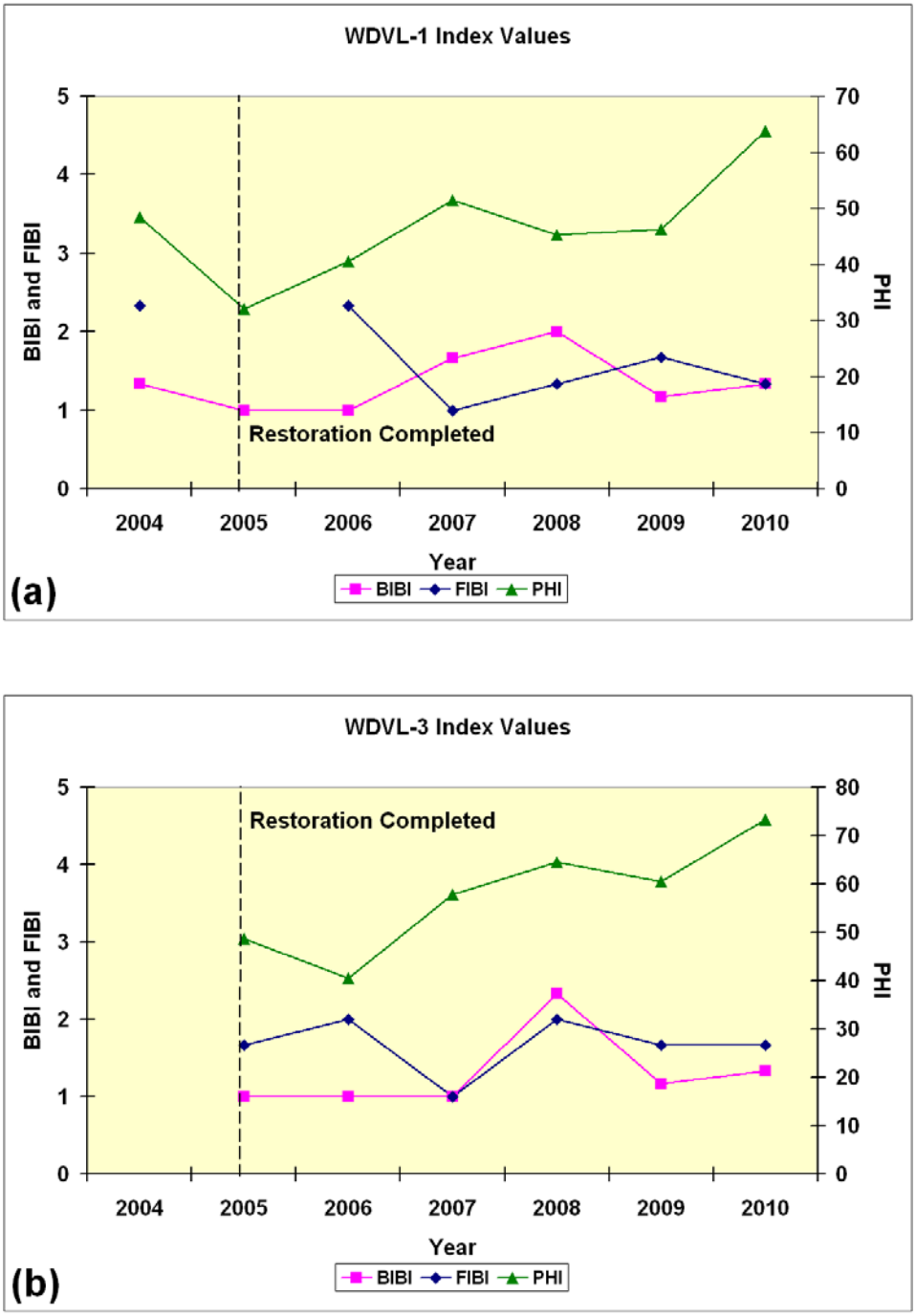
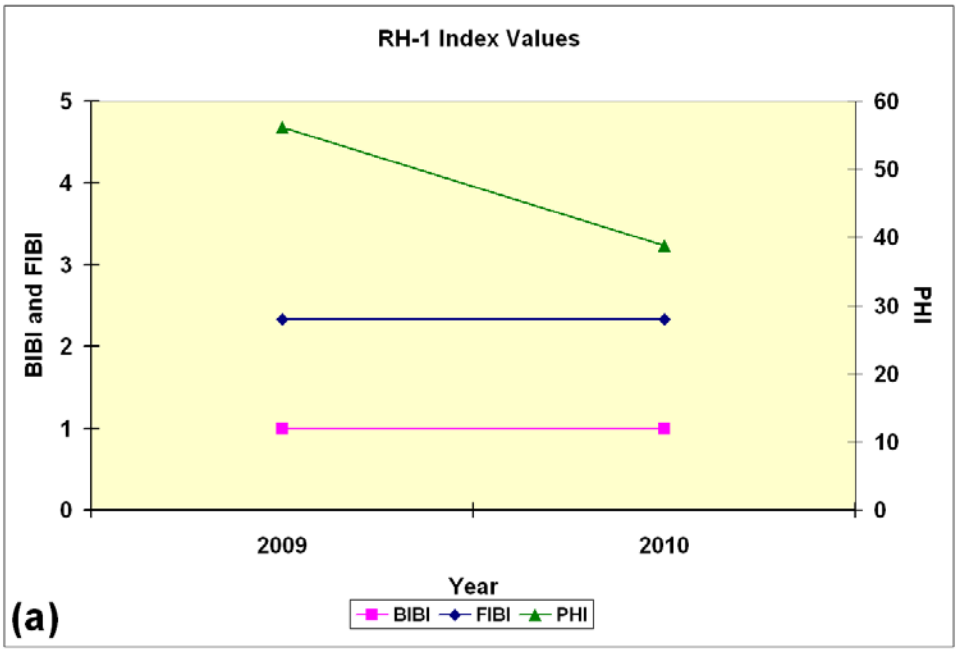
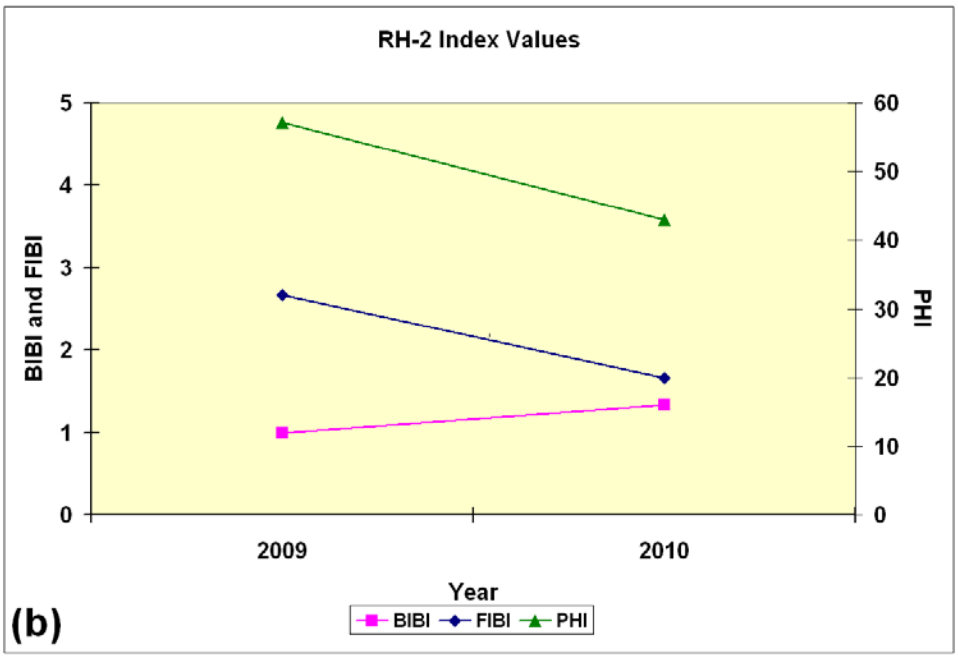


Figure 9-19: Benthic and Fish IBI and Physical Habitat Index Values for (a) WDVL-1 (restored) and (b) WDVL-3 (control).

Redhouse Run, a tributary of the Back River, was restored in early 2011. Pre-restoration monitoring of benthos and fish was completed in 2009 and 2010. Figure 9-20 summarizes BIBI, FIBI, and PHI values for three stations.


RH-1 Index Values
BIBI and FIBI
PHI
5
4
3
2
1
0
60
50
40
30
20
10
0
2009
2010
Year
BIBI
FIBI
PHI
(a)


RH-2 Index Values
BIBI and FIBI
PHI
5
4
3
2
1
0
60
50
40
30
20
10
0
2009
2010
Year
BIBI
FIBI
PHI
(b)

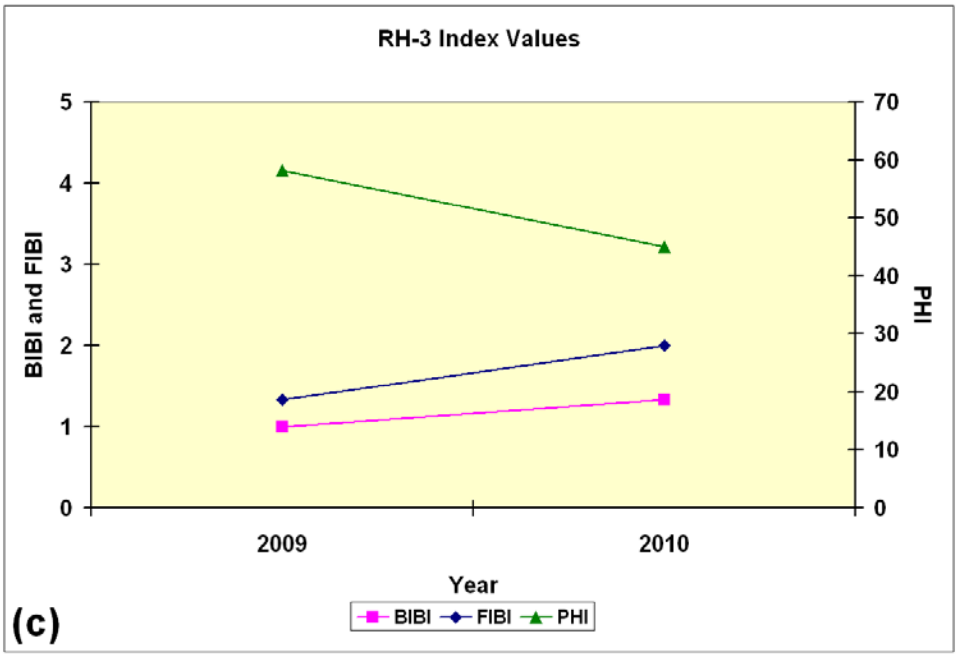


Figure 9-20: Biological index values for Redhouse Run stations, 2009 and 2010.

Presently, Redhouse Run exhibits the biological and physical characteristics of an urbanized stream. Benthic populations are depressed (all BIBI values are rated Very Poor). FIBI values, while slightly better than BIBI values, are Poor at RH-1 and RH-2, and Very Poor at RH-3. PHI values show stream habitat to be impaired. Unstable stream banks and stream bottom substrates characterize the study reach. Data collected during the 2011 index periods will determine any immediate benefits of the stream restoration, which was completed early in 2011.

Spring Branch, a direct tributary to Loch Raven Reservoir, was restored during the summer of 2008, between Dulaney Valley Road and Pot Spring Road. Spring Branch had previously been restored upstream of Pot Spring Road. Five stations were monitored for benthos during the Spring Index Period and three stations were monitored for fish during the Summer Index Period. Pre-restoration data were collected during 2008. Post-restoration data were collected during 2009 and 2010. Biological index values are presented in Figure 9-21.

Benthic community condition has shown little early response to restoration. All stations are rated Very Poor, except for MER-1, the control station, which is rated Poor. Fish community condition showed slight initial improvement in 2009, but decreased slightly in 2010. Physical habitat condition has steadily decreased at the station upstream of Dulaney Valley Road (SB-8). This may be a result of the filling of several deep areas since the completion of restoration. The restored station upstream of Pot Spring Road (SB-2) has shown PHI values which are almost identical to the control site (MER-1).

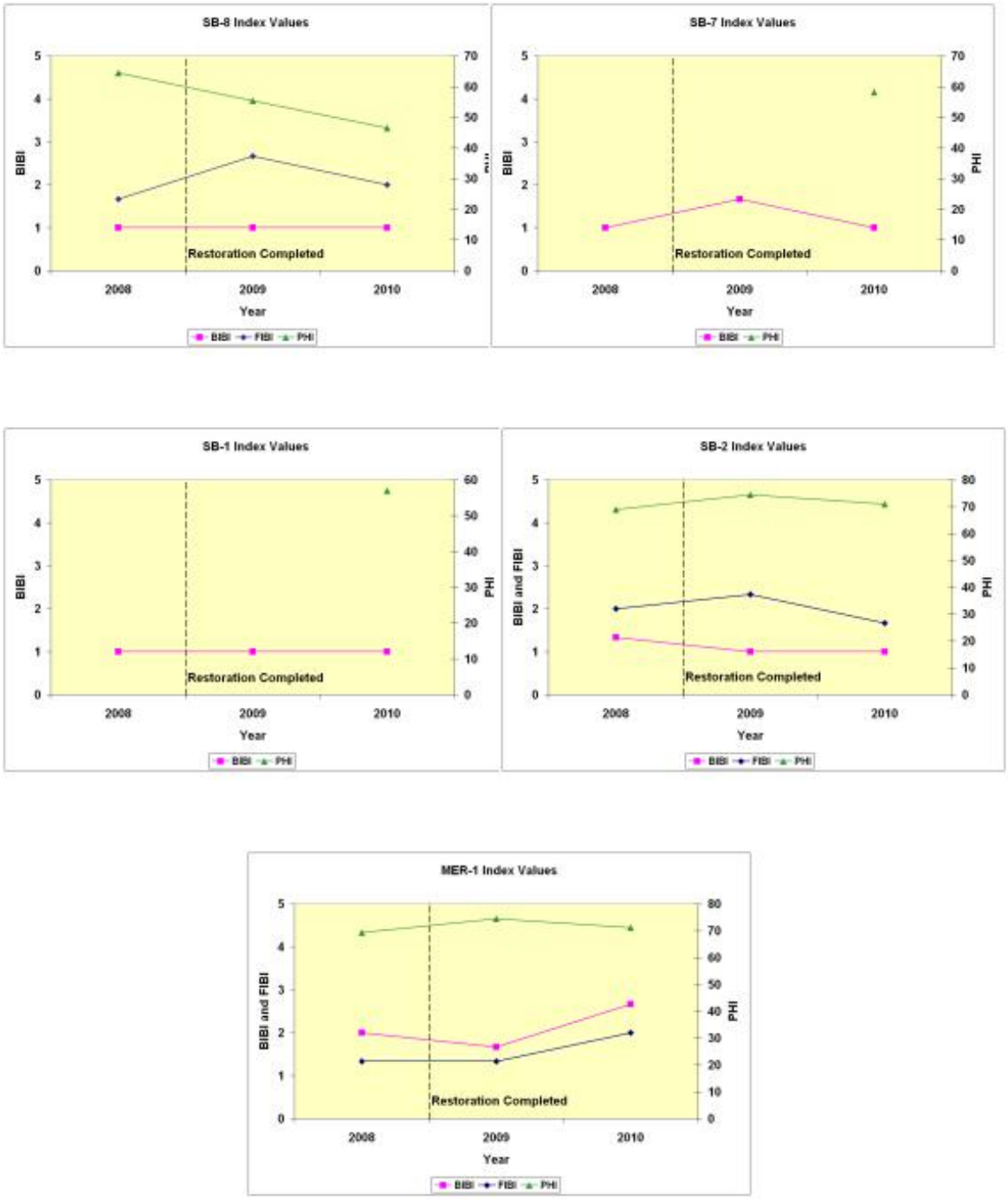


Figure 9-21: Spring Branch biological index values.

9.4.3 Reference Site Monitoring

Baltimore County has been monitoring eight (8) reference sites since spring of 2001. GIS was used to identify watersheds within the County that contained greater than 50% forested land use and less than 20% urban land use. An initial suite of twenty-one (21) sites was reduced to eight (8) sites for future monitoring based on land use, chemical, and stream physical habitat benchmarks. The ADC map site locations, along with the stream name are displayed in Table 9-7.

Table 9-7: Reference Site Locations

Station	Stream Name and Location	ADC Map, Grid
REF-001	Baisman Run upstream of Ivy Hill Road	18 C5
REF-004	Poplar Run upstream of Gunpowder Road	1 H11
REF-009B	Springhouse Run downstream of Gunpowder Rd	1 H8
REF-012	Panther Branch upstream of Gunpowder Falls	7 H8
REF-013	Mingo Branch upstream of Gunpowder Falls	7 C7
REF-015	Charles Run upstream of Gerting Road	8 F11
REF-017	Sunnyking Run near Sunnyking Drive	24 A3
REF-019	Fourth Mine Branch upstream of Stablers Church Road	3 H12

The eight sites are sampled annually for benthic macroinvertebrates in the spring index period using MBSS sampling protocols. The samples are sorted and identified in the laboratory to genus or the lowest practical taxonomic level. The metrics in Table 9-3 are used to calculate BIBIs. Fish sampling is done only periodically to reduce stress to the naturally reproducing trout populations inhabiting these streams. All reference sites had BIBI values in the Fair to Good range in 2010 (Figure-22), although BIBI values have varied in relation to climactic factors over the period of record. The sites support benthic communities with high numbers of EPT and mayfly taxa, low percentages of chironomids, and high percentages of clingers.

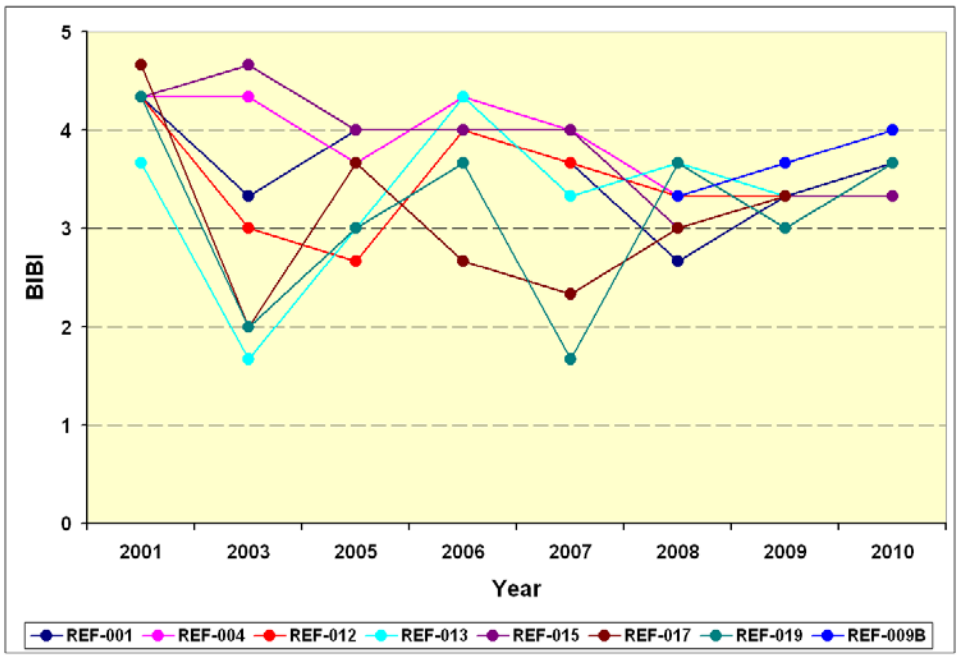


Figure 9-22: Benthic IBI values for Reference Sites, 2001-2010

Stream physical habitat is assessed annually at the reference stations. Field scoring of habitat features is converted to the MBSS Physical Habitat Index (PHI). Values for PHI over the period of record are shown in Figure 9-23. Most PHI values have remained in the minimally or partially degraded categories.

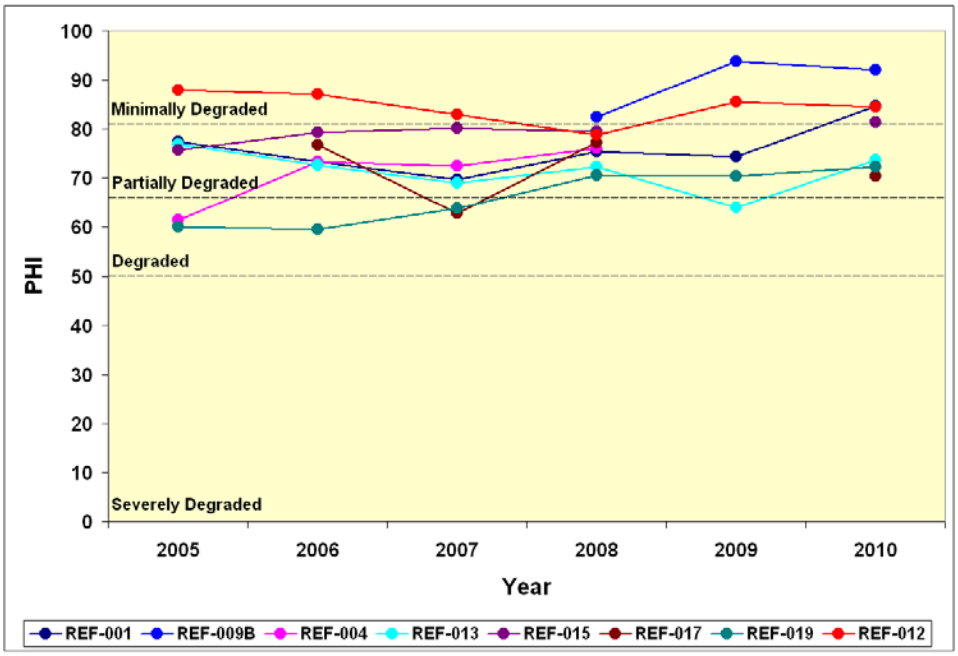


Figure 9-23: Physical Habitat Index values for Reference Sites, 2001-2010

9.4.4 Submerged Aquatic Vegetation Monitoring Program

Baltimore County has conducted Submerged Aquatic Vegetation monitoring since 1989 on certain waterways. With the advent of water quality standards for submerged aquatic vegetation, reporting on the monitoring results commenced in the 2006 NPDES Annual Report. During the last Water Quality Standards Triennial Review Maryland Department of the Environment adopted standards for tidal water submerged aquatic vegetation and water clarity, among other standards also adopted. The standards are based on water quality segments that are derived from the Chesapeake Bay Program model. There are a total of seven segments in Baltimore County tidal waters. Three of the segments (MIDOH, GUNOH1, and BACOH) are entirely within Baltimore County tidal waters. Four other segments have tidal waters that extend to other jurisdictions. Two of these segments (CB2OH and CB3MH) are Chesapeake Bay mainstem segments and extend to the eastern shore of Maryland. The Chesapeake Bay Program draft document *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries 2006 Addendum* provides guidance on assessing the attainment of the SAV acreage criteria. The document states "the shallow-water bay grass designated use is considered in attainment if there are sufficient acres of SAV observed within the segment or there are enough acres of shallow-water habitat meeting the applicable water clarity criteria to support restoration of the desired acres of SAV for that segment." The recommended procedure is to use the **single best year SAV acreage** based on the most recent

three-year period of available data. The criteria may also be met by attaining water clarity acres for the most recent three-year period of available data. The water clarity depth varies by tidal segment (see Table 9-8). Water clarity data is currently not collected in Baltimore County, so only the SAV acreage will be used.

The 2009 Triennial Review of Water Quality Standards proposed several changes that affect the SAV criteria. First, the tidal segment BACOH, which covers tidal Back River, has had a change in the target SAV acreage goal from 0 to 340 acres. Secondly, credit for meeting water clarity standards in areas with no SAV have changed from an acre by acre basis to 2.5 acres per acre basis. In other words, using Back River as an example, if no SAV were present in Back River, water clarity standards would have to be met for 850 acres (340 acres SAV goal X 2.5).

Baltimore County monitors SAV distributions in the spring and summer of each year in accordance with the US Fish and Wildlife methodologies. There are currently 29 waterways in the County that are monitored. In order to assess the total acres of yearly coverage for the creeks surveyed, the data for the spring and summer were analyzed for overlap in SAV distribution between the two seasons. The total SAV coverage for each year is calculated by the following formula:

$$\textbf{Total SAV}_{acres} = (\textbf{Spring SAV}_{acres} - \textbf{Overlap}_{acres}) + (\textbf{Summer}_{acres}\ \textbf{SAV} - \textbf{Overlap}_{acres}) + \textbf{Overlap}_{acres}$$

To estimate the progress in meeting the SAV goal for each tidal segment the Total SAV_{acres} are divided by the SAV goal for that segment. Only two of the seven segments are totally within Baltimore County jurisdiction and therefore can be assessed for SAV criteria attainment. However, these two segments are not entirely surveyed for SAV coverage and so, like the other five segments this analysis will only provide a conservative estimate of SAV criteria attainment. Table 9-8 presents the SAV water quality standard for each segment and the results of the last three years of SAV monitoring. The yellow highlighted water quality segments lie entirely within Baltimore County. The green highlighted cells are the highest percent attainment for each water quality segment based on the last three years of data.

Table 9-8: SAV Standards and Baltimore County SAV Monitoring Results (2007-2009)

Water Quality Segment	SAV Goal (Acres)	Water Clarity Depth (m)	2008		2009		2010	
			Acres	% of Goal	Acres	% of Goal	Acres	% of Goal
MIDOH	879	2.0	518.0	58.9	686.2	78.1	646.5	73.5
GUNOH1	1,860	0.5	**	**	**	**	**	**
GUNOH2	572	2.0	187.7	32.8	296.9	51.7	255.4	44.7
BACOH	340	0.5	0	0	9.9	2.9	13.9	4.1
PATMH	389	1.0	6.1	1.6	17.7	4.6	17.0	4.4
CB2OH	705	0.5	197.9	28.1	218.0	30.9	224.0	31.8
CB3MH	1,370	0.5	77.4	5.6	155.7	11.4	160.2	11.7
Total SAV Acres			**987.1**		**1,384.5**		**1,317.0**	

** No monitoring conducted by Baltimore County in this segment.

The Middle River segment (MIDOH) has had the highest acreage of SAV coverage for the past three years. In 2004 Middle River attained 54.9% of the SAV criteria. 2008 saw a resurgence of SAV in Middle River with a total of 518 acres representing ~59% of the goal. This resurgence has continued in 2009 with 696.2 acres of SAV representing 78.1% of the goal for Middle River, with a slight drop off to 646.5 acres in 2010. Back River has the least amount of SAV coverage over the three-year period and is far from meeting the new draft criteria of 340 acres of SAV

coverage. However, there is an overall increasing trend in SAV coverage in Back River going from zero in 2008 to 13.9 acres in 2010. Overall, the SAV coverage has increased over time, with almost 1,400 acres of coverage in 2009 and only a slight drop off in 2010. Since not all of the county tidal waters are monitored through this program, the numbers represent a conservative estimate of progress in meeting the SAV goals. The Gunpowder segment (GUNOH1) is not monitored by Baltimore County.

Figure 9-24 displays the trends in SAV coverage over 22 years of monitoring. The figure displays the percent of the area survey that was covered by SAV. As can be seen from the figure there is a generally increasing trend in the percent of the area surveyed that is covered by SAV from a low in 1989 of 0.37% to a high of 37.0% in 2009. The 2010 SAV coverage was reduced to 30.8%. While there is a certain degree of variability, possibly related to climatic events (record wet year in 2003 with reduced % coverage) the overall trend is improved coverage.

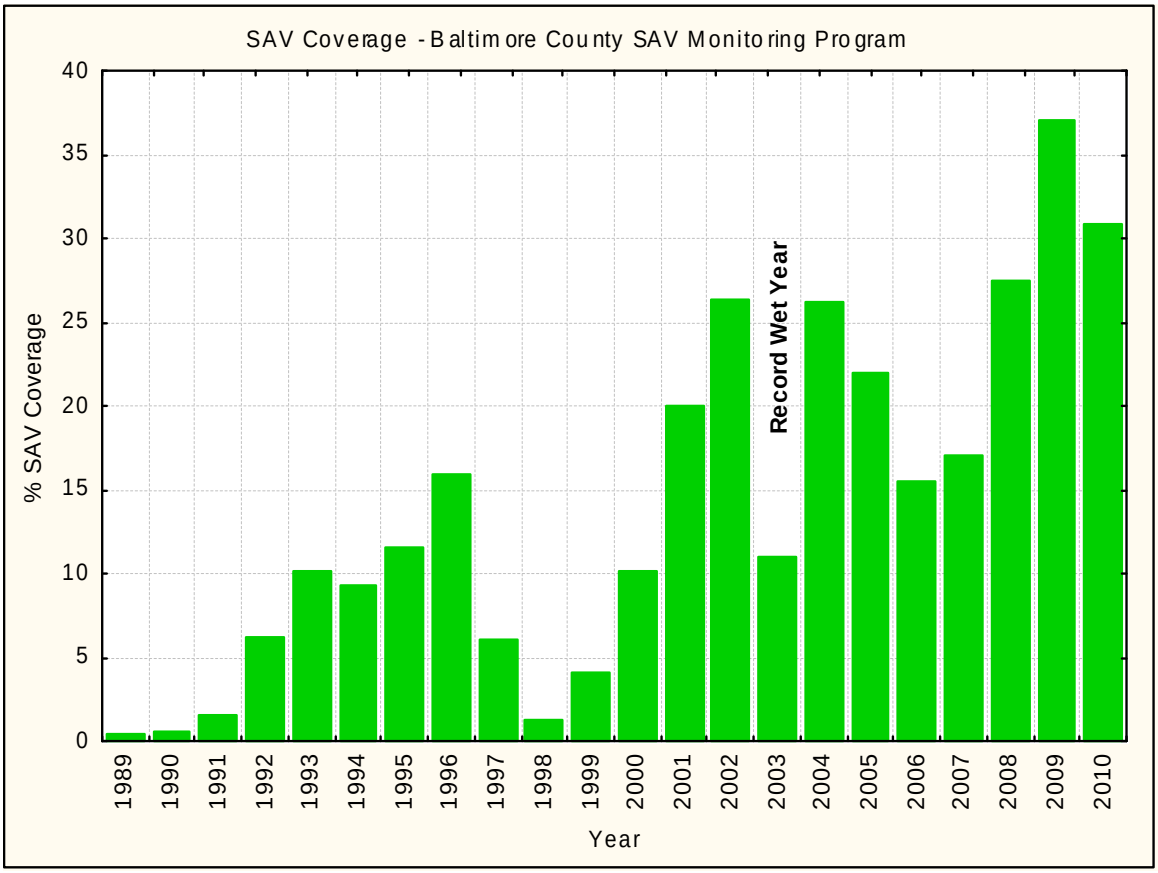


Figure 9-24: Baltimore County SAV Monitoring Program – Trends in % Coverage

9.5 Status of Brook Trout in the Prettyboy Reservoir Watershed

The overall goal of this study was to assess the current extent of wild brook trout in the Prettyboy Reservoir watershed. The first year of sampling was completed in 2008. The brook trout population data, and water temperature and physical habitat data, were used to establish fixed sampling stations to evaluate the variability/long-term stability of brook trout populations. Physical habitat and riparian zone conditions are being examined to isolate streams where habitat improvement measures may bolster brook trout populations. The objectives of the study in 2009

were to collect brook trout distribution and abundance data, air and water temperature data, and physical habitat data, in streams not sampled in 2008, and re-sample the fixed stations. In 2010, the fixed stations were re-sampled. The three years of data will be analyzed to determine the variability in brook trout populations in Prettyboy streams.

9.6 Stream Corridor Assessment

9.6.1 Introduction

In 1998, the Maryland Clean Water Action Plan identified the Prettyboy Reservoir watershed as one of the State's water bodies that did not meet water quality requirements. In response to this finding, the Maryland Department of Environment (MDE) and Baltimore County formed a partnership to develop a Watershed Restoration Action Strategy (WRAS) for the Prettyboy Reservoir watershed. This Stream Corridor Assessment (SCA) survey is a result of recommendations that came out of the WRAS. It was recommended that the remaining sub-watersheds be surveyed that had not been completed prior to the completion of the WRAS. In Baltimore County this includes Direct Drainage 1, 2, 3, and 4, Gunpowder Falls, Muddy Creek and Indian Creek (See Figure 25). The Indian Creek portion of Baltimore County is so small that it will be excluded. The remaing subwatersheds have been completed.
Direct Drainage 3 and 4 were completed fall 2008 and winter 2009, Gunpowder Falls was completed fall 2009. The most recent surveys in Direct Drainage 1, Direct Drainage 2, and Muddy Creek were completed between fall 2010 and spring 2011.

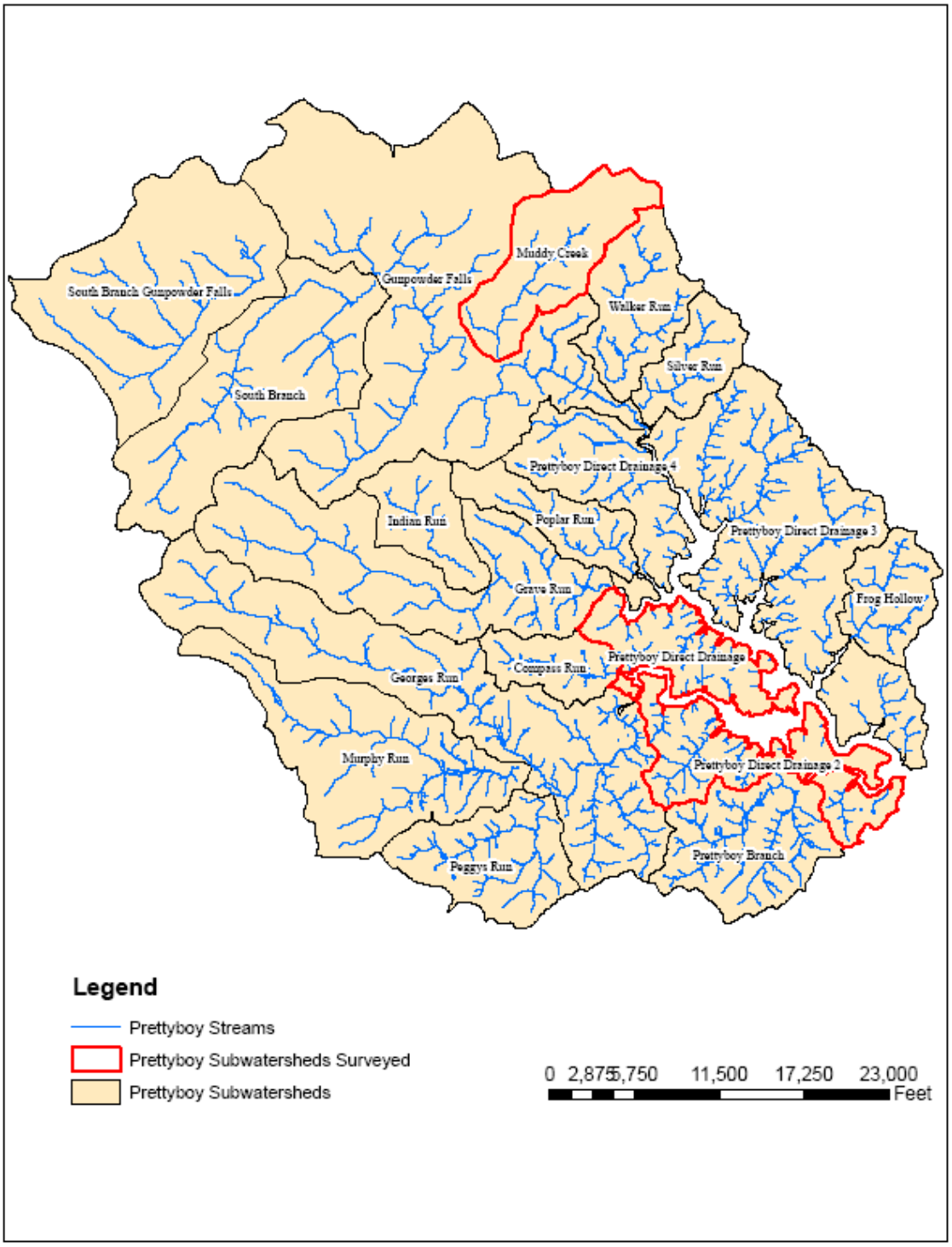


Figure 9-25 Map of Prettyboy Subwatersheds

The SCA survey provides descriptive and positional data for potential environmental problems along a watershed's non-tidal stream network. Developed by DNR's Watershed Services, the survey is a watershed management tool to identify environmental problems and helps prioritize restoration opportunities on a watershed basis. As part of the survey, specially trained personnel walk a watershed's streams and record data for several potential environmental problems that

can be easily observed within the stream corridor. Each potential problem site is ranked on a scale of one to five for its severity, correctability, and access for restoration work.

9.6.2 Summary of Results

The Stream Corridor Assessment crew surveyed 8.61 miles of streams in the Baltimore County portions of the Direct Drainage 1, Direct Drainage 2, and Muddy Creek subwatersheds (Figure 9-26 and Table 9-9). The sections of stream that were not walked were on private property where permission had not been granted, or where staff did not have adequate time to survey. Thirty-eight potential environmental problems were identified. The majority of the Baltimore County portion of the subwatershed is owned by Baltimore City. At the time of the survey, the most frequently observed potential problem sites were channel alterations, reported at 9 sites. Other potential environmental problems recorded during the survey included: 8 erosion sites, 7 inadequate buffers, 5 pipe outfalls, 4 unusual conditions/comments, 3 trash dumping sites, and 2 fish barriers. Additionally, crews recorded descriptive stream stability assessments at 15 reaches.

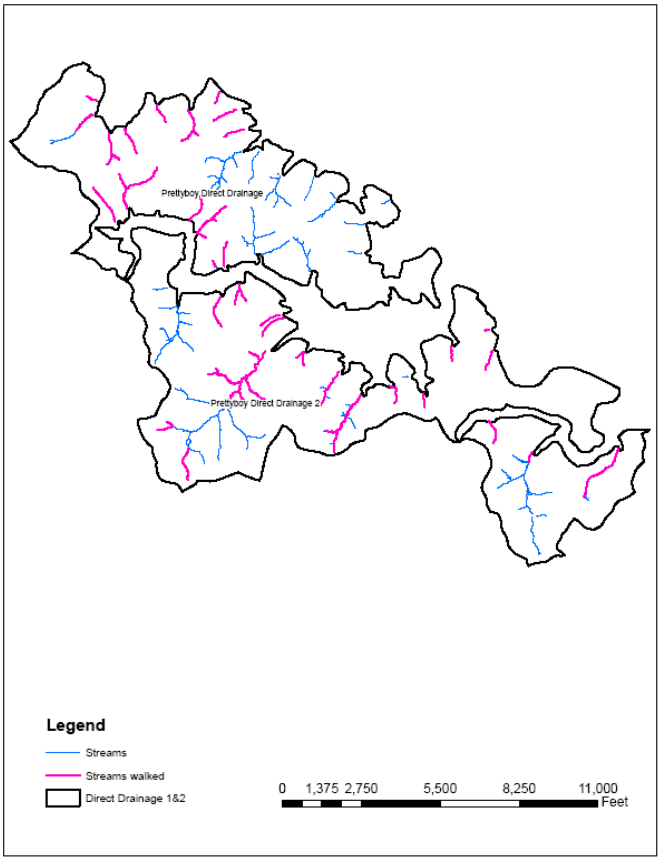


Figure 9-26a Map of the Streams Surveyed (Direct Drainage 1&2)

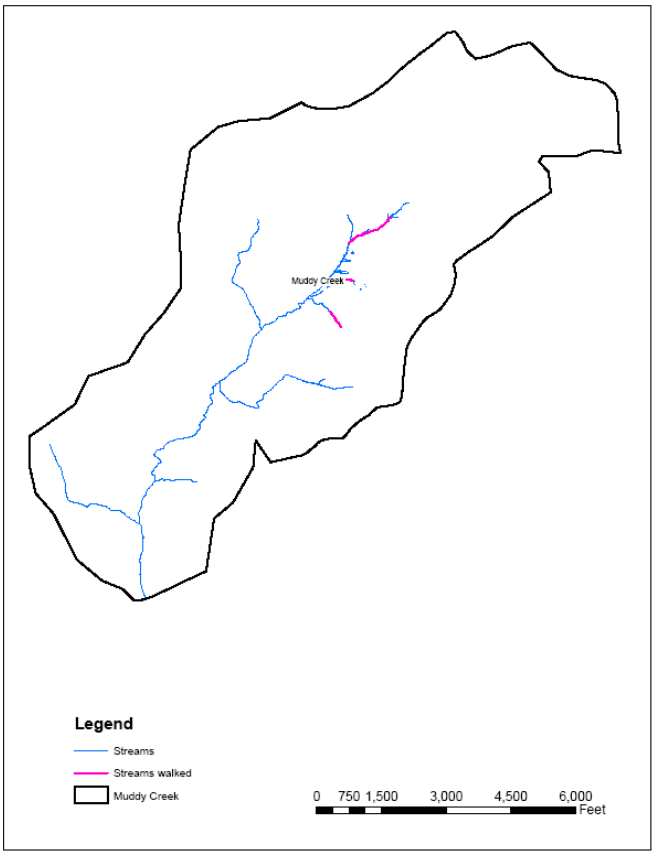


Figure 9-26b Map of the Streams Surveyed (Muddy Creek)

Table 9-10 presents a summary of survey results by problem type by sub-watershed. Figure 9-27 provides a histogram of potential problems found by sub-watershed. Table 9-11 provides a listing of information by site number. In Table 9-12, the data are presented by problem type and lists the collected descriptive data. Presenting the data by problem type allows the reader to see which problems are rated as most severe or easiest to correct within each category. Result categories are discussed further in order of those with the greatest number of sites to those with the least. As mentioned earlier, the number of potential problem sites is not the only measure of the overall extent of the problem, but is used here to order the data.

Table 9-9 Total Stream Miles and Stream Miles Surveyed, by Subwatershed

Subwatershed	Total Stream Miles	Miles Surveyed	Percentage
Direct Drainage 1	6.91	3.32	48%
Direct Drainage 2	10.23	4.9	48%
Muddy Creek	1.51	0.39	26%

Table 9-10a Summary of Results From Direct Drainage 1

Potential Problems Identified	Number	Estimated Length (mi)	Very Severe	Severe	Moderate	Low Severity	Minor
Pipe Outfall	0		0	0	0	0	0
Fish Barrier	1		0	0	0	1	0
Inadequate Buffer	1	0.1	0	1	0	0	0
Erosion	3	0.17	0	0	1	0	2
Unusual Condition	1		0	0	0	0	1
Channel Alteration	1	0.001	0	0	0	1	0
Trash Dumping	1		0	0	0	1	0
Exposed Pipe	0		0	0	0	0	0
Construction	0		0	0	0	0	0
Total	8	0.26	0	1	1	3	3
Representative Sites	3						

Table 9-10b Summary of Results From Direct Drainage 2

Potential Problems Identified	Number	Estimated Length (mi)	Very Severe	Severe	Moderate	Low Severity	Minor
Pipe Outfall	3		0	0	1	2	0
Fish Barrier	1		0	0	0	1	0
Inadequate Buffer	4	0.20	0	1	1	2	0
Erosion	5	0.44	0	0	2	1	2
Unusual Condition	2		0	0	1	1	0
Channel Alteration	7	0.03	0	0	0	2	5
Trash Dumping	2		0	1	0	0	1
Exposed Pipe	0		0	0	0	0	0
Construction	0		0	0	0	0	0
Total	24	0.66	0	2	5	9	8
Representative Sites	12						

Table 9-10c Summary of Results From Muddy Creek

Potential Problems Identified	Number	Estimated Length (mi)	Very Severe	Severe	Moderate	Low Severity	Minor
Pipe Outfall	2		0	0	0	0	2
Fish Barrier	0		0	0	0	0	0
Inadequate Buffer	2	0.32	1	0	0	1	0
Erosion	0		0	0	0	0	0
Unusual	1		0	1	0	0	0

Condition							
Channel Alteration	1	0.002	0	0	0	0	1
Trash Dumping	0		0	0	0	0	0
Exposed Pipe	0		0	0	0	0	0
Construction	0		0	0	0	0	0
Total	6	0.32	1	1	0	1	3
Representative Sites	0						

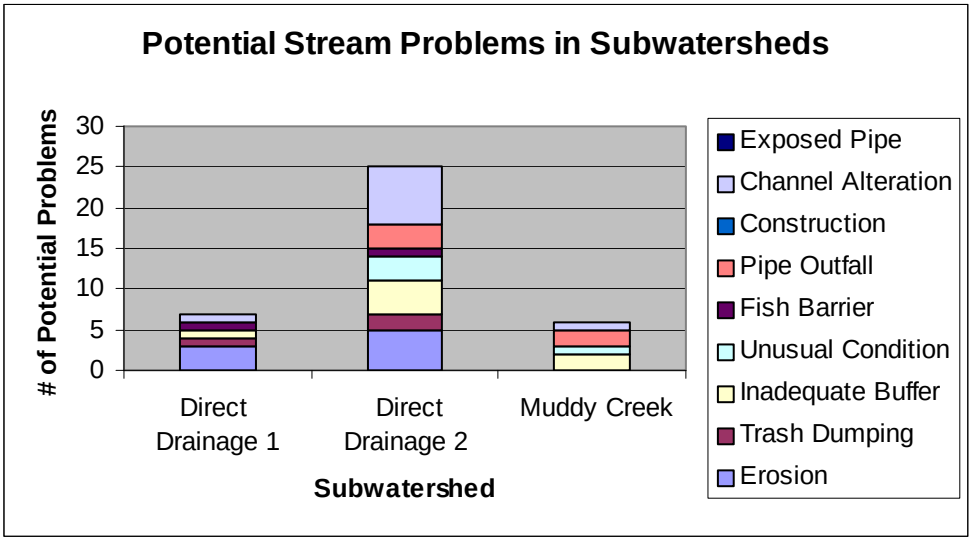


Figure 9-27 Potential Stream Problems

9.6.3 Summary of Erosion

The survey teams reported 3 eroding stream banks that totaled 3,194 feet or 0.6 miles (7% of the 8.61 miles surveyed). Figure 9-28 shows the severity distribution of these sites, and Figure 9-29 shows their location and severity. There were no erosion sites observed in the Muddy Creek Watershed. In this survey, unstable eroding streams are defined as areas where the stream banks are almost vertical, and the vegetative roots along the stream are unable to hold the soil onto the banks. The severity rating of the site is based on the length and height of the eroding streambank. An erosion site was rated as very severe if it was a long section of stream (>1000 ft.) with unstable banks on both sides; a site was ranked as minor if it was a short section of stream (<300 ft.) with limited bank instability. While survey teams are asked to visually assess whether the stream was down cutting, widening, or headcutting at a specific site, the only way to evaluate the full significance of the erosion processes at a specific site is to do more detailed monitoring over time.

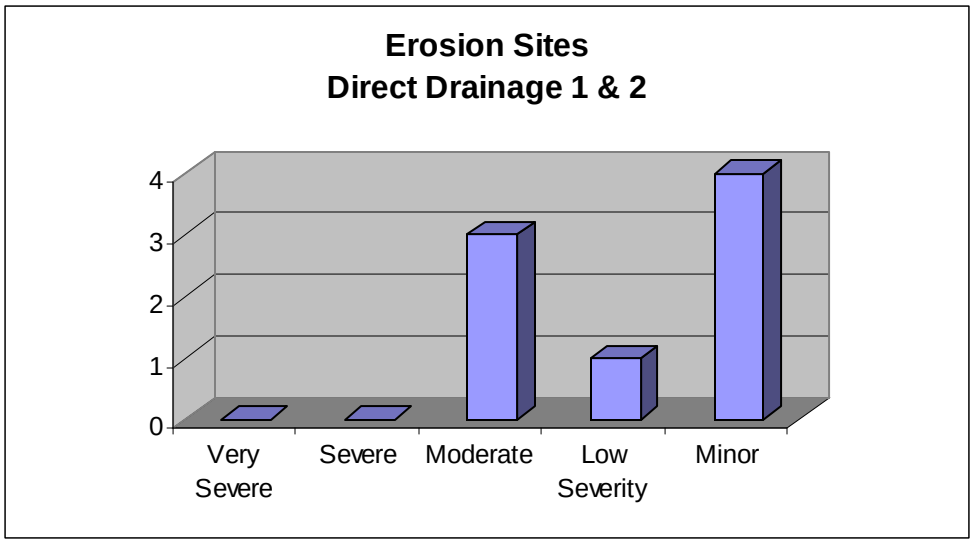


Figure 9-28 Severity Distribution of Sites

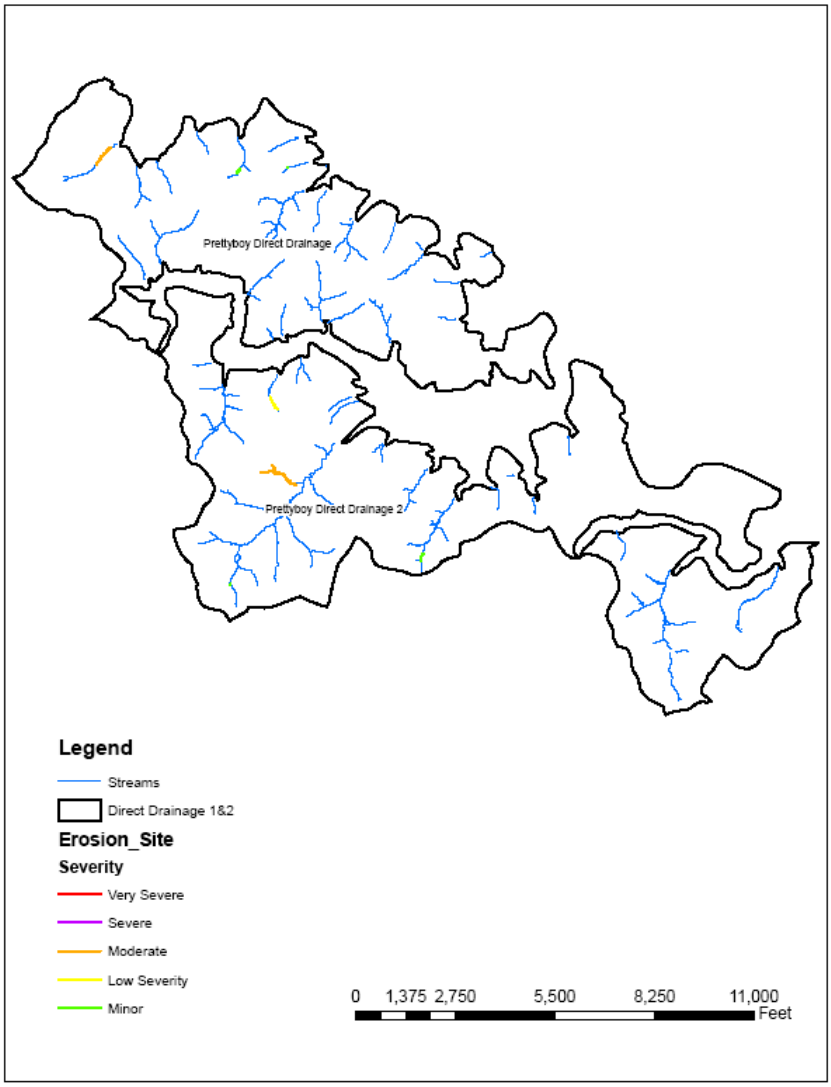


Figure 9-29 Map of Erosion Severity and Location

9.6.4 Summary of Trash Dumping

Survey crews documented 3 trash dumping sites, one each in the severe, low severity, and minor categories (Figure 9-30). Figure 9-31 shows the location and severity of each site. There were no trash dumping sites observed in the Muddy Creek subwatershed. Trash dumps are rated as being of very high severity when there is a large amount of trash spread over a very large and inaccessible area. A site is rated as minor if it is a small amount of trash located inside a park with easy access.

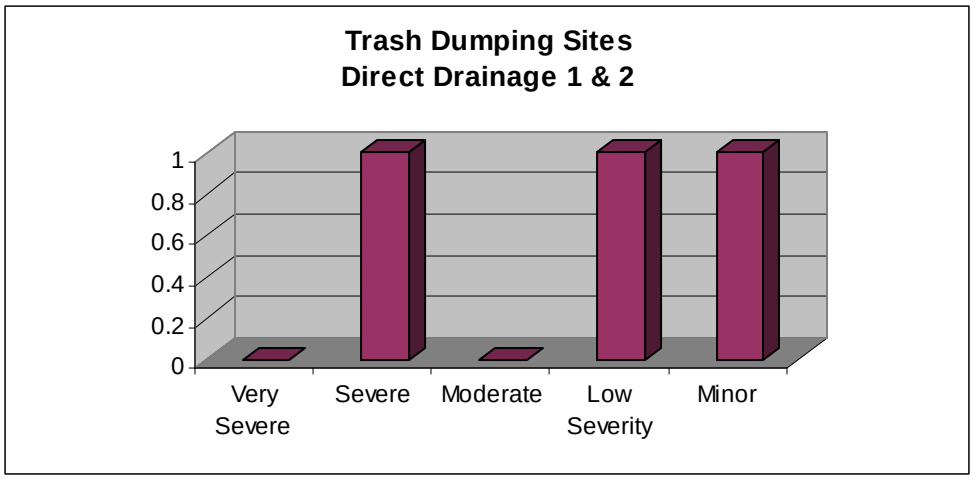


Figure 9-30 Severity Distribution of Sites

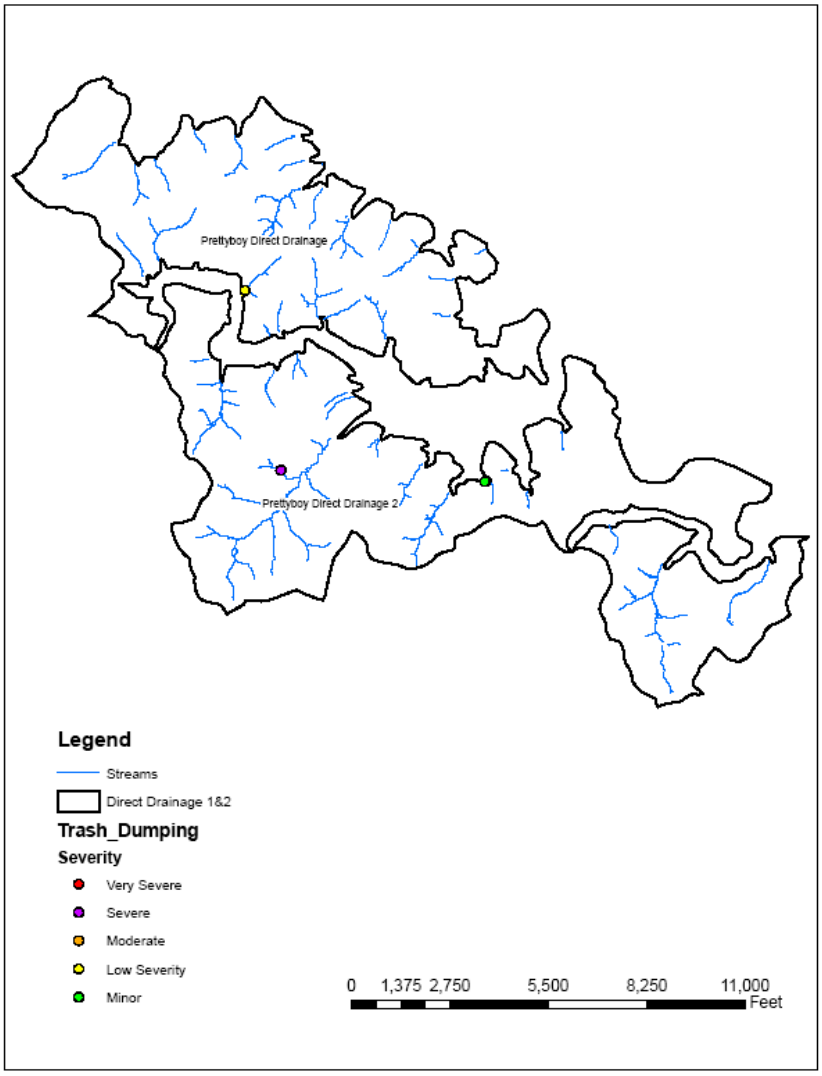


Figure 9-31 Map of Trash Dumping Severity and Location

9.6.5 Summary of Inadequate Buffer

The Baltimore County survey teams identified 7 inadequate buffer sites in the study area, with a total length of 3,240 ft (0.61 miles). This accounted for approximately 7.1% of the 8.61 miles surveyed. The severity distribution of these inadequate buffers is shown in Figure 9-32, and their location and severity are shown in Figure 9-33. While there is no single minimum standard for how wide a stream buffer should be in Maryland, for the purposes of this study a forest buffer is considered inadequate if it is less than 50 feet wide, measured from the edge of the stream. The severity of inadequate forest buffers is based on both the length and width of the site. Those sites over 1,000 feet long with no forest on either side of the stream rank as the most severe. The buffer was inadequate on both sides of the stream. The stream was unshaded and the adjacent landuse was lawn.

The inadequate buffer measure is a cumulative along the stream segment, so the number of inadequate buffers observed is not necessarily the best indication of the level of the problem. One alternative is to examine the most severe potential problems. The sites found during the survey ranked from very severe to low severity (Figure 9-33).

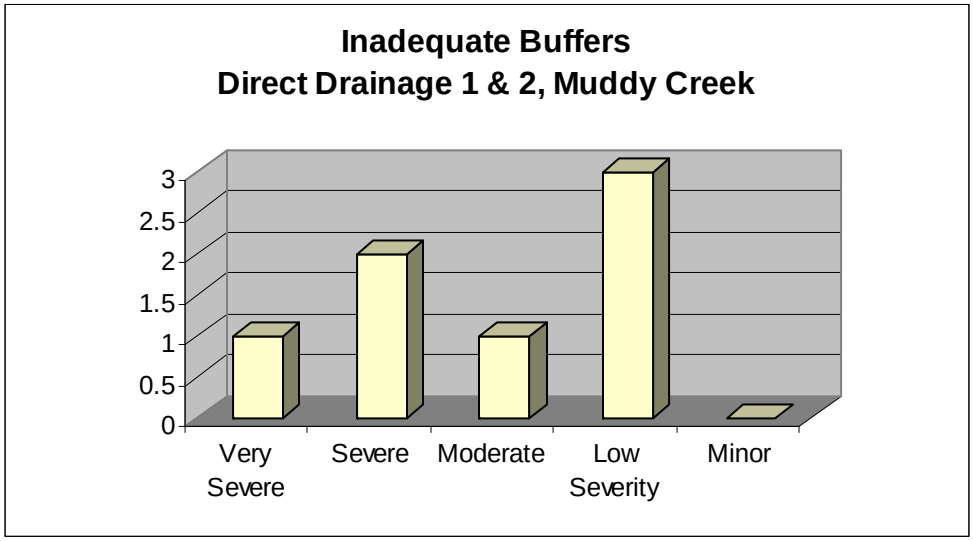


Figure 9-32 Severity Distribution of Sites

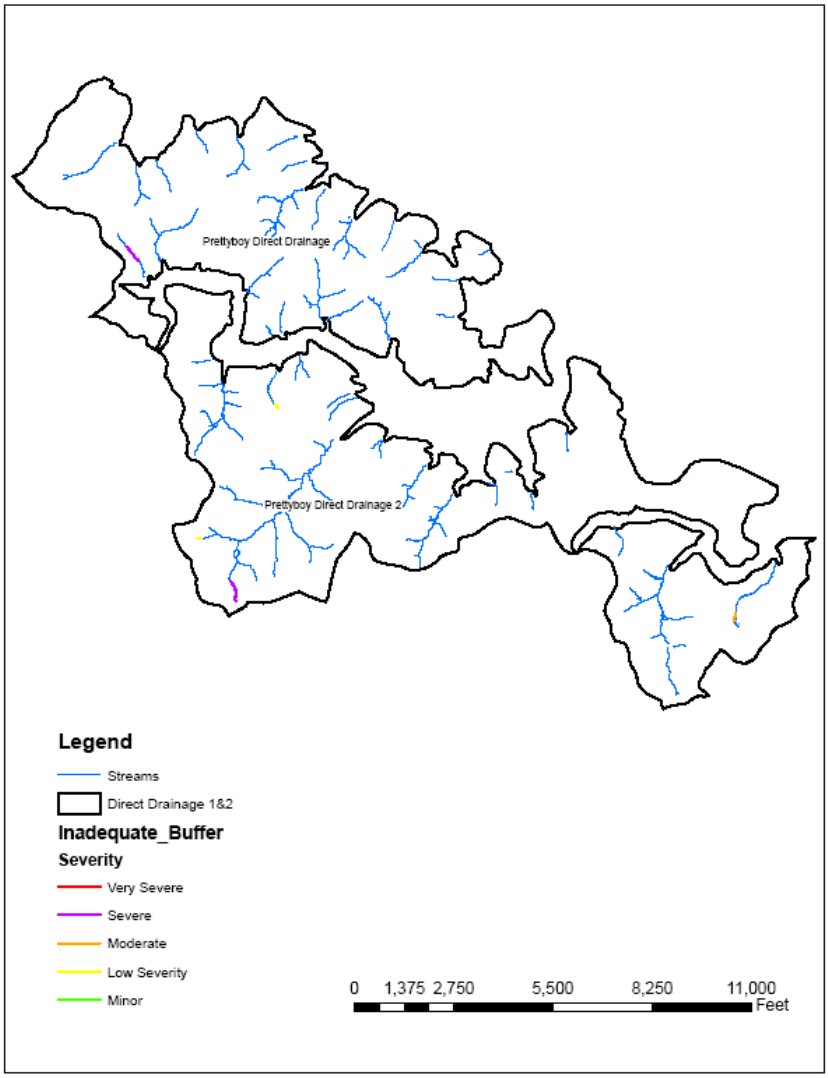


Figure 9-33a Map of Inadequate Buffer Severity and Location (Direct Drainage 1&2)

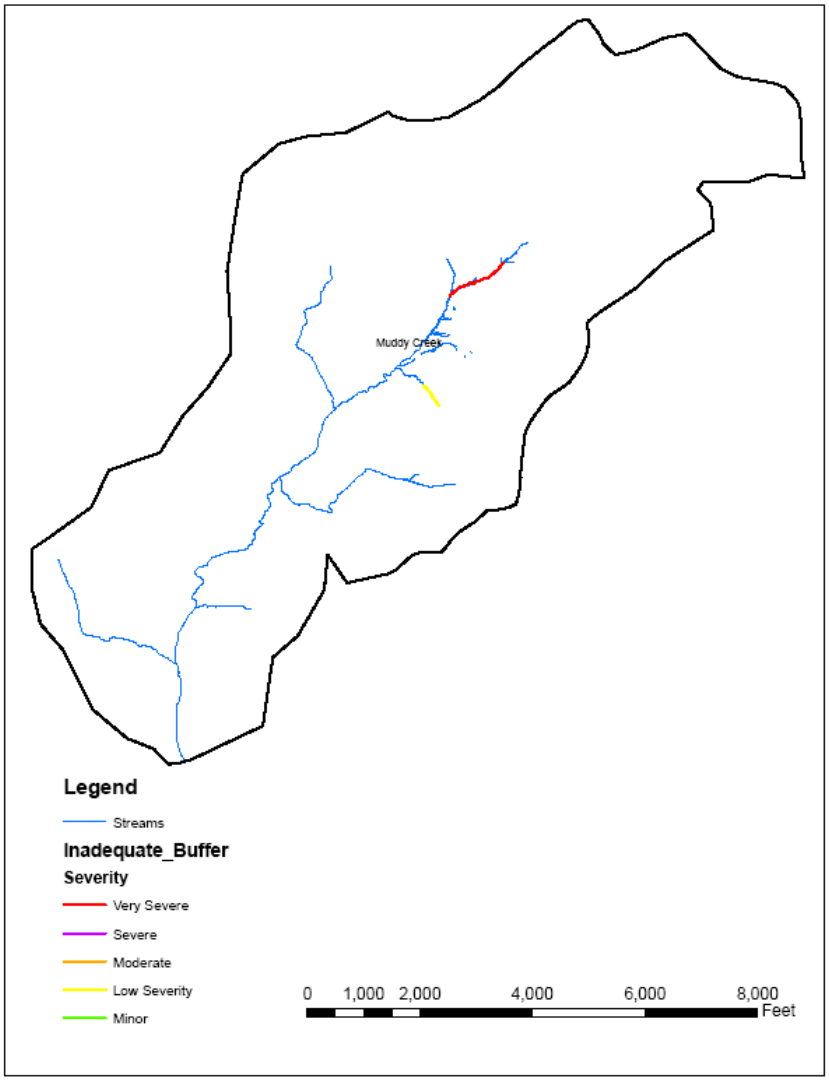


Figure 9-33b Map of Inadequate Buffer Severity and Location (Muddy Creek)

9.6.6 Summary of Unusual Conditions and Comments

The Baltimore County SCA teams documented a total of four unusual conditions and comments. Figure 9-34 shows the severity distribution of the unusual condition sites, and Figure 9-35 shows their location and severity. There were no unusual conditions/comments found in the Direct Drainage 1 subwatershed. An unusual condition site was ranked as very severe if the survey crew judged that the potential problem would have a direct and wide-reaching impact on the stream's aquatic resources, and was among the worst that field teams would expect to observe. A site was ranked of minor severity if it was a potential problem that did not appear to have a significant impact on aquatic resources. One site was ranked as being severe, one as moderate, and two sites were ranked as low severity.

Field crews also assessed the possible causes for the unusual conditions. In some cases, the causes are apparent. For example, a site with excessive farm animal feces near the stream is due to the landowner allowing animals access close to the stream.

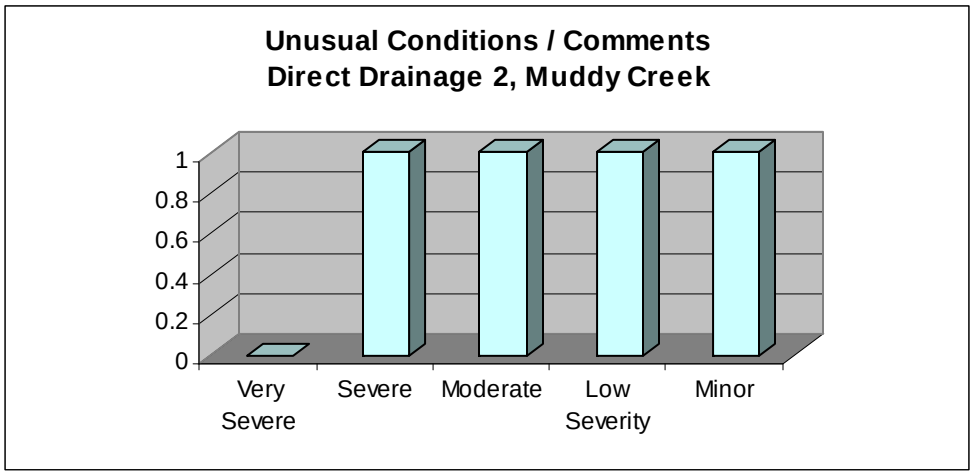


Figure 9-34 Severity Distribution of Sites

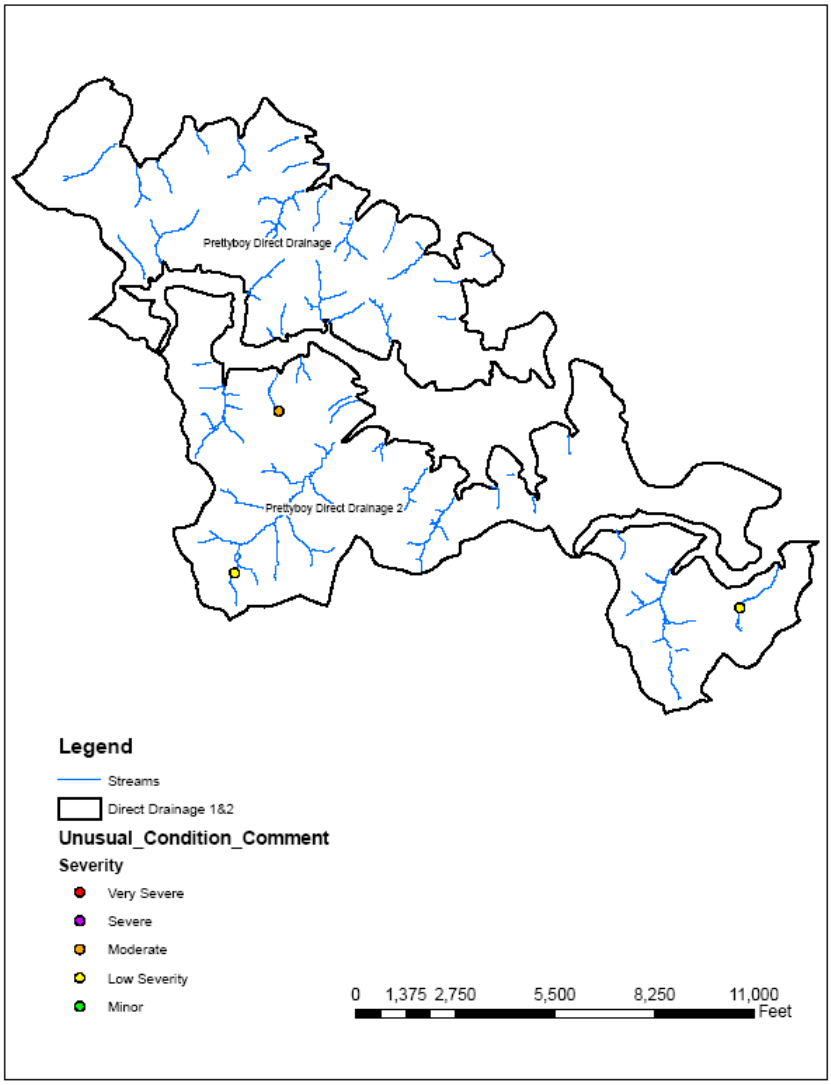


Figure 9-35a Map of Unusual Condition/Comment Severity and Location (Direct Drainage 2)

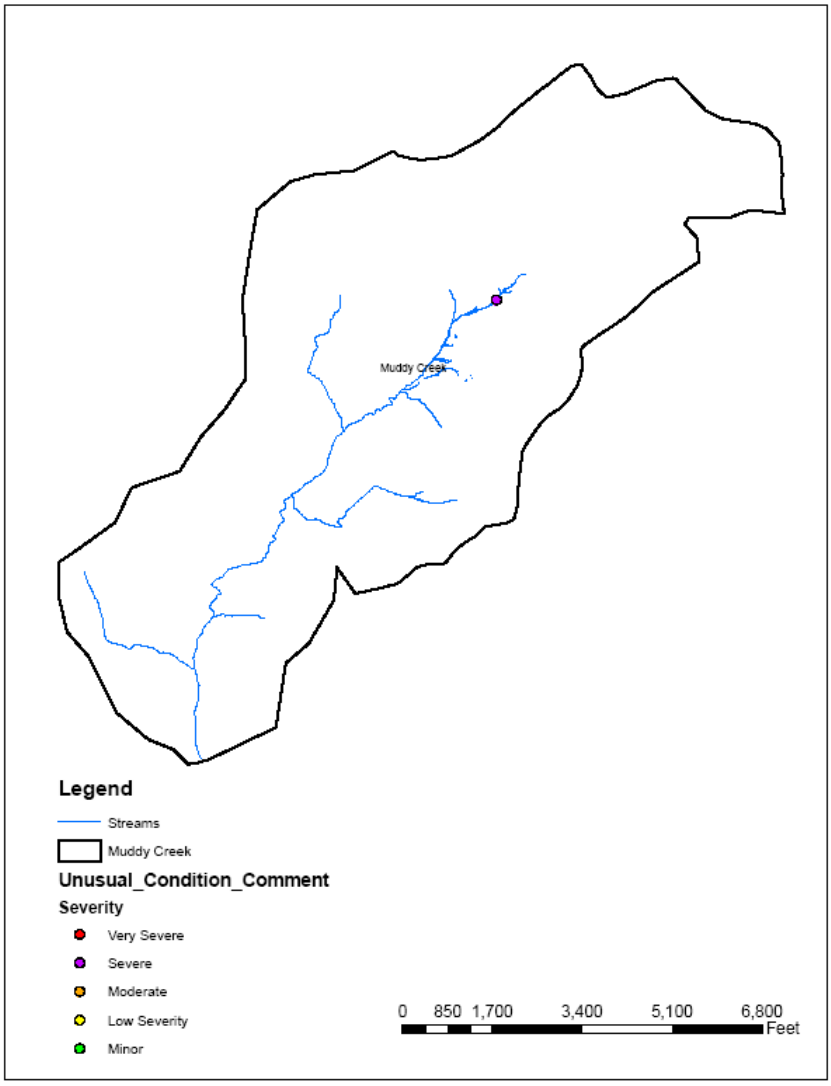


Figure 9-35b Map of Unusual Condition/Comment Severity and Location (Muddy Creek)

9.6.7 Summary of Fish Barrier

The Baltimore County SCA team identified 2 low severity barriers to fish migration. Figure 9-36 shows the severity distribution of these barriers, and figure 9-37 shows their location and severity. There were no fish barriers observed in the Muddy Creek subwatershed. Most of these barriers are caused by road crossing culverts that result in water that is too shallow or drops that are too high for fish to pass. Other causes include man-made dams, natural falls, and beaver dams. A fish barrier is rated very severe when it is a structure that totally blocks a large stream or river, and is considered minor when it is a temporary barrier that blocks very little in-stream habitat. The fish barriers observed during this survey were moderate severity, both part of road crossings.

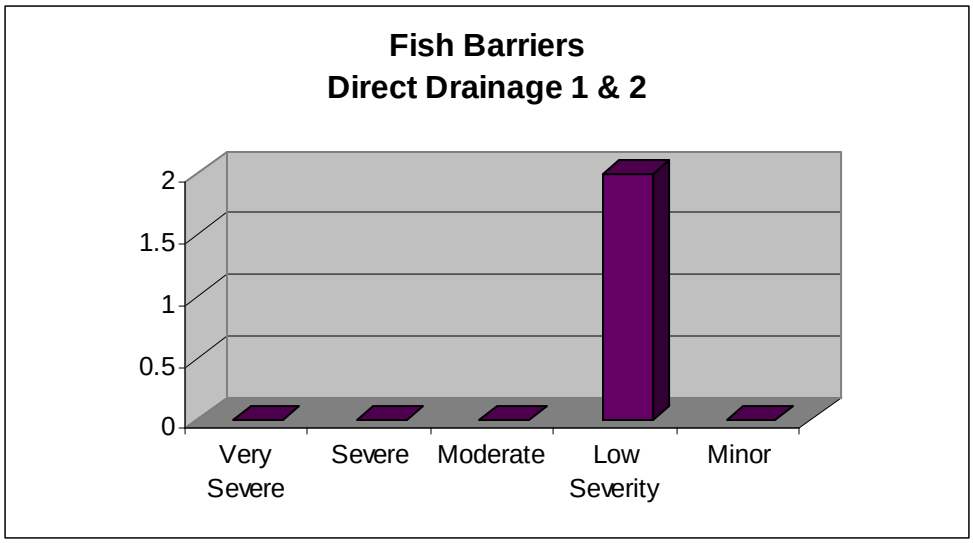


Figure 9-36 Severity Distribution of Sites

Figure 9-37 Map of Fish Barrier Severity and Location

9.6.8 Summary of Pipe Outfall

Survey crews identified 5 pipe outfalls. The severity distribution of these outfalls is shown in Figure 9-38. Figure 9-39 shows the location and severity of representative pipe outfall sites. The labels on this and all subsequent maps refer to the unique site number assigned to each potential problem. Four of the pipe outfalls had a clear discharge, and 1 had no discharge. A pipe outfall warrants a very severe rating when it has a strong discharge and a distinct color or odor, and a minor rating when it is a storm water outfall with no dry weather discharge. Most of the pipe outfalls serve as pond overflow, and have a moderate to minor severity ranking.

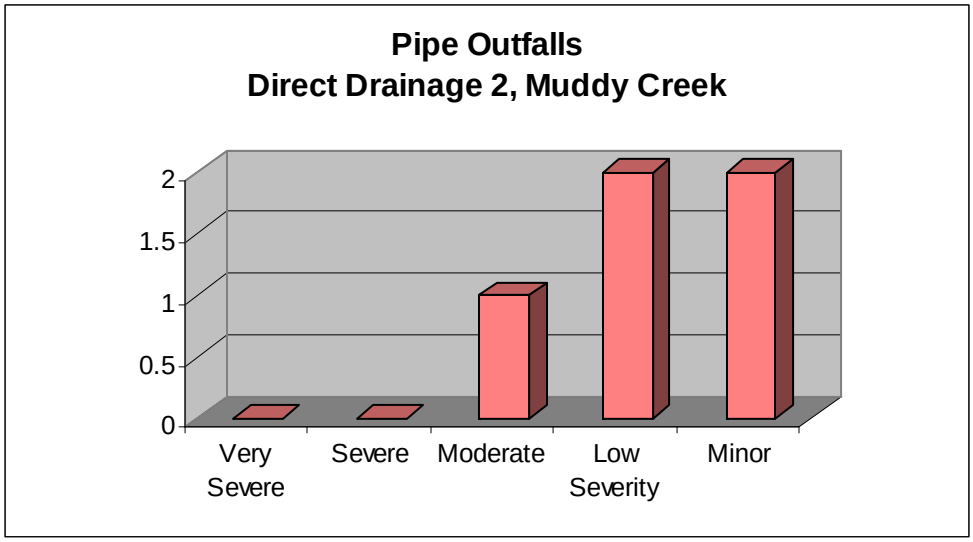


Figure 9-38 Severity Distribution of Sites

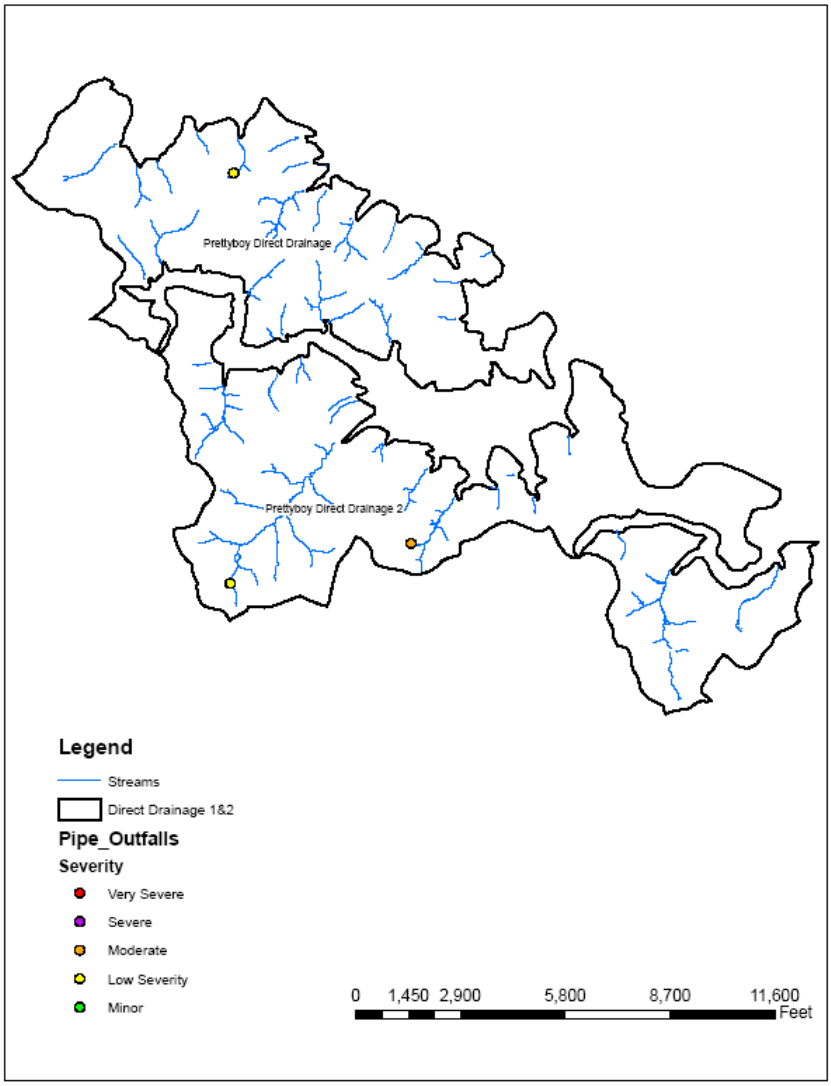


Figure 9-39a Map of Pipe Outfall Severity and Location (Direct Drainage 2)

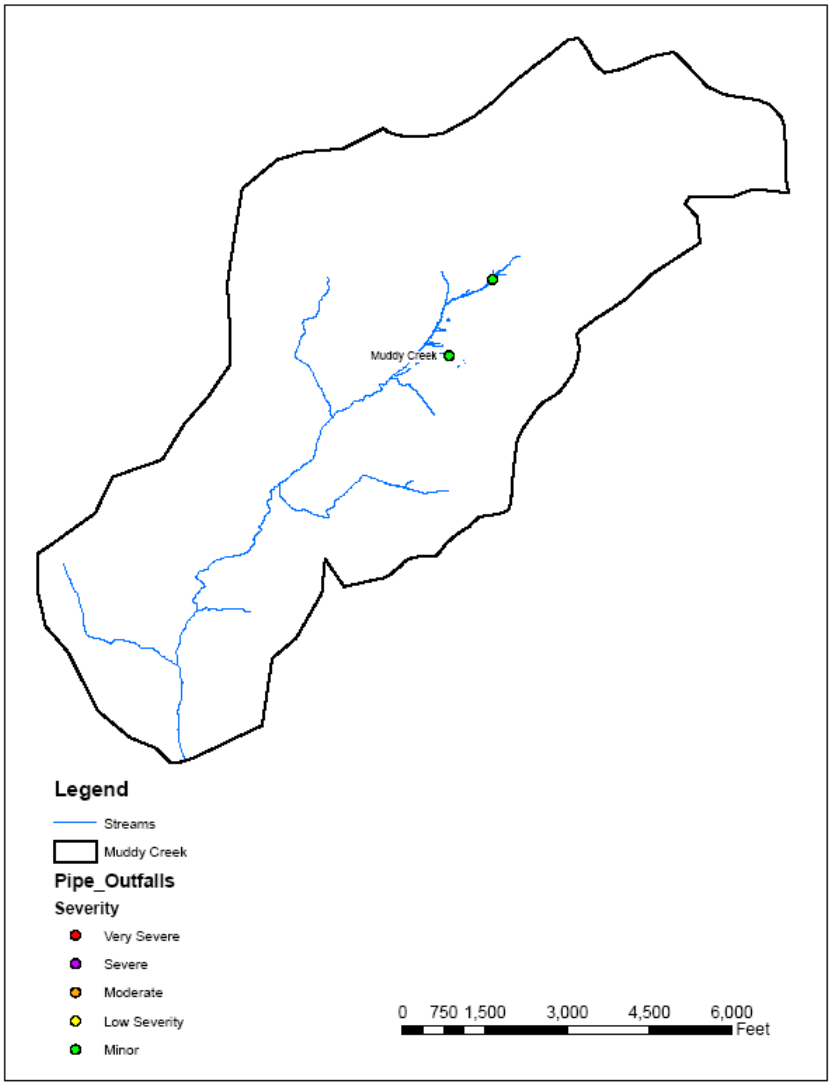


Figure 9-39b Map of Pipe Outfall Severity and Location (Muddy Creek)

9.6.9 Channel Alteration

Channel alterations are sections where the stream's banks or channel are significantly altered from their naturally occurring structure or condition. The SCA survey teams reported 9 channel alteration sites throughout the survey. The total length of these channel alterations was 153 feet or 0.03 miles. Figure 9-40 shows the severity distribution of these alterations, and Figure 9-41 shows their location and severity. A channel alteration is rated very severe when a significant length (>1000 ft.) of stream has been lined with concrete, and minor if it is an earthen channel less than 100 feet long.

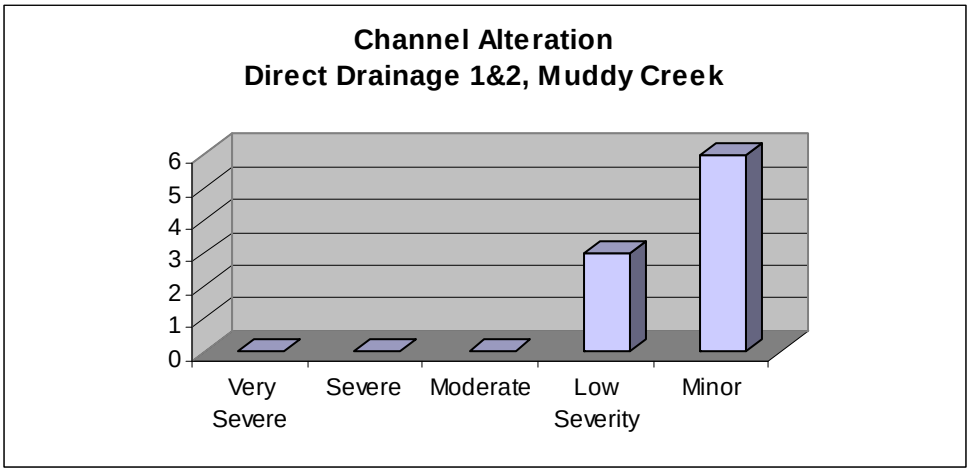


Figure 9-40 Severity Distribution of Sites

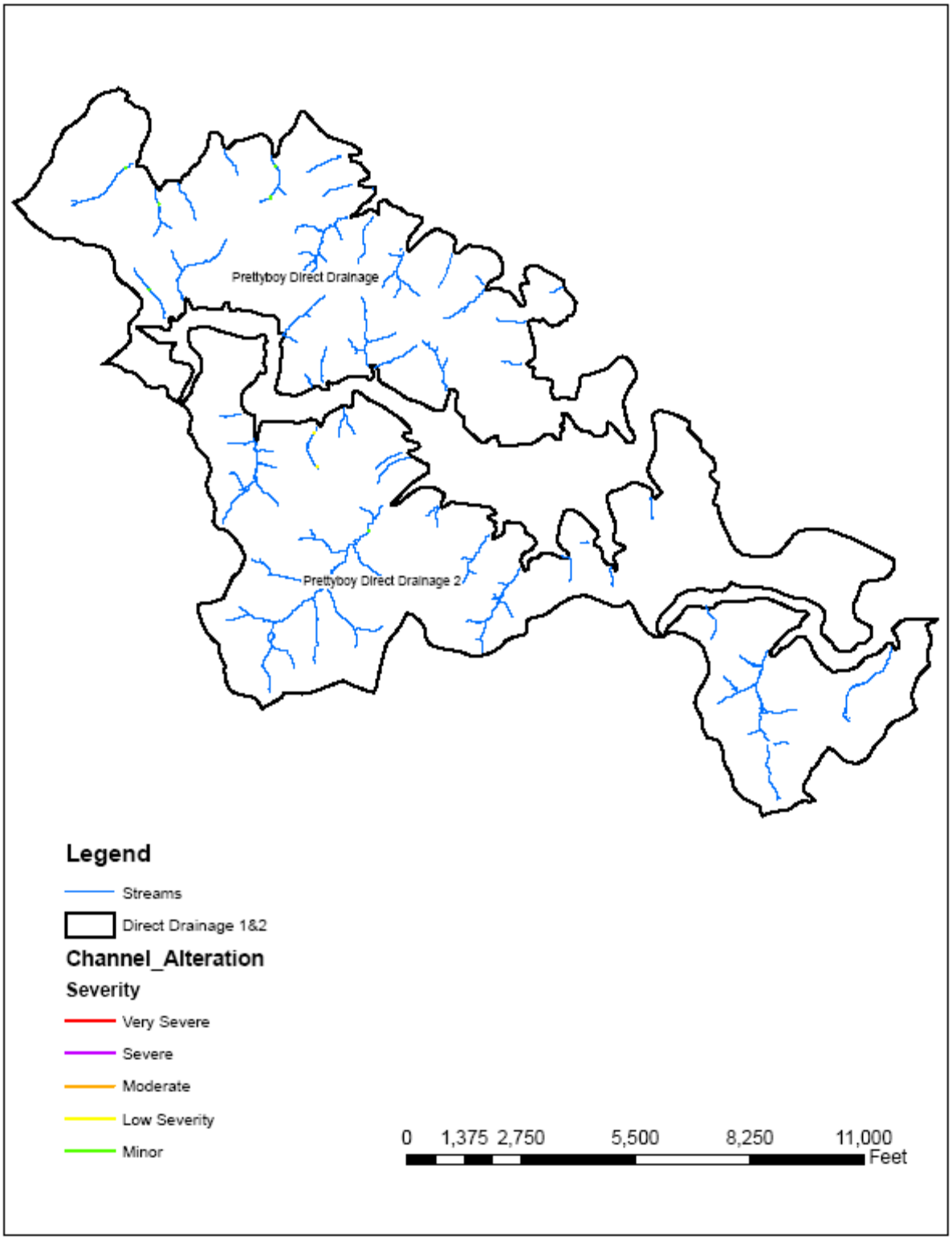


Figure 9-41a Map of Channel Alteration Severity and Location (Direct Drainage 1&2)

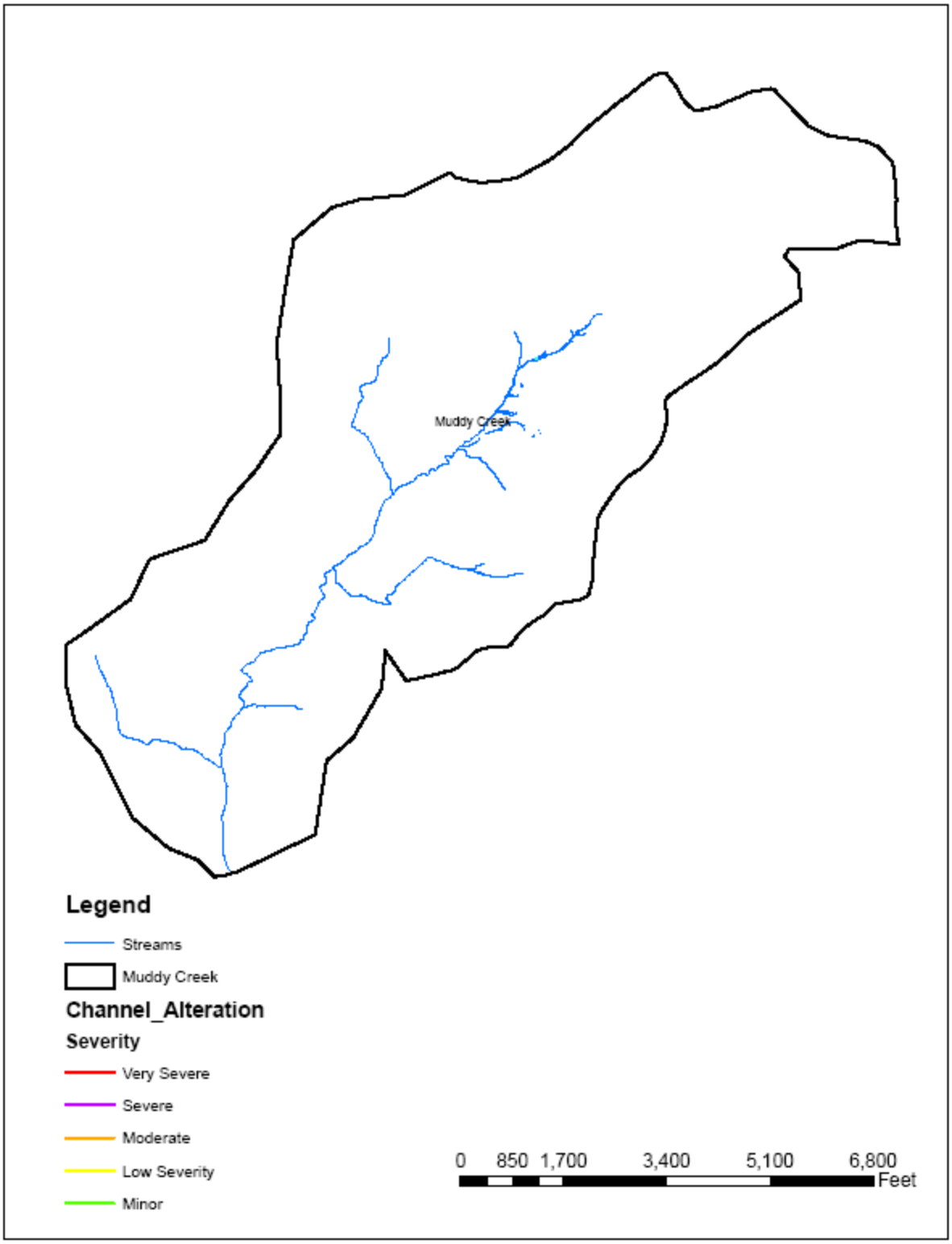


Figure 9-41b Map of Channel Alteration Severity and Location (Muddy Creek)

9.6.10 Stream Stability Assessment

The stream stability assessment replaced the representative site assessment from previous SCAs. This was done in order to get a more accurate representation of stream conditions so that the data may be better used within other sections of EPS. For this assessment, the field crew identifies reaches of streams with certain geomorphological attributes. Using the Channel Evolution Model (Simon, 1989), the stream is classified as Pre-Disturbance (Stage I), Disturbance (Stage II), Incision (Stage III), Widening (Stage IV), Deposition (Stage V), or Recovery and Reconstruction (Stage VI). The Bank Height Ratio is also determined by dividing the top of bank height by the bankfull height, which is measured for each reach. Based on the ratio, the stream is classified as Stable (1-1.1), Slightly Incised (1.1-1.2), Moderately Incised (1.3-1.5), or Deeply Incised (1.5-2). A map showing the locations from the assessments is shown in figure 9-42, while the results are shown in table 9-11. Due to constraints in staff training, the assessment was not done in the Muddy Creek subwatershed.

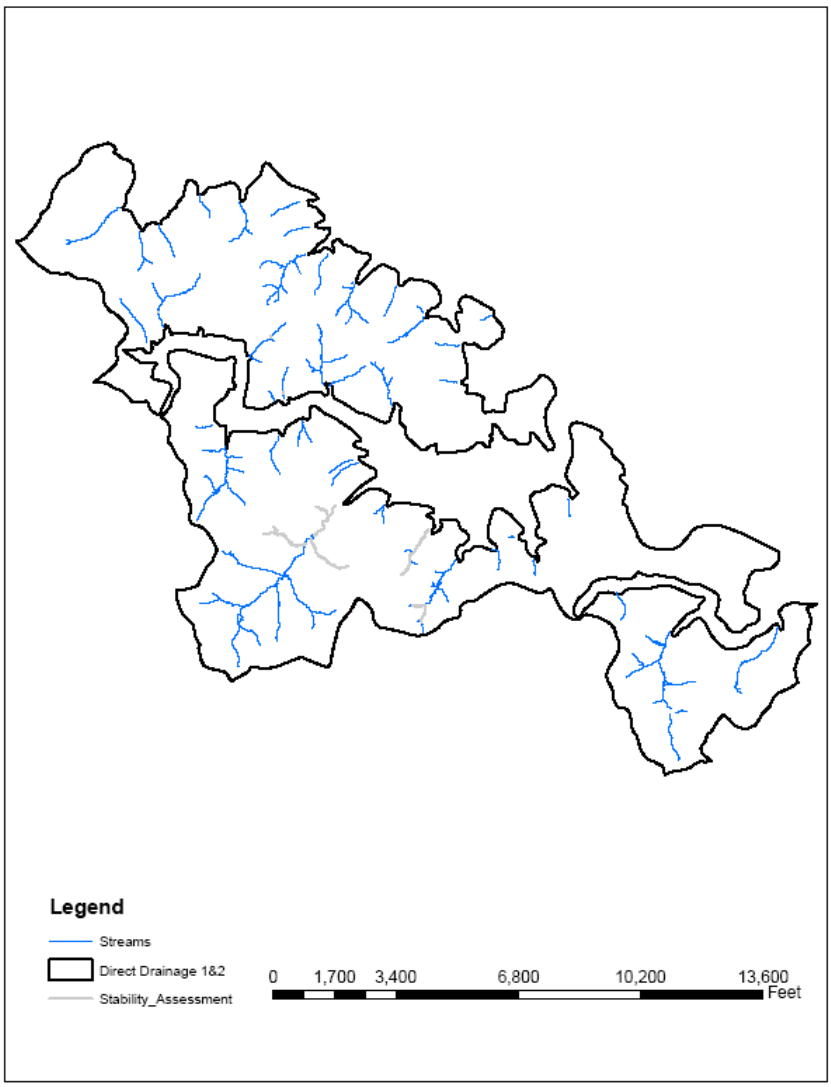


Figure 9-42 Map of Stream Stability Assessment Location (Direct Drainage 1&2)

9.6.11 Summary of In or Near Stream Construction

No in or near stream construction sites were observed during survey.

9.6.12 Summary of Exposed Pipe

No exposed pipe sites were observed during survey.

9.6.13 Discussion

The results of the Prettyboy Reservoir SCA survey list, summarize, and show the location of the observable environmental problems along the stream corridor network in this watershed. Each potential problem site has a corresponding ranking for severity, correctability, and access and a photograph of the site. The data from this effort can be used to target future restoration efforts. After this list of potential problem sites is compiled and distributed, county planners, resource managers, and others can initiate a dialog to cooperatively set the direction and goals for the watershed's management and plan future restoration work at specific problem sites. In addition, this data can be combined with other GIS data and local information to prioritize areas for restoration.

Projects can be further targeted to restoring areas where rare or threatened species, gaps in continuous forest or the state's Green Infrastructure, or quality fish and wildlife habitat are found. In addition, sites can be prioritized for restoration based on their location in headwater areas, streams that deposit directly into the Chesapeake Bay, areas of specific local interest, or sites where the surrounding land use is particularly suited to restoration projects. The values of the present survey is its help in placing individual stream problems into their watershed context and its potential common use among resource managers and land-use planners to cooperatively and consistently prioritize future restoration work. Results of the present survey will be given to the Prettyboy Reservoir Watershed WRAS committee, which is in the implementation phase of the Watershed Restoration Action Strategy for the Prettyboy Reservoir.

Table 9-11 Listing of Information by Site

Site	Subwatershed	Category	Severity	Access
01A301	Muddy Creek	Channel Alteration	Minor	1
01A302	Muddy Creek	Inadequate Buffer	Very Severe	1
01A303	Muddy Creek	Pipe Outfall	Minor	1
01A304	Muddy Creek	Inadequate Buffer	Low Severity	1
01B301	Muddy Creek	Pipe Outfall	Minor	1
01B302	Muddy Creek	Unusual Condition or Comment	Severe	1
10B301	Direct Drainage 2	Channel Alteration	Minor	1
10B302	Direct Drainage 2	Channel Alteration	Minor	1
10B303	Direct Drainage 1	Erosion	Moderate	2
10C301	Direct Drainage 1	Erosion	Minor	1
10C302	Direct Drainage 2	Channel Alteration	Minor	
10C303	Direct Drainage 2	Pipe Outfall	Low Severity	1
10C304	Direct Drainage 1	Erosion	Minor	2
10C305	Direct Drainage 2	Channel Alteration	Minor	2
15B101	Direct Drainage 1	Fish Barrier	Low Severity	
15B102	Direct Drainage 1	Channel Alteration	Minor	
15B103	Direct Drainage 1	Inadequate Buffer	Severe	
15B104	Direct Drainage 1	Stream Stability Assessment		

15B301	Direct Drainage 2	Inadequate Buffer	Low Severity	2
15C101	Direct Drainage 1	Trash Dumping	Low Severity	
15C102	Direct Drainage 1	Stream Stability Assessment		
15C103	Direct Drainage 1	Stream Stability Assessment		
15C201	Direct Drainage 2	Channel Alteration	Minor	1
15C202	Direct Drainage 2	Stream Stability Assessment		
15C203	Direct Drainage 2	Stream Stability Assessment		
15C204	Direct Drainage 2	Stream Stability Assessment		
15C205	Direct Drainage 2	Trash Dumping	Severe	
15C206	Direct Drainage 2	Stream Stability Assessment		
15C207	Direct Drainage 2	Stream Stability Assessment		
15C208	Direct Drainage 2	Stream Stability Assessment		
15C209	Direct Drainage 2	Stream Stability Assessment		
15C210	Direct Drainage 2	Erosion	Moderate	
15C211	Direct Drainage 2	Unusual Condition or Comment	Moderate	1
15C212	Direct Drainage 2	Channel Alteration	Low Severity	1
15C213	Direct Drainage 2	Erosion	Low Severity	1
15C214	Direct Drainage 2	Channel Alteration	Low Severity	
15C215	Direct Drainage 2	Inadequate Buffer	Low Severity	1
15C301	Direct Drainage 2	Pipe Outfall	Low Severity	1
15C302	Direct Drainage 2	Erosion	Minor	2
15C303	Direct Drainage 2	Unusual Condition or Comment	Low Severity	1
15C304	Direct Drainage 2	Stream Stability Assessment		
15C305	Direct Drainage 2	Stream Stability Assessment		
15C306	Direct Drainage 2	Inadequate Buffer	Severe	1
15C307	Direct Drainage 2	Pipe Outfall	Moderate	
15C308	Direct Drainage 2	Stream Stability Assessment		
15C309	Direct Drainage 2	Stream Stability Assessment		
15C310	Direct Drainage 2	Stream Stability Assessment		
15C311	Direct Drainage 2	Erosion	Minor	
16A301	Direct Drainage 2	Trash Dumping	Minor	3
16B301	Direct Drainage 2	Inadequate Buffer	Moderate	2
16B302	Direct Drainage 2	Unusual Condition or Comment	Low Severity	2
16B303	Direct Drainage 2	Fish Barrier	Low Severity	1

Table 9-12 Listing of Sites by Problem Category

Erosion Sites

Site	Type	Cause	Height	Land Use Left	Land Use Right	Threat To Infrastructure	Severity	Access
10B303	Widening	Land use change		Forest	Forest	N	Moderate	2
10C301	Headcutting	Land use change	2	Forest	Forest	N	Minor	1
10C304	Widening	Below road crossing		Forest	Forest	N	Minor	2
15C302	Headcutting	Other	3.5	Crop field	Shrubs and small trees	N	Minor	2
15C311	Downcutting	Land use change	10	Forest	Forest	N	Minor	
15C213	Widening	Land use change		Forest	Forest	N	Low Severity	1

15C210	Widening	Land use change	4.5	Forest	Forest	N	Moderate	
15C210	Widening	Land use change		Forest	Forest	N	Moderate	

Trash Dumping Sites

Site	Type	Truckloads	Other Measure	Extent	Volunteer Project?	Owner Type	Severity
15C101	Floatables	6	trash bags	Single Site	Y	Public	Low Severity
15C205	Residential	3		Single Site	N	Private	Severe
16A301	Floatables	5	trash bags	Single Site	Y	Public	Minor

Inadequate Buffers

Site	Sides	Unshaded	Width Left (ft)	Length Left (ft)	Width Right (ft)	Length Right (ft)	Land Use Left	Land Use Right	Recently Established	Livestock	Severity	Access	Wetland Potential
15C306	Both	Neither	5	645	10	645	Crop Field	Lawn	N	N	Severe	1	3
15C215	Left	Neither	20	152			Lawn	Forest	N	N	Low Severity	1	2
15B301	Left	Neither	8	86	8	86	Shrubs Small Trees	Shrubs Small Trees	N	N	Low Severity	2	2
15B103	Both	Neither	7	520	7	520	Shrubs Small Trees	Shrubs Small Trees	N	N	Severe		5
16B301	Both	Neither	10	230	15	230	Shrubs Small Trees	Shrubs Small Trees	N	N	Moderate	2	4

Unusual Conitions/Comments

Site	Type	Notes	Potential Cause	Severity	Access
15C303	Unusual Condition	Sticks piled in stream, could be causing erosion upstream by backing up water (see 15C302)		Low Severity	1
15C211	Unusual Condition	Stream starts on other side of driveway and runs off into ditch.	Groundwater from field.	Moderate	1
16B302	Comment	Large stand of bamboo, several hundred feet		Low Severity	2
1B302	Unusual Condition	Excessive animal feces next to stream (donkey)		Severe	1

Fish Barriers

Site	Blockage	Type	Reason	Drop (in)	Depth (in)	Severity	Access
15B101	Total	Other	Too shallow		1.2	Low Severity	
16B303	Total	Road Crossing	Too high	6		Low Severity	1

Pipe Outfalls

Site	Type	Pipe	Location	Pipe Diameter (in)	Discharge	Color	Odor	Severity	Access
10C303	Stormwater	Concrete Pipe	Head of Stream	24	N		None	Low Severity	1
15C301	Other	Smooth Metal Pipe	Head of Stream	2	Y	Clear	None	Low Severity	1
15C307	Agricultural	Smooth Metal Pipe	Head of Stream	18	Y	Clear	None	Moderate	
1A303	Other	Concrete Pipe	Head of Stream	24	Y	Clear	None	Minor	1
1B301	Other	Corrugated Metal Pipe	Right Bank	12	Y	Clear	None	Minor	1

Channel Alteration

Site	Type	Perennial Flow	Sediment Deposition	Vegetation	Road Crossing	Severity	Access	Length
1A301	Road Crossing	Y	Y	Y	Both	Minor	1	12.790488
10B301	Road Crossing	Y	Y	N	Both	Minor	1	11.99983
10B302	Road Crossing	Y	Y	N	Both	Minor	1	12.000127
10C305	Road Crossing	Y	Y	N	Both	Minor	2	9.999833
10C302	Road Crossing	Y	Y	N	Both	Minor		51.200372
15C214	Road Crossing	Y	Y	N	Both	Low Severity		19.999937
15C212	Road Crossing	Y	Y	N	Both	Low Severity	1	17.667727
15C201	Road Crossing	Y	Y	N	Both	Minor	1	12.000025
15B102	Other	Y	Y	N	Both	Minor		4.99987

Stream Stability Assessment

Site	CEM Stage	Bank Height Ratio	Reach Length
15C102	Stage I Pre-Disturbance	1-1.1 Stable	21.943082
15C103	Stage VI Recovery and Reconstruction	>1.5 Deeply Incised	54.877505
15C305	Stage I Pre-Disturbance	>1.5 Deeply Incised	697.964415
15C304	Stage I Pre-Disturbance	1-1.1 Stable	769.702324
15C308	Stage VI Recovery and Reconstruction	1-1.1 Stable	471.190458
15C309	Stage II Disturbance	1.1-1.2 Slightly Incised	228.932283
15C310	Stage III Incision	>1.5 Deeply Incised	246.365255
15C204	Stage V Deposition	>1.5 Deeply Incised	1593.055639
15C202	Stage V Deposition	>1.5 Deeply Incised	1233.697481
15C203	Stage III Incision	>1.5 Deeply Incised	527.816516
15C209	Stage VI Recovery and Reconstruction	1-1.1 Stable	447.998111
15C208	Stage II Disturbance	1-1.1 Stable	369.20391
15C207	Stage IV Widening	1-1.1 Stable	724.329835
15C206	Stage III Incision	>1.5 Deeply Incised	337.74274
15B104	Stage V Deposition	1.3-1.5 Moderately Incised	14.49173

9.7 Trash TMDL

9.7.1 Introduction

Middle Branch and the Inner Harbor at the base of Gwynns Falls and Jones Falls, are listed as impaired for trash on the Maryland Department of the Environment (MDE) 303d list under the Clean Water Act (CWA). Baltimore County has begun a monitoring program to collect data in order for a TMDL to be developed by MDE. This yearlong study began in October 2010 and will be completed in October 2011.

9.7.2. Monitoring Protocol

Twenty stream sites were randomly selected in the Jones Falls and Gwynns falls, with ten sites in each watershed. The drainage areas were calculated and categorized by land use. Within the stream, a 500 ft. reach was measured for the survey. All trash is collected within the bankfull of the reach. Seventeen stormwater management ponds were also selected for this study, and are representative of the overall acreage of land use type for the streams sites in each watershed. Trash is collected within the boundary of the pond. Site locations are shown in Figure 9-43. Collected trash is sorted into 5 categories: plastic bottles; glass bottles, aluminum cans; other; and dumping. Once sorted, the categories are weighed individually. Additionally, the bottles and cans are counted per item in each category.

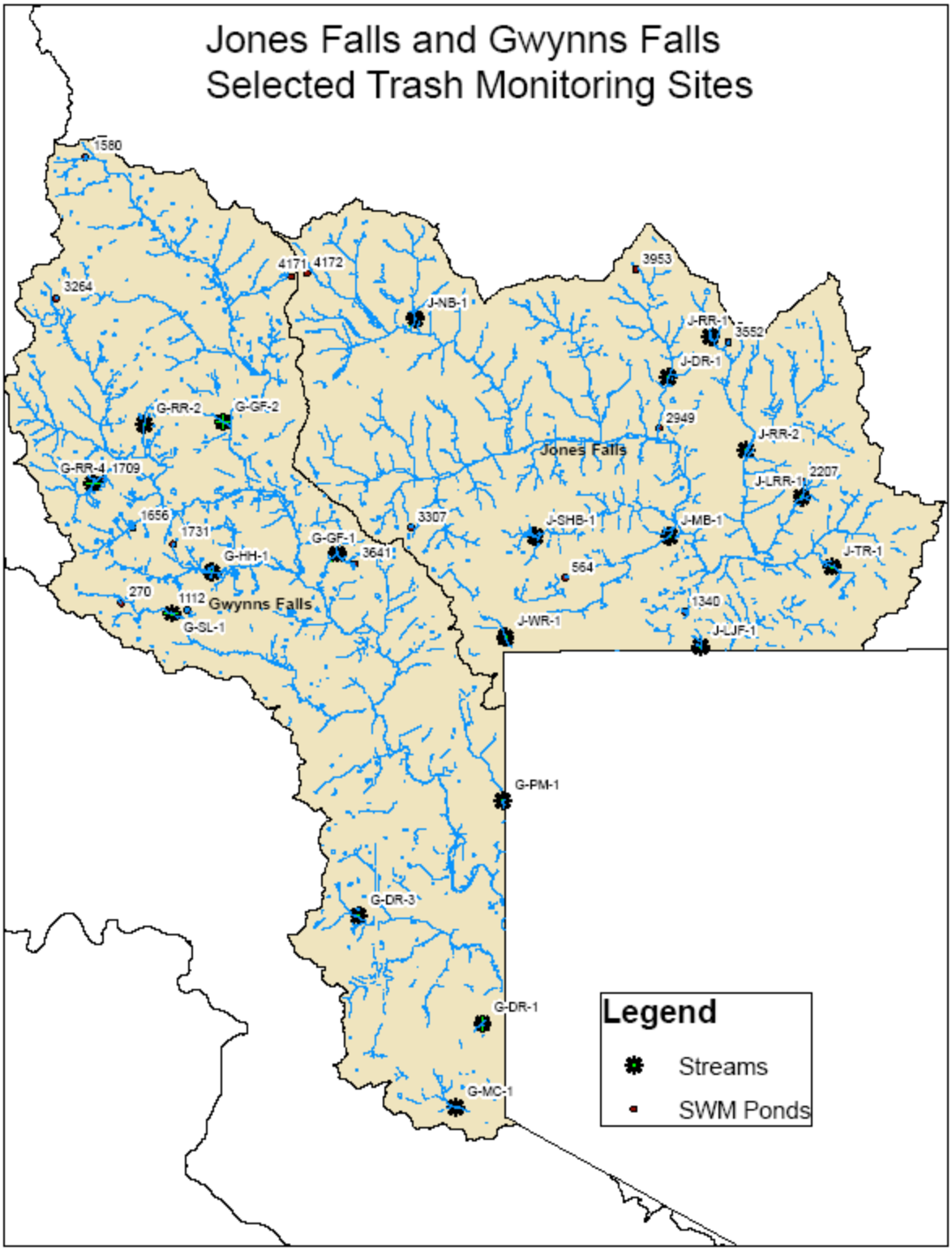


Figure 9-43 Map of Trash TMDL Monitoring Locations

9.7.3 Preliminary Results

Baseline data was collected in October 2010 at each site, and a total of 2,454 pounds of trash was removed. During the winter survey in January 2011 a total of 282 pounds was removed, while during the spring survey in April 2011 a total of 678 pounds was removed. This data has been extrapolated to represent the average pounds/acre/year for each site, shown in Figure 9-44. Sites 564 and G-PM-1 are not represented in the figure, as their drainage area has not yet been calculated.

Figure 9-44a Graph of Data for Gwynns Falls

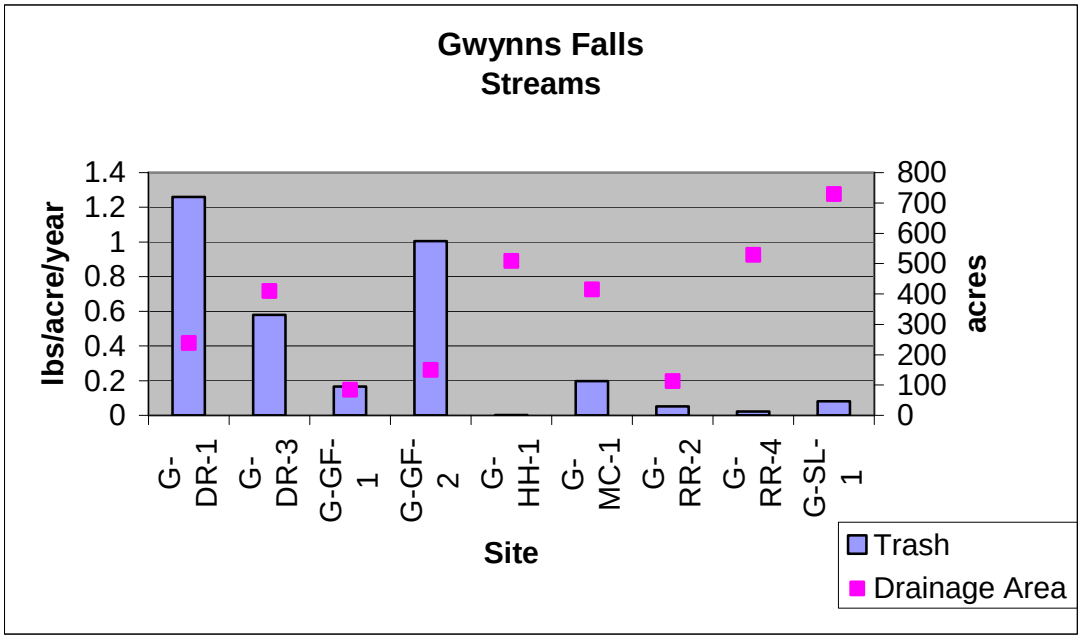


Figure 9-44b Graph of Data for Gwynns Falls

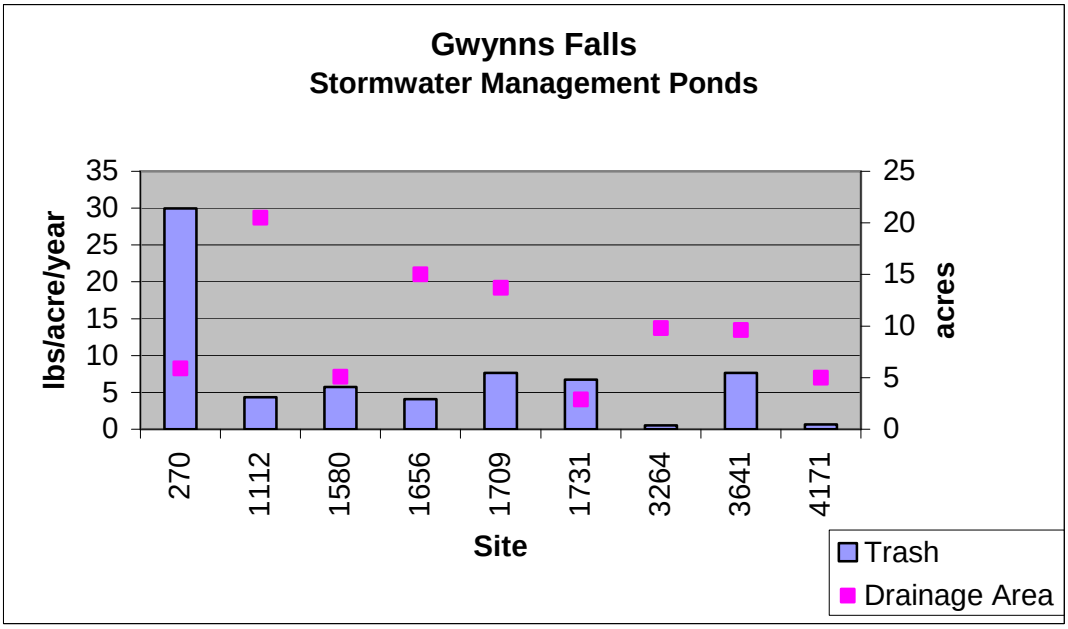


Figure 9-44c Graph of Data for Jones Falls

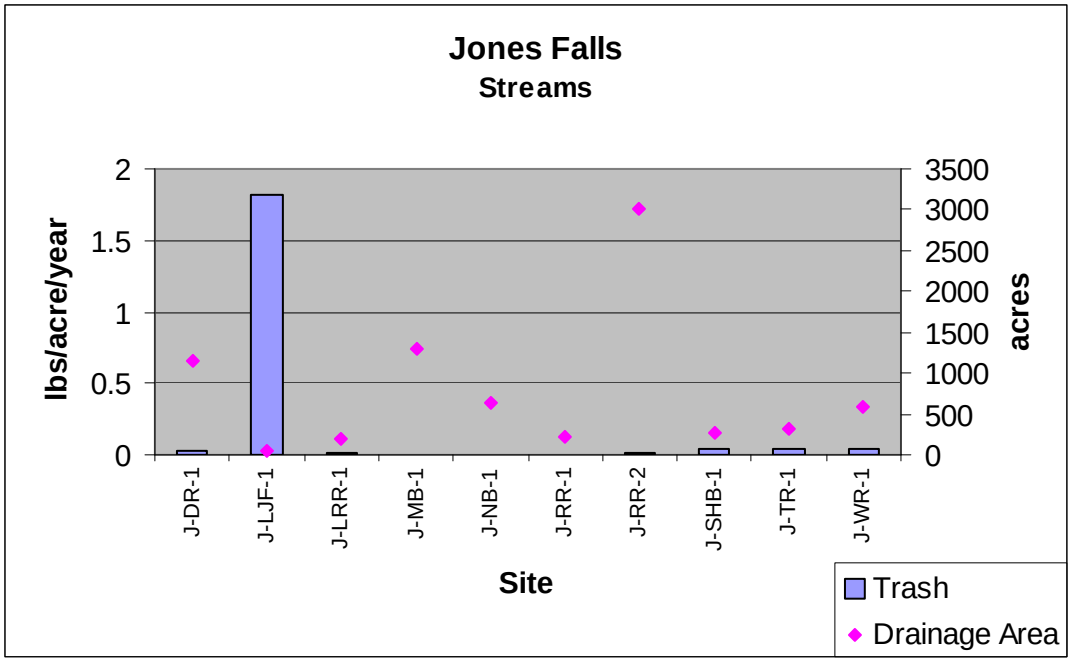
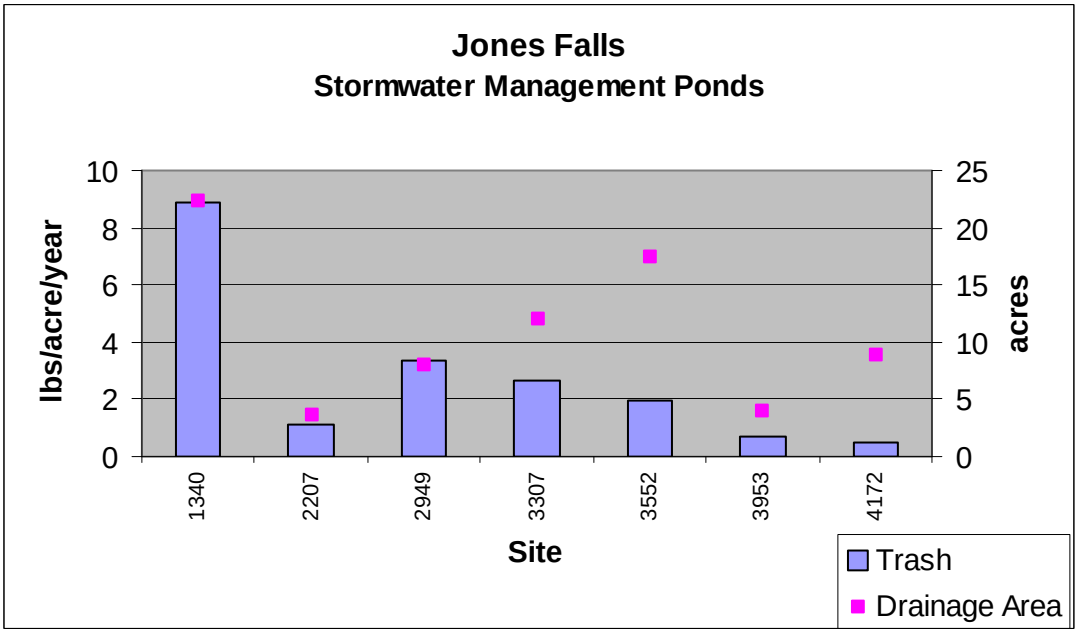


Figure 9-44d Graph of Data for Jones Falls



9.8 Bacteria TMDL

9.8.1 Introduction

Baltimore County EPS has coordinated with Baltimore City Surface Water Management Division to monitor trend over time levels of bacteria at 27 monitoring locations within 1 subwatershed and 5 major watersheds that have had TMDLs developed for bacteria. They include Herring Run, Gwynns Falls, Loch Raven, Prettyboy, Jones Falls, and Patapsco. Bacteria monitoring began in June 2010, with 16 sites in Baltimore County, and 11 sites in Baltimore City. Figure 9-45 shows the locations of the sites.

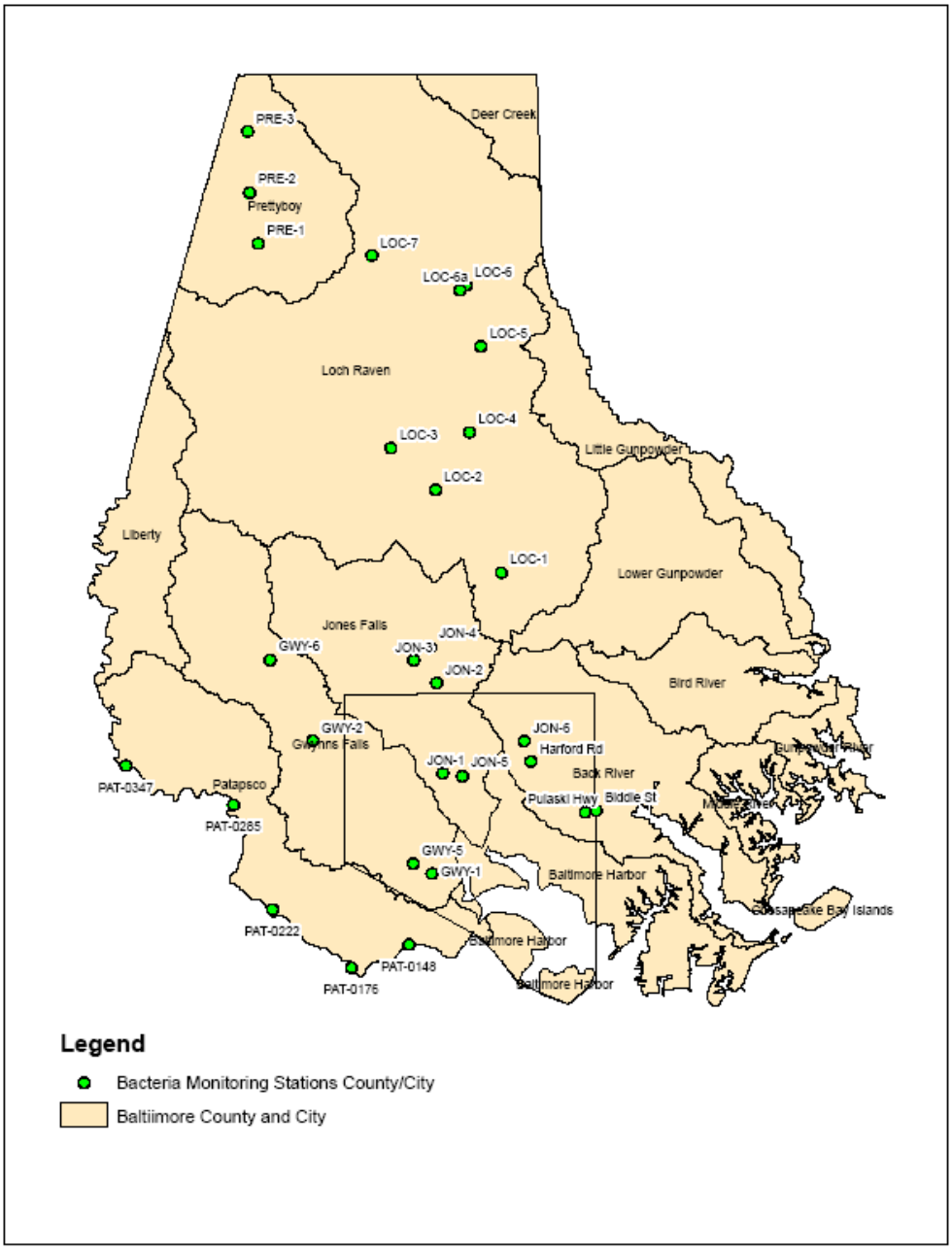


Figure 9-45 Map of Bacteria TMDL Monitoring Stations

9.8.2 Monitoring Protocol

Samples are collected on the first Thursday of every month, regardless of weather conditions. Using sterile sample containers containing sodium thiosulfate, 100mL of water is collected and is kept in a cooler with ice until analyzed.

The samples are analyzed for E. coli using IDEXX methodology and equipment including Colilert-18 and Quanti-Tray/2000, and are read after 18-24 hours of incubation. Results are given in Most Probable Number (MPN), which is an estimate based on the number of organisms present per sample.

Dilutions are done on samples that are taken during or after heavy rains, or at sites with chronically high levels of bacteria, so that the sample reading is within the limit of detection for the analysis (between 1 MPN and 2419.6 MPN).

9.8.3 Results

Results from June 2010 through June 2011 are shown graphically by watershed in figure 9-46. The Geometric Mean was calculated for each site to determine if E. coli exceeds the 126 limit for recreational waters. Samples with MPN outside of the limit of detection cannot be used to calculate the geometric mean. The two sites in the Herring Run watershed have only been sampled one time, so the geometric mean was not calculated and data shown is from the single sample MPN.

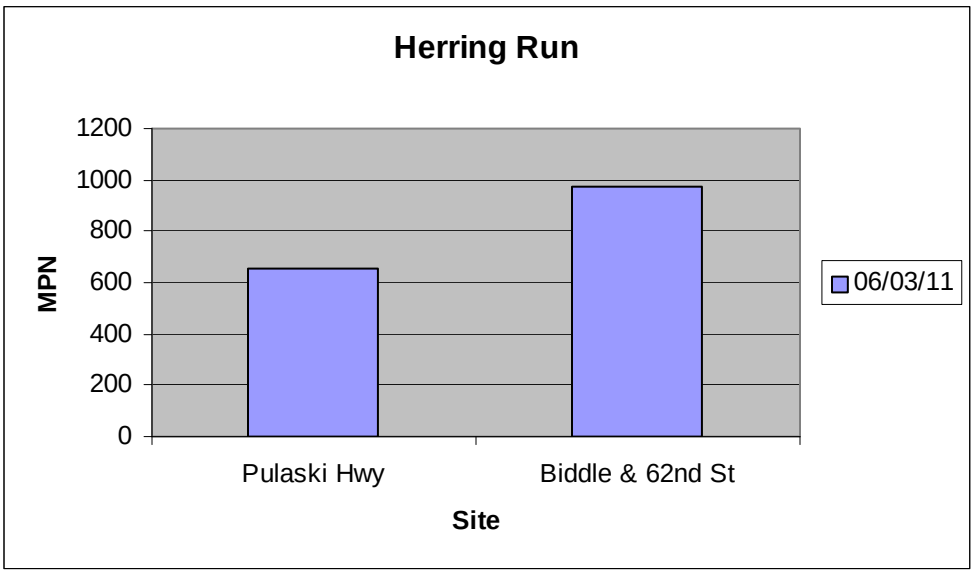


Figure 9-46a Herring Run MPN

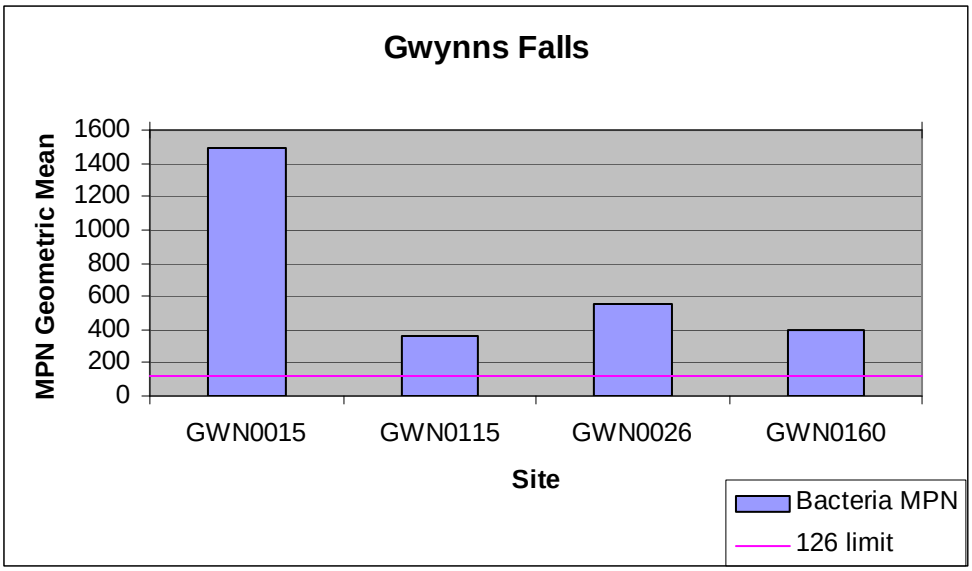


Figure 9-46b Gywnns Falls Geometric Mean

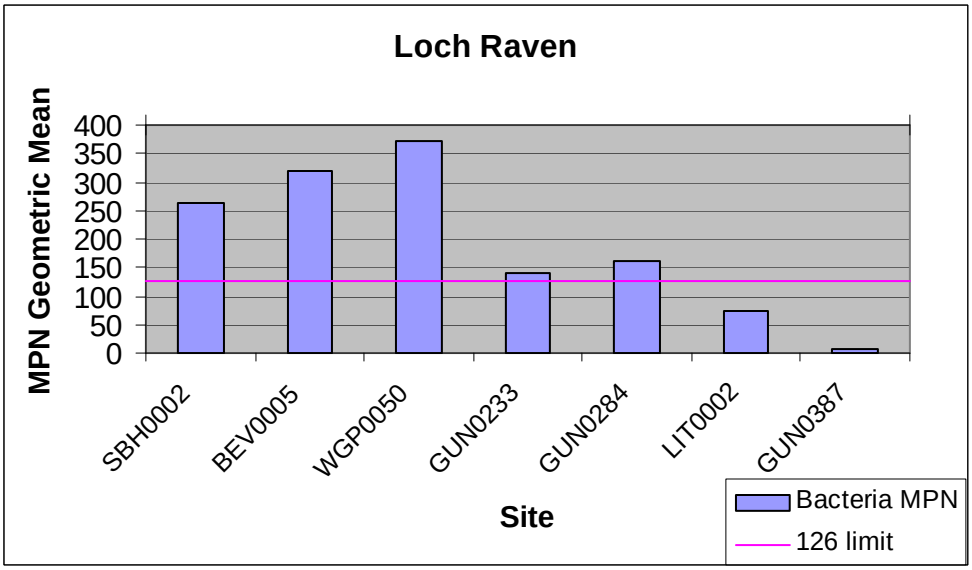


Figure 9-46c Loch Raven Geometric Mean

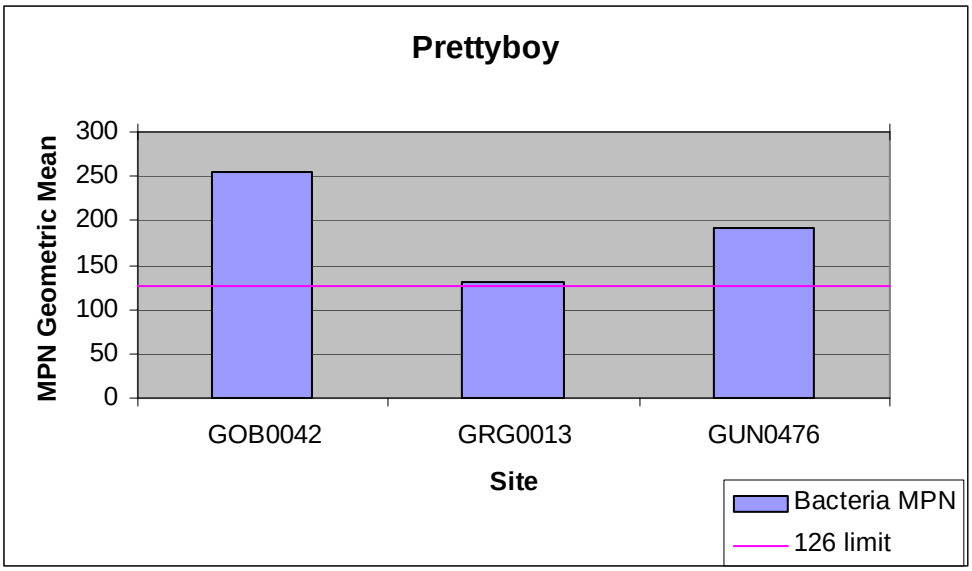


Figure 9-46d Prettyboy Geometric Mean

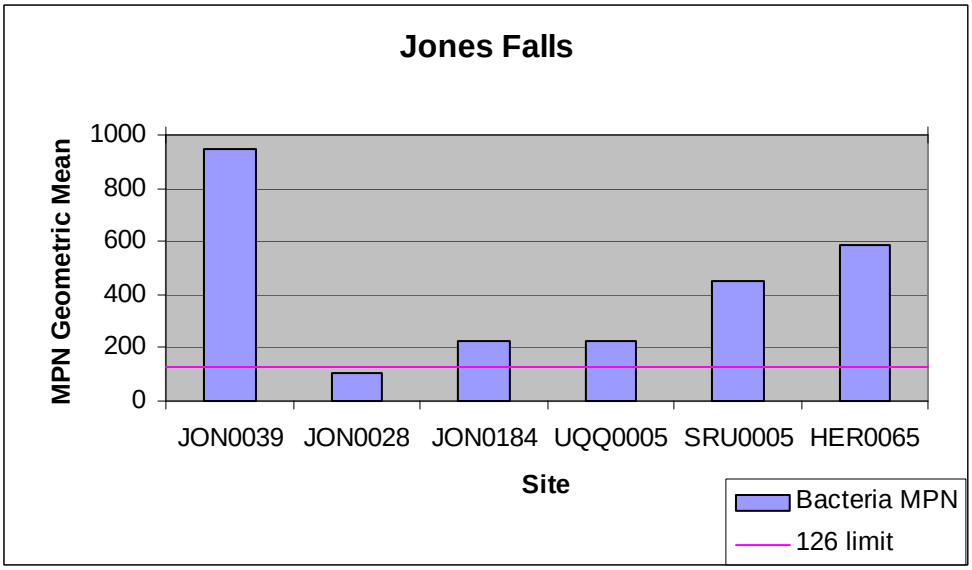


Figure 9-46e Jones Falls Geometric Mean

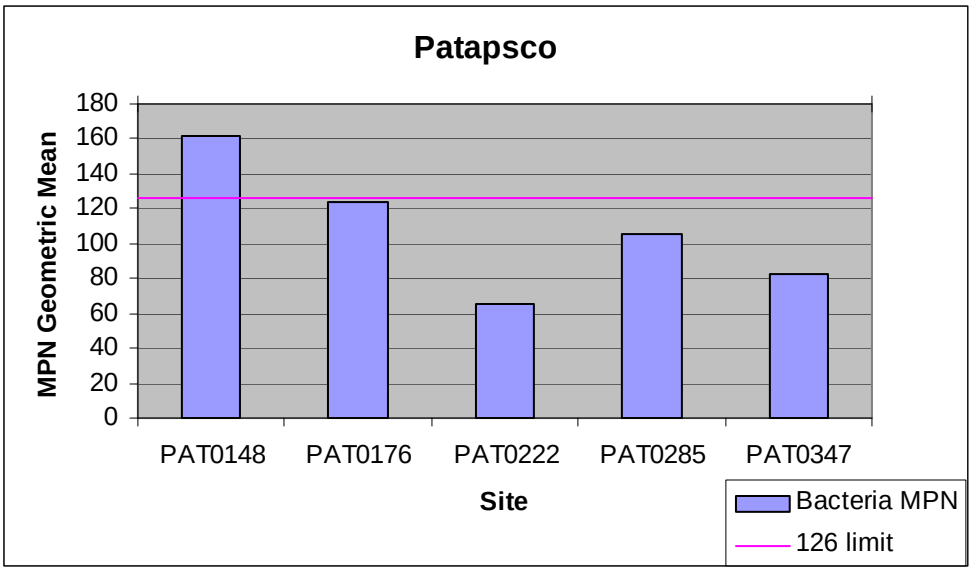


Figure 9-46f Patapsco Geometric Mean

Table 9-13 shows the percentage of samples at each site that were above the Single Sample Maximum Allowable Density for Infrequently Used Full Body Contact Recreation of 576 MPN/100mL (from EPA). Based on the percentage of samples that exceeded the limit, each site was rated as Good (0-25%), Fair (26-50%), Poor (51-75%), or Very Poor (76-100%).

Table 9-13 Bacteria Site Rating

Watershed	Site	Total # samples	# Samples exceeded limit	% Samples exceeded limit	Rating
Herring Run	Pulaski Hwy	1	1	100.00	Very Poor
Herring Run	Biddle & 62nd St	1	1	100.00	Very Poor
Gwynns Falls	GWN0015	12	11	91.67	Very Poor
Gwynns Falls	GWN0115	13	7	53.85	Poor
Gwynns Falls	GWN0026	13	8	61.54	Poor
Gwynns Falls	GWN0160	13	6	46.15	Fair
Jones Falls	JON0039	13	12	92.31	Very Poor
Jones Falls	JON0028	13	3	23.08	Good
Jones Falls	JON0184	13	4	30.77	Fair
Jones Falls	UQQ0005	13	6	46.15	Fair
Jones Falls	SRU0005	13	9	69.23	Poor
Jones Falls	HER0065	12	9	75.00	Poor
Loch Raven	SBH0002	13	5	38.46	Fair
Loch Raven	BEV0005	13	7	53.85	Poor
Loch Raven	WGP0050	13	6	46.15	Fair
Loch Raven	GUN0233	13	2	15.38	Good
Loch Raven	GUN0284	13	3	23.08	Good
Loch Raven	LIT0002	3	0	0.00	Good
Loch Raven	GUN0387	13	0	0.00	Good

Patapasco	PAT0148	13	5	38.46	Fair
Patapasco	PAT0176	13	2	15.38	Good
Patapasco	PAT0222	13	2	15.38	Good
Patapasco	PAT0285	13	3	23.08	Good
Patapasco	PAT0347	13	2	15.38	Good
Prettyboy	GOB0042	13	5	38.46	Fair
Prettyboy	GRG0013	13	2	15.38	Good
Prettyboy	GUN0476	13	4	30.77	Fair

Appendix 9-1: Baseflow Monitoring Sites by Watershed

Liberty Reservoir – 6 Sites			
Site ID	**Subwatershed**	**Site ID**	**Subwatershed**
LI-01	Cliffs Branch	LI-09	Timber Run
LI-02	Glen Falls Run	LI-10	Locust Run
LI-03	Keysers Run		
LI-04	Norris Run		
Patapsco River – 5 Sites			
PA-04	Ben's Run	PA-12	Brice Run
PA-06	Cooper Branch	PA-13	West Branch
PA-09	Soapstone Branch		
Gwynns Falls – 6 Sites			
GW-01	Gwynns Falls – Glyndon	GW-07	Gwynn's Falls Trib.
GW-03	Holly Branch	GW-10	Dead Run – Mainstem
GW-04	Red Run	GW-11	USGS gage at Gwynnbrook Road
GW-05	Horsehead Branch		
Jones Falls – 8 Sites			
JF-01	Western Run	JF-08	Shaughterhouse Run
JF-04	Dipping Pond Run	JF-09	Moores Run
JF-05	Deep Run	JF-10	Towson Run
JF-07	Roland Run	JF-11	Jones Falls
Back River – 10 Sites			
HR-01	West Branch – Herring Run	BR-02	Brians Run
HR-02	West Branch – Herring Run	BR-03	Redhouse Run
HR-03	East Branch – Herring Run	BR-04	Redhouse Run
HR-04	East Branch – Herring Run	BR-05A	Stemmers Run
BR-01	Bread and Cheese Creek	BR-06	Stemmers Run
Deer Creek – 4 Sites			
DC-01	Harris Mill	DC-03	Deer Creek – mainstem
DC-02	Ebaughs Creek	DC-04	Plumtree Branch
Prettyboy Reservoir – 8 Sites			
PR01	Walker Run	PR05A	Prettyboy Branch (Left facing US)
PR02	Gunpowder Falls above Prettyboy	PR05B	Prettyboy Branch (Right)
PR03	Grave Run	PR06	Frog Hollow Run
PR04	George's Run		

Loch Raven Reservoir – 32 Sites			
LR-02	Fitzhugh Run	LR-23	Charles Run
LR-03	Dulaney Valley Branch	LR-24	Little Falls
LR-10 (LQ3)	Long Quarter Branch	LR-27	Third Mine Branch
LR-13 (BR1)	Beaver Dam Run – York Road	LR-28	Owl Branch
LR-14	Baisman Run	LR-30	Beetree Run
LR-15	Beaver Dam Run – Rises Court	LR-31	Mingo Branch
LR-17 (WR1)	Western Run	LR-32	Black Rock Run – Western Run
LR-18	Green Branch	LR-34	McGill Run
LR-19 (OR1)	Overshot Run	LR-35	Piney Run
LR-20	Carroll Branch	LR-36	Piney Run
LR-21	Piney Creek	LR-38	Delaware Run
LR-22 (GF1)	Gunpowder Falls - Glencoe		
Lower Gunpowder Falls – 7 Sites			
GU-01	Bean Run	GU-06	Cowen Run
GU-03	Haystack Branch	GU-07	Jennifer Branch
GU-04	Long Green Creek – Hydes Rd.	GU-08	Minebank Run
GU-05	Long Green Creek – Hartley Mill		
Little Gunpowder Falls – 7 Sites			
LG-01	Nelson Branch	LG-05	Little Gunpowder Falls
LG-02	Parker Branch	LG-07	Little Gunpowder Falls
LG-03	Sawmill Branch	LG-09	Frannklinville Channel.
LG-04	Little Gunpowder Falls		
Bird River – 5 Sites			
BI-01	Windlass Run	BI-04	North Fork
BI-02	Honeygo Run	BI-05	Whitemarsh Run – Mainstem
BI-03	Whitemarsh Run - Headwaters		

Appendix 9-4: Results of 2010 Probabilistic Monitoring

StationID	Subwatershed	DNR 12digit Subsheds	Benthic Index of Biotic Integrity Score	Rating
Prettyboy Reservoir				
0204014	Prettyboy Direct Drainage-A	0313	3.67	Fair
0204033	Georges Run	0314	3.00	Fair
0210003	Peggy's Run	0314	2.67	Poor
0210008	Prettyboy Branch	0313	3.67	Fair
0210009	Prettyboy Branch	0313	3.00	Fair
0210010	Peggy's Run	0314	2.33	Poor
0210013	Georges Run	0314	2.67	Poor
0210015	Georges Run	0314	3.00	Fair
0210018	Georges Run	0314	3.00	Fair
0210039	Prettyboy Direct Drainage-A	0313	3.67	Fair
0210041	Prettyboy Direct Drainage-B	0313	4.00	Good
Loch Raven Reservoir				
0304021	Fourth Mine Branch	0309	3.67	Fair
0304084	Piney Run	0308	3.00	Fair
0304121	Blackrock Run	0307	3.33	Fair
0304197	Baisman Run	0302	3.00	Fair
0304208	Goodwin Run	0302	1.00	Very Poor

0304214	Merryman's Branch	0300	3.00	Fair
0310006	Spring Branch	0300	1.67	Very Poor
0310007	Loch Raven Reservoir-D	0300	2.33	Poor
0310011	Beaver Dam Run	0302	3.00	Fair
0310012	Beaver Dam Run	0302	3.67	Fair
0310013	Beaver Dam Run	0302	2.33	Poor
0310014	Goodwin Run	0302	1.00	Very Poor
0310015	Loch Raven Reservoir-D	0300	2.00	Poor
0310018	Loch Raven Reservoir-I	0300	3.33	Fair
0310030	Councilman's Run	0303	3.00	Fair
0310033	Beaver Dam Run	0302	3.67	Fair
0310036	Baisman Run	0302	3.67	Fair
0310037	Beaver Dam Run	0302	1.00	Very Poor
0310042	Baisman Run	0302	3.67	Fair
0310043	Baisman Run	0302	3.67	Fair
0310054	Oregon Run	0302	3.33	Fair
0310055	Dulaney Valley Branch	0300	3.67	Fair
0310056	Oregon Run	0302	2.67	Poor
0310059	Oregon Run	0302	2.67	Poor
0310061	Slade Run	0303	3.67	Fair
0310064	Slade Run	0303	3.67	Fair
0310065	Oregon Run	0302	3.67	Fair
0310066	Slade Run	0303	3.33	Fair
0310067	Slade Run	0303	3.33	Fair
0310071	Slade Run	0303	3.67	Fair
0310073	Overshot Run	0301	3.67	Fair
0310074	Overshot Run	0301	3.33	Fair
0310075	Slade Run	0303	3.67	Fair
0310079	Greene Branch	0301	2.67	Poor
0310088	Greene Branch	0301	3.67	Fair
0310098	Western Run-Loch Raven-A	0303	2.33	Poor
0310099	Western Run-Loch Raven-A	0303	3.00	Fair
0310101	Western Run-Loch Raven-A	0303	3.00	Fair
0310105	Western Run-Loch Raven-A	0303	3.33	Fair
0310107	Greene Branch	0301	3.67	Fair
0310110	McGill Run	0308	3.67	Fair
0310111	McGill Run	0308	3.67	Fair
0310120	Carroll Branch	0304	4.00	Good
0310124	Western Run-Loch Raven-A	0303	4.33	Good
0310126	Indian Run-Loch Raven	0307	2.00	Poor
0310132	McGill Run	0308	2.00	Poor
0310136	Western Run-Loch Raven-A	0303	4.00	Good
0310137	My Ladys Manor Branch	0304	3.67	Fair
0310143	Piney Run	0308	3.00	Fair
0310145	Carroll Branch	0304	3.33	Fair
0310151	Little Piney Run	0308	3.67	Fair

0310154	Buffalo Creek	0305	4.00	Good
0310155	Indian Run-Loch Raven	0307	3.67	Fair
0310156	Piney Run	0308	4.00	Good
0310157	Piney Run	0308	3.00	Fair
0310161	Piney Run	0308	4.00	Good
0310162	Little Piney Run	0308	3.00	Fair
0310164	Piney Run	0308	3.67	Fair
0310170	Blackrock Run	0307	3.00	Fair
Deer Creek				
0404001	Harris Mill	0332	3.33	Fair
0404006	Plumtree Branch	0332	3.67	Fair
0410011	Harris Mill	0332	3.33	Fair
Little Gunpowder Falls				
0904008	Parker Branch	0299	3.67	Fair
0910002	Franklinville Channel	0298	2.67	Poor
0910014	Little Gunpowder Falls-A	0298	2.33	Poor
0910028	Parker Branch	0299	3.67	Fair
0910030	Little Gunpowder Falls-A	0299	3.67	Fair
0910031	Little Gunpowder Falls-A	0299	3.00	Fair
0910032	Nelson Branch	0299	3.00	Fair
Lower Gunpowder Falls				
1004002	Jennifer Branch	0297	2.00	Poor
1004029	Long Green Creek	0297	2.33	Poor
1010013	Lower Gunpowder Falls	0297	2.33	Poor
1010016	Lower Gunpowder Falls	0296	3.00	Fair
1010017	Lower Gunpowder Falls	0296	3.00	Fair
1010021	Long Green Creek	0297	3.33	Fair
1010027	Long Green Creek	0297	2.67	Poor
1010030	Long Green Creek	0297	3.00	Fair
1010033	Long Green Creek	0297	3.33	Fair
1010035	Long Green Creek	0297	3.00	Fair
1010041	Long Green Creek	0297	3.67	Fair
1010050	Jennifer Branch	0297	1.33	Very Poor
1010051	Bean Run	0296	2.33	Poor
Bird River				
1110004	Whitemarsh Run (S.Fo)	0295	2.43	Poor
1110010	Whitemarsh Run	0295	1.57	Very Poor
1110012	Whitemarsh Run	0295	2.14	Poor
1110018	Bird River-D	0294	1.57	Very Poor
1110019	Whitemarsh Run (N.Fork)	0295	2.00	Poor
1110025	Whitemarsh Run (N.Fork)	0295	1.67	Very Poor
1110026	Honeygo Run	0295	1.33	Very Poor