APPENDIX A – TECHNICAL MEMORANDA

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SITE SELECTION OF STREAM CROSSINGS TO BE ANALYZED FOR FLOOD OVERTOPPING

TECHNICAL MEMORANDUM

Subtask 2.1.6
Magothy River Watershed Study

October 2008

Prepared For:
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Watershed Management Program
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Magothy River HY8 Crossings Selection Procedure and Recommendations

LimnoTech recommends six stream crossings be surveyed for selected hydraulic design information (as outlined in Subtask 2.1.7) for utilization by the County in HY8 modeling. Selection of these sites was performed using the criteria outlined by the County along with County-provided GIS data and crossing information collected during field activities. A more detailed description of the criteria and data sources used and the steps taken to identify the six recommended crossings are discussed below.

Selection Criteria

The County's selection criteria as described in the statement of work include:

- stream crossing must be owned by the County;
- road must be classified as Freeway, Principal Arterial, Minor Arterial, or Collector in the County's Master Transportation Plan;
- overtopping is likely, given field conditions;
- crossings must be older than 5 years and not scheduled for replacement; and
- flooding would completely cut off an area from emergency services.

Data Sources

Site selection was conducted using County-provided GIS data and crossings information collected during field activities associated with the Physical Habitat Condition Assessment task (Subtask 3.2). Data utilized included:

- Stream reaches ("Magothy_StreamReach_v2" *LimnoTech*)
- Roadway types ("Streets_functional_class" *County*)
- Magothy River subwatershed boundaries ("Subwatersheds" *County*)
- Aerial photography
- Crossings ("Magothy_Crossings" *LimnoTech*):
  - includes both data collected during the Spring 2008 Physical Habitat Condition Assessment field work (Subtask 3.2) as well as the following additional fields:
    - NameFull: Street name from "Streets_Functional_class" shapefile.
    - Func_Class: Roadway classification based on County Master Transportation Plan road classification system for roads within Anne Arundel County (Freeway, Principal Arterial, Minor Arterial, Collector, or Local) from "Streets_functional_class" shapefile.

- St_Type: Stream type (perennial, ephemeral, intermittent, wetland, underground), from Magothy_StreamReach_v2 (based on Physical Habitat Condition Assessment streamwalks) generated by LimnoTech
- Field_Cond: Potential for stormwater to flow over road embankment was assessed both in the field and utilizing GIS to assess drainage area contribution. Key features included the height of the roadway above the stream surface (assuming those >20 ft would have minimal overtopping potential), crossing dimensions, drainage areas, and upstream and downstream floodplain characteristics. Crossings with field conditions that indicated possible overtopping are designated “yes”.
- Isolate: Potential for roads, if overtopped, to completely isolate an area from emergency services where a stream crosses a single access point to a community or business area.
- HY8_Survey: Sites suggested for surveying/ HY8 modeling designated “yes”.

Selection Process

The selection process was conducted as follows:

1. County ownership information was not available, so all crossings were included in the analysis.

2. A subset of crossings inventoried during field activities was selected if the road crossed was classified as Freeway, Principal Arterial, Minor Arterial, or Collector under the County Master Transportation Plan as provided in the “Streets_functional_class” shapefile, and crossed a perennial stream or channel that became perennial at the downstream side. Crossings on large roads, including Rt. 100 and Rt. 2 (Ritchie Highway) were not included as it is assumed that they are designed for large storm capacity. Foot trail crossings, driveway culverts, and SWM associated culverts were eliminated from consideration. Of 90 crossings assessed during field activities, **27** met these criteria (Figure 1).

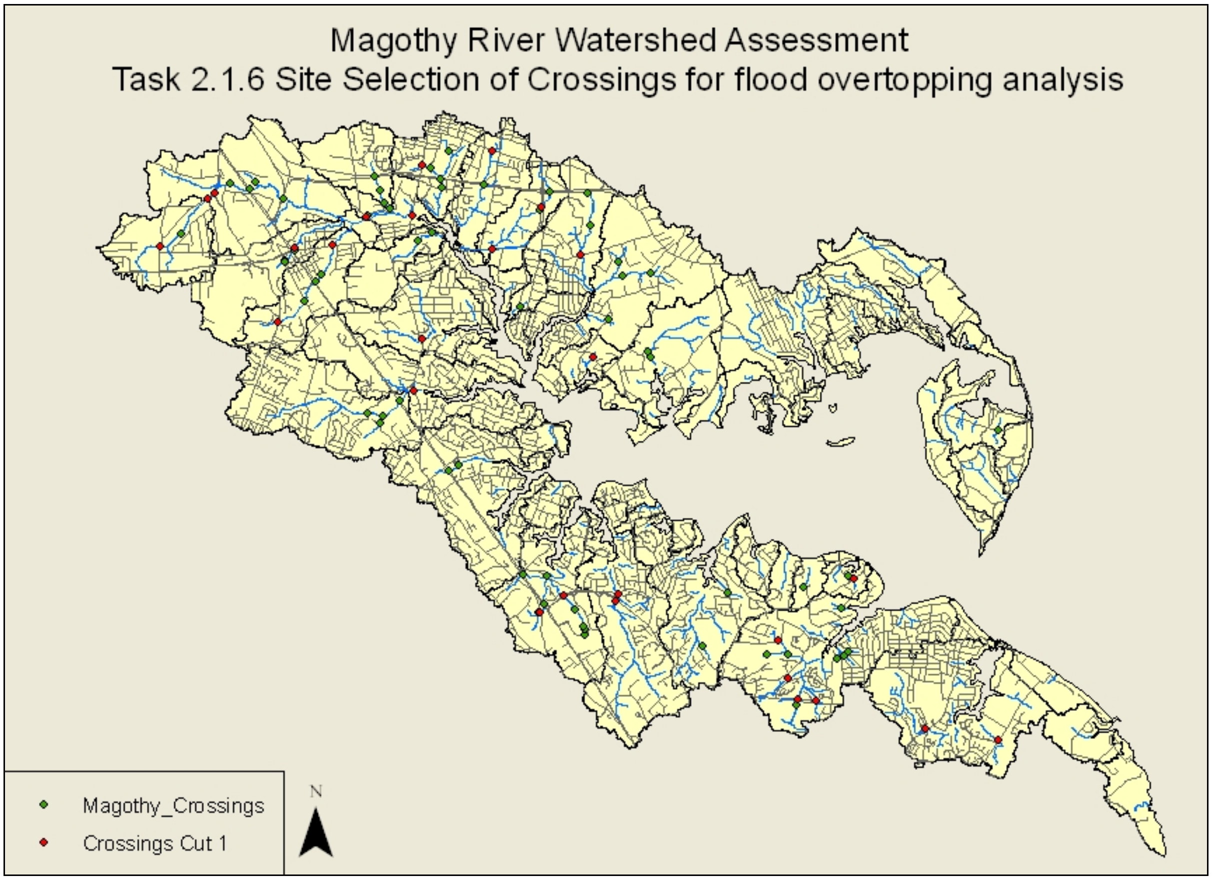

Figure 1: Crossings Meeting the Road Type and Perenniality Criteria

3. Crossings were selected if field conditions indicated that overtopping is likely, determined primarily by the height (less than 20 ft.) of the road surface above the water surface. LimnoTech also assessed pertinent channel and floodplain characteristics, including culvert dimensions, embankment height, surrounding land use, and probable drainage area contribution. Cases where upstream conditions were non-perennial, while downstream conditions were perennial were assessed on an individual basis and included if warranted. Of the 27 remaining crossings, **14** met this criterion (Figure 2).

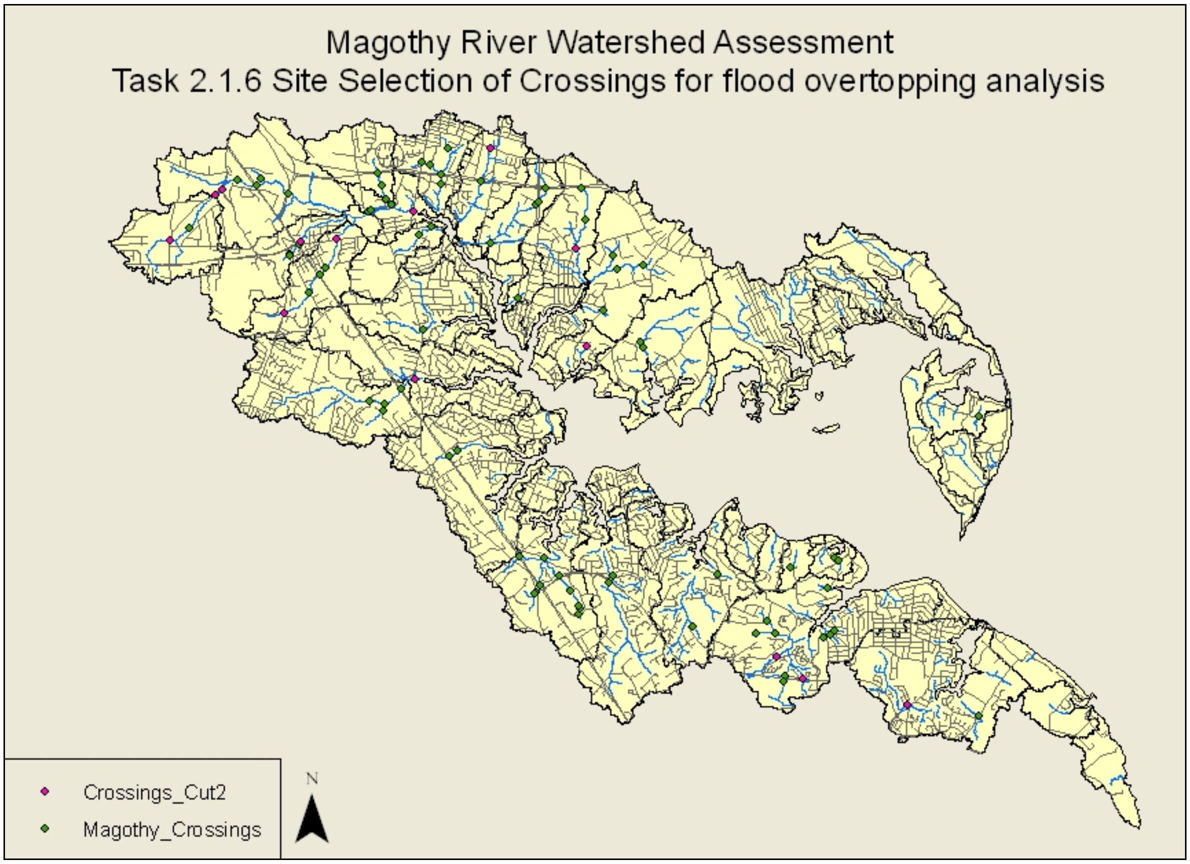

Figure 2: Crossings Meeting Road Type, Perenniality and Field Conditions Criteria

4. Crossings were to be selected only if older than 5 years and not scheduled for replacement. Age data for crossings was not available. The *Anne Arundel County, Capital Budget and Program. Fiscal Year 2008: Supplement 2*, and the *Anne Arundel County, Proposed Capital Budget and Program. Fiscal Year 2009: Supplement 2* were consulted to determine replacement plans. None of the 14 remaining crossings are scheduled for replacement.

5. Crossings were to be selected if there was potential that overtopped roads may completely isolate an area from emergency services. Aerial photography and county roads coverage were used to visually assess alternate routes to both sides of each crossing**.** Of the 14 crossings meeting previous criteria, none were found to isolate an area when flooded either singly or concurrently. LimnoTech expanded this analysis to include crossings that cross “Local” road types and also met all previous criteria that (a.) if flooded in conjunction with any of the 14 previously selected crossings would isolate an area from emergency services, and (b.) would isolate areas from emergency services if flooded singly.

a. Overtopping of one “Local” roadway crossing in conjunction with overtopping of one “non-Local” roadway was determined to isolate a significant number of homes at the following crossings:

Inventory ID	Street Name	Road Functional Class
MR6015.C001	WALDO RD	LOCAL
MRL003.C001	LAKE SHORE RD	COLLECTOR

b. Additionally, the following “Local” roadway crossings would isolate homes if overtopped:

Inventory ID	Street Name	Road Functional Class
MR1006.C002*	ARMIGER	LOCAL
MR1013.C001	SAGAMORE WAY	LOCAL
MR5020.C001	SEABORNE DRIVE	LOCAL
MRG006.C001	GLENCREST RD	LOCAL

*MR1006.C002 was cited by field assessors as being very likely to flood.

LimnoTech therefore suggested, with County concurrance, that the County expand the criteria to include local road ways.

6. LimnoTech and the County also considered the following crossings for surveying. While not resulting in isolation, both crossings were noted by either LimnoTech field assessors or County personnel as being likely to flood based on field indicators. The County has opted to not include these for further study, as they do not meet the isolation criterion.

Inventory ID	Street Name	Road Functional Class
MRO005.C002	MCBRIDE LANE	LOCAL
MGI024.C001	JOYCE LANE	LOCAL

Final Recommendations

As described above, LimnoTech recommends the following six crossings be surveyed and included in the County’s HY8 modeling for flood overtopping (Figure 3):

Inventory ID	Street Name
MR1006.C002	ARMIGER
MR1013.C001	SAGAMORE WAY
MR5020.C001	SEABORNE DRIVE
MRG006.C001	GLENCREST RD
MR6015.C001	WALDO RD
MRL003.C001	LAKE SHORE RD

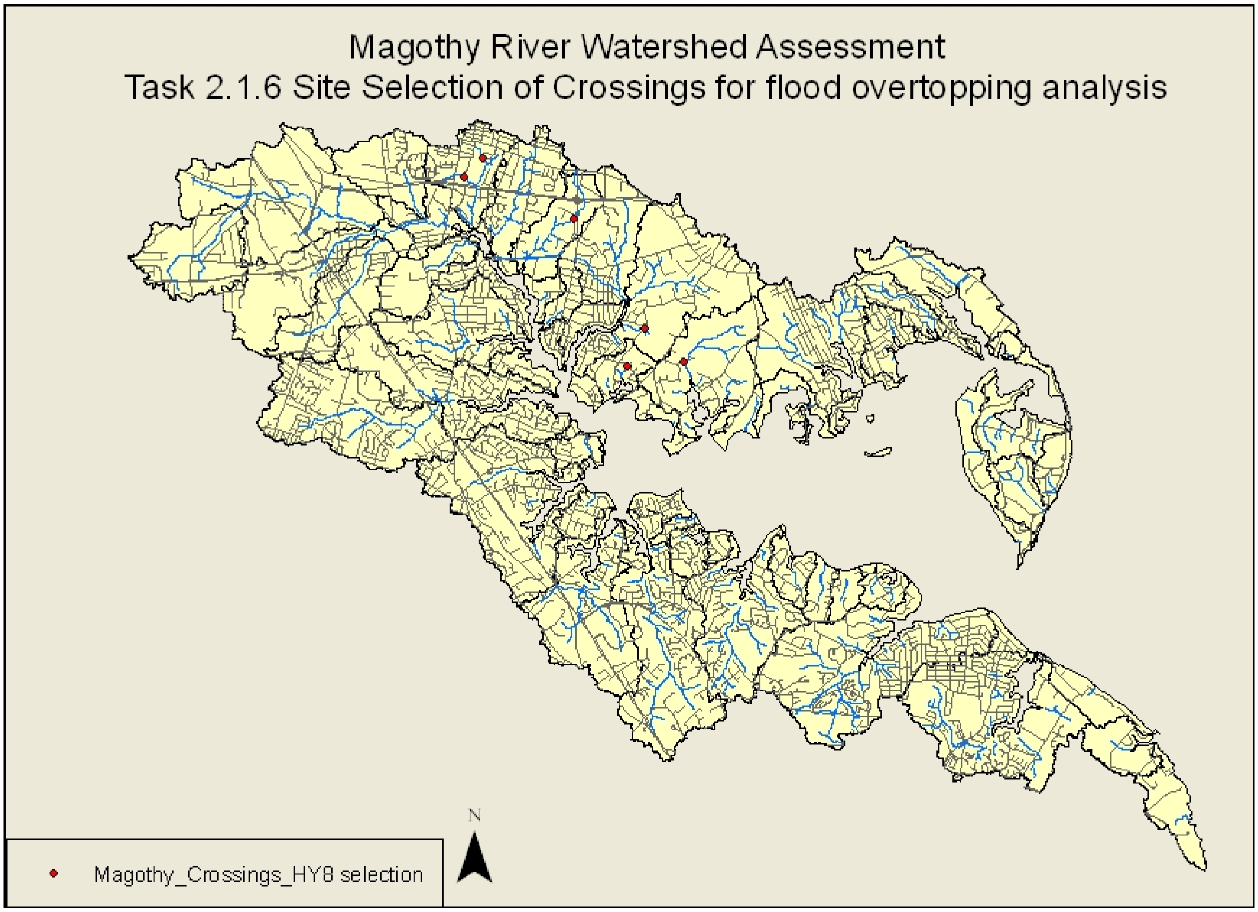

Figure 3: Suggested Crossings for Surveying and HY8 Modeling

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URBAN BEST MANAGEMENT PRACTICES TECHNICAL MEMORANDUM

Subtask 2.2
Magothy River
Watershed Study

February 2009

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Introduction

Under Subtask 2.2 of the Magothy River watershed study, LimnoTech was tasked by the Anne Arundel County Department of Public Works with developing a complete geospatial dataset of available urban stormwater best management practices (BMPs) within the Magothy River watershed. In summary, the effort to develop the dataset entailed:

- compiling existing data from multiple County and other sources,
- narrowing the dataset to eliminate those BMPs outside of the Magothy River watershed,
- confirming or updating the spatial locations of the remaining BMPs,
- removing duplicate records, and
- performing research to fill any data gaps.

This Technical Memorandum documents the steps and procedures LimnoTech performed to complete this task. These steps and procedures were performed in accordance with discussions with County personnel, and the County's Technical Memorandum dated June 7, 2007 entitled "*Anne Arundel County Comprehensive Watershed Studies, Subtask 2.2 – SWM facility maps*."

Compiling Existing Data

The first step in the process was to compile all of the existing BMP records for the Magothy River watershed. Several sources were utilized in this process. The following is a list and brief description of the data sources:

- **Urban BMP Database:** The County provided this dataset to LimnoTech in the form of two point shapefiles. The first contained data current through 2007, while the second contained data compiled in 2008. The dataset is derived from the Anne Arundel County Inspections and Permit urban stormwater management database. The dataset contains Anne Arundel County permitted public and private urban BMPs. Facilities permitted directly by other entities are not included in this dataset. The two shapefiles together contained 10,257 BMP records.

- **County's Public BMP Polygon Shapefile:** The County provided a second dataset containing a subset of public BMPs that had been digitized from operating maps and As-built plans. This dataset was provided as a polygon shapefile. The County noted that it is considered to be a spatially accurate, but incomplete inventory of the County-owned facilities. The County also noted that some of the records may be duplicates of those contained in the Urban BMP database. The polygon shapefile contained 97 BMP records.

- **SHA Highway Hydraulics BMP Database:** At the County's request, LimnoTech contacted the Maryland State Highway Administration (SHA) to obtain a list of SHA owned BMPs in the Magothy River watershed. SHA responded to the request and provided LimnoTech with an MS Access database of all BMPs in Anne Arundel County within its purview. The database contained spatial and attribute data for 461 BMP records.

- **Soil Conservation District Ponds:** At the County's request, LimnoTech contacted the Anne Arundel County Soil Conservation District (SCD) to obtain a list of MD-378 ponds in the

Magothy River watershed. LimnoTech was provided a spreadsheet containing attribute data for 1,210 ponds, but was informed that spatial information was only available on hard copy maps available for review at SCD offices.

Narrowing the Dataset to Eliminate BMPs Outside of the Watershed

With a draft dataset of BMP records compiled from the sources listed above, LimnoTech next worked to remove those BMP records known to be outside of the watershed. LimnoTech followed the protocols for this step as outlined in the County's Technical Memo. As each BMP data source had different degrees of inherent spatial accuracy, the steps for eliminating records varied among the sources. The rationales for eliminating specific records are provided in the companion spreadsheet "Magothy_BMP_Analysis_v1.xls." The code in the companion spreadsheet for removal rationale is provided in italicized parentheses following each data source or type. The procedures for each data source are provided below.

- **Urban BMP Database:** LimnoTech was informed that the data contained in this dataset is under review by the Department of Public Works' Infrastructure Management Division and that the spatial locations for many BMP records are inaccurate or unknown. To facilitate this analysis, LimnoTech defined a study area using a one-mile buffer of the Magothy River watershed as an overlay layer. This helped eliminate the need to make close calls for BMPs located near the watershed boundary. The following steps were taken:
    - All records with an *XY_Source* value of "CPF", "CV", "MapOptix", or "Geocoded Address" that fell outside of the study area were removed from the draft dataset, as these sources were assumed to yield spatially accurate data *(Code: Point outside buffer, XY_Source is CPF; Point outside buffer, XY_Source is CV; Point outside buffer, XY_Source is Geocoded Address; Point outside buffer, XY_Source is MapOptix)*
    - All BMPs previously researched and positively identified within the Upper Patuxent River watershed during that study were removed from the draft dataset. *(Code: BMP positively located in Upper Patuxent watershed)*
    - A spatial join was performed with the draft database and the County's Planning and Zoning zip code polygon shapefile. All BMP records (except those located at the County centroid) with matching zip codes that fell outside of the study area were removed from the draft dataset *(Code: Zip code matched, point outside buffer)*
    - A spatial join was performed with the draft database and the ADC map grid polygon shapefile. All BMP records (except those located at the County centroid) with matching ADC map grid values that fell outside of the study area were removed from the draft dataset. *(Code: Map grid matched, point outside buffer)*
    - Using a parcel map layer at the County offices, all BMP records (except those located at the County centroid) with matching tax accounts that fell outside of the study area were removed from the draft dataset. *(Code: Parcel ID matched, point outside buffer)*
    - For the remaining records that plotted outside of the study area, including records with *XY_Source* value of "County Centroid," LimnoTech performed two additional checks to determine if a particular record should be eliminated. The first was a check of the BMP name against the USGS Geographic Names Information System (GNIS) and

against the various index search categories within the County ADC map (e.g., place names, airports, business parks, campsites, golf courses, parks, police stations, etc.). The second was a check of the street name or address against the County's street centerline file. If either of these approaches yielded a match outside of the study area, then the record was removed. *(Code: Address identified outside watershed; Place name located outside watershed)*

- For those records that still remained at this point, additional checks performed at the County offices eliminated another subset of BMP records. This entailed utilizing various County tools to positively identify a BMP record and determine its location. Specifically, LimnoTech reviewed As-builts on CountyView, scanned grading and building permits, other archived electronic records, and GoogleMaps. A record was considered positively identified if two pieces of identifying information matched a record in the draft dataset. *(Code: Identified outside of watershed based on [County resource])*

This process eliminated 7,338 of the 10,257 BMP records and retained 2,919 records in the draft dataset for further study.

- **County's Public BMP Polygon Shapefile:** The County's Technical Memo dictated that the public BMP polygons were spatially accurate. As all 97 of the BMP polygons in this dataset were within the Magothy River watershed, no BMP records were eliminated. All 97 BMPs were retained in the draft dataset for further study.

- **SHA Highway Hydraulics BMP Database:** The County's Technical Memo assumed that the SHA database was also spatially accurate. As such, LimnoTech performed a spatial join with this dataset and the watershed boundary shapefile. Of the 461 BMP records in the database, 31 were located within the watershed boundary and thus retained in the draft dataset for further study. *(Code: SHA BMP outside watershed, location assumed final)*

- **Soil Conservation District Ponds:** The primary identifying attributes of the MD-378 ponds in the SCD dataset were a unique ID number, a grading permit number, and a map number with grid coordinates. At the County SCD office, LimnoTech reviewed hard copy maps to determine the maps or portions of maps that lie within the Magothy River watershed. This was cross-checked with the map and grid coordinates to determine whether a pond should be retained or eliminated. Additionally, those ponds with valid grading permits were compared to the grading permits of previously eliminated BMPs to determine if there were any matches. Ponds with grading permits that match BMPs already established to be outside the study area were eliminated. Finally, all hard copy maps containing portions of the watershed were carefully examined in an attempt to identify any remaining ponds that may exist within the Magothy River watershed. Of the 1,210 ponds in the spreadsheet, 63 were positively identified within the watershed and retained in the draft dataset for further evaluation. *(Code: Grading permit match with BMP outside watershed; Map includes part of watershed, but point not found on hard copy maps; Map outside watershed; No grading permit match or map coordinates, pond not found on hard copy maps)*

Confirming or Updating Spatial Locations

A total of 3,110 records were ultimately retained in the draft dataset. For these records, LimnoTech worked to confirm or update the spatial location of the BMP using various record attributes. LimnoTech completed the majority of this step at the County offices during multiple visits between December 2008 and January 2009. Looking at each BMP record individually, LimnoTech used various County tools to first positively identify a BMP record from the draft dataset and second to confirm or update its location. Specifically, LimnoTech used the parcel layer, As-built records on CountyView, scanned grading and building permits, other archived electronic records, and GoogleMaps to assist in this process. A record was considered positively identified if two pieces of identifying information (*e.g.*, name, tax account ID, address) from the draft dataset matched the record or file from one of the County's resources.

Each positively identified record was then evaluated for spatial accuracy. The BMP record location in the draft dataset was compared to the location indicated in the County tool or resource where the record was positively identified. If the locations were within 500 feet (a value determined in consultation with the County program manager), then the BMP record was considered spatially accurate. A BMP in the draft dataset that was in the vicinity of, but over 500 feet from, the location suggested in the County tool or resource was moved to the new location only when aerial imagery, parcel maps, or facility drawings supported the move. This helped ensure that BMP points would only be relocated when enough evidence suggested a move was appropriate.

If the BMP record was located at the County centroid and the County tool or resource provided limited evidence of the correct location (which occurred in a few instances), LimnoTech used its best professional judgment to locate the BMP point as accurately as possible. Notes about relocating points and rationales for doing so are provided in the companion spreadsheet "Magothy_BMP_Analysis_v1.xls." A total of 60 BMP records did not contain enough identifying information to be positively identified or spatially confirmed. These records are included separately in the companion spreadsheet under a separate tab called "BMPs Requiring More Research."

Resolving Duplicates

Given that data was compiled from multiple datasets, it is inevitable there may be some duplicate records. Note that the degree of identifying information available made it very difficult to identify duplicates within an individual data source. As such, an effort to identify and remove duplicates was only rigorously performed between data sources. LimnoTech identified duplicate records by examining attributes and spatial locations. Only when points were co-located with matching identifying attributes and structure types were they considered to be redundant. All 63 MD-378 ponds were determined to be duplicates of records in one of the other primary references, while 94 of the 97 DPW BMP polygons were found to be duplicates.

Researching Data Gaps

To perform the prioritization modeling using these BMPs, the County requires that the data attributes listed below be fully populated. LimnoTech performed the step to research data gaps concurrently with the step to confirm and update spatial locations at the County offices. Looking at each BMP record individually, LimnoTech used County tools including As-builts on CountyView, scanned grading and building permits, and other archived electronic records to fill in data gaps.

- **Drainage Area (Drainage):** The County noted that all BMPs within the Magothy River watershed were to be attributed with the drainage area. The drainage area for the majority of records was found in the existing Urban BMP database. For records with null or zero values, the scanned grading and building permits, archived records, and As-builts on CountyView were researched for the information. As a last resort, LimnoTech moved the BMP point to the appropriate flow accumulation grid and obtained drainage area delineations from the County. In those few instances where the drainage area for a residential infiltration drywell was missing from the Urban BMP database, an average value of 0.05 acres was used. This assumption was only used to populate missing information and not to override existing data.

- **Structure Type (StrucType):** The County noted that all BMPs within the Magothy River watershed were to be attributed with the Structure Type. The structure type was documented using structure codes in accordance with the County BMP master list. For records with missing structure type information, the scanned grading and building permits, archived records, and As-builts on CountyView were researched for that information.

- **Ownership (Ownership):** This information was only to be compiled if it existed in the original dataset or if it was revealed during the record research for another required parameter.

- **Built Date (Built_Date):** This information was only to be compiled if it existed in the original dataset or if it was revealed during the record research for another required parameter.

- **Inspection Notes (Inspection):** This information was only to be compiled if it existed in the original dataset or if it was revealed during the record research for another required parameter.

Data Deliverables to County

In addition to this memo, the deliverable for this subtask also includes:

- a point shapefile (Magothy_BMPs_v1.shp) with all compiled, verified, and researched attributes;
- a point shapefile (Magothy_BMPs_requiring_additional_research.shp) with the existing locations of BMPs requiring additional research; and
- a spreadsheet (Magothy_BMP_Analysis_v1.xls) containing the final dataset, data requiring additional research, eliminated records with rationales, and the original datasets.

Summary of Findings

At the conclusion of the research efforts outlined above, 1,764 BMPs were confirmed to be located within the Magothy River watershed boundary. The data compiled for these BMPs will be used in further analyses of the Magothy River watershed study, including the evaluation of water quality under various current and future development scenarios.

The sum of the drainage areas for all 1,764 BMPs in the Magothy River watershed is 2,913 acres, while the entire watershed is approximately 22,800 acres in size. Thus the area of the Magothy River watershed that is receiving water quality treatment through a BMP is approximately 13 percent (13%).[1] The total impervious area in the Magothy River watershed is approximately 3,200 acres, equating to approximately 14 percent (14%) impervious cover. The BMP drainage areas range in size from 0.01 to 188.46 acres, with a mean drainage area of 1.65 acres, and a median drainage area of 0.10 acres. This indicates that many of the BMPs are very small in size. Over 81 percent (81%) of the BMPs treat less than one acre, but there are 34 BMPs that treat drainage areas over twenty acres.

Most of the BMPs are privately owned (83%), followed by publicly owned (13%), SHA owned (2%), and owned by a group termed “Other” (2%). However, when evaluated by the percent of the drainage area they treat in the Magothy River watershed, private BMPs treat 38% of the area, public BMPs treat 57%, “Other” BMPs treat 3%, and SHA BMPs treat 1%. Further statistics on BMPs by ownership type are presented in Table 1.

Table 1. Statistics on BMPs by Ownership Type

Ownership	Quantity	Percent by Quantity	Drainage Area (acres)	Percent by Drainage Area	Mean Drainage Area (acres)	Standard Deviation (acres)	Minimum Drainage Area (acres)	Maximum Drainage Area (acres)	Median Drainage Area (acres)
Private	1,466	83%	1,117.0	38%	0.76	6.27	0.01	188.46	0.08
Public (DPW)	228	13%	1,670.2	57%	7.33	11.09	0.03	57.86	2.33
SHA	31	2%	28.0	1%	0.90	0.73	0.15	3.44	0.70
Other	39	2%	97.8	3%	2.51	4.38	0.01	22.00	0.15
TOTAL	1,764	100%	2,913.1	100%	1.65	7.34	0.01	188.46	0.10

The BMPs can be classified into six categories: filtration practices, infiltration practices, dry detention practices, dry extended detention practices, wet structures, and other. The majority of the BMPs fall into the category of infiltration (73%) and this category also represents a good portion of the total BMP drainage area (24%). While wet ponds and wetlands only make up 4% of the BMPs by number, they cover 31% of the total BMP drainage area. Similarly, dry detention and dry extended detention compose 2% and 4% respectively of the BMPs by number, but cover 22% and 17% respectively of the total BMP drainage area. Further statistics on the BMPs by category can be found in Table 2.

Table 2. Statistics on BMPs by BMP Category

BMP Category	Quantity	Percent by Quantity	Drainage Area (acres)	Percent by Drainage Area
Dry Detention	36	2%	630.6	22%
Dry Extended Detention	64	4%	504.3	17%
Filtration	87	5%	83.4	3%
Infiltration	1,293	73%	710.1	24%

[1] Some of the BMP drainage areas may overlap, meaning the same piece of land could be getting treated by a series of BMPs.

BMP Category	Quantity	Percent by Quantity	Drainage Area (acres)	Percent by Drainage Area
Other	207	12%	83.0	3%
Wet Structures	77	4%	901.6	31%
TOTAL	1,764	100%	2,913.1	100%

Further investigation into the 228 publicly owned BMPs indicates that the largest type in number is infiltration (48%), and these also treat 20% of the public BMP drainage area. The largest treated drainage area for publicly owned BMPs is associated with wet structures (44%) even though they only account for 22% of the total number of BMPs. The average drainage area for public infiltration BMPs is greater than seven acres. Further statistics on the publicly owned BMPs can be found in Table 3.

Table 3. Statistics on Publicly (DPW) Owned BMPs

Category	Quantity	Percent by Quantity	Drainage Area (acres)	Percent by Drainage Area	Mean Drainage Area (acres)	Standard Deviation (acres)	Minimum Drainage Area (acres)	Maximum Drainage Area (acres)	Median Drainage Area (acres)
Dry Detention	12	5%	171.0	10%	14.25	17.21	1.22	49.53	4.93
Dry Ext Detent	37	16%	389.8	23%	10.54	10.03	0.57	36.32	7.61
Filtration	15	7%	21.0	1%	1.40	1.33	0.06	3.59	1.00
Infiltration	110	48%	331.7	20%	3.02	6.67	0.07	57.86	0.75
Other	4	2%	27.4	2%	6.84	10.17	0.27	22.00	2.55
Wet Structure	50	22%	729.3	44%	14.59	14.09	0.03	53.00	10.35
TOTAL	228	100%	1,670.2	100%	7.33	11.09	0.03	57.86	2.33

Further investigation into the 1,466 privately owned BMPs indicates that the largest type in number is also infiltration (77%), and these treat 29% of the privately-owned BMP drainage area. While dry detention practices make up 2% of the total by number, they treat a significant part of the privately-owned BMP drainage area (40%). Much of this drainage area treated by dry detention is composed of a single BMP that treats over 188 acres of the 448 total acres treated. Further statistics on the privately owned BMPs can be found in Table 4.

Table 4. Statistics on Privately Owned BMPs

Category	Quantity	Percent by Quantity	Drainage Area (acres)	Percent by Drainage Area	Mean Drainage Area (acres)	Standard Deviation (acres)	Minimum Drainage Area (acres)	Maximum Drainage Area (acres)	Median Drainage Area (acres)
Dry Detention	22	2%	448.2	40%	20.37	46.25	0.05	188.46	5.63
Dry Ext Detent	26	2%	109.0	10%	4.19	6.33	0.03	28.94	1.66
Filtration	66	5%	44.8	4%	0.68	1.01	0.03	5.00	0.30
Infiltration	1,136	77%	323.1	29%	0.28	0.79	0.01	12.78	0.07
Other	191	13%	45.7	4%	0.24	0.50	0.00	4.82	0.10
Wet Structure	25	2%	146.2	13%	5.85	7.05	0.01	25.70	3.38
TOTAL	1,466	100%	1,117.0	100%	0.76	6.28	0.01	188.46	0.08

Further investigation into the 31 BMPs owned by SHA indicates all BMPs were infiltration practices. Further statistics on the BMPs owned by the SHA can be found in Table 5.

Table 5. Statistics on BMPs Owned by SHA

Category	Quantity	Percent by Quantity	Drainage Area (acres)	Percent by Drainage Area	Mean Drainage Area (acres)	Standard Deviation (acres)	Minimum Drainage Area (acres)	Maximum Drainage Area (acres)	Median Drainage Area (acres)
Dry Detention	0	0%	0.0	0%	0.00	--	0.00	0.00	--
Dry Ext Detent	0	0%	0.0	0%	0.00	--	0.00	0.00	--
Filtration	0	0%	0.0	0%	0.00	--	0.00	0.00	--
Infiltration	31	100%	28.0	100%	0.90	0.73	0.15	3.44	0.70
Other	0	0%	0.0	0%	0.00	--	0.00	0.00	--
Wet Structure	0	0%	0.0	0%	0.00	--	0.00	0.00	--
TOTAL	31	100%	28.0	100%	0.90	0.73	0.15	3.44	0.70

The 39 BMPs with unknown ownership ("Other") predominantly fall into the Infiltration or Other BMP category. Further statistics on the BMPs with unknown ownership can be found in Table 6.

Table 6. Statistics on BMPs with "Other" Ownership

Category	Quantity	Percent by Quantity	Drainage Area (acres)	Percent by Drainage Area	Mean Drainage Area (acres)	Standard Deviation (acres)	Minimum Drainage Area (acres)	Maximum Drainage Area (acres)	Median Drainage Area (acres)
Dry Detention	2	5%	11.4	12%	5.70	3.25	3.40	8.00	5.70
Dry Ext Detent	1	3%	5.5	6%	5.50	--	5.50	5.50	5.50
Filtration	6	15%	17.6	18%	2.94	3.95	0.07	8.00	0.74
Infiltration	16	41%	27.3	28%	1.70	3.01	0.04	11.19	0.41
Other	12	31%	10.0	10%	0.83	2.06	0.01	7.00	0.05
Wet Structure	2	5%	26.1	27%	13.05	12.66	4.10	22.00	13.05
TOTAL	39	100%	97.8	100%	2.57	4.42	0.01	22.00	0.22

Figure 1 and Figure 2 show the BMPs in the Magothy River watershed by structure type and ownership. Table 7 contains additional detailed information on the urban BMPs in the Magothy River watershed.

Figure 1. BMPs in the Magothy River Watershed (Western Section)

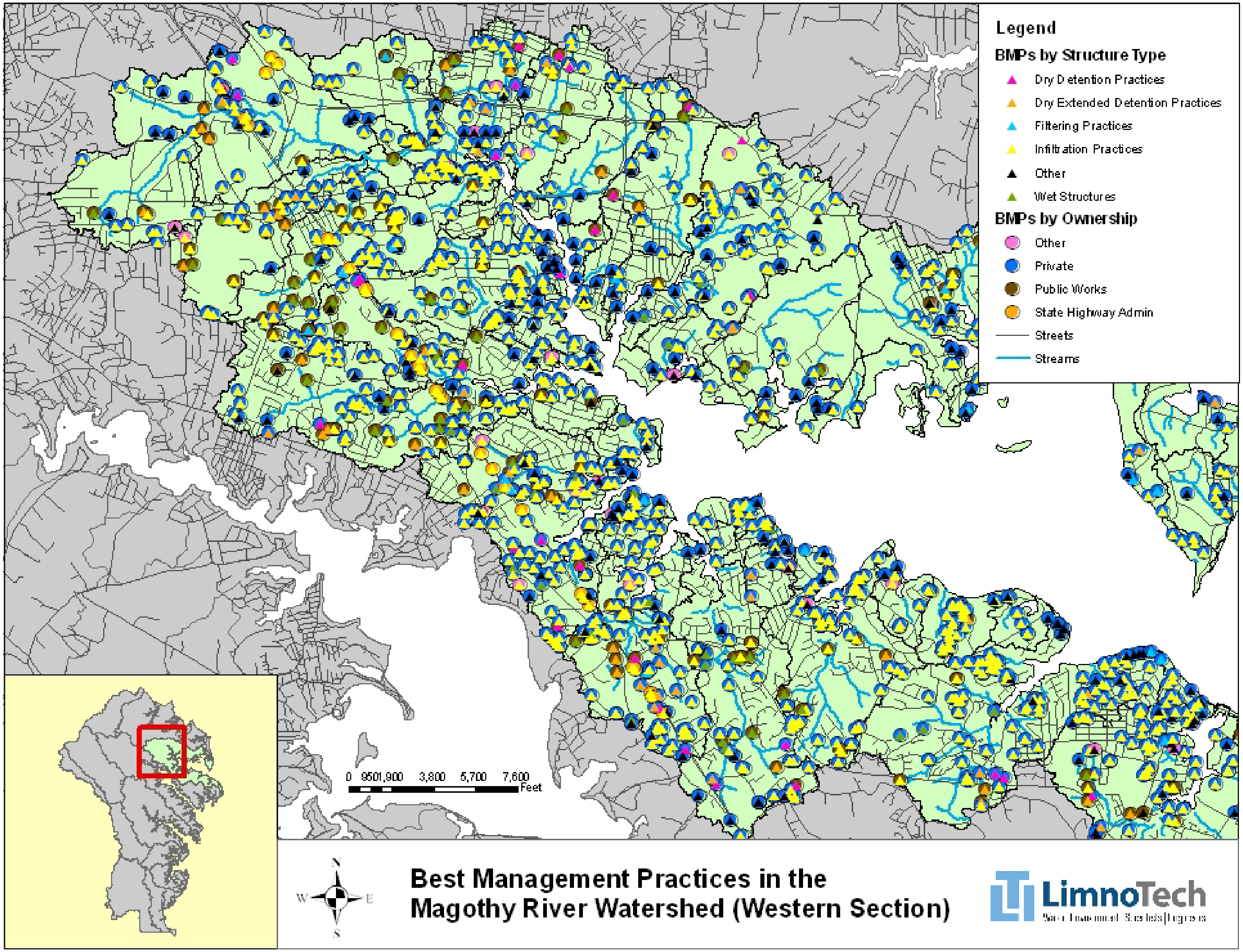

Figure 2. BMPs in the Magothy River Watershed (Eastern Section)

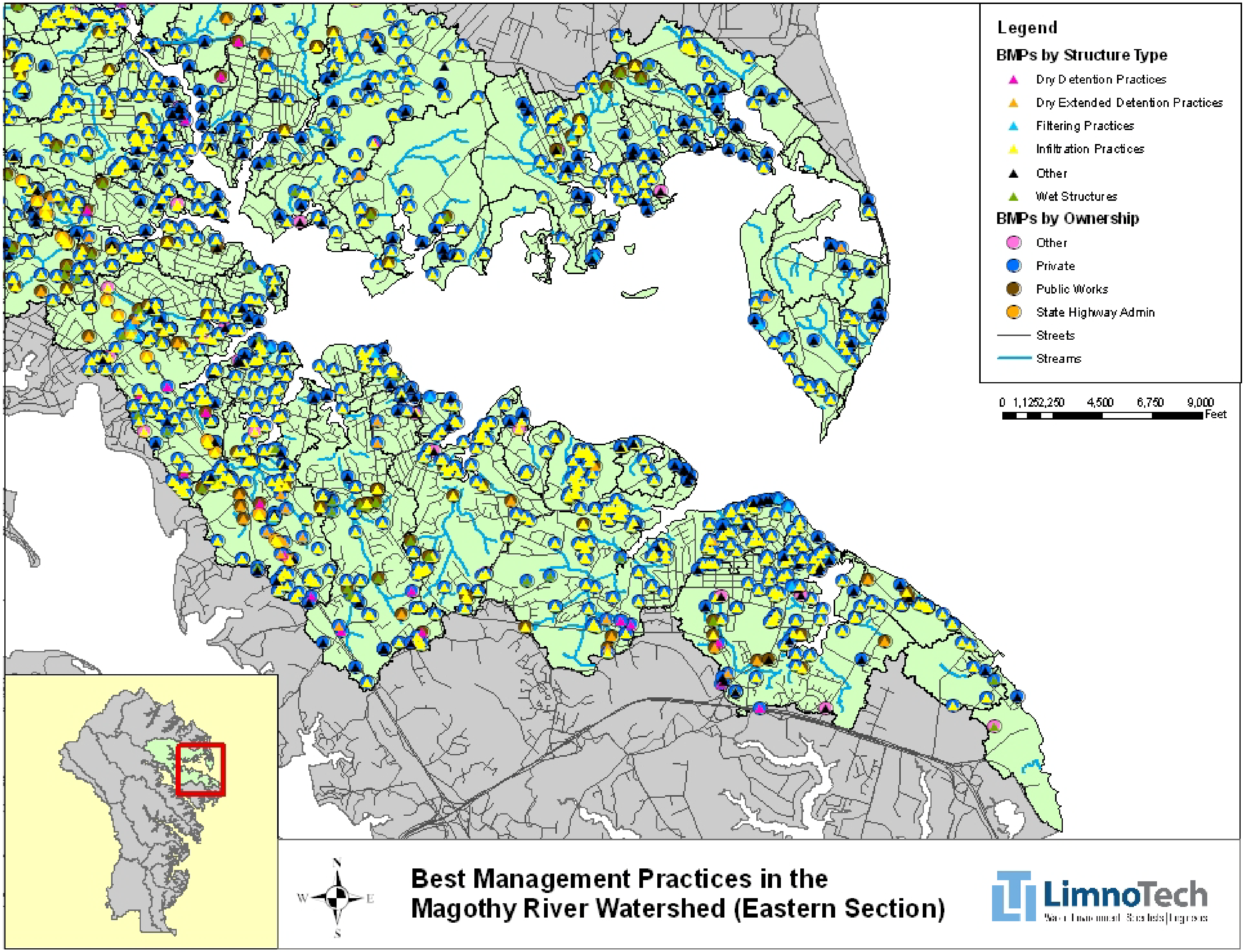

Table 7. Detailed Statistics on the Urban BMPs in the Magothy River Watershed

Structure Type	BMP Category	Quantity	Drainage Area (acres)	Mean Drainage Area (acres)	Standard Deviation (acres)	Minimum Drainage Area (acres)	Maximum Drainage Area (acres)	Median Drainage Area (acres)	Public Ownership	Private Ownership	SHA Ownership	Other Ownership
DP	Dry Detention	32	611.3	19.10	39.30	0.05	188.46	6.03	11	19	0	2
UGS	Dry Detention	4	19.3	4.82	7.48	0.08	15.99	1.61	1	3	0	0
Total Dry Detention		**36**	**630.6**	**17.52**	**37.33**	**0.05**	**188.46**	**5.63**	**12**	**22**	**0**	**2**
ED	Dry Ext Detention	3	35.7	11.88	14.93	1.21	28.94	5.50	1	1	0	1
EDSD	Dry Ext Detention	60	450.5	7.51	8.86	0.03	36.32	4.00	35	25	0	0
EDSDITCE	Dry Ext Detention	1	18.2	18.18	--	18.18	18.18	18.18	1	0	0	0
Total Dry Extended Detention		**64**	**504.3**	**7.88**	**9.12**	**0.03**	**36.32**	**4.03**	**37**	**26**	**0**	**1**
ASCD	Filtration	3	2.2	0.73	0.43	0.35	1.20	0.64	1	2	0	0
ATTENSWA	Filtration	16	11.6	0.73	0.91	0.03	3.59	0.39	7	9	0	0
BRT	Filtration	58	52.7	0.91	1.43	0.04	8.00	0.30	6	47	0	5
SANDPO	Filtration	9	15.1	1.67	2.85	0.05	8.00	0.30	1	7	0	1
WQINLET	Filtration	1	1.8	1.79	--	1.79	1.79	1.79	0	1	0	0
Total Filtration		**87**	**83.4**	**0.96**	**1.53**	**0.03**	**8.00**	**0.31**	**15**	**66**	**0**	**6**
ATTTRENCH	Infiltration	11	3.4	0.31	0.61	0.03	2.10	0.09	0	11	0	0
DW	Infiltration	65	5.9	0.09	0.17	0.04	1.00	0.05	0	65	0	0
DWIT	Infiltration	29	6.4	0.22	0.32	0.01	1.40	0.08	1	26	0	2
DWITCE	Infiltration	383	52.6	0.14	0.45	0.01	7.13	0.05	0	383	0	0
DWITCW	Infiltration	3	0.2	0.06	0.00	0.06	0.06	0.06	0	3	0	0
DWITPE	Infiltration	21	1.7	0.08	0.12	0.01	0.58	0.05	0	21	0	0
DWITWQE	Infiltration	19	1.6	0.08	0.08	0.03	0.31	0.05	0	19	0	0
IB	Infiltration	26	205.1	7.89	11.89	0.16	57.86	3.54	16	10	0	0
IT	Infiltration	307	141.2	0.46	0.96	0.01	11.19	0.12	23	239	31	14
ITCE	Infiltration	342	227.4	0.66	1.58	0.01	10.81	0.10	56	286	0	0
ITPE	Infiltration	42	36.0	0.86	1.91	0.01	11.43	0.21	5	37	0	0
ITWQE	Infiltration	37	19.2	0.52	1.20	0.02	7.10	0.13	8	29	0	0
ITWQPE	Infiltration	1	2.2	2.21	--	2.21	2.21	2.21	0	1	0	0
OGS	Infiltration	5	3.1	0.62	0.41	0.14	1.05	0.65	0	5	0	0
PP	Infiltration	1	3.7	3.65	--	3.65	3.65	3.65	0	1	0	0

Structure Type	BMP Category	Quantity	Drainage Area (acres)	Mean Drainage Area (acres)	Standard Deviation (acres)	Minimum Drainage Area (acres)	Maximum Drainage Area (acres)	Median Drainage Area (acres)	Public Ownership	Private Ownership	SHA Ownership	Other Ownership
WQITPE	Infiltration	1	0.4	0.40	--	0.40	0.40	0.40	1	0	0	0
Total Infiltration		**1,293**	**710.1**	**0.55**	**2.24**	**0.01**	**57.86**	**0.08**	**110**	**1136**	**31**	**16**
CRDT	Other	91	47.9	0.53	1.04	0.00	7.00	0.18	2	85	0	4
LS	Other	2	0.3	0.17	0.00	0.17	0.17	0.17	0	2	0	0
OTHER	Other	6	23.9	3.98	8.84	0.05	22.00	0.34	1	5	0	0
PL	Other	108	10.9	0.10	0.09	0.01	0.60	0.07	1	99	0	8
Total Other		**207**	**83.0**	**0.40**	**1.67**	**0.00**	**22.00**	**0.10**	**4**	**191**	**0**	**12**
EDSW	Wet Structures	35	330.2	9.43	12.24	0.04	52.60	5.51	19	16	0	0
SM	Wet Structures	2	22.2	11.12	15.39	0.24	22.00	11.12	0	1	0	1
WP	Wet Structures	40	549.2	13.73	13.08	0.01	53.00	11.63	31	8	0	1
Total Wet Structures		**77**	**901.6**	**11.71**	**12.75**	**0.01**	**53.00**	**6.83**	**50**	**25**	**0**	**2**
Total All BMPs		**1,764**	**2,913.1**	**1.65**	**7.34**	**0.01**	**188.46**	**0.10**	**228**	**1466**	**31**	**39**

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AGRICULTURAL BEST MANAGEMENT PRACTICES TECHNICAL MEMORANDUM

Subtask 2.3
Magothy River
Watershed Study

December 2009

Prepared For:

Anne Arundel County Department of Public Works
Watershed Management Program
2662 Riva Road
Annapolis, Maryland 21401

Prepared by:

LimnoTech
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Introduction

Understanding the contribution of agricultural practices to the total nutrient loads within a watershed is important when developing watershed plans and performing watershed modeling activities. Pollution from agricultural sources includes nitrogen, phosphorus, sediment, bacteria and other agrochemicals like pesticides. These pollutants can be dissolved in or attached to soil particles suspended in runoff. Agricultural Best Management Practices (BMPs) are often applied to farm fields as part of watershed management to reduce non-point source pollution from agricultural runoff. The role BMPs play in reducing the generation of these pollutants in runoff is important at the site and watershed scale. Watershed planning and watershed modeling benefit from accurate information on the extent of agricultural activities and the extent and effectiveness of agricultural BMPs. Important information may include: types of crops grown; farming practices including conservation practices (*e.g.* no-till, strip, contour cropping, nutrient management); and types of BMPs employed (*e.g.* grass strip, buffer, grass swale).

The purpose of this task was to update the most current landcover GIS shapefile to reflect field verified crop and pasture types, conservation practices, and BMPs that could be identified through a “windshield survey,” and to the extent possible compile available information on agricultural activities and best management practices within the watershed from government agencies.

Existing Data

Existing data provided to LimnoTech consisted of the GIS layers provided by the County including:

- Watershed boundary shapefile
- 2007 County landcover shapefile
- Aerial orthophotography

Windshield Survey

The County’s landcover shapefile identifies the agricultural land in the Magothy River Watershed as either Pasture/Hay (PAS) or Row Crop (SRC). Windshield surveys were conducted during early Spring 2009 and Fall 2009, in an attempt to identify farming and conservation practices at the site-specific level. The landcover shapefile, watershed shapefile, and digital orthophotos provided by the County were overlain in GIS, and the landcover polygons in the landcover layer identified as Pasture/Hay and Row Crop were highlighted. Hardcopy maps of each subwatershed were made from the overlay and taken into the field for the survey.

Where access was possible by public road, farms identified on the maps were verified as active farms in the field, or noted otherwise if the farmland was fallow. If it could be determined, the crop grown was documented and it was noted if conservation practices were evident. Multi-cropping practices within a landuse polygon were noted, when observed. It was not possible to access all of the farms labeled as Row Crop or Pasture/Hay within the subwatersheds and therefore several agricultural lands do not have updated information and are left with these pre-existing identifiers.

GIS Agricultural Layer Development

A dataset of all farmlands with agricultural activity were identified in the landcover shapefile provided by the County and updated with information obtained from the windshield survey. Data processing was limited to attribute changes; GIS polygon boundaries were not modified to reflect parcel information. Three fields were added to the attribute table: 1) Crop/Animal, 2) Conservation Practice, and 3) BMP. The available fields for each of these attributes are presented in Table 1. During the survey, the Crop/Animal observed attributes included: corn, soybean, fallow, horses, and cows; the conservation practices observed attributes were limited to no till; BMPs observed included grass filter strips and wooded buffers. Where livestock were identified, the number of animals was recorded and placed in the data table in parenthesis. Note that the absence of conservation practices or BMPs within the GIS dataset does not mean that they are not present; but rather that none were identified during the surveys.

Table 1. Available Fields for Attributes Identified During Windshield Surveys

Crop/Animal	**Conservation Practices**	**BMPs**
Corn	Strip Cropping	Grass Filter Strip
Fallow	No-Till	Grass Drainage Ditch
Garden	Contour Cropping	Pond
Strawberries	Cover Crop	Possible Manure Storage
Horses	Rotation	Wooded Buffer
Open Space	Nutrient Management	Multi BMPs (List)
Soybean	Multi Practice (List)	
Sod		
Wildlife		
Flowers		
Vegetables		

External Data Compilation

Ideally, watershed planning would be best served by site-specific, detailed data on agricultural and conservation practices; however, privacy laws generally restrict agricultural agencies from disseminating such information

During the development of the Upper Patuxent Watershed Study, LimnoTech contacted the National Resource Conservation Service (NRCS), the Maryland Department of Agriculture

(MDA), and the Anne Arundel County Soil Conservation District (AA SCD) including formal written requests under the Freedom of Information Act requesting information such as: locations of federal cost-share conservation practices, lists of agricultural farmlands with information on soil conservation practices and BMPs, locations of Code 378 Farm Ponds, and data on nutrient application and management practices on farmlands. In general the agencies were unable to provide such information (see Upper Patuxent Agricultural Best Management Practices Technical Memorandum March 2008).

We were able to get limited information on the Magothy River Watershed from the MDA. While unable to provide site-specific information, they were able to provide the number of acres in Nutrient Management Plans (NMP) in the watershed (Table 2). NMPs are plans that help farmers manage crop nutrients and animal waste, grow crops more efficiently and protect water quality. All farm operators in the State who produce more than $2,500 annually or who have 8,000 pounds or more of live animal weight are required to have an NMP. MDA also provided the number of acres of winter cover crops paid for by the Maryland Agricultural Cost-Share (MACS) program, and the number of acres in Soil Conservation and Water Quality Plans (SCWQ) in the watershed (Table 2). SCWQ plans are a large part of Maryland's resource conservation and protection efforts. In general, the plans help farmers manage natural resources and identify and solve potential environmental problems while reaching optimal but sustainable production goals. The plans contain a menu of BMPs to help farmers prevent sediment, nutrients, and fertilizers from impacting nearby waterways. Specific information on what BMPs were being funded was not supplied (personal communication Jason Keppler, MDA, 9/22/2009).

While the AA SCD was able to provide the total acreage of corn, soybean, wheat and pasture within the watershed during the Upper Patuxent Watershed assessment; they were unable to provide such information during the Magothy River Watershed assessment (personal communication Robert Miller, District Manager, AASCD 9/16/2009).

Table 2. Number of Acres of Conservation Practices and Nutrient Removal Rates

Conservation Practice	Acres in Watershed	Expected Nutrient Removal Rates*		Nutrient Removal/year	
		N (lbs/ac)	P (lbs/ac)	N (lbs)	P (lbs)
Nutrient Management Plan	42.3	3.11	0.3	132	13
Winter Cover Crop	0	9.48	0.13	0	0
SCWQ Plan	465	0.93	0.14	432	65

* provided by MDA during development of Upper Patuxent Watershed Study

Summary

There are few agricultural lands in the Magothy River watershed, with row crop or pasture/hay landcover making up less than 1% (92 acres) of the watershed's total area. The data obtained during the windshield surveys indicate that approximately half of that is in soybean crop. Horse farms comprise approximately one quarter of the agricultural land and there is a small amount of corn farmed in the watershed as well.

Because site-specific data on where specific crops were grown was not made available, this document does not specifically determine total acreages of the various crops identified from the windshield survey, nor does it provide statistics on conservation practices, as very few conservation practices could be identified in the field.

Despite these limitations, a more detailed landcover layer for use in the County's water quality modeling is deemed unnecessary, given the County's use of single row crop (SRC) and pasture (PAS) annotation, along with published total nitrogen (TN) and total Phosphorus (TP) event mean concentration values (EMCs) within the updated landcover layer. For example, while there is an EMC value for pasture, there is no modified EMC value that takes into account the number of animals counted on a farm. By a similar example, while the modified landcover layer has 'verified' the type of crop grown on a particular field, currently used EMC values only refer to whether or not the field is in a row crop, and is not modified based on whether that crop is corn or soybean or something else. Furthermore, EMC values are likely to be influenced by factors other than crop type such as soil type, slope, and tillage. In order to address this issue, a recommendation of site and practice specific EMC values would be more effective in determining TN and TP from a particular field and would also allow the modified landcover layer to be utilized more effectively.

Data from Updated 2007 Landcover Shapefile

FID	Sub-watershed	Sub-watershed Name	Land Cover Class	Acres	Crop Animal	Conservation Practices	BMP	Notes
410	MGH	Dividing Creek	Row Crops	0.22	No access or indeterminate			
535	MGI	Mill Creek	Pasture/Hay	6.60	Horses (6)		Wooded Buffer	Part of larger horse farm; only portion is in watershed
536	MGI	Mill Creek	Pasture/Hay	1.11	No access or indeterminate			
537	MGI	Mill Creek	Pasture/Hay	1.27	Horses (6)			Part of larger horse farm; only portion is in watershed
538	MGI	Mill Creek	Pasture/Hay	2.42	No access or indeterminate			
10641	MGI	Mill Creek	Pasture/Hay	<0.01	No access or indeterminate			Part of larger horse farm; only portion is in watershed
10642	MGI	Mill Creek	Pasture/Hay	0.05	Horses (6)			
759	MGT	Deep Creek	Row Crops	1.69	No access or indeterminate			
760	MGT	Deep Creek	Row Crops	0.97	Multiple (Corn/ Cows (6))			
761	MGT	Deep Creek	Row Crops	0.37	Corn	No Till		
762	MGT	Deep Creek	Row Crops	3.61	Corn	No Till	Grass Filter	
763	MGT	Deep Creek	Row Crops	4.99	No access or indeterminate			
15404	MGT	Deep Creek	Row Crops	<0.01	Corn			
15405	MGT	Deep Creek	Row Crops	0.02	Corn			
882	MGV	Little Magothy River	Row Crops	8.04	Horses (1)		Wooded Buffer	

Data from Updated 2007 Landcover Shapefile

FID	Sub-watershed	Sub-watershed Name	Land Cover Class	Acres	Crop Animal	Conservation Practices	BMP	Notes
883	MGV	Little Magothy River	Row Crops	7.88	Soybean			
884	MGV	Little Magothy River	Pasture/Hay	2.06	Horses (unknown)			Modified Class name and codes from Row Crops to Pasture/Hay
885	MGV	Little Magothy River	Row Crops	35.32	Soybean			
20631	MGV	Little Magothy River	Pasture/Hay	<0.01	Horses (unknown)			Modified Class name and codes from Row Crops to Pasture/Hay
20632	MGV	Little Magothy River	Row Crops	<0.01	Soybean			
20633	MGV	Little Magothy River	Row Crops	<0.01	Soybean			
20634	MGV	Little Magothy River	Row Crops	0.05	Soybean			
20635	MGV	Little Magothy River	Row Crops	0.04	Soybean			
20636	MGV	Little Magothy River	Row Crops	0.15	Soybean			
1221	MR3	Magothy Branch 1	Row Crops	4.69	No access or indeterminate			

Data from Updated 2007 Landcover Shapefile

FID	Sub-watershed	Sub-watershed Name	Land Cover Class	Acres	Crop Animal	Conservation Practices	BMP	Notes
1222	MR3	Magothy Branch 1	Open Space	10.77	Open Space			Modifed Class name and codes from row crops to open space
23147	MR3	Magothy Branch 1	Row Crops	<0.01	No access or indeterminate			
23148	MR3	Magothy Branch 1	Row Crops	<0.01	No access or indeterminate			
23149	MR3	Magothy Branch 1	Open Space	<0.01	Fallow			Modified Class name and codes from Row Crops to Open Space
23150	MR3	Magothy Branch 1	Open Space	0.57	Fallow			Modified Class name and codes from Row Crops to Open Space

APPENDIX B – BIOASSESSMENT REPORT

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Magothy River Watershed

Targeted Biological Monitoring and Assessment

2007

Anne Arundel County, Maryland

Prepared for and in collaboration with Anne Arundel County

Department of Public Works
Watershed and Ecosystem Services Division
Watershed Management Program

ANNE ARUNDEL COUNTY
MARYLAND

DPW

KCI Technologies, Inc.
August 2007

KCI TECHNOLOGIES

Magothy River Watershed

Targeted Biological Monitoring and Assessment - 2007

August 2007

Prepared for:

Anne Arundel County
Department of Public Works
Watershed and Ecosystem Services Division
Watershed Management Division

A.A. Co. Contract No. D406947

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CONTENTS

FIGURES

TABLES

APPENDICES

1 Background and Objectives

Anne Arundel County, in an effort to improve its water quality and streams, initiated systematic and comprehensive watershed assessments and action plans for restoration and protection across the County. The Magothy River watershed targeted biological assessment and monitoring fulfills part of the County's water quality assessment requirements under their National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit issued by the Maryland Department of the Environment and also assists the County in preparing TMDL implementation plans.

Anne Arundel County contracted KCI to conduct a targeted assessment of the biological community and physical habitat in the Magothy River watershed during the Spring of 2007. The targeted assessment focuses on water quality, sampling and analysis of the benthic macroinvertebrate community, and assessment of instream and riparian physical habitat conditions.

The data collected and reported herein will be primarily utilized in the County's Watershed Management Tool (WMT), which is developed and maintained by the Department of Public Works, Watershed and Ecosystem Services Division, Watershed Management Program. Within the WMT, relationships between biological condition, water quality and landuse are developed to support watershed and landuse planning and restoration efforts.

The biological data will also be beneficial for the ongoing County-wide Biological Monitoring and Assessment Program to further develop status, trends and problem identification for the portions of the County sampled. The Magothy River watershed (MDE 8-digit watershed 02131001) encompasses 22,641 acres and contains approximately 67 miles of perennial, non-tidal streams. It should be noted, however, that the Watershed Management Program has currently updated the watershed and subwatershed boundaries to account for the year 2007 earth data and current storm infrastructure. The watershed covers two primary sampling units (PSUs) defined by the County-wide monitoring and assessment strategy, the Upper Magothy (PSU-07) and the Lower Magothy (PSU-08). The Upper Magothy PSU was most recently assessed by the County in 2006 and the Lower Magothy PSU was completed in 2007. A full watershed comprehensive study is anticipated for completion by 2009.

The Magothy River watershed was subdivided into 27 sub-basins by the County's Watershed Management Program for targeted site selection. Within these sub-basins, 27 targeted sites were selected, at which water quality sampling, benthic macroinvertebrate collection / assessment, and physical habitat assessment were completed between April 17 and April 26, 2007.

The Magothy River watershed is part of Maryland's Lower Western Shore tributary basin. The Lower Western basin drains approximately 270 square miles of land, including portions of Anne Arundel and Calvert Counties along the Western Shore of the Chesapeake Bay. Other large water bodies comprising the basin include the Severn, South, West, and Rhode Rivers. The current study area is located in the northern most portion of the basin, within the Coastal Plain physiographic province. Figure 1 – Vicinity Map shows the general location of the watershed as well as drainage areas to each sampling point. It should be noted, that the MD DNR boundaries do not match exactly with the Anne Arundel County Watershed Boundaries.

2 Methods

The monitoring program includes chemical, physical and biological assessment conducted throughout the watershed. The sampling methods used are compatible with the Sampling and Analysis Plan for Anne Arundel County Biological Monitoring (SAP) (Tetra Tech, 2005) and the Quality Assurance Project Plan (QAPP) for Anne Arundel County Biological Monitoring and Assessment Program (Tetra Tech, 2004). All data was entered into an Ecological Data Application System (EDAS) database. A summary of these methods and the results of the 2007 monitoring are documented in this report.

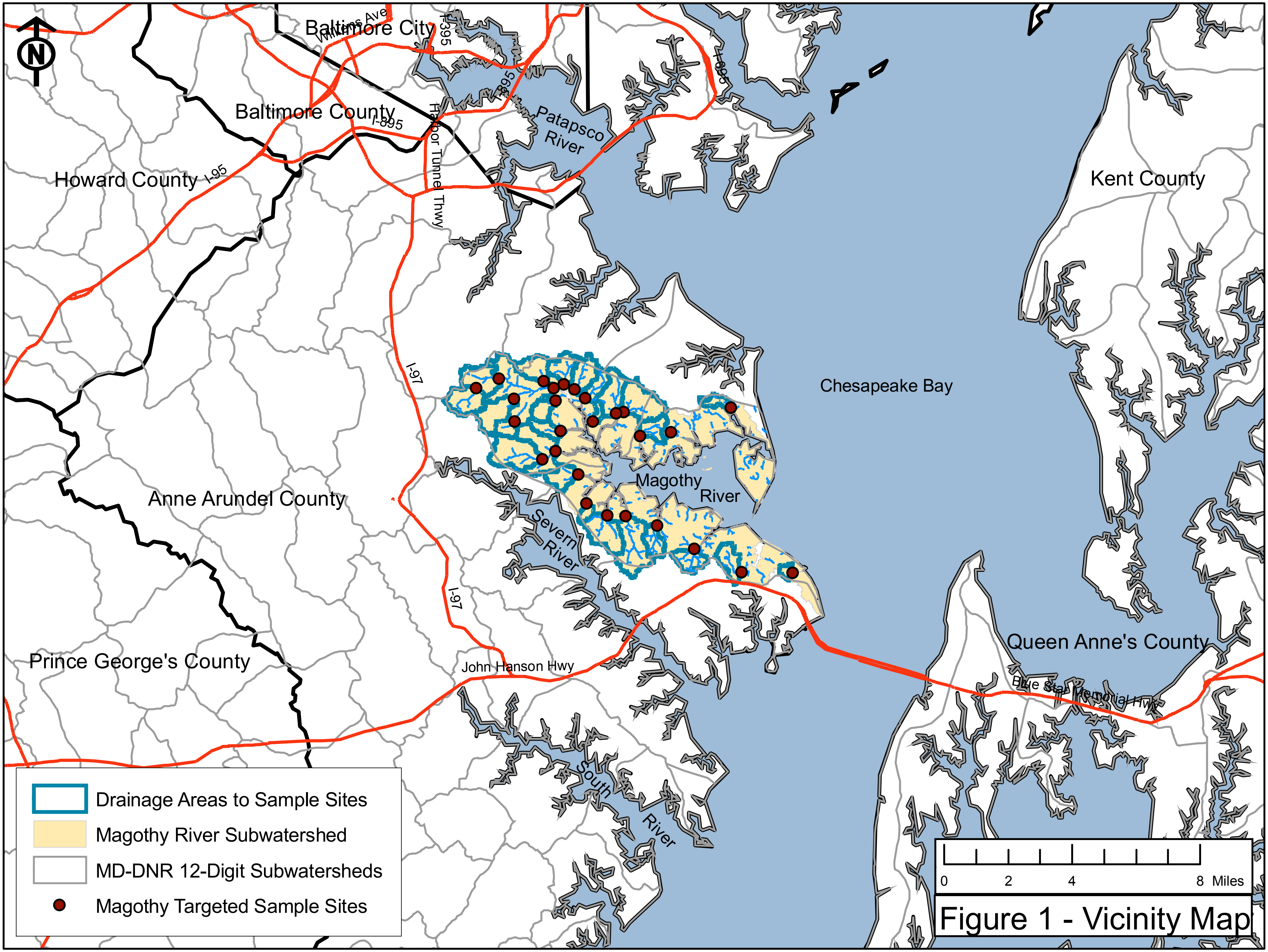

Figure 1 - Vicinity Map

Biological assessment methods within Anne Arundel County are designed to be consistent and comparable with the methods used by Maryland Department of Natural Resources (DNR) in their Maryland Biological Stream Survey (MBSS). All field crew leaders received recent training in MBSS protocols prior to the sampling. The County has adopted the MBSS methodology to be consistent with statewide monitoring programs and programs adopted by other Maryland counties. The methods have been developed locally and are calibrated specifically to Maryland's physiographic regions and stream types. MBSS physical habitat assessment parameters were collected for the Magothy watershed. Physical habitat was also assessed using the EPA's Rapid Bioassessment Protocol (RBP) (Barbour et al., 1999) habitat assessment for low-gradient streams.

2.1 Selection of Sampling Sites

The sampling design employed a targeted approach with a total of 27 sites distributed throughout the study area on each of the major stream reaches, covering 26 non-tidal subwatersheds, as shown in Figure 2. A complete list of targeted sites along with the corresponding subwatershed name and code is displayed in Table 1. The primary goal was to establish adequate spatial coverage of the watershed. Additionally, data from the County-wide random sampling program was used in the site selection process. The Magothy watershed was sampled for the County-wide program in 2006 and 2007. The targeted sites were generally selected in the downstream reaches of the Magothy's tributaries and placed to fill gaps not covered by the County-wide assessment.

Table 1 – Sampling Sites and Corresponding Subwatersheds

Site ID	Subwatershed Name	Code
MAGO-01-2007	Cornfield Creek	MR0
MAGO-02-2007	Gray's Creek	MRE
MAGO-03-2007	Blackhole Creek	MRG
MAGO-04-2007	Cockey Creek	MR6
MAGO-05-2007	Nannys Branch	MGY
MAGO-06-2007	Indian Village Branch	MGW
MAGO-07-2007	Beechwood Branch	MR5
MAGO-08-2007	Brookfield Branch	MR4
MAGO-09-2007	Bailys Branch	MR1
MAGO-10-2007	Magothy Branch	MR7
MAGO-11-2007	Muddy Run	MR2
MAGO-12-2007	Magothy Branch 1	MR3
MAGO-13-2007	Magothy Branch 2	MG1
MAGO-14-2007	Kinder Branch	MR9
MAGO-15-2007	Rouses Branch	MRA
MAGO-16-2007	Nannys Creek	MRB
MAGO-17-2007	Old Man Creek	MRF
MAGO-18-2007	Cattail Creek 1	MRI
MAGO-19-2007	Cattail Creek 2	MRO
MAGO-20-2007	Cypress Creek	MGC
MAGO-21-2007	Cypress Creek	MGC
MAGO-22-2007	Dividing Creek	MGH
MAGO-23-2007	Mill Creek	MGI
MAGO-24-2007	Forked Creek	MGL
MAGO-25-2007	Deep Creek	MGT
MAGO-26-2007	Little Magothy River	MGV
MAGO-27-2007	Podickery Creek	MGZ

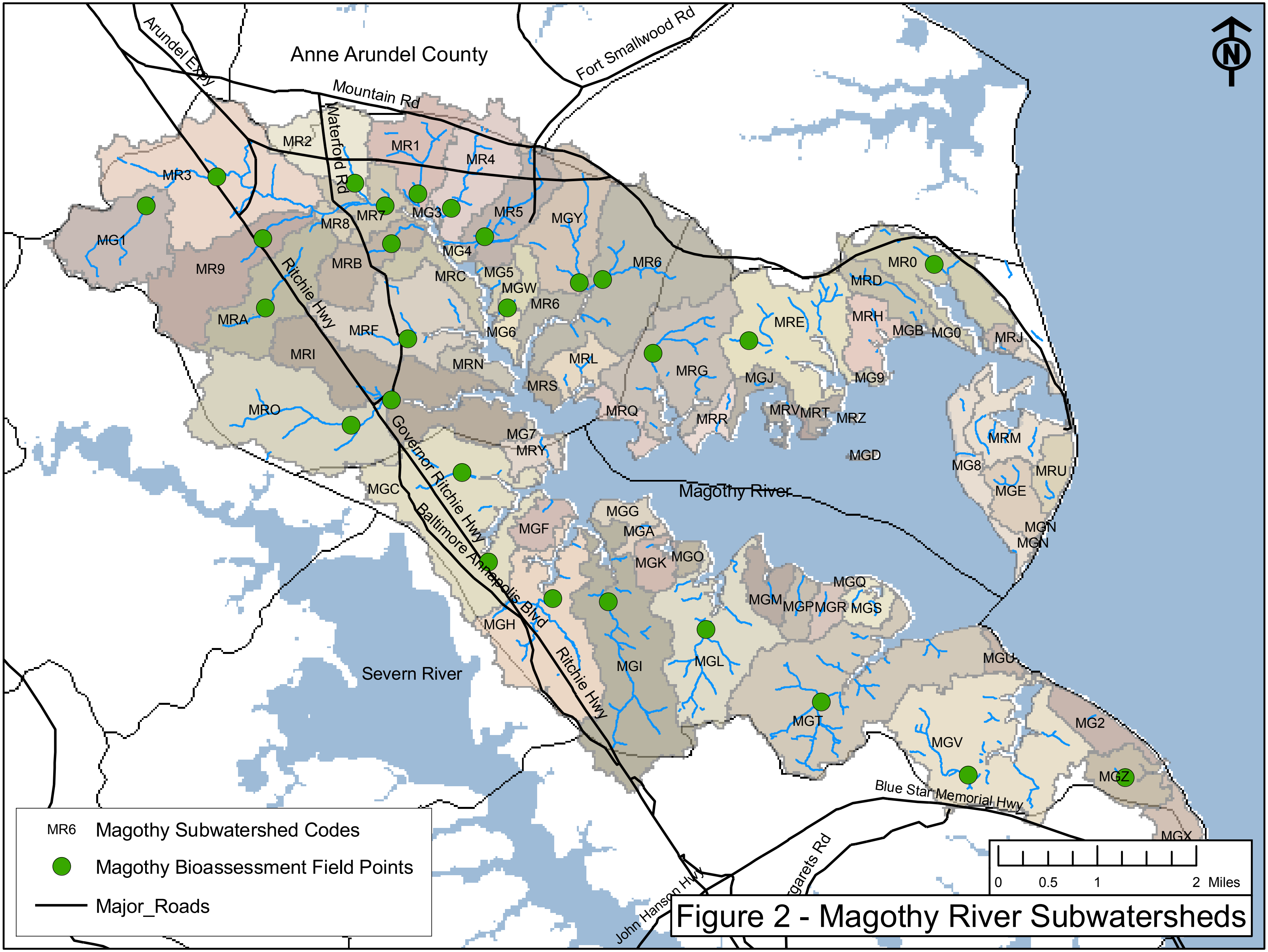

Figure 2 - Magothy River Subwatersheds

If the stream channel at the selected site was found to be unfit for sampling during the field visit, the site was moved to another sampleable reach either on the same stream, or in an adjacent sub-basin, pending approval by the Project Manager and the County. Conditions that would make a site unsampleable include predominant wetland or dry channel conditions, unsafe conditions, and lack of access due to property ownership issues. Several of the initially selected sites were shifted due to the lack of a defined stream channel and tidal influence. However, all subwatersheds targeted for sampling were able to be sampled.

Field crews used GPS and field maps with ortho-photography overlaid with the sites, streams and drainage areas to navigate to the selected sites. The sites include a 75-meter reach. The position of the reach mid-point was collected with GPS, and the upstream and downstream ends were marked with tree tags. The tags were marked with the site name (i.e. MAGO-01-2007) and either 0 m or 75 m to denote the downstream or upstream end, respectively.

Duplicate biological samples, water quality measurements and physical habitat assessments were collected at three sites as Quality Assurance/Quality Control (QA/QC) samples. These samples were collected immediately upstream of selected sites in an area where the habitat was very similar to the original sampling site based on visual inspection. The duplicate sites were selected in the field by the field crew at the time of the assessment. This method, as opposed to selecting the sites randomly or by desktop analysis, ensures that the stream type and habitat are similar, that no significant inputs of stormwater or confluences occur in the reach, and that the site is sampleable. The duplicate sites are described further in the Quality Assurance and Quality Control section of the document (Appendix C).

2.2 Impervious Surface/GIS Analysis

Upon arrival at sampling locations, latitude and longitude coordinates were recorded using a Thales hand-held GPS unit at the midpoint of each reach to create a point layer showing sampling locations accurate to within one to two meters. These sampling points were then snapped to the stream layer on the Digital Elevation Model (DEM) for the watershed using the ArcHydro toolset to delineate drainage areas to each sampling location. The DEM was generated by the Watershed Management Program based on the 2004 DNR DEM coverage. Before drainage areas were delineated, the DEM was modified with inclusion of County and State Highway Administration stormdrain layers, and streams in areas with low relief. The DEM was reconditioned utilizing terrain preprocessing functionality within the ArcHydro extension toolset.

The impervious surface acreage and percent was calculated for the drainage area to each site using a raster dataset of impervious land cover from 2004, maintained by the DPW, Bureau of Engineering, Watershed Management Program[1]. The GIS data used represents the area of all impervious surfaces (roads, buildings, and parking lots) clipped to the watershed boundaries and then summed for each of the drainage areas. The results include all of the impervious surfaces and do not distinguish between connected versus disconnected surfaces.

The planimetric stream layer was used for locating sampling points and determining stream order. It should be noted, however, that the current planimetric stream layer used for stream ordering has limitations and, consequently, is programmed for update through upcoming Magothy Watershed Study. Stream order, based on the planimetric stream layer, was not used in habitat assessment or BIBI calculations, but was included to demonstrate approximate stream size.

Point and polygon GIS files were generated for the targeted Magothy Bioassessment and include summary data for the landscape, biological, habitat and water quality assessments. Metadata for each file is included with entity attribute descriptions.

[1] Data custodian: Mary Searing, PWSEAR00@aacounty.org

2.3 Water Quality Sampling

To supplement the macroinvertebrate sampling and habitat assessments, water quality sampling was performed. Field water quality was measured at all monitoring sites, including the duplicate sites, according to methods in the County QAPP. Measurements were collected *in situ* from three locations within each sampling reach (upstream end, mid-point, and downstream end) and results were averaged to minimize variability and better represent water quality conditions throughout the entire sampling reach. Most in-situ parameters (i.e., temperature, pH, conductivity, total dissolved solids, and dissolved oxygen) were measured with a YSI 6920 series multiprobe, and turbidity was measured with a Hach 2100 Turbidimeter.

Water quality equipment was regularly inspected, maintained and calibrated to ensure proper usage and accuracy of the readings. Calibration logs were kept by field crew leaders and checked by the project manager regularly. Field tested parameters include those listed below.

pH (standard pH units)	Conductivity (microSiemans per cm, µS/cm)
Temperature (degrees Celsius, °C)	Total dissolved solids (mg/L)
Dissolved oxygen (milligrams per liter, mg/L)	Turbidity (NTU)

2.4 Physical Habitat Assessment

Each biological monitoring site was characterized based on visual observation of physical characteristics and various habitat parameters, including QC sites. Both the EPA's Rapid Bioassessment Protocol (RBP) habitat assessment for low gradient streams (Barbour et al., 1999) and the Maryland Biological Stream Survey's (MBSS) Physical Habitat Index (PHI; Paul et al., 2002) were used to assess the physical habitat at each site. Both assessment techniques rely on subjective scoring of selected habitat parameters. To reduce individual sampler bias, both assessments were completed as a team with discussion and agreement of the scoring for each parameter. In addition to the visual assessments, photographs were taken from three locations within the sampling reach (downstreamr end, mid-point, and upstream end) facing both upstream and downstream, for a total of six (6) photographs per site. Representative photographs for each site are included in Appendix D.

The RBP habitat assessment consists of a review of ten biologically significant habitat parameters that assess a stream's ability to support an acceptable level of biological health. Each parameter is given a numerical score from 0-20 and a categorical rating of optimal, suboptimal, marginal or poor. Overall habitat quality typically increases as the total score for each site increases. The RBP parameters assessed are listed in Table 2

Table 2 – RBP Low Gradient Habitat Parameters

Low Gradient Stream Parameters	
Epifaunal substrate/available cover	Channel alteration
Pool substrate characterization	Channel sinuosity
Pool variability	Bank stability
Sediment deposition	Vegetative protection
Channel flow status	Riparian Vegetative Zone Width

The RBP habitat parameters for each reach are summed with a total possible score of 200. The total score is then placed into one of four categories (Table 3) based on their percent comparability to reference conditions. Since adequate reference condition scores do not currently exist for Anne Arundel County, the categories used in this report are based on reference conditions obtained from Prince George's County streams and watersheds (Stribling et al., 1999).

Table 3 – RBP Habitat Score and Ratings

Score	Percent Comparability	Narrative Rating
≥151	≥75.5	Comparable to Reference
126-150	63.0-75.0	Supporting
97-125	48.5-62.5	Partially Supporting
≤96	≤48.0	Non-supporting

Source: Stribling et al., 1999

The PHI incorporates the results of a series of habitat parameters selected for Coastal Plain, Piedmont and Highlands regions. While all parameters are rated during the field assessment, the Coastal Plain parameters are used to develop the PHI score. In developing the PHI, MBSS identified six parameters that have the most discriminatory power for the coastal plain streams. These parameters are used in calculating the PHI (see Table 4). Several of the parameters have been found to be drainage area dependent and are scaled accordingly. The drainage area to each point was calculated using GIS with County digital elevation model (DEM) topography as described in Section 2.2.

Table 4 – PHI Coastal Plain Parameters

Coastal Plain Stream Parameters	
Remoteness	Instream Habitat
Shading	Woody Debris and Rootwads
Epibenthic Substrate	Bank Stability

Each habitat parameter is given a value from 0-20. A prepared score and scaled score (0-100) are then calculated. The average of these scores yields the final PHI score. The final scores are then ranked according to the ranges shown in Table 5 and assigned corresponding narrative ratings, which allows for a score that can be compared to habitat assessments done statewide.

Table 5 – PHI Score and Ratings

PHI Score	Narrative Rating
81.0 – 100.0	Minimally Degraded
66.0 – 80.9	Partially Degraded
51.0 – 65.9	Degraded
0.0 – 50.9	Severely Degraded

2.5 Benthic Macroinvertebrate Sampling

Biological assessment using benthic macroinvertebrate sampling and analysis was completed at all sites including QC sites. Benthic macroinvertebrate collection follows the QAPP which closely mirrors MBSS procedures (Kazyak, 2001). The monitoring sites consist of a 75-meter sampling reach, and benthic macroinvertebrate sampling is conducted during the spring index period (March 1^{st} to May 1^{st}). The sampling methods utilize systematic field collections of the benthic macroinvertebrate community. The multi-habitat D-frame net approach is used to sample a range of the most productive habitat types present within the reach. In this sampling approach, a total of twenty jabs are distributed among all available productive habitats within the stream system and combined into a single composite sample. Potential habitats include submerged vegetation, overhanging bank vegetation, leaf packs, stream bed substrate (i.e., cobbles, gravel, sand), and submerged organic matter (i.e., logs, stumps, snags, dead branches, and other debris).

2.5.1 Sample Processing and Laboratory Identification

Benthic macroinvertebrate samples were processed and subsampled according to the County QAPP and methods described in the MBSS *Laboratory Methods for Benthic Macroinvertebrate Processing* *and Taxonomy* (Boward and Friedman, 2000). Subsampling is conducted to standardize the sample size and reduce variation caused by samples of different size. In this method, the sample is spread evenly across a gridded tray (100 total grids), and each grid is picked clean of organisms until a minimum count of 120 is reached. The 120 organism target is used to allow for specimens that are missing parts or are not mature enough for proper identification. For those sites with a final count of greater than 120 organisms, a post-processing subsampling procedure was conducted using an Excel spreadsheet application (Tetra Tech, 2006). This post-processing application is designed to randomly subsample all identified organisms within a given sample to a desired target number. Each taxon is subsampled based on its original proportion to the entire sample. In this case, the desired sample size selected was 110 individuals. This allows for a final sample size of approximately 110 individuals (±20percent) but keeps the total number of individuals below the 120 maximum.

Identification of the subsampled specimens is conducted by Environmental Services and Consulting, LLC[2]. Taxa are identified to the genus level for most organisms. Groups including Oligochaeta and Nematomorpha are identified to the family level while Nematoda is left at phylum. Individuals of early instars or those that may be damaged are identified to the lowest possible level, which could be phylum or order, but in most cases would be family. Chironomidae can be further subsampled depending on the number of individuals in the sample and the numbers in each subfamily or tribe. Most taxa are identified using a stereoscope. Temporary slide mounts are used to identify Oligochaeta to family with a compound scope. Chironomid sorting to subfamily and tribe is also conducted using temporary slide mounts. Permanent slide mounts are then used for final genus level identification. Results are logged on a bench sheet and entered into a spreadsheet for analysis.

2.5.2 Biological Data Analysis

Benthic macroinvertebrate data was analyzed using methods developed by MBSS as outlined in the *New Biological Indicators to Better Assess the Condition of Maryland Streams* (Southerland et al., 2005). The Benthic Index of Biotic Integrity (BIBI) approach involves statistical analysis using metrics that have a predictable response to water quality and/or habitat impairment. The metrics selected fall into five major groups including taxa richness, composition measures, tolerance to perturbation, trophic classification, and habit measures.

Raw values from each metric are given a score of 1, 3 or 5 based on ranges of values developed for each metric. The results are combined into a scaled BIBI score ranging from 1.0 to 5.0 and a corresponding narrative rating is assigned. Three sets of metric calculations have been developed for Maryland streams based on broad physiographic regions. These include the coastal plain, piedmont and combined highlands regions, divided by the Fall Line. The current study area is located within the coastal plain region. The following metrics and BIBI scoring were used for the analysis.

2.5.2.1 Coastal Plain BIBI Metrics (Modified from Table 2-3 in Southerland et al., 2005)

Total Number of Taxa – Equals the richness of the community in terms of the total number of genera at the genus level or higher. A large variety of genera typically indicate better overall water quality, habitat diversity and/or suitability, and community health.

Number of EPT Taxa – Equals the richness of genera within the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). EPT taxa are generally considered pollution sensitive, thus higher levels of EPT taxa would be indicative of higher water quality.

[2] Address: 101 Professional Park Drive, STE 303, Blacksburg, VA

Number of Ephemeroptera Taxa – Equals the total number Ephemeroptera Taxa in the sample. Ephemeroptera are generally considered pollution sensitive, thus communities dominated by Ephemeroptera usually indicate lower disturbances in water quality.

Percent Intolerant Urban – Percentage of sample considered intolerant to urbanization. Equals the percentage of individuals in the sample with a tolerance value of 0-3. As impairment increases the percent of intolerant taxa decreases.

Percent Ephemeroptera – Equals the percent of Ephemeroptera individuals in the sample. Ephemeroptera are generally considered pollution sensitive, thus communities dominated by Ephemeroptera usually indicate lower disturbances in water quality.

Number Scraper Taxa – Equals the number of scraper taxa in the sample, those taxa that scrape food from the substrate. As the levels of stressors or pollution rise there is an expected decrease in the numbers of Scraper taxa.

Percent Climbers – Equals the percentage of the total number of individuals who are adapted to living on stem type surfaces. Higher percentages of climbers typically represent a decrease in stressors and overall better water quality.

Information on trophic or functional feeding group and habit were based heavily on information compiled by DNR and from Merritt and Cummins (1996). Scoring criteria are shown below in Table 6. The raw metric value ranges are given with the corresponding score of 1, 3 or 5. Table 7 includes the BIBI scoring ranges and related narrative ratings.

Table 6 - Biological Condition Scoring for the Coastal Plain Benthic Macroinvertebrates

Metric	Score		
	5	3	1
Total Number of Taxa	≥22	14-21	<14
Number of EPT Taxa	≥5	2-4	<2
Number of Ephemeroptera Taxa	≥2.0	1-1	<1.0
Percent Intolerant Urban Taxa	≥28	10-27	<10.0
Percent Ephemeroptera Taxa	≥11	0.8-10.9	<0.8
Number Scraper Taxa	≥2	1-1	<1.0
Percent Climber Taxa	≥8.0	0.9-7.9	<0.9

Table 7 – BIBI Scoring and Rating

BIBI Score	Narrative Rating
4.0 – 5.0	Good
3.0 – 3.9	Fair
2.0 – 2.9	Poor
1.0 – 1.9	Very Poor

3 Results

Biological monitoring was conducted between April 17 and April 26, 2007. A total of 27 sites were visited. Additionally, three biological duplicate QC samples were collected in each subwatershed at stations where upstream habitat was considered similar. Presented below are the summary results for each assessment site. Maps of the Magothy watershed displaying the bioassessment results can be found in Figure 3 and Appendix B. For full bioassessment data and results, refer to Appendix A.

3.1 Impervious Surface Analysis

The sampled sites are listed below in Table 8 with general information and the results of the impervious surface calculation. Stream order (Strahler) is based on the County's planimetric stream layer. Drainage areas ranged from 37.27 acres at site 2, to 3511.93 acres at site 10, the most downstream site on the major northwestern tributary of the Magothy River. The average area for the study is 553.94 acres. Imperviousness ranged from 0.83 percent, at site 27, to 42.89 percent, at site 20. The average impervious percent for the study is 19.49.

Table 8 - Site Characteristics/Imperviousness

Site	Date Sampled	Stream Order	Drainage Area (acres)	Impervious Area (acres)	Impervious Percent
MAGO-01-2007	4/17/2007	1	167.44	33.01	19.71
MAGO-02-2007	4/17/2007	1	37.27	0.94	2.52
MAGO-03-2007	4/17/2007	3	314.99	7.71	2.45
MAGO-04-2007	4/17/2007	3	733.70	78.98	10.76
MAGO-05-2007	4/17/2007	2	544.58	120.61	22.15
MAGO-06-2007	4/18/2007	1	90.79	20.93	23.05
MAGO-07-2007	4/18/2007	2	264.42	40.43	15.29
MAGO-08-2007	4/18/2007	2	420.16	106.06	25.24
MAGO-09-2007	4/18/2007	2	382.83	104.92	27.41
MAGO-10-2007*	4/18/2007	3	3511.93	569.84	16.23
MAGO-11-2007	4/19/2007	1	387.03	71.20	18.40
MAGO-12-2007	4/19/2007	1	1046.76	186.85	17.85
MAGO-13-2007	4/19/2007	1	522.11	81.92	15.69
MAGO-14-2007	4/19/2007	1	522.79	72.41	13.85
MAGO-15-2007	4/23/2007	1	202.57	41.83	20.65
MAGO-16-2007*	4/23/2007	1	243.81	28.92	11.86
MAGO-17-2007	4/23/2007	2	230.91	37.97	16.44
MAGO-18-2007	4/24/2007	3	1463.47	321.29	21.95
MAGO-19-2007	4/24/2007	2	788.38	176.72	22.42
MAGO-20-2007	4/24/2007	1	324.66	139.23	42.89
MAGO-21-2007	4/26/2007	1	116.71	32.09	27.49
MAGO-22-2007	4/24/2007	3	641.18	160.32	25.00
MAGO-23-2007*	4/25/2007	3	882.38	237.73	26.94
MAGO-24-2007	4/25/2007	3	300.28	71.18	23.70
MAGO-25-2007	4/25/2007	3	349.70	92.04	26.32
MAGO-26-2007	4/26/2007	2	373.52	108.43	29.03
MAGO-27-2007	4/26/2007	1	91.89	0.77	0.83

*QC sampling was conducted at these sites

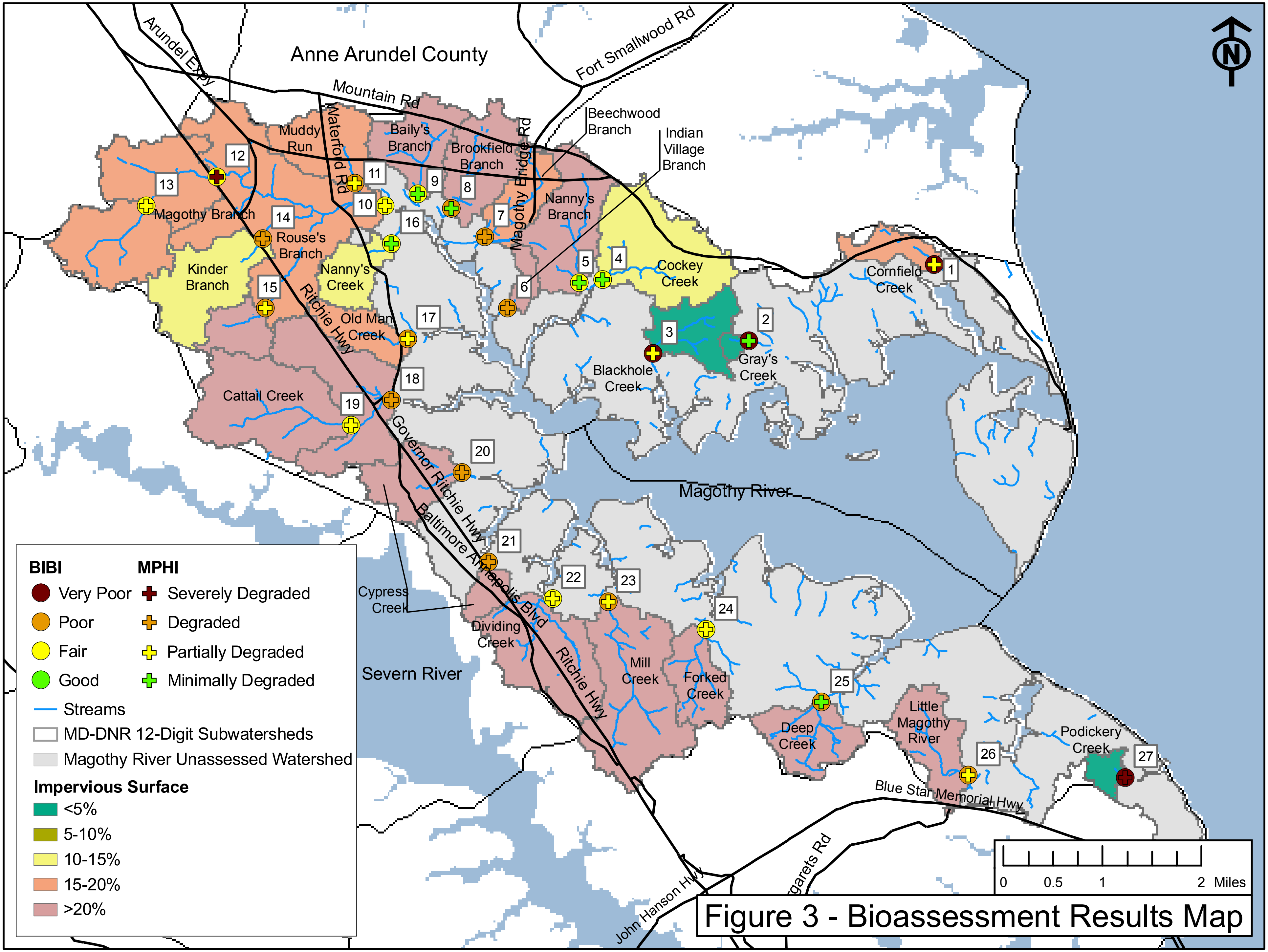

Figure 3 - Bioassessment Results Map

3.2 Water Quality

Instream water quality sampling was conducted in conjunction with macroinvertebrate sampling and occurred between April 17 and April 26, 2007. Table 9 presents the results of the instream water quality sampling. It should be noted that problems were encountered with the DO probe on three separate occasions: April 24^{th}, 25^{th}, and 26^{th}, and therefore data may have been compromised. On April 24^{th}, the DO membrane became damaged and had to be replaced in the field. It was later discovered that the KCl solution in the field kit, which was used to repair the probe, was past its expiration date and consequently may not have been performing as intended. For two sites on the final day of sampling the probe failed altogether and no data was recorded. Samples prior to April 24^{th} were collected with a fully operable probe with functional KCl solution.

The Maryland Department of the Environment (MDE) has established acceptable standards for several of the sampled parameters for each designated Stream Use Classification. Currently, there are no standards available for conductivity or TSS. Acceptable standards are listed in the *Code of Maryland Regulations (COMAR) 26.08.02.01-.03 - Water Quality*. The Magothy River watershed is listed in *COMAR* in Sub-Basin 02-13-10: West Chesapeake Area. It is classified as a Use I stream, Water Contact Recreation, and Protection of Aquatic Life. Specific designated uses for Use I streams include water contact sports, fishing, the growth and propagation of fish, and agricultural, and industrial water supply. The acceptable standards for Use I streams are as follows:

- pH - 6.5 to 8.5
- DO - may not be less than 5 mg/l at any time
- Turbidity - maximum of 150 Nephelometer Turbidity Units (NTU's) and maximum monthly average of 50 NTU
- Temperature - maximum of 90°F (32°C) or ambient temperature of the surface water, whichever is greater

Overall, the water quality fell within COMAR limits for a Use I stream and are typical of a coastal plain stream. The shaded cells represent values that were outside acceptable COMAR limits. There were six sites with pH values below the acceptable limit of 6.5 and five with a dissolved oxygen reading below the acceptable level of 5.0 mg/l.

Table 9 - Instream Water Quality Results

Site	pH	Temperature (°C)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Conductivity (µS/cm)	Total Dissolved Solids (mg/L)
MAGO-01-2007	6.44	8.14	11.16	16.60	365	238
MAGO-02-2007	4.21	7.99	9.60	1.97	80	52
MAGO-03-2007	3.85	8.05	10.89	1.38	95	62
MAGO-04-2007	6.05	10.50	10.79	4.00	179	116
MAGO-05-2007	6.38	10.83	10.80	5.42	214	139
MAGO-06-2007	6.36	8.69	11.86	20.23	316	205
MAGO-07-2007	6.63	8.30	9.75	10.40	338	219
MAGO-08-2007	6.91	8.80	11.48	5.17	259	169
MAGO-09-2007	6.89	10.27	11.63	3.65	368	239
MAGO-10-2007	7.19	9.48	11.75	11.87	173	113
*MAGO-10-2007-QC	6.98	9.72	11.70	12.50	174	113
MAGO-11-2007	6.87	10.7	11.09	4.46	191	125
MAGO-12-2007	7.00	10.41	11.75	3.91	211	137
MAGO-13-2007	7.09	10.73	11.64	5.74	173	119
MAGO-14-2007	6.71	11.5	11.61	8.18	182	119
MAGO-15-2007	7.29	15.00	4.62[1]	2.64	292	190
MAGO-16-2007	7.16	15.68	3.36[1]	12.32	292	190
*MAGO-16-2007-QC	7.19	17.57	3.32[1]	18.70	308	207
MAGO-17-2007	7.18	19.31	5.74[1]	1.79	234	152
MAGO-18-2007	7.12	21.27	10.82	5.17	285	185
MAGO-19-2007	7.09	22.44	8.03	10.20	184	120
MAGO-20-2007	7.22	16.18	3.08[1]	5.67	462	300
MAGO-21-2007	6.90	15.49	#	12.47	599	389
MAGO-22-2007	7.64	15.21	4.08[1]	16.77	393	256
MAGO-23-2007	7.41	15.43	10.59	11.17	251	163
*MAGO-23-2007-QC	7.18	15.29	9.33	9.99	253	165
MAGO-24-2007	7.35	15.19	10.07	7.62	127	83
MAGO-25-2007	6.94	15.67	9.58	5.30	180	117
MAGO-26-2007	7.36	13.30	7.42[1]	7.26	230	149
MAGO-27-2007	6.97	13.73	#	8.57	102	66
Study Mean	6.75	12.90	9.33	7.78	250.9	163
Standard Deviation	0.83	4.01	2.98	5.13	112.7	73

*QC sampling was conducted at these sites, excluded from mean and SD.

Dissolved Oxygen probe malfunctioned, no data recorded

[1] Questionable DO values, possibly due to malfunctioning probe

3.3 Physical Habitat Assessment

The results of the RBP and PHI habitat assessments are presented in Table 10. The percent comparability to reference scores ranged from 45.5 percent at site 06 to a high of 83.5 percent at site 08. Overall, six sites (22 percent) were classified as 'Comparable to Reference.' Thirteen sites (48 percent) were rated as 'Supporting' and seven (26 percent) were rated as 'Partially Supporting.' Only one site (4 percent) received a 'Non-Supporting' rating.

The lowest PHI score of 47.34 was recorded at site 12 while the highest score, 91.05 was recorded at site 8. Two sites, 12 and 27 rated as 'Severely Degraded', the lowest classification, and seven sites were rated as 'Degraded.' Six sites received the highest classification of 'Minimally Degraded', and the remaining 12 sites were rated as 'Partially Degraded.'

Table 10 – Habitat Assessment Results

Site	Total RBP	Percent Reference	RBP Classification	PHI Score	PHI Narrative Rating
MAGO-01-2007	136	68.0	Supporting	77.01	Partially Degraded
MAGO-02-2007	145	72.5	Supporting	83.47	Minimally Degraded
MAGO-03-2007	145	72.5	Supporting	78.79	Partially Degraded
MAGO-04-2007	160	80.0	Comparable to Reference	88.61	Minimally Degraded
MAGO-05-2007	156	78.0	Comparable to Reference	89.27	Minimally Degraded
MAGO-06-2007	91	45.5	Not Supporting	58.05	Degraded
MAGO-07-2007	131	65.5	Supporting	60.76	Degraded
MAGO-08-2007	167	83.5	Comparable to Reference	91.05	Minimally Degraded
MAGO-09-2007	156	78.0	Comparable to Reference	87.42	Minimally Degraded
MAGO-10-2007	155	77.5	Comparable to Reference	76.95	Partially Degraded
*MAGO-10-2007-QC	156	78.0	Comparable to Reference	77.32	Partially Degraded
MAGO-11-2007	128	64.0	Supporting	71.85	Partially Degraded
MAGO-12-2007	110	55.0	Partially Supporting	47.34	Severely Degraded
MAGO-13-2007	147	73.5	Supporting	72.69	Partially Degraded
MAGO-14-2007	128	64.0	Supporting	65.83	Degraded
MAGO-15-2007	111	55.5	Partially Supporting	66.91	Partially Degraded
MAGO-16-2007	147	73.5	Supporting	80.99	Partially Degraded
*MAGO-16-2007-QC	145	72.5	Supporting	78.71	Partially Degraded
MAGO-17-2007	124	62.0	Partially Supporting	76.63	Partially Degraded
MAGO-18-2007	138	69.0	Supporting	55.96	Degraded
MAGO-19-2007	122	61.0	Partially Supporting	66.14	Partially Degraded
MAGO-20-2007	98	49.0	Partially Supporting	54.99	Degraded
MAGO-21-2007	98	49.0	Partially Supporting	61.07	Degraded
MAGO-22-2007	141	70.5	Supporting	71.81	Partially Degraded
MAGO-23-2007	139	69.5	Supporting	68.89	Partially Degraded
*MAGO-23-2007-QC	154	77.0	Comparable to Reference	73.90	Partially Degraded
MAGO-24-2007	139	69.5	Supporting	65.94	Degraded
MAGO-25-2007	151	75.5	Comparable to Reference	84.33	Minimally Degraded
MAGO-26-2007	141	70.5	Supporting	78.15	Partially Degraded
MAGO-27-2007	97	48.5	Partially Supporting	50.07	Severely Degraded
Study Mean	133.4	66.7	Supporting	72.03	Partially Degraded
Standard Deviation	20.98	10.3	--	11.73	--

*QC sampling was conducted at these sites, excluded from mean and SD.

3.4 Benthic Macroinvertebrates

The BIBI scores and ratings for each site are presented in Table 11. Overall, there were four sites (15 percent) rated as 'Very Poor,' and no primary sites rated as 'Good.' Ten sites were rated as 'Fair' (37 percent) and thirteen were 'Poor' (48 percent).

Table 11 – BIBI Summary

Site	BIBI Score	Narrative Rating
MAGO-01-2007	1.6	Very Poor
MAGO-02-2007	1.6	Very Poor
MAGO-03-2007	1.6	Very Poor
MAGO-04-2007	3.9	Fair
MAGO-05-2007	3.3	Fair
MAGO-06-2007	2.1	Poor
MAGO-07-2007	2.4	Poor
MAGO-08-2007	2.7	Poor
MAGO-09-2007	3.9	Fair
MAGO-10-2007	3.6	Fair
*MAGO-10-2007-QC	4.1	Good
MAGO-11-2007	2.7	Poor
MAGO-12-2007	3.6	Fair
MAGO-13-2007	3.9	Fair
MAGO-14-2007	2.1	Poor
MAGO-15-2007	2.1	Poor
MAGO-16-2007	3.6	Fair
*MAGO-16-2007-QC	3.0	Fair
MAGO-17-2007	2.7	Poor
MAGO-18-2007	2.1	Poor
MAGO-19-2007	3.9	Fair
MAGO-20-2007	2.1	Poor
MAGO-21-2007	2.7	Poor
MAGO-22-2007	3.0	Fair
MAGO-23-2007	2.1	Poor
*MAGO-23-2007-QC	2.4	Poor
MAGO-24-2007	3.3	Fair
MAGO-25-2007	2.7	Poor
MAGO-26-2007	2.7	Poor
MAGO-27-2007	1.9	Very Poor
Study Mean	2.78	Poor
Standard Deviation	0.78	-

*QC sampling was conducted at these sites, excluded from mean and SD.

An analysis of the percent abundance and percent occurrence was completed and the results of the top 30 taxa are shown in Tables 12 and 13, respectively. *Caecidotea*, an isopod, was the most commonly collected genus making up over 9 percent of the total collected individuals. Of the top 30 taxa by percent abundance, 13 were in the family Chironomidae (midges).

Table 12 – Percent Abundance (by top 30 taxa)

Final Identification	Order	Family	Functional Feeding Group	Habit[1]	Tolerance Value	Total Number of Individuals	Percent of collected individuals
Caecidotea	Isopoda	Asellidae	Collector	sp	2.6	277	9.33
Rheocricotopus	Diptera	Chironomidae	Collector	sp	6.2	157	5.29
Polypedilum	Diptera	Chironomidae	Shredder	cb, cn	6.3	154	5.19
Tubificidae	Haplotaxida	Tubificidae	Collector	cn	8.4	120	4.04
Simulium	Diptera	Simuliidae	Filterer	cn	5.7	102	3.44
Crangonyx	Amphipoda	Crangonyctidae	Collector	sp	6.7	99	3.34
Pseudorthocladius	Diptera	Chironomidae	Collector	sp	6	98	3.30
Thienemannimyia	Diptera	Chironomidae	Predator	sp	6.7	91	3.07
Cheumatopsyche	Trichoptera	Hydropsychidae	Filterer	cn	6.5	85	2.86
Enchytraeidae	Haplotaxida	Enchytraeidae	Collector	bu	9.1	85	2.86
Orthocladiinae (tribe)	Diptera	Chironomidae	Collector	bu, sp	7.6	78	2.63
Valvata	Heterostropha	Valvatidae	Scraper	na	9	78	2.63
Gammarus	Amphipoda	Gammaridae	Shredder	sp	6.7	70	2.36
Orthocladius	Diptera	Chironomidae	Collector	sp, bu	9.2	66	2.22
Physa	Basommatophora	Physidae	Scraper	cb	7	64	2.16
Crangonyctidae	Amphipoda	Crangonyctidae	Collector	sp	6.5	60	2.02
Micropsectra	Diptera	Chironomidae	Collector	cb, sp	2.1	57	1.92
Stenelmis	Coleoptera	Elmidae	Scraper	cn	7.1	56	1.89
Hydrobaenus	Diptera	Chironomidae	Scraper	sp	7.2	46	1.55
Parametriocnemus	Diptera	Chironomidae	Collector	sp	4.6	45	1.52
Ceratopogonidae	Diptera	Ceratopogonidae	Predator	sp, bu	3.6	43	1.45
Calopteryx	Odonata	Calopterygidae	Predator	cb	8.3	42	1.42
Rheotanytarsus	Diptera	Chironomidae	Filterer	cn	7.2	41	1.38
Lumbricina (suborder)	Haplotaxida	not identified	Collector	bu	10	39	1.31
Pisidium	Veneroida	Pisidiidae	Filterer	bu	5.7	37	1.25
Polycentropus	Trichoptera	Polycentropodidae	Filterer	cn	1.1	33	1.11
Diplocladius	Diptera	Chironomidae	Collector	sp	5.9	28	0.94
Macronychus	Coleoptera	Dryopidae	Scraper	cn	6.8	28	0.94
Eukiefferiella	Diptera	Chironomidae	Collector	sp	6.1	26	0.88
Potthastia	Diptera	Chironomidae	Omnivore	sp	0	25	0.84

1 – Habit abbreviations: bu – burrower, cn – clinger, cb – climber, sp – sprawler, dv – diver, sk – skater.
QC sites were excluded from calculations.

The tolerant chironomids, *Polypedilum* and Orthocladiinae (tribe) were found at 20 (74.1 percent) and 18 (66.7 percent) of the sampling sites, respectively. An intolerant isopod, *Caecidotea* (Tolerance value = 2.6), was found at 17 of the 27 sites (63.0 percent). Other intolerant taxa in the top 30 include the midge, *Micropsectra* (Tol. val. = 2.1), the caddisfly, *Polycentropus* (Tol. val. = 1.1), and the midge, *Potthastia* (Tol. val. = 0). By percent occurrence, chironomids (midges) make up nearly half (14) of the top 30 taxa.

Table 13 – Percent Occurrence (by top 30 taxa)

Final Identification	Order	Family	Functional Feeding Group	Habit[1]	Tolerance Value	Number of sites with this taxa	Percent of sites with this taxa
Polypedilum	Diptera	Chironomidae	Shredder	cb, cn	6.3	20	74.1
Orthocladiinae (tribe)	Diptera	Chironomidae	Collector	bu, sp	7.6	18	66.7
Caecidotea	Isopoda	Asellidae	Collector	sp	2.6	17	63.0
Calopteryx	Odonata	Calopterygidae	Predator	cb	8.3	16	59.3
Thienemannimyia	Diptera	Chironomidae	Predator	sp	6.7	16	59.3
Tubificidae	Haplotaxida	Tubificidae	Collector	cn	8.4	16	59.3
Simulium	Diptera	Simuliidae	Filterer	cn	5.7	15	55.6
Crangonyx	Amphipoda	Crangonyctidae	Collector	sp	6.7	14	51.9
Orthocladius	Diptera	Chironomidae	Collector	sp, bu	9.2	14	51.9
Ceratopogonidae	Diptera	Ceratopogonidae	Predator	sp, bu	3.6	13	48.1
Enchytraeidae	Haplotaxida	Enchytraeidae	Collector	bu	9.1	12	44.4
Hydrobaenus	Diptera	Chironomidae	Scraper	sp	7.2	12	44.4
Lumbricina (suborder)	Haplotaxida	not identified	Collector	bu	10	12	44.4
Cheumatopsyche	Trichoptera	Hydropsychidae	Filterer	cn	6.5	11	40.7
Eukiefferiella	Diptera	Chironomidae	Collector	sp	6.1	11	40.7
Micropsectra	Diptera	Chironomidae	Collector	cb, sp	2.1	11	40.7
Stenelmis	Coleoptera	Elmidae	Scraper	cn	7.1	11	40.7
Lepidoptera	Lepidoptera	not identified	Shredder	na	6.7	10	37.0
Parametriocnemus	Diptera	Chironomidae	Collector	sp	4.6	10	37.0
Rheocricotopus	Diptera	Chironomidae	Collector	sp	6.2	10	37.0
Diplocladius	Diptera	Chironomidae	Collector	sp	5.9	9	33.3
Physa	Basommatophora	Physidae	Scraper	cb	7	9	33.3
Polycentropus	Trichoptera	Polycentropodidae	Filterer	cn	1.1	9	33.3
Chironomini	Diptera	Chironomidae	Collector	bu	5.9	8	29.6
Cricotopus	Diptera	Chironomidae	Shredder	cn, bu	9.6	8	29.6
Gammarus	Amphipoda	Gammaridae	Shredder	sp	6.7	8	29.6
Pisidium	Veneroida	Pisidiidae	Filterer	bu	5.7	8	29.6
Pseudorthocladius	Diptera	Chironomidae	Collector	sp	6	8	29.6
Rheotanytarsus	Diptera	Chironomidae	Filterer	cn	7.2	8	29.6
Tipula	Diptera	Tipulidae	Shredder	bu	6.7	8	29.63

1 – Habit abbreviations: bu – burrower, cn – clinger, cb – climber, sp – sprawler, dv – diver, sk – skater.
QC sites were excluded from calculations.

As shown in Tables 12 and 13, members of the family Chironomidae were dominant throughout the watershed. In general, the relative abundance of chironomids increases with increased perturbation. Table 14 lists all sites sampled and the percentage of identified individuals that were in the Chironomidae family. Site 25 contained the highest percentage of chironomids (87 percent) followed by sites 03 (70 percent) and 11 (69 percent). The lowest percentage was found at site 21, with only 3 individuals (3 percent).

Table 14 – Chironomidae Analysis

Site	Total Chironomidae per site	Total number of individuals per site	Percent Chironomidae
MAGO-01-2007	42	119	35
MAGO-02-2007	42	116	36
MAGO-03-2007	81	116	70
MAGO-04-2007	35	112	31
MAGO-05-2007	68	118	58
MAGO-06-2007	65	109	60
MAGO-07-2007	15	109	14
MAGO-08-2007	53	116	46
MAGO-09-2007	47	102	46
MAGO-10-2007	54	109	50
MAGO-10-2007-QC	36	121	30
MAGO-11-2007	74	108	69
MAGO-12-2007	44	106	42
MAGO-13-2007	67	106	63
MAGO-14-2007	32	105	30
MAGO-15-2007	42	118	36
MAGO-16-2007	31	105	30
MAGO-16-2007-QC	37	117	32
MAGO-17-2007	43	102	42
MAGO-18-2007	10	112	9
MAGO-19-2007	47	107	44
MAGO-20-2007	18	108	17
MAGO-21-2007	3	114	3
MAGO-22-2007	25	120	21
MAGO-23-2007	51	89	57
MAGO-23-2007-QC	22	86	26
MAGO-24-2007	38	115	33
MAGO-25-2007	90	104	87
MAGO-26-2007	32	111	29
MAGO-27-2007	22	112	20

4 Site Conditions

The Magothy watershed study area is made up of multiple small tributaries with average drainage areas of approximately 500 acres. The study area can be effectively divided into a northern portion and southern portion, with Cattail Creek being the lower extent of the northern section and Cypress Creek being the upper extent of the southern section, as is the case with the County-wide Biological Monitoring Program. Table 15 contains consolidated assessment results for each site to allow for easier comparisons of site specific conditions. Biological potential is limited by the quality of the physical habitat, which forms the template upon which biological communities develop (Southwood 1977). To examine the biological condition in comparison to the site's biological potential as defined by the habitat ratings (both RBP and PHI), a matrix was developed by plotting each station by biological rating on one axis and habitat rating on the other in order to determine whether they exceed, match, or fall short of their expected biological potential. The biological potential matrix for both RBP and PHI habitat ratings is shown in Table 16. The following section contains brief descriptions of the site-specific results and conditions.

Table 15 – Consolidated Assessment Results

Site	Subwatershed Code	Drainage Area (acres)	Impervious Percent	BIBI Score	RBP Score	RBP Percent Reference	PHI Score
MAGO-01-2007	MR0	167.44	19.71	1.6	136	68	77.01
MAGO-02-2007	MRE	37.27	2.52	1.6	145	72.5	83.47
MAGO-03-2007	MRG	314.99	2.45	1.6	145	72.5	78.79
MAGO-04-2007	MR6	733.7	10.76	3.9	160	80	88.61
MAGO-05-2007	MGY	544.58	22.15	3.3	156	78	89.27
MAGO-06-2007	MGW	90.79	23.05	2.1	91	45.5	58.05
MAGO-07-2007	MR5	264.42	15.29	2.4	131	65.5	60.76
MAGO-08-2007	MR4	420.16	25.24	2.7	167	83.5	91.05
MAGO-09-2007	MR1	382.83	27.41	3.9	156	78	87.42
MAGO-10-2007	MR7	3511.93	16.23	3.6	155	77.5	76.95
MAGO-11-2007	MR2	387.03	18.4	2.7	128	64	71.85
MAGO-12-2007	MR3	1046.76	17.85	3.6	110	55	47.34
MAGO-13-2007	MG1	522.11	15.69	3.9	147	73.5	72.69
MAGO-14-2007	MR9	522.79	13.85	2.1	128	64	65.83
MAGO-15-2007	MRA	202.57	20.65	2.1	111	55.5	66.91
MAGO-16-2007	MRB	243.81	11.86	3.6	147	73.5	80.99
MAGO-17-2007	MRF	230.91	16.44	2.7	124	62	76.63
MAGO-18-2007	MRI	1463.47	21.95	2.1	138	69	55.96
MAGO-19-2007	MRO	788.38	22.42	3.9	122	61	66.14
MAGO-20-2007	MGC	324.66	42.89	2.1	98	49	54.99
MAGO-21-2007	MGC	116.71	27.49	2.7	98	49	61.07
MAGO-22-2007	MGH	641.18	25	3	141	70.5	71.81
MAGO-23-2007	MGI	882.38	26.94	2.1	139	69.5	68.89
MAGO-24-2007	MGL	300.28	23.7	3.3	139	69.5	65.94
MAGO-25-2007	MGT	349.7	26.32	2.7	151	75.5	84.33
MAGO-26-2007	MGV	373.52	29.03	2.7	141	70.5	78.15
MAGO-27-2007	MGZ	91.89	0.83	1.9	97	48.5	50.07

Table 16 – Station Biological Potential Matrix

EPA RBP HABITAT RATING	BIOLOGICAL RATING				MBSS PHI HABITAT RATING	BIOLOGICAL RATING			
	GOOD	FAIR	POOR	VERY POOR		GOOD	FAIR	POOR	VERY POOR
Comparable		04; 05; 09; 10	08; 25		Minimally Degraded		04; 05; 09;	08; 25	2
Supporting		13; 16; 22; 24	07; 11; 14; 18; 23; 26	01; 02; 03	Partially Degraded		10; 13; 16; 19; 22;	11; 15; 17; 23; 26	01; 03
Partially Supporting		12; 19	15; 17; 20; 21	27	Degraded		24	06; 07; 14; 18; 20; 21	
Non-Supporting			6		Severely Degraded		12		27

Green indicates stations where the biological community exceeded the habitat potential
Orange indicates stations where the biological community reached habitat potential
Pink indicates stations where the biological community did not reach the habitat potential

01 Cornfield Creek (Subwatershed MR0)

Site 01 is located along a segment of Cornfield Creek situated in a residential neighborhood and has a drainage area of 167 acres. The drainage area has a high percentage of imperviousness (19.7 percent), primarily due to residential and commercial land uses. The site received a 'Supporting' RBP habitat rating and the PHI habitat received a similar 'Partially Degraded' rating. The biological condition was rated 'Very Poor' with a BIBI score of 1.6. Water quality, including a low pH (6.44), is likely a more limiting factor to the biota than is habitat quality. The low pH was likely attributed to an abundance of leaf and organic matter decomposing in the swampy wetlands draining into the stream. Conductivity (365 uS/cm) and total dissolved solids (238 mg/L) were also above average for the watershed, suggesting excessive urban runoff may be impacting the biota.

02 Gray's Creek (Subwatershed MRE)

This site is located along a small, shallow first-order segment of Gray's Creek, which lacked the necessary drainage area and depth to provide good instream habitat for fish. The channel was not well defined and had very little flow, most of which was likely the result of recent heavy rains. Much of the water in the channel was present as standing pools with an abundance of leaf matter. The decomposing leaf matter is likely contributing to the low pH (4.21). The drainage area is mostly forested (only 2.5 percent imperviousness), and both RBP and PHI habitat received 'Supporting' and 'Minimally Degraded' ratings, respectively. However, the biological condition was rated 'Very Poor' (BIBI = 1.6). The benthic community was dominated by midges and aquatic worms, with an overall diversity of 19 total taxa. Based on the small drainage area (37.3 acres), lack of defined channel features, and limited flow, it is likely that this is an intermittent tributary with seasonal flow.

03 Black Hole Creek (Subwatershed MRG)

Located on a third-order segment of the Blackhole Creek mainstem, this site has a mostly forested drainage with minimal impervious cover (2.4 percent) and an area of 315 acres. This site was rated

'Partially Degraded,' for the PHI, and the RBP rating was similar and in the 'Supporting' category. The BIBI score was a very low 1.6, placing the biological condition in the 'Very Poor' category. The benthic community was dominated by midges, which comprised 70 percent of the sample. *Pseudorthocladius*, a fairly tolerant midge (Tol. val. = 6) was the most abundant taxon. There was an abundance of leaves, pine needles, and woody debris in the channel, some of which appeared to have been dumped into the channel by nearby residences. The decomposing pine needles and leaves and the Blackhole Creek Bog located upstream complex, which is naturally acidic, could explain the very low pH (3.85), which, consequently may be inhibiting the biological community

04, 05 Cockey Creek and Nannys Branch (Subwatersheds MR6 and MGY)

Sites 04 and 05 are located on Cockey Creek and Nannys Branch, respectively. Site 04 had significantly less impervious drainage (10.8 percent) and had a larger drainage area (734 acres) than site 05 (22.1 percent, 545 acres); both received RBP habitat ratings of 'Comparable to Reference' and PHI ratings of 'Minimally Degraded.' Both sites also received biological condition ratings of 'Fair', with site 04 having a slightly higher BIBI score (3.9) than site 05 (3.3). Both sites had good numbers of taxa present, but site 04 scored slightly higher due to the presence of Ephemeroptera and a greater percentage of individuals intolerant to urban stressors (52 percent versus 19 percent). These sites had ample riparian buffers, stable banks, and were well shaded.

06 Indian Village Branch (Subwatershed MGW)

Site 06 is located in the middle of a residential yard and had virtually no riparian buffer due to the landowner mowing to the edge of the stream banks. There was an abundance of rip-rap placed in the channel and along the lower banks along much of the reach. There was also a very large pile of refuse and tires dumped in the channel just upstream of the site. This was a relatively small drainage area (90.8 acres), with high imperviousness (23.1 percent). Habitat assessment results were 'Non-Supporting' (RBP) and 'Degraded' (PHI) primarily due to the lack of adequate instream habitat, riparian buffers, pools, and low flow diversity. The benthic community had very low taxa diversity (14 total) and was dominated by midges (*Polypedilum* and *Chironomus*) and aquatic worms (Enchytraeidae and Tubificidae), resulting in a BIBI score of 2.1 and a 'Poor' rating.

07 Beechwood Branch (Subwatershed MR5)

Site 07 has a drainage area of 264 acres, 15.29 percent of which is impervious and is located just upstream of Magothy Bridge Road on the mainstem of Beechwood Branch. The stream was a shallow, sandy bottom channel and contained a large amount of refuse. The site is rated as 'Degraded' by the PHI primarily due to its proximity to the road, lack of epibenthic substrate and instream habitat, and poor shading. For RBP habitat, however, it was rated as 'Supporting' since it had high scores for bank stability, vegetative protection, and riparian buffers. Along with site 06 it had the lowest number of taxa (14) in the entire Magothy watershed and received a BIBI score of 2.4, resulting in a 'Poor' biological rating. Dominant taxa include the intolerant isopod *Caecidotea* (Tol. val. = 2.6) and the clam Pisidiidae (Tol. val. = 5.5). No Ephemeroptera or EPT taxa were present and only one scraper taxa was found.

08 Brookfield Branch (Subwatershed MR4)

Site 08 has a drainage area of over 420 acres and an imperviousness of 25.2 percent due to residential developments, portions of Rte 100 and Mountain Road and their associated commercial land use. The site is located in a mostly wetland area, with a narrow (less than 1 meter), fairly deep (70 cm) channel dominated by sandy substrate. The overall habitat rating is 91.0 in the 'Minimally Degraded' PHI category and 83.5 in the 'Comparable to Reference' RBP category. The BIBI score was 2.7 in the 'Poor' range, which is below what would be expected based on the habitat scores. While the benthic sample had a high number of overall taxa and a good number of scraper taxa, the lack of Ephemeroptera and low percentage of individuals intolerant to urbanization indicate an impaired biological community. Possible water quality issues may be causing biological impairment, especially following storm flows given the high imperviousness of the drainage area. It should also be noted that a large (approximate 2 foot diameter) corrugated plastic pipe ran parallel to the channel along the entire length of the floodplain, possibly acting as a replacement storm sewer line. It is possible that the pipe may be leaking into the stream channel causing impairment.

09 Bailys Branch (Subwatershed MR1)

Site 09 is located in a steep valley in relatively mature forest, however the 383 acre drainage area has a high degree of imperviousness (27.4 percent) due to residential landuse and portions of Rte 100 and Mountain Road and associated commercial land use. The habitat rating was 'Minimally Degraded' matching fairly well with the rating from RBP of 'Comparable to Reference.' The BIBI score was 3.9, in the 'Fair' category and just below the rating of 'Good,' which ranges from 4.0 to 5.0. The channel had a broad riparian buffer and good undercut bank habitat. The banks in the reach were stable, with only minor signs of erosion. Five EPT taxa were present in the sample of 29 overall taxa, however, none were Ephemeroptera.

10, 12, 13 Magothy Branch (Subwatersheds MR7, MR3, and MG1)

Sites 10, 12, and 13 are all located along the Magothy Branch mainstem. These sites all received 'Fair' biological ratings. The most downstream site (10) has the largest drainage area (3512 acres) of sites in the Magothy watershed study and a below average percent imperviousness (16.2 percent). The site received habitat ratings of 'Comparable to Reference' (RBP) and 'Partially Degraded' (PHI), with the PHI rating slightly lower for remoteness, due to the proximity to a nearby road, and reduced woody debris. Site 12 has a drainage area of 1047 acres and an imperviousness of 17.85 percent. Located just downstream of Ritchie Highway this site had more degraded habitat conditions, resulting in ratings of 'Partially Supporting' (RBP) and 'Severely Degraded' (PHI). Most of the channel was eroding due to an active headcut. The substrate was primarily hard-pan clay. Proximity to the highway and a lack of stable habitat for biota were also responsible for the low habitat ratings. The low habitat rating and moderate biological rating, suggests that there may be some nutrient enrichment occurring at this location, which would explain the higher than expected BIBI scores. Site 13, the most upstream site on the mainstem with a drainage area of 577 acres, is located in a residential neighborhood and has a moderately impervious drainage area (15.7 percent), most of which is attributed to residential land use. The stream is a braided, sandy bottom channel with a sufficient amount of woody debris and rootmats. Physical habitat was rated 'Supporting' (RBP) and 'Partially Degraded' (PHI). Low scores were given for remoteness and percent shading, but sinuosity, channel flow, and bank stability all scored well.

11, 14, and 15 Magothy Branch Tributaries (Muddy Run MR2, Kinder Branch MR9, and Rouses Branch MRA)

Site 11 is located just upstream of a farm pond impoundment on Muddy Run and has a drainage area of 387 acres, 18.4 percent of which is impervious. There was excessive sedimentation observed in the channel, which is likely exacerbated by the alterations in flow and transport patterns resulting from the instream impoundment. As expected, this site was rated 'Poor' (BIBI = 2.7) for biological condition. Of 24 total taxa found, only one EPT taxa was present, and greater than two-thirds of the individuals (69 percent) were Chironomidae taxa. The site received ratings of 'Partially Degraded' (PHI) and 'Supporting' (RBP) for habitat. Sites 14 and 15 also had 'Poor' biological ratings, with identical BIBI scores of 2.1. Both sites also had low total taxa counts of 17 and 15, respectively. Site 14 had a slightly better RBP habitat rating ('Supporting' vs. 'Partially Supporting), while site 15 received a slightly better PHI rating ('Partially Degraded' vs. 'Degraded'). Percent imperviousness was greater at site 15 (20.7 percent) than at site 14 (13.9 percent).

16 Nannys Creek (Subwatershed NRB)

Site 16 is located in a wooded valley surrounded by wetlands, adjacent to a residential neighborhood. The drainage area is fairly small at 244 acres, and it has an impervious cover of 11.9 percent, which is well below the average in the watershed. The habitat was rated as 'Partially Degraded' (PHI) and 'Supporting' (RBP), with very little bank erosion. The biology was rated 'Fair' with a BIBI score of 3.6. This site had 31 total taxa present, five EPT taxa and five scraper taxa.

17 Old Man Creek (Subwatershed MRF)

This site is located on the mainstem of Old Man Creek, a short distance downstream of Baltimore Annapolis Boulevard. Much of the drainage area is comprised of residential land use, and subsequently, impervious cover accounts for 16.4 percent of the 231 acre drainage. The overall habitat rating is 76.6 in the 'Partially Degraded' PHI category and 62.0 in the 'Partially Supporting' RBP category. The biological condition was rated 'Poor' with a BIBI score of 2.7. The dominant taxa found were *Simulium,* a black fly, (Tol. val.= 5.7), and *Corynoneura*, a midge, (Tol. val.= 4.1). The complete lack of Ephemeroptera and low percentage of individuals intolerant to urbanization signify an impaired biological community.

18, 19 Cattail Creek (Subwatersheds MRI and MRO)

Sites 18 and 19 are both located along the Cattail Creek mainstem in highly impervious drainages of 22.0 and 22.4 percent, respectively. Site 18, located downstream of site 19, has the second largest drainage area in the Magothy watershed at 1463 acres. This stream flows through a large wetland and had a very mucky, organic substrate. Some beaver activity was observed around the stream. This site was rated 'Degraded' for the PHI, but had a slightly better RBP rating of 'Supporting.' The BIBI score was low (2.1), placing the biological condition in the 'Poor' category. The benthic community was dominated by *Valvata*, a pollution tolerant snail (Tol. val. = 9). Site 19, which has a drainage area of 788 acres, had a BIBI score of 3.9, resulting in a 'Fair' biological condition rating. The dominant taxon at this site was *Micropsectra*, an intolerant midge (Tol. val. = 2.1). In addition, there was a high number of scraper taxa (7) as well as a high percentage of climbers present (40.2 percent). Physical habitat was rated 'Partially Supporting' (RBP) and 'Partially Degraded' (PHI).

20, 21 Cypress Creek (Subwatershed MGC)

Sites 20 and 21 are located on the north fork and south fork of Cypress Creek, respectively. Site 20 has a drainage area of 325 acres and has the highest imperviousness (42.9 percent) within the entire watershed due in large part to the presence of Severna Park Market Place, Park Plaza, and Loehmanns Plaza upstream. As expected, the biological condition was rated 'Poor' with a BIBI score of 2.1. The benthic community was dominated by pollution tolerant worm taxa including Tubificidae (Tol. val.= 8.1), Enchytraeidae (Tol. val.= 9.1), and Lumbricina (Tol. val.=10). Only one percent of the sample was comprised of urban intolerant individuals, suggesting that urban stressors are largely responsible for the biological impairment at this site. Both sites were rated as 'Degraded' (PHI) and 'Partially Supporting' (RBP), however, site 20 had more severely eroded banks and an excessive amount of refuse in the channel. Although it had slightly less impervious at 27.5 percent, site 21, which has a drainage area of 117 acres, also had a 'Poor' biological condition (BIBI = 2.7). In contrast to site 20, the dominant taxon was *Caecidotea* (Tol. val.= 2.6), a fairly intolerant isopod. However, total taxa was low compared with the rest of the watershed, and EPT taxa were absent from the sample altogether.

22 Dividing Creek (Subwatershed MGH)

Site 22, located on the Dividing Creek mainstem and has a drainage area of 641 acres, has an impervious drainage of 25 percent, due in large part to Anne Arundel Community College and a large stretch of Ritchie Highway. Physical habitat was rated 'Partially Degraded,' for the PHI in part due to the adjacent roadway and an incomplete riparian buffer. The RBP rating was similar and in the

'Supporting' category. An active headcut was observed in the channel indicating active downcutting and erosion. A clay substrate dominates a large portion of the reach. The biological condition was rated 'Fair' with a BIBI score of 3.0, which is just above the upper threshold of 2.9 for the 'Poor' category. *Physa*, a tolerant snail (Tol. val.= 7) was the dominant taxon present. Metrics for total taxa, number of scrapers, and percent climbers all scored well, however, a low intolerant to urban percentage and a complete lack of Ephemeroptera taxa kept the sample from achieving a higher BIBI score.

23 Mill Creek (Subwatershed MGI)

Also located downstream of Anne Arundel Community College and a large stretch of Ritchie Highway, site 23 has an 882 acre drainage area with a high percentage of impervious surface (26.9 percent). The site was located along a segment of Mill Creek with prominent beaver activity, and a beaver dam was observed just upstream of the sampling reach. The sampling reach was uncharacteristically deep and slow flowing, suggesting that there may have been a beaver dam further downstream. Habitat assessment results were 'Supporting' (RBP) and 'Partially Degraded' (PHI). Biological condition, however, was rated 'Poor' (BIBI = 2.1), due to the absence of both EPT taxa (including Ephemeroptera) and scraper taxa, as well a low percentage of individuals intolerant to urban stressors (4 percent). It is possible that the depressed biological score can be partially attributed to hydrologic alterations caused by beaver activity, although to a lesser extent than stressors related to elevated imperviousness.

24 Forked Creek (Subwatershed MGL)

Site 24 is located along a section of Forked Creek that meanders through a broad, swampy wetland and has a very mucky, organic matter dominated substrate. Due to a large proportion of residential land use in the 300 acre drainage area, imperviousness is 23.7 percent. Physical habitat was rated as 'Degraded' by the PHI in large part due to its lack of shading and remoteness. For RBP habitat, however, it was rated as 'Supporting' since it received high scores for bank stability, vegetative protection, and riparian buffers in addition to channel features (i.e., flow, sinuosity, and alteration). The BIBI score was 3.3, placing the biological condition in the 'Fair' category. The benthic community was dominated by *Caecidotea* (Tol. val.= 2.6), a fairly intolerant isopod, resulting in the maximum score for the percent intolerant to urban metric. High scores were also received for total taxa and number of scraper metrics, however, the absence of *Ephemeroptera* kept the BIBI score at the lower end of the 'Fair' category.

25 Deep Creek (Subwatershed MGT)

Site 25 is located within a broad wetland valley on a braided segment of Deep Creek. Much of the 350 acre drainage area is comprised of residential land uses, and impervious cover accounts for 26.3 percent of the drainage area. The site received a BIBI score of 2.7, resulting in a 'Poor' condition rating. The benthic results indicate that 87 percent of the individuals were Chironomidae taxa (midges). Additionally, only one EPT taxon was present, the percentage of intolerant individuals was very low (6 percent), and Ephemeroptera taxa were absent. The overall habitat rating is 84.3 in the 'Minimally Degraded' PHI category and 75.5 in the 'Comparable to Reference' RBP category, suggesting that habitat is not the limiting factor affecting the biota. It is likely that water quality, primarily during storm flows, may be responsible for the observed biological impairment at this location.

26 Little Magothy River (MGV)

The imperviousness at site 26 was the second highest in the watershed at 29 percent of the 374 acre drainage area, which is due in large part to Broadneck High School and Cape Saint Claire Elementary School in addition to high density residential land use. This site was located adjacent to a residential home, and it was observed that the landowner had been filling in the floodplain with mulch and attempting to stabilize the streambank with timbers and cinderblock. The physical habitat was rated 'Partially Degraded' (PHI) and 'Supporting' (RBP) due to the abundance of woody debris, high shading, and stable, well-vegetated banks. The biological condition, however, was rated 'Poor' with a BIBI score of 2.7. Total taxa was relatively low (15) for the site, Ephemeroptera were absent, and only one EPT taxa was present. Since the biological community did not reflect the potential provided by the habitat, it is likely that water quality impairment may be the limiting stressor at this site, given the highly impervious drainage area.

27 Podickery Creek (Subwatershed MGZ)

Located immediately downstream of Tydings Road and Sandy Point State Park, site 27 had the lowest percentage of impervious area of all sites in the watershed at 0.8 percent. While predominantly forested, the drainage area is relatively small (91.9 acres), and a wetland upstream of the road appeared to limit the flow out of the culvert and into the sampling reach. The stream was very narrow and shallow and lacks the necessary drainage area and depth to provide good instream habitat for fish and suitable substrate to support a healthy benthic macroinvertebrate community. Physical habitat was rated 'Severely Degraded' (PHI) due to the lack of fish and epifaunal habitat, poor shading, and the proximity to the road. Habitat was rated slightly higher for RBP as 'Partially Supporting', but the score was at the lowest end of that range and only one point above the 'Non-Supporting' category. There were also some signs of channel alteration (i.e., gabion baskets) and stabilization, and the lack of sinuosity suggests that there may have been some past channel straightening. As anticipated, the biological community was rated 'Very Poor' (BIBI = 1.9), due to low total taxa (15), no EPT or Ephemeroptera Taxa, and a small percentage of climbers (0.8 percent).

5 Conclusion

While the targeted study design does not support assessment results at the overall watershed scale, general statements about the Magothy study area can be made based on site-specific results. Of the 27 sites assessed, 63 percent had impaired biological conditions and no sites were rated 'Good'. The biological results indicate a mean BIBI score of 2.73, which would be in the 'Poor' category. Four sites were rated as 'Very Poor' and most received either 'Poor' (thirteen sites) or 'Fair' (ten sites) biological ratings. Chironomidae taxa dominated many of the samples and made up three of the top five taxa by percent occurrence. While some chironomid taxa are intolerant to stressors, the relevant abundance of chironomids tends to increase in urbanized drainages. Other prevalent taxa included *Caecidotea,* an intolerant isopod (as defined by Bressler at al. 2004 and accepted by MBSS), and *Calopteryx*, a stressor tolerant damselfly. Although *Caecidotea* is defined by MBSS as intolerant based on its revised tolerance value for Maryland (Tol. val. = 2.6), several other sources have assigned higher tolerance ratings indicative of greater pollution tolerance (i.e., Hilsenhoff, 1987 [Tol. val. = 8]; Barbour et al., 1999 [Tol. val. = 6] Davies and Jackson, 2006[Biological Condition Gradient = 5, i.e. tolerant], Carlisle et al., 2007 [highly tolerant to nutrients and ions and to a lesser extent fine substrates]). Additionally, *Caecidotea* has been found to be tolerant to sedimentation and able to withstand high flow effects (Meidel 2005), which are both common stressors in urbanized watersheds. A broad lack of taxa in the sensitive orders – Ephemeroptera, Plecoptera, and Trichoptera – is further indication that urban stressors are broadly affecting the biological integrity of these streams.

Habitat scores for the RBP and PHI assessments were well correlated (r squared = 0.68), and both indicate varying habitat conditions throughout the watershed. The majority of sites assessed were rated as "Supporting" by the RBP (48 percent) or "Partially Degraded" by the PHI (46 percent). Twenty-six percent of the sites were rated as 'Partially Supporting' (RBP) or 'Degraded' (PHI), while 22 percent were rated 'Comparable to Reference' (RBP) or 'Minimally Degraded'(PHI). Only a small proportion of sites were rated as either 'Non-Supporting'(four percent) or 'Severely Degraded'(seven percent).

Impervious surface coverage was relatively high throughout the study area with an average imperviousness of 19.5 percent. Only three drainage areas had imperviousness below 10 percent, while eight sites had impervious drainages of 25 percent or greater. Water quality parameters were primarily within the required levels, however, a few sites had very low pH values. These low values are likely due to tannic conditions caused by decomposing organic matter and from naturally occurring acidic bog conditions.

The responses observed in the Magothy Watershed are fairly consistent with those predicted by the Impervious Cover Model (Scheuler 1994), which concludes that most stream quality indicators (in this case benthic macroinvertebrates) decline when watershed impervious cover exceeds 10%, with severe degradation expected beyond 25% impervious cover. By and large, urban stressors appear to be the primary cause of biological impairment observed throughout the watershed. Urban stressors likely occurring in the Magothy Watershed include altered hydrologic regimes, increased sedimentation, degraded instream habitat, degraded riparian habitat, and possibly increased nutrients and toxics from runoff.

6 References

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Appendix A: Benthic Macroinvertebrate Data

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	I	1	Predator	sp	8.1
Insecta	Diptera	Chironomidae	Alotanypus	Alotanypus	I	2	na	na	6.6
Bivalvia	not identified	not identified	not identified	Bivalvia	U	1	Filterer	na	5.5
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	26	Collector	sp	2.6
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	1	Predator	sp, bu	3.6
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	P	1	Predator	sp, bu	3.6
Insecta	Diptera	Chironomidae	not identified	Chironomini	P	1	Collector	bu	5.9
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	37	Collector	sp	6.7
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	3	Collector	sp	5.9
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	2	Collector	bu	9.1
Arachnida	Acariformes	Hydrachnidae	not identified	Hydrachnidae	I	2	na	na	na
Insecta	Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	I	17	Collector	sp	4
Insecta	Diptera	Chironomidae	Paratendipes	Paratendipes	I	1	Collector	bu	6.6
Insecta	Diptera	Chironomidae	Phaenopsectra	Phaenopsectra	I	1	Collector	cn	8.7
Insecta	Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	I	1	Filterer	cn	1.1
Insecta	Diptera	Chironomidae	Psectrocladius	Psectrocladius	I	1	Shredder	sp, bu	6.6
Insecta	Diptera	Chironomidae	Pseudorthocladius	Pseudorthocladius	I	2	Collector	sp	6
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Insecta	Diptera	Syrphidae	not identified	Syrphidae	I	1	Collector	na	na
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	5	Predator	sp	6.7
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	3	Shredder	bu	6.7
Insecta	Diptera	Tipulidae	not identified	Tipulidae	I	1	Predator	bu, sp	4.8
Insecta	Diptera	Chironomidae	Tribelos	Tribelos	I	8	Collector	bu	7

1 Life Stage; I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion; includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values; based on Hilsenhoff, modified for Maryland, na idicates information for the particular taxa was not available.

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Culicidae	Aedes	Aedes	I	7	Filterer	sw	8
Insecta	Diptera	Chironomidae	Cantopelopia	Cantopelopia	I	1	Predator	sp	6.6
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	12	Predator	sp, bu	3.6
Hexapoda	Collembola	not identified	not identified	Collembola	U	1	Collector	sp, sk	6
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	3	Collector	sp	4.1
Insecta	Diptera	Ceratopogonidae	Culicoides	Culicoides	I	2	Predator	bu	5.9
Insecta	Coleoptera	Dytiscidae	not identified	Dytiscidae	I	2	Predator	sw, dv	5.4
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	14	Collector	bu	9.1
Insecta	Coleoptera	Dytiscidae	Hydaticus	Hydaticus	I	2	Predator	sw	5.4
Insecta	Coleoptera	Hydrophilidae	not identified	Hydrophilidae	I	1	Collector	sw, dv	4.1
Insecta	Lepidoptera	not identified	not identified	Lepidoptera	I	5	Shredder	na	6.7
Insecta	Diptera	Chironomidae	Limnophyes	Limnophyes	I	3	Collector	sp	8.6
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	13	Collector	bu	10
Insecta	Diptera	Tipulidae	Molophilus	Molophilus	I	6	Shredder	bu	4.8
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	3	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	3	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Pseudorthocladius	Pseudorthocladius	I	10	Collector	sp	6
Insecta	Coleoptera	Staphylinidae	not identified	Staphylinidae	A	1	Predator	cn, cb, bu	5
Insecta	Diptera	Chironomidae	not identified	Tanypodinae	P	4	Predator	sp, sw	7.5
Insecta	Coleoptera	Dytiscidae	Thermonectus	Thermonectus	A	1	Predator	sw, dv	5.4
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	5	Shredder	bu	6.7
Insecta	Diptera	Tipulidae	Tipula	Tipula	P	2	Shredder	bu	6.7
Insecta	Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	I	15	Predator	sp	5.3

1 Life Stage; I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion; includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values; based on Hilsenhoff, modified for Maryland, na idicates information for the particular taxa was not available.

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Bibionidae	not identified	Bibionidae	I	4	na	na	na
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	5	Predator	sp, bu	3.6
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	P	1	Predator	sp, bu	3.6
Insecta	Diptera	Chironomidae	not identified	Chironomidae	P	1	Collector	na	6.6
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	3	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	1	Shredder	cn, bu	9.6
Insecta	Diptera	Chironomidae	Heterotrissocladius	Heterotrissocladius	I	1	Collector	sp, bu	2
Insecta	Diptera	Chironomidae	Limnophyes	Limnophyes	I	1	Collector	sp	8.6
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	1	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Pseudorthocladius	Pseudorthocladius	I	73	Collector	sp	6
Insecta	Megaloptera	Corydalidae	Chauliodes	Chauliodes	I	2	Predator	cn, cb	1.4
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	I	2	Collector	sp	6.7
Crustacea	Amphipoda	Crangonyctidae	Stygobromus	Stygobromus	I	2	Collector	sp	6.5
Insecta	Diptera	Culicidae	Aedes	Aedes	I	1	Filterer	sw	8
Insecta	Coleoptera	Dytiscidae	Laccophilus	Laccophilus	A	2	Predator	sw, dv	5.4
Insecta	Coleoptera	Dytiscidae	Rhantus	Rhantus	I	1	Predator	sw	5.4
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	3	Collector	bu	9.1
Insecta	Plecoptera	Nemouridae	Prostoia	Prostoia	I	2	Shredder	sp, cn	4.5
Insecta	Diptera	not identified	not identified	Diptera	P	1	na	na	6
Insecta	Lepidoptera	not identified	not identified	Lepidoptera	I	1	Shredder	na	6.7
Insecta	Coleoptera	Scirtidae	Elodes	Elodes	I	7	Collector	cb, sp	4
Insecta	Diptera	Tabanidae	Chrysops	Chrysops	I	1	Predator	sp, bu	2.9

1 Life Stage; I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion; includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values; based on Hilsenhoff, modified for Maryland, na idicates information for the particular taxa was not available.

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Odonata	Aeshnidae	Boyeria	Boyeria	I	1	Predator	cb, sp	6.3
Insecta	Trichoptera	Calamoceratidae	Heteroplectron	Heteroplectron	I	1	Shredder	sp	3
Insecta	Plecoptera	Capniidae	not identified	Capniidae	I	2	Shredder	sp, cn	3.7
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	P	1	Predator	sp, bu	3.6
Insecta	Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	I	1	Predator	sp	8.1
Insecta	Diptera	Chironomidae	Apsectrotanypus	Apsectrotanypus	I	1	Predator	bu, sp	6.6
Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	2	Shredder	cn, bu	9.6
Insecta	Diptera	Chironomidae	Heterotrissocladius	Heterotrissocladius	I	2	Collector	sp, bu	2
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	1	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	P	1	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	1	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Paracladopelma	Paracladopelma	I	1	Collector	sp	6.6
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	8	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	15	Predator	sp	6.7
Insecta	Plecoptera	Chloroperlidae	not identified	Chloroperlidae	I	14	Predator	cn	1.6
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	I	1	Collector	sp	6.7
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	1	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	I	11	Filterer	cn	2.7
Insecta	Trichoptera	Leptoceridae	Triaenodes	Triaenodes	I	2	Shredder	sw, cb	5
Insecta	Ephemeroptera	Leptophlebiidae	not identified	Leptophlebiidae	I	1	Collector	sw, cn	1.7
Insecta	Lepidoptera	not identified	not identified	Lepidoptera	I	1	Shredder	na	6.7
Insecta	Plecoptera	not identified	not identified	Plecoptera	I	20	Predator	na	2.4
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	1	Filterer	cn	4.4
Insecta	Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	I	8	Filterer	cn	1.1
Insecta	Trichoptera	Psychomyiidae	Lype	Lype	I	4	Scraper	cn	4.7
Insecta	Coleoptera	Ptilodactylidae	Anchytarsus	Anchytarsus	I	5	Shredder	cn	3.1
Bivalvia	Veneroida	Sphaeriidae	Musculium	Musculium	I	1	Filterer	-	5.5
Insecta	Diptera	Tipulidae	Polymera	Polymera	I	2	Predator	bu, sp	4.8

1 Life Stage; I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion; includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values; based on Hilsenhoff, modified for Maryland, na idicates information for the particular taxa was not available.

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	I	4	Predator	sp	8.1
Insecta	Diptera	Chironomidae	Acricotopus	Acricotopus	I	2	Collector	sp	6.6
Insecta	Coleoptera	Elmidae	Ancyronyx	Ancyronyx	I	1	Scraper	cn, sp	7.8
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	2	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	4	Predator	cb	8.3
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	3	Predator	sp, bu	3.6
Insecta	Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	I	1	Filterer	cn	2.7
Insecta	Coleoptera	Dytiscidae	not identified	Dytiscidae	I	1	Predator	sw, dv	5.4
Insecta	Coleoptera	Dryopidae	Helichus	Helichus	A	3	Scraper	cn	6.4
Insecta	Diptera	Chironomidae	Heterotrissocladius	Heterotrissocladius	I	2	Collector	sp, bu	2
Insecta	Trichoptera	Hydropsychidae	not identified	Hydropsychidae	P	1	Filterer	cn	5.7
Insecta	Trichoptera	Lepidostomatidae	Lepidostoma	Lepidostoma	I	1	Shredder	cb, sp, cn	0
Insecta	Odonata	Libellulidae	not identified	Libellulidae	I	1	Predator	na	9
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	1	Collector	bu	10
Insecta	Trichoptera	Psychomyiidae	Lype	Lype	I	4	Scraper	cn	4.7
Insecta	Diptera	Ceratopogonidae	Mallochohelea	Mallochohelea	I	1	Predator	bu	3.6
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	1	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Natarsia	Natarsia	I	1	Predator	sp	6.6
Insecta	Megaloptera	Corydalidae	Nigronia	Nigronia	I	3	Predator	cn, cb	1.4
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	1	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Parachaetocladius	Parachaetocladius	I	1	Collector	sp	3.3
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	P	1	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	6	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	I	1	Collector	sp	4
Insecta	Diptera	Chironomidae	Paratendipes	Paratendipes	P	1	Collector	bu	6.6
Insecta	Diptera	Chironomidae	Phaenopsectra	Phaenopsectra	I	1	Collector	cn	8.7
Insecta	Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	I	9	Filterer	cn	1.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	6	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Potthastia	Potthastia	I	1	Omnivore	sp	0
Insecta	Diptera	Tipulidae	Pseudolimnophila	Pseudolimnophila	I	1	Predator	bu	2.8
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	15	Filterer	cn	7.2
Insecta	Megaloptera	Sialidae	Sialis	Sialis	I	2	Predator	bu, cb, cn	1.9

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Insecta	Coleoptera	Staphylinidae	not identified	Staphylinidae	A	1	Predator	cn, cb, bu	5
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	4	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	4	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	19	Predator	sp	6.7
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	1	Shredder	bu	6.7
Insecta	Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	I	4	Predator	sp	5.3

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Chironomidae	not identified	Chironomidae	I	1	Collector	na	6.6
Insecta	Diptera	Chironomidae	Chironomus	Chironomus	I	11	Collector	bu	4.6
Insecta	Diptera	Chironomidae	Chironomus	Chironomus	P	1	Collector	bu	4.6
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	26	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	3	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Goeldichironomus	Goeldichironomus	I	1	Collector	bu	5.9
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	1	Scraper	sp	7.2
Insecta	Lepidoptera	not identified	not identified	Lepidoptera	I	1	Shredder	na	6.7
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	1	Collector	bu	10
Clitellata	Lumbriculada	Lumbriculidae	not identified	Lumbriculidae	U	1	Collector	bu	6.6
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	45	Shredder	cb, cn	6.3
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	U	3	Predator	na	7.3
Insecta	Diptera	Chironomidae	Psectrocladius	Psectrocladius	I	1	Shredder	sp, bu	6.6
Insecta	Diptera	Chironomidae	Smittia	Smittia	I	1	Collector	lentic	6.6
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	1	Shredder	bu	6.7
Insecta	Diptera	Tipulidae	not identified	Tipulidae	P	1	Predator	bu, sp	4.8
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	10	Collector	cn	8.4

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	I	63	Collector	sp	2.6
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	1	Predator	sp, bu	3.6
Insecta	Diptera	Chironomidae	Chironomus	Chironomus	I	2	Collector	bu	4.6
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	1	Collector	sp	5.9
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	1	Scraper	sp	7.2
Insecta	Odonata	Coenagrionidae	Ischnura	Ischnura	I	1	Predator	cb	9
Insecta	Diptera	Stratiomyidae	Myxosargus	Myxosargus	I	1	Collector	sp, sw	10
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	1	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Paratendipes	Paratendipes	P	1	Collector	bu	6.6
Bivalvia	Veneroida	Pisidiidae	not identified	Pisidiidae	I	13	Filterer	bu	5.5
Bivalvia	Veneroida	Pisidiidae	Pisidium	Pisidium	I	2	Filterer	bu	5.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	6	Shredder	cb, cn	6.3
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	9	Filterer	cn	5.7
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	3	Predator	sp	6.7
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	4	Collector	cn	8.4

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Odonata	Coenagrionidae	Argia	Argia	I	1	Predator	cn, cb, sp	9.3
Insecta	Odonata	Aeshnidae	Boyeria	Boyeria	I	2	Predator	cb, sp	6.3
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	2	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	2	Predator	cb	8.3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	26	Filterer	cn	6.5
Insecta	Diptera	Chironomidae	Chironomus	Chironomus	I	1	Collector	bu	4.6
Insecta	Odonata	Corduliidae	not identified	Corduliinae	I	1	Predator	sp, cb	2
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	I	8	Collector	sp	6.7
Insecta	Coleoptera	Dryopidae	Helichus	Helichus	A	1	Scraper	cn	6.4
Insecta	Diptera	Chironomidae	Heterotrissocladius	Heterotrissocladius	I	1	Collector	sp, bu	2
Insecta	Trichoptera	Limnephilidae	Ironoquia	Ironoquia	I	1	Shredder	sp	4.9
Insecta	Trichoptera	Psychomyiidae	Lype	Lype	I	3	Scraper	cn	4.7
Clitellata	Haplotaxida	Naididae	not identified	Naididae	U	4	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Nanocladius	Nanocladius	I	1	Collector	sp	7.6
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	2	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	2	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	7	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	1	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Paratendipes	Paratendipes	I	1	Collector	bu	6.6
Gastropoda	Basommatophor	Physidae	Physa	Physa	U	1	Scraper	cb	7
Bivalvia	Veneroida	Pisidiidae	not identified	Pisidiidae	I	1	Filterer	bu	5.5
Insecta	Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	I	4	Filterer	cn	1.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	24	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	6	Filterer	cn	7.2
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	2	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	4	Predator	sp	6.7
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	1	Shredder	bu	6.7
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	3	Collector	cn	8.4
Insecta	Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	I	2	Predator	sp	5.3

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Odonata	Aeshnidae	Boyeria	Boyeria	I	3	Predator	cb, sp	6.3
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	8	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	6	Predator	cb	8.3
Insecta	Diptera	Ceratopogonidae	Ceratopogon	Ceratopogon	I	1	Predator	sp, bu	2.7
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	2	Filterer	cn	6.5
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	2	Collector	sp	6.7
Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	2	Shredder	cn, bu	9.6
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	5	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Georthocladius	Georthocladius	I	1	Collector	sp	7.6
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	1	Predator	sp, bu	7.9
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	3	Scraper	sp	7.2
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	1	Filterer	cn	7.5
Insecta	Trichoptera	Limnephilidae	Ironoquia	Ironoquia	I	2	Shredder	sp	4.9
Insecta	Lepidoptera	not identified	not identified	Lepidoptera	I	1	Shredder	na	6.7
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	1	Collector	bu	10
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	1	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	2	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	4	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Phaenopsectra	Phaenopsectra	I	2	Collector	cn	8.7
Insecta	Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	I	5	Filterer	cn	1.1
Insecta	Diptera	Chironomidae	Potthastia	Potthastia	I	20	Omnivore	sp	0
Insecta	Diptera	Chironomidae	Psectrocladius	Psectrocladius	I	3	Shredder	sp, bu	6.6
Insecta	Trichoptera	Phryganeidae	Ptilostomis	Ptilostomis	I	1	Shredder	cb	4.3
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	2	Filterer	cn	5.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	3	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	2	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	7	Predator	sp	6.7
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	4	Shredder	bu	6.7
Insecta	Diptera	Tipulidae	not identified	Tipulidae	I	1	Predator	bu, sp	4.8
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	4	Collector	cn	8.4
Insecta	Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	P	1	Predator	sp	5.3

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Coleoptera	Elmidae	Ancyronyx	Ancyronyx	I	1	Scraper	cn, sp	7.8
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	16	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	3	Predator	cb	8.3
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	3	Predator	sp, bu	3.6
Insecta	Diptera	Empididae	Chelifera	Chelifera	I	1	Predator	sp, bu	7.1
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	2	Filterer	cn	6.5
Insecta	Odonata	Cordulegastridae	Cordulegaster	Cordulegaster	I	1	Predator	bu	2.4
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	1	Collector	sp	6.7
Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	2	Shredder	cn, bu	9.6
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	2	Collector	bu	9.1
Crustacea	Amphipoda	Gammaridae	Gammarus	Gammarus	U	5	Shredder	sp	6.7
Insecta	Coleoptera	Dryopidae	Helichus	Helichus	A	2	Scraper	cn	6.4
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	1	Filterer	cn	7.5
Insecta	Lepidoptera	not identified	not identified	Lepidoptera	I	1	Shredder	na	6.7
Insecta	Coleoptera	Dryopidae	Macronychus	Macronychus	A	1	Scraper	cn	6.8
Insecta	Coleoptera	Dryopidae	Macronychus	Macronychus	I	1	Scraper	cn	6.8
Insecta	Coleoptera	Elmidae	Microcylloepus	Microcylloepus	I	1	Collector	cn, cb, bu	4.8
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	P	5	Collector	cb, sp	2.1
Insecta	Megaloptera	Corydalidae	Nigronia	Nigronia	I	3	Predator	cn, cb	1.4
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	20	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	2	Collector	sp, bu	9.2
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	I	5	Scraper	cn	2.7
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	1	Collector	sp	4.6
Insecta	Plecoptera	not identified	not identified	Plecoptera	I	1	Predator	na	2.4
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	P	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	6	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Potthastia	Potthastia	I	3	Omnivore	sp	0
Insecta	Diptera	Chironomidae	Pseudorthocladius	Pseudorthocladius	I	8	Collector	sp	6
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	1	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	1	Scraper	cn	7.1

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Chironomidae	Stenochironomus	Stenochironomus	I	2	Shredder	bu	7.9
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	2	Predator	sp	6.7
Insecta	Trichoptera	Leptoceridae	Triaenodes	Triaenodes	I	1	Shredder	sw, cb	5

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Coleoptera	Elmidae	Ancyronyx	Ancyronyx	A	1	Scraper	cn, sp	7.8
Insecta	Coleoptera	Elmidae	Ancyronyx	Ancyronyx	I	2	Scraper	cn, sp	7.8
Insecta	Odonata	Aeshnidae	Boyeria	Boyeria	I	1	Predator	cb, sp	6.3
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	3	Collector	sp	2.6
Insecta	Ephemeroptera	Caenidae	Caenis	Caenis	I	1	Collector	sp	2.1
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	4	Predator	cb	8.3
Insecta	Diptera	Ceratopogonidae	Ceratopogon	Ceratopogon	I	1	Predator	sp, bu	2.7
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	2	Predator	sp, bu	3.6
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	2	Filterer	cn	6.5
Insecta	Diptera	Chironomidae	Conchapelopia	Conchapelopia	P	2	Predator	sp	6.1
Bivalvia	Veneroida	Corbiculidae	Corbicula	Corbicula	U	1	Filterer	bu	6
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	1	Collector	sp	4.1
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	16	Collector	sp	6.7
Insecta	Diptera	Empididae	not identified	Empididae	P	1	Predator	sp, bu	7.5
Insecta	Diptera	Chironomidae	Glyptotendipes	Glyptotendipes	I	1	Filterer	bu, cn	6.6
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	1	Filterer	cn	7.5
Insecta	Plecoptera	Leuctridae	Leuctra	Leuctra	I	1	Shredder	cn	0.4
Insecta	Coleoptera	Dryopidae	Macronychus	Macronychus	I	5	Scraper	cn	6.8
Insecta	Coleoptera	Dryopidae	Macronychus	Macronychus	A	3	Scraper	cn	6.8
Insecta	Coleoptera	Elmidae	Microcylloepus	Microcylloepus	A	1	Collector	cn, cb, bu	4.8
Insecta	Coleoptera	Elmidae	Microcylloepus	Microcylloepus	I	4	Collector	cn, cb, bu	4.8
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	P	1	Collector	cb, sp	2.1
Insecta	Megaloptera	Corydalidae	Nigronia	Nigronia	I	1	Predator	cn, cb	1.4
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	2	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	1	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Parachaetocladius	Parachaetocladius	I	2	Collector	sp	3.3
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	9	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Potthastia	Potthastia	I	2	Omnivore	sp	0
Insecta	Diptera	Chironomidae	Pseudorthocladius	Pseudorthocladius	I	2	Collector	sp	6
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	20	Filterer	cn	5.7

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Chironomidae	Smittia	Smittia	I	1	Collector	lentic	6.6
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	7	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	2	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	Stenochironomus	Stenochironomus	I	2	Shredder	bu	7.9
Insecta	Ephemeroptera	Heptageniidae	Stenonema	Stenonema	I	5	Scraper	cn	4.6
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	3	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	5	Predator	sp	6.7

1 Life Stage; I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion; includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values; based on Hilsenhoff, modified for Maryland, na idicates information for the particular taxa was not available.

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	2	Shredder	bu, sp	7.4
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	2	Predator	cb	8.3
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	1	Predator	sp, bu	3.6
Insecta	Diptera	Chironomidae	not identified	Chironomini	I	1	Collector	bu	5.9
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	1	Collector	sp	5.9
Insecta	Coleoptera	Dytiscidae	not identified	Dytiscidae	I	1	Predator	sw, dv	5.4
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	7	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	27	Scraper	sp	7.2
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	1	Filterer	cn	7.5
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	3	Collector	bu	10
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	P	1	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Paracladopelma	Paracladopelma	I	2	Collector	sp	6.6
Insecta	Diptera	Chironomidae	Phaenopsectra	Phaenopsectra	I	2	Collector	cn	8.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	9	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	P	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Prodiamesa	Prodiamesa	I	1	Collector	bu, sp	6.6
Insecta	Diptera	Chironomidae	Pseudorthocladius	Pseudorthocladius	I	2	Collector	sp	6
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	8	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	3	Filterer	cn	7.2
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	14	Filterer	cn	5.7
Insecta	Diptera	Chironomidae	Smittia	Smittia	I	1	Collector	lentic	6.6
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	8	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	1	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	not identified	Tanypodinae	P	1	Predator	sp, sw	7.5
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	3	Predator	sp	6.7
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	1	Shredder	bu	6.7
Insecta	Diptera	Chironomidae	Tribelos	Tribelos	I	1	Collector	bu	7
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	2	Collector	cn	8.4
Insecta	Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	I	1	Predator	sp	5.3

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Ephemeroptera	Baetidae	Acerpenna	Acerpenna	I	1	Collector	sw, cn	2.6
Insecta	Coleoptera	Elmidae	Ancyronyx	Ancyronyx	A	2	Scraper	cn, sp	7.8
Insecta	Diptera	Tipulidae	Antocha	Antocha	I	1	Collector	cn	8
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	1	Collector	sw, cn	2.3
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	2	Predator	cb	8.3
Insecta	Trichoptera	Hydropsychidae	Ceratopsyche	Ceratopsyche	I	1	Filterer	cn	5
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	4	Filterer	cn	6.5
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	17	Collector	sp	6.7
Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	2	Shredder	cn, bu	9.6
Insecta	Coleoptera	Elmidae	Dubiraphia	Dubiraphia	I	1	Scraper	cn, cb	5.7
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	1	Collector	sp	6.1
Insecta	Coleoptera	Dryopidae	Helichus	Helichus	A	1	Scraper	cn	6.4
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	1	Predator	sp, bu	7.9
Crustacea	Amphipoda	Hyalellidae	Hyalella	Hyalella	U	2	Shredder	sp	4.2
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	1	Scraper	sp	7.2
Insecta	Trichoptera	Limnephilidae	Ironoquia	Ironoquia	I	2	Shredder	sp	4.9
Insecta	Lepidoptera	not identified	not identified	Lepidoptera	I	1	Shredder	na	6.7
Insecta	Coleoptera	Dryopidae	Macronychus	Macronychus	A	8	Scraper	cn	6.8
Insecta	Coleoptera	Dryopidae	Macronychus	Macronychus	I	3	Scraper	cn	6.8
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	2	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	P	2	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	8	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	2	Collector	sp	4.6
Bivalvia	Veneroida	Pisidiidae	Pisidium	Pisidium	I	1	Filterer	bu	5.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	21	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Potthastia	Potthastia	I	1	Omnivore	sp	0
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	12	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	3	Predator	sp	6.7

1 Life Stage; I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion; includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values; based on Hilsenhoff, modified for Maryland, na idicates information for the particular taxa was not available.

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Ephemeroptera	Baetidae	Acerpenna	Acerpenna	I	2	Collector	sw, cn	2.6
Insecta	Odonata	Aeshnidae	not identified	Aeshnidae	I	1	Predator	cb	6.2
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Crustacea	Decapoda	Cambaridae	not identified	Cambarinae	U	1	Shredder	sp	2.8
Insecta	Ephemeroptera	Baetidae	Centroptilum	Centroptilum	I	2	Collector	sw, cn	2.3
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	1	Predator	sp, bu	3.6
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	6	Filterer	cn	6.5
Insecta	Diptera	Chironomidae	not identified	Chironomini	I	1	Collector	bu	5.9
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	I	1	Collector	sp	6.7
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	2	Collector	sp	6.1
Insecta	Coleoptera	Dryopidae	Helichus	Helichus	A	2	Scraper	cn	6.4
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	1	Scraper	sp	7.2
Insecta	Coleoptera	Hydrophilidae	Hydrobius	Hydrobius	I	1	Collector	cb, cn, sp	4.1
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	1	Collector	bu	10
Insecta	Coleoptera	Dryopidae	Macronychus	Macronychus	A	1	Scraper	cn	6.8
Insecta	Coleoptera	Dryopidae	Macronychus	Macronychus	I	6	Scraper	cn	6.8
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	1	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	1	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	7	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	32	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Psectrocladius	Psectrocladius	I	1	Shredder	sp, bu	6.6
Insecta	Diptera	Chironomidae	Pseudorthocladius	Pseudorthocladius	I	1	Collector	sp	6
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	12	Filterer	cn	7.2
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	9	Filterer	cn	5.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	2	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	1	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	4	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	3	Predator	sp	6.7
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	2	Collector	cn	8.4

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3
Crustacea	Decapoda	Cambaridae	Cambarus	Cambarus	U	1	Collector	sp	0.4
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	22	Filterer	cn	6.5
Insecta	Diptera	Chironomidae	not identified	Chironomini	I	1	Collector	bu	5.9
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	2	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	1	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	1	Scraper	sp	7.2
Insecta	Trichoptera	Hydropsychidae	not identified	Hydropsychidae	P	17	Filterer	cn	5.7
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	3	Collector	bu	10
Clitellata	Haplotaxida	Naididae	not identified	Naididae	U	8	Collector	bu	9.1
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	1	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	P	2	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	23	Collector	sp, bu	9.2
Bivalvia	Veneroida	Pisidiidae	not identified	Pisidiidae	U	1	Filterer	bu	5.5
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	I	1	Predator	na	7.3
Insecta	Diptera	Chironomidae	Psectrocladius	Psectrocladius	I	1	Shredder	sp, bu	6.6
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	7	Filterer	cn	5.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	2	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	2	Predator	sp	6.7
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	8	Collector	cn	8.4

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	10	Collector	sp	2.6
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	5	Predator	sp, bu	3.6
Hexapoda	Collembola	not identified	not identified	Collembola	A	6	Collector	sp, sk	6
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	1	Collector	sp	6.1
Insecta	Coleoptera	Dytiscidae	Hydaticus	Hydaticus	I	1	Predator	sw	5.4
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	3	Scraper	sp	7.2
Insecta	Lepidoptera	not identified	not identified	Lepidoptera	I	1	Shredder	na	6.7
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	28	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	4	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	1	Collector	sp	7.7
Gastropoda	Basommatophor	Physidae	Physa	Physa	U	4	Scraper	cb	7
Bivalvia	Veneroida	Pisidiidae	not identified	Pisidiidae	U	2	Filterer	bu	5.5
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	1	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	P	2	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	47	Collector	cn	8.4

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Odonata	Aeshnidae	Boyeria	Boyeria	I	1	Predator	cb, sp	6.3
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	5	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	3	Predator	sp, bu	3.6
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	P	1	Predator	sp, bu	3.6
Insecta	Diptera	Chironomidae	not identified	Chironomidae	I	1	Collector	na	6.6
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	2	Collector	sp	4.1
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	I	9	Collector	sp	6.7
Insecta	Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	I	1	Filterer	cn	2.7
Insecta	Coleoptera	Scirtidae	Elodes	Elodes	I	2	Collector	cb, sp	4
Gastropoda	Basommatophor	Lymnaeidae	Fossaria	Fossaria	U	6	Scraper	cb	6.9
Insecta	Diptera	Tipulidae	Hexatoma	Hexatoma	I	1	Predator	bu, sp	1.5
Crustacea	Amphipoda	Hyalellidae	Hyalella	Hyalella	I	1	Shredder	sp	4.2
Insecta	Coleoptera	Hydrophilidae	Hydrobius	Hydrobius	I	1	Collector	cb, cn, sp	4.1
Insecta	Plecoptera	Leuctridae	Leuctra	Leuctra	I	1	Shredder	cn	0.4
Insecta	Trichoptera	Psychomyiidae	Lype	Lype	I	4	Scraper	cn	4.7
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	1	Collector	cb, sp	2.1
Insecta	Hemiptera	Veliidae	Microvelia	Microvelia	I	1	Predator	skater	6
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	1	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	4	Collector	sp	4.6
Gastropoda	Basommatophor	Physidae	Physa	Physa	U	12	Scraper	cb	7
Bivalvia	Veneroida	Pisidiidae	not identified	Pisidiidae	U	1	Filterer	bu	5.5
Insecta	Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	I	1	Filterer	cn	1.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	4	Shredder	cb, cn	6.3
Insecta	Diptera	Tipulidae	Pseudolimnophila	Pseudolimnophila	I	1	Predator	bu	2.8
Insecta	Diptera	Chironomidae	Pseudorthocladius	Pseudorthocladius	I	1	Collector	sp	6
Insecta	Trichoptera	Odontoceridae	Psilotreta	Psilotreta	I	1	Scraper	sp	0.9
Insecta	Diptera	Ptychopteridae	Ptychoptera	Ptychoptera	I	2	Collector	bu	4
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	5	Collector	sp	6.2
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	12	Filterer	cn	5.7
Insecta	Diptera	Simuliidae	Simulium	Simulium	P	1	Filterer	cn	5.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	1	Scraper	cn	7.1

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	1	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	12	Predator	sp	6.7
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	1	Shredder	bu	6.7
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	2	Collector	cn	8.4

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	3	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	3	Predator	sp, bu	3.6
Insecta	Odonata	Cordulegastridae	Cordulegaster	Cordulegaster	I	2	Predator	bu	2.4
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	3	Collector	sp	4.1
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	8	Collector	sp	6.7
Gastropoda	Basommatophora	Lymnaeidae	Fossaria	Fossaria	U	2	Scraper	cb	6.9
Insecta	Coleoptera	Hydrophilidae	not identified	Hydrophilidae	I	1	Collector	sw, dv	4.1
Insecta	Trichoptera	Limnephilidae	Ironoquia	Ironoquia	I	1	Shredder	sp	4.9
Insecta	Trichoptera	Psychomyiidae	Lype	Lype	I	1	Scraper	cn	4.7
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	2	Collector	cb, sp	2.1
Clitellata	Haplotaxida	Naididae	not identified	Naididae	U	1	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Natarsia	Natarsia	I	1	Predator	sp	6.6
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	1	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	P	1	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Paracladopelma	Paracladopelma	I	1	Collector	sp	6.6
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	4	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Phaenopsectra	Phaenopsectra	I	2	Collector	cn	8.7
Gastropoda	Basommatophora	Physidae	Physa	Physa	U	12	Scraper	cb	7
Bivalvia	Veneroida	Pisidiidae	Pisidium	Pisidium	U	5	Filterer	bu	5.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	11	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Potthastia	Potthastia	I	1	Omnivore	sp	0
Insecta	Diptera	Tipulidae	Pseudolimnophila	Pseudolimnophila	I	1	Predator	bu	2.8
Insecta	Coleoptera	Dytiscidae	Rhantus	Rhantus	I	1	Predator	sw	5.4
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	4	Collector	sp	6.2
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	32	Filterer	cn	5.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	1	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	3	Predator	sp	6.7
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	1	Shredder	bu	6.7
Insecta	Diptera	Tipulidae	not identified	Tipulidae	I	1	Predator	bu, sp	4.8
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	3	Collector	cn	8.4
Insecta	Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	I	2	Predator	sp	5.3

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	I	1	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	2	Filterer	cn	6.5
Insecta	Diptera	Chironomidae	not identified	Chironomini	I	1	Collector	bu	5.9
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	11	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	6	Collector	sp	5.9
Insecta	Trichoptera	Philopotamidae	Dolophilodes	Dolophilodes	I	1	Filterer	cn	1.7
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	3	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	4	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	1	Scraper	sp	7.2
Insecta	Trichoptera	Limnephilidae	Ironoquia	Ironoquia	I	1	Shredder	sp	4.9
Clitellata	Haplotaxida	Naididae	not identified	Naididae	U	10	Collector	bu	9.1
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	P	2	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	3	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	P	2	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	2	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Paratendipes	Paratendipes	I	1	Collector	bu	6.6
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	2	Collector	sp	6.2
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	35	Filterer	cn	5.7
Bivalvia	Veneroida	Pisidiidae	Sphaerium	Sphaerium	U	1	Collector	bu	5.5
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	1	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	Stenochironomus	Stenochironomus	I	2	Shredder	bu	7.9
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	4	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	1	Predator	sp	6.7
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	3	Collector	cn	8.4

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Coleoptera	Elmidae	Ancyronyx	Ancyronyx	A	1	Scraper	cn, sp	7.8
Insecta	Odonata	Coenagrionidae	Argia	Argia	I	2	Predator	cn, cb, sp	9.3
Insecta	Diptera	Ceratopogonidae	Atrichopogon	Atrichopogon	I	1	Predator	sp, cn	3.6
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	1	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	1	Filterer	cn	6.5
Insecta	Diptera	Chironomidae	Clinotanypus	Clinotanypus	I	1	Predator	bu	6.6
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	9	Collector	sp	6.7
Insecta	Coleoptera	Curculionidae	not identified	Curculionidae	U	1	Shredder	cn, cb	4.1
Crustacea	Amphipoda	Hyalellidae	Hyalella	Hyalella	U	6	Shredder	sp	4.2
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	1	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	1	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Paratendipes	Paratendipes	I	4	Collector	bu	6.6
Bivalvia	Veneroida	Pisidiidae	Pisidium	Pisidium	U	1	Filterer	bu	5.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	2	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	1	Collector	sp	5.1
Gastropoda	Heterostropha	Valvatidae	Valvata	Valvata	U	78	Scraper	na	9

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Coleoptera	Elmidae	Ancyronyx	Ancyronyx	I	3	Scraper	cn, sp	7.8
Insecta	Odonata	Coenagrionidae	Argia	Argia	I	6	Predator	cn, cb, sp	9.3
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	7	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	2	Predator	cb	8.3
Insecta	Diptera	Chironomidae	not identified	Chironomini	I	1	Collector	bu	5.9
Insecta	Coleoptera	Elmidae	Dubiraphia	Dubiraphia	I	2	Scraper	cn, cb	5.7
Insecta	Coleoptera	Elmidae	Dubiraphia	Dubiraphia	A	2	Scraper	cn, cb	5.7
Insecta	Coleoptera	Dytiscidae	not identified	Dytiscidae	I	1	Predator	sw, dv	5.4
Insecta	Ephemeroptera	Ephemerellidae	Eurylophella	Eurylophella	I	1	Scraper	cn, sp	4.5
Crustacea	Amphipoda	Gammaridae	Gammarus	Gammarus	U	1	Shredder	sp	6.7
Insecta	Coleoptera	Dryopidae	Helichus	Helichus	A	7	Scraper	cn	6.4
Crustacea	Amphipoda	Hyalellidae	Hyalella	Hyalella	U	2	Shredder	sp	4.2
Insecta	Odonata	Libellulidae	not identified	Libellulidae	I	2	Predator	na	9
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	1	Collector	bu	10
Insecta	Coleoptera	Dryopidae	Macronychus	Macronychus	A	1	Scraper	cn	6.8
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	37	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Paratendipes	Paratendipes	I	1	Collector	bu	6.6
Gastropoda	Basommatophor	Physidae	Physa	Physa	U	2	Scraper	cb	7
Bivalvia	Veneroida	Pisidiidae	Pisidium	Pisidium	U	7	Filterer	bu	5.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	2	Shredder	cb, cn	6.3
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	1	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	9	Scraper	cn	7.1
Insecta	Diptera	Chironomidae	not identified	Tanytarsini	I	1	Filterer	na	3.5
Insecta	Diptera	Chironomidae	Tribelos	Tribelos	I	5	Collector	bu	7
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	I	2	Collector	cn	8.4

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Odonata	Coenagrionidae	Argia	Argia	I	7	Predator	cn, cb, sp	9.3
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	3	Predator	cb	8.3
Insecta	Diptera	Chironomidae	not identified	Chironomini	I	3	Collector	bu	5.9
Insecta	Diptera	Chironomidae	Chironomus	Chironomus	I	1	Collector	bu	4.6
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	3	Collector	sp	6.7
Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	2	Shredder	cn, bu	9.6
Insecta	Diptera	not identified	not identified	Diptera	I	1	na	na	6
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	18	Collector	bu	9.1
Insecta	Odonata	Libellulidae	Erythemis	Erythemis	I	1	Predator	sp	7
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	2	Collector	sp	6.1
Insecta	Odonata	Coenagrionidae	Ischnura	Ischnura	I	3	Predator	cb	9
Insecta	Lepidoptera	not identified	not identified	Lepidoptera	U	4	Shredder	na	6.7
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	9	Collector	bu	10
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	1	Collector	cb, sp	2.1
Clitellata	Arhynchobdellida	Eropdellidae	Mooreobdella	Mooreobdella	U	3	Predator	sp	8
Clitellata	Haplotaxida	Naididae	not identified	Naididae	U	1	Collector	bu	9.1
Gastropoda	Basommatophor	Physidae	Physa	Physa	U	13	Scraper	cb	7
Bivalvia	Veneroida	Pisidiidae	not identified	Pisidiidae	U	1	Filterer	bu	5.5
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	U	5	Predator	na	7.3
Insecta	Diptera	Chironomidae	Smittia	Smittia	I	7	Collector	lentic	6.6
Insecta	Diptera	Chironomidae	Stenochironomus	Stenochironomus	I	1	Shredder	bu	7.9
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	18	Collector	cn	8.4

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Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	52	Collector	sp	2.6
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	1	Predator	sp, bu	3.6
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	1	Collector	sp	6.7
Insecta	Coleoptera	Curculionidae	not identified	Curculionidae	A	1	Shredder	cn, cb	4.1
Insecta	Coleoptera	Dytiscidae	not identified	Dytiscidae	I	3	Predator	sw, dv	5.4
Gastropoda	Basommatophor	Lymnaeidae	Fossaria	Fossaria	U	1	Scraper	cb	6.9
Crustacea	Amphipoda	Gammaridae	Gammarus	Gammarus	U	21	Shredder	sp	6.7
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	1	Scraper	sp	7.2
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	4	Collector	bu	10
Clitellata	Lumbriculada	Lumbriculidae	not identified	Lumbriculidae	U	21	Collector	bu	6.6
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	1	Collector	cb, sp	2.1
Insecta	Diptera	Tipulidae	Molophilus	Molophilus	I	1	Shredder	bu	4.8
Gastropoda	Basommatophor	Physidae	Physa	Physa	U	1	Scraper	cb	7
Insecta	Diptera	Chironomidae	Psectrocladius	Psectrocladius	I	1	Shredder	sp, bu	6.6
Insecta	Diptera	Psychodidae	Psychoda	Psychoda	I	1	Collector	bu	4
Bivalvia	Veneroida	Pisidiidae	Sphaerium	Sphaerium	U	1	Collector	bu	5.5
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	2	Collector	cn	8.4

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Insecta	Coleoptera	Elmidae	Ancyronyx	Ancyronyx	A	3	Scraper	cn, sp	7.8
Insecta	Coleoptera	Elmidae	Ancyronyx	Ancyronyx	I	2	Scraper	cn, sp	7.8
Insecta	Odonata	Aeshnidae	Boyeria	Boyeria	I	3	Predator	cb, sp	6.3
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	5	Predator	cb	8.3
Insecta	Trichoptera	Hydropsychidae	Ceratopsyche	Ceratopsyche	I	12	Filterer	cn	5
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	18	Filterer	cn	6.5
Insecta	Diptera	Chironomidae	not identified	Chironomidae	I	1	Collector	na	6.6
Hexapoda	Collembola	not identified	not identified	Collembola	A	1	Collector	sp, sk	6
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	3	Collector	sp	5.9
Insecta	Coleoptera	Scirtidae	Elodes	Elodes	I	1	Collector	cb, sp	4
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	2	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	2	Collector	sp	6.1
Crustacea	Amphipoda	Gammaridae	Gammarus	Gammarus	U	8	Shredder	sp	6.7
Insecta	Coleoptera	Dryopidae	Helichus	Helichus	A	4	Scraper	cn	6.4
Insecta	Lepidoptera	not identified	not identified	Lepidoptera	I	1	Shredder	na	6.7
Insecta	Megaloptera	Corydalidae	Nigronia	Nigronia	I	1	Predator	cn, cb	1.4
Gastropoda	Basommatophor	Physidae	Physa	Physa	U	28	Scraper	cb	7
Insecta	Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	I	2	Filterer	cn	1.1
Insecta	Diptera	Chironomidae	Psectrocladius	Psectrocladius	I	4	Shredder	sp, bu	6.6
Insecta	Trichoptera	Phryganeidae	Ptilostomis	Ptilostomis	I	1	Shredder	cb	4.3
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	2	Filterer	cn	5.7
Insecta	Diptera	Chironomidae	Smittia	Smittia	I	1	Collector	lentic	6.6
Insecta	Odonata	Corduliidae	Somatochlora	Somatochlora	I	1	Predator	sp	1
Insecta	Diptera	Chironomidae	Stenochironomus	Stenochironomus	I	7	Shredder	bu	7.9
Insecta	Diptera	Chironomidae	not identified	Tanypodinae	I	1	Predator	sp, sw	7.5
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	5	Predator	sp	6.7

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Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Crustacea	Amphipoda	not identified	not identified	Amphipoda	U	1	Collector	sp	6
Insecta	Odonata	Coenagrionidae	Argia	Argia	I	1	Predator	cn, cb, sp	9.3
Insecta	Odonata	Aeshnidae	Boyeria	Boyeria	I	2	Predator	cb, sp	6.3
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	1	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	4	Predator	cb	8.3
Insecta	Diptera	Chironomidae	Chironomus	Chironomus	I	4	Collector	bu	4.6
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	1	Collector	sp	6.7
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	1	Collector	sp	5.9
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	6	Collector	bu	9.1
Crustacea	Amphipoda	Gammaridae	Gammarus	Gammarus	U	4	Shredder	sp	6.7
Insecta	Odonata	Coenagrionidae	Ischnura	Ischnura	I	1	Predator	cb	9
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	1	Collector	bu	10
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	3	Collector	cb, sp	2.1
Insecta	Diptera	Tipulidae	Molophilus	Molophilus	I	1	Shredder	bu	4.8
Not Identified	not identified	not identified	not identified	Nematoda	U	1	Parasite	na	na
Insecta	Diptera	Chironomidae	Odontomesa	Odontomesa	I	1	Collector	sp	6.6
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	2	Collector	bu, sp	7.6
Bivalvia	Veneroida	Pisidiidae	Pisidium	Pisidium	I	5	Filterer	bu	5.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	2	Shredder	cb, cn	6.3
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	U	1	Predator	na	7.3
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	31	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	P	1	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Stenochironomus	Stenochironomus	I	5	Shredder	bu	7.9
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	8	Collector	cn	8.4

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Insecta	Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	I	2	Predator	sp	8.1
Crustacea	Amphipoda	not identified	not identified	Amphipoda	U	1	Collector	sp	6
Insecta	Odonata	Coenagrionidae	Argia	Argia	I	9	Predator	cn, cb, sp	9.3
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3
Insecta	Diptera	Chironomidae	not identified	Chironomidae	I	1	Collector	na	6.6
Insecta	Diptera	Chironomidae	not identified	Chironomini	I	1	Collector	bu	5.9
Insecta	Diptera	Chironomidae	Chironomus	Chironomus	I	2	Collector	bu	4.6
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	11	Collector	sp	6.7
Insecta	Diptera	Ceratopogonidae	Dasyhelea	Dasyhelea	I	1	Collector	sp	3.6
Insecta	Diptera	not identified	not identified	Diptera	P	1	na	na	6
Insecta	Coleoptera	Scirtidae	Elodes	Elodes	I	1	Collector	cb, sp	4
Insecta	Odonata	Coenagrionidae	Enallagma	Enallagma	I	1	Predator	cb	9
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	11	Collector	bu	9.1
Insecta	Coleoptera	Dryopidae	Helichus	Helichus	A	1	Scraper	cn	6.4
Insecta	Odonata	Coenagrionidae	Ischnura	Ischnura	I	1	Predator	cb	9
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	1	Collector	bu	10
Gastropoda	Basommatophor	Planorbidae	Menetus	Menetus	U	1	Scraper	cb	7.6
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	2	Collector	cb, sp	2.1
Insecta	Diptera	Stratiomyidae	Odontomyia	Odontomyia	I	3	Collector	sp	7
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	P	1	Collector	bu, sp	7.6
Gastropoda	Basommatophor	Physidae	Physa	Physa	U	1	Scraper	cb	7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Prodiamesa	Prodiamesa	I	1	Collector	bu, sp	6.6
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	10	Collector	sp	6.2
Insecta	Diptera	Chironomidae	not identified	Tanypodinae	P	1	Predator	sp, sw	7.5
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	19	Collector	cn	8.4

1 Life Stage; I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion; includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values; based on Hilsenhoff, modified for Maryland, na idicates information for the particular taxa was not available.

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	2	Shredder	bu, sp	7.4
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	38	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	2	Predator	cb	8.3
Insecta	Diptera	Chironomidae	not identified	Chironomidae	P	1	Collector	na	6.6
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	1	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	P	1	Collector	sp	4.1
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	7	Collector	sp	6.7
Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	1	Shredder	cn, bu	9.6
Insecta	Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	I	2	Filterer	cn	2.7
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	1	Collector	sp	5.9
Crustacea	Amphipoda	Gammaridae	Gammarus	Gammarus	U	1	Shredder	sp	6.7
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	4	Collector	cb, sp	2.1
Insecta	Trichoptera	Mollanidae	Molanna	Molanna	I	1	Scraper	sp, cn	6
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	P	3	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	2	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	2	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	P	1	Collector	sp, bu	9.2
Gastropoda	Basommatophor	Physidae	Physa	Physa	U	1	Scraper	cb	7
Bivalvia	Veneroida	Pisidiidae	Pisidium	Pisidium	U	19	Filterer	bu	5.7
Insecta	Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	I	1	Filterer	cn	1.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	2	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	9	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	4	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	3	Predator	sp	6.7
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	3	Collector	cn	8.4
Turbellaria	not identified	not identified	not identified	Turbellaria	U	1	Predator	sp	4

1 Life Stage; I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion; includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values; based on Hilsenhoff, modified for Maryland, na idicates information for the particular taxa was not available.

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	2	Collector	sp	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	3	Predator	cb	8.3
Insecta	Diptera	Chironomidae	Chironomus	Chironomus	I	1	Collector	bu	4.6
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	1	Collector	sp	4.1
Clitellata	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	U	2	Collector	bu	9.1
Insecta	Diptera	Tipulidae	Eriopterini	Eriopterini	I	1	na	na	4.8
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	1	Collector	sp	6.1
Crustacea	Amphipoda	Gammaridae	Gammarus	Gammarus	U	1	Shredder	sp	6.7
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	5	Scraper	sp	7.2
Clitellata	Haplotaxida	not identified	not identified	Lumbricina	U	1	Collector	bu	10
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	2	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	P	2	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	1	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	P	1	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	1	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Parachaetocladius	Parachaetocladius	I	3	Collector	sp	3.3
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	P	1	Collector	sp	4.6
Bivalvia	Veneroida	Pisidiidae	Pisidium	Pisidium	U	1	Filterer	bu	5.7
Gastropoda	Basommatophor	Planorbidae	Planorbella	Planorbella	U	1	Scraper	cb	7.6
Insecta	Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	I	2	Filterer	cn	1.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	5	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Prodiamesa	Prodiamesa	I	1	Collector	bu, sp	6.6
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	61	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Stenochironomus	Stenochironomus	I	1	Shredder	bu	7.9
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	3	Collector	sp	5.1

1 Life Stage; I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion; includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values; based on Hilsenhoff, modified for Maryland, na idicates information for the particular taxa was not available.

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Crustacea	Amphipoda	not identified	not identified	Amphipoda	U	1	Collector	sp	6
Insecta	Coleoptera	Elmidae	Ancyronyx	Ancyronyx	A	1	Scraper	cn, sp	7.8
Bivalvia	not identified	not identified	not identified	Bivalvia	U	1	Filterer	na	5.5
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	37	Collector	sp	2.6
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	1	Filterer	cn	6.5
Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	1	Shredder	cn, bu	9.6
Insecta	Diptera	Chironomidae	Cryptochironomus	Cryptochironomus	I	1	Predator	sp, bu	7.6
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	1	Collector	sp	5.9
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	2	Collector	sp	6.1
Crustacea	Amphipoda	Gammaridae	Gammarus	Gammarus	U	29	Shredder	sp	6.7
Insecta	Coleoptera	Dryopidae	Macronychus	Macronychus	I	5	Scraper	cn	6.8
Insecta	Coleoptera	Dryopidae	Macronychus	Macronychus	A	2	Scraper	cn	6.8
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	I	2	Collector	bu, sp	7.6
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	P	7	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	1	Collector	sp, bu	9.2
Gastropoda	Basommatophor	Physidae	Physa	Physa	U	2	Scraper	cb	7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	2	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	11	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	4	Predator	sp	6.7

1 Life Stage; I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion; includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values; based on Hilsenhoff, modified for Maryland, na idicates information for the particular taxa was not available.

Subphylum/Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Crustacea	Isopoda	Asellidae	Caecidotea	Caecidotea	U	6	Collector	sp	2.6
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	P	2	Predator	sp, bu	3.6
Insecta	Diptera	Ceratopogonidae	not identified	Ceratopogonidae	I	1	Predator	sp, bu	3.6
Insecta	Diptera	Chironomidae	not identified	Chironomini	I	2	Collector	bu	5.9
Insecta	Diptera	Tabanidae	Chrysops	Chrysops	I	1	Predator	sp, bu	2.9
Crustacea	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	U	77	Collector	sp	6.7
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	11	Collector	sp	5.9
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	1	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	P	1	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	1	Collector	sp, bu	9.2
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	1	Collector	sp	7.7
Bivalvia	Veneroida	Pisidiidae	Pisidium	Pisidium	U	1	Filterer	bu	5.7
Insecta	Diptera	Chironomidae	Pseudorthocladius	Pseudorthocladius	I	1	Collector	sp	6
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	3	Collector	sp	6.2
Insecta	Diptera	Ceratopogonidae	Serromyia	Serromyia	I	1	Predator	sp, bu	3.6
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	5	Filterer	cn	5.7
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Clitellata	Haplotaxida	Tubificidae	not identified	Tubificidae	U	2	Collector	cn	8.4

1 Life Stage; I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion; includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values; based on Hilsenhoff, modified for Maryland, na idicates information for the particular taxa was not available.

Appendix B: Bioassessment Results Map

Appendix C: QA/QC Procedures and Results

Appendix C: Quality Assurance/Quality Control Procedures and Results

The monitoring program for the Magothy River includes chemical, physical and biological assessment conducted throughout the watershed. The sampling methods used are compatible with the Sampling and Analysis Plan for Anne Arundel County Biological Monitoring (SAP) (Tetra Tech, 2005) and the Quality Assurance Project Plan (QAPP) for Anne Arundel County Biological Monitoring and Assessment Program (Tetra Tech, 2004). A summary of the Quality Assurance/Quality Control (QA/QC) procedures and results are included in this Appendix.

A quality assurance and quality control analysis was completed for the assessment work conducted in the Magothy watershed following the methods described by Hill et al. (2005). This analysis included performance characteristics of precision, accuracy, bias and completeness. Performance measures include:

- Precision (consistency) of field sampling and overall site assessments using intra-team site duplication
  - median relative percent difference (mRPD)
  - coefficient of variability (CV)
  - 90% confidence interval (CI)
- Bias of sample sorting and subsampling
  - percent sorting efficiency (PSE)
- Precision of taxonomic identification and enumeration
  - percent taxonomic disagreement (PTD)
  - percent difference in enumeration (PDE)
- Accuracy of data entry
  - number of errors/corrective actions
- Completeness
  - number of valid data points obtained as a proportion of those planned (Sampling and Analysis Plan, 2005).

Data that does not meet performance or acceptable criteria are re-evaluated to correct any problems or investigated further to determine the reason behind the results.

Field Sampling

All field crew leaders were recently trained in MBSS Spring Sampling protocols prior to the start of field sampling. All subjective scoring was completed with the input of all team members at the sampling site to reduce individual sampler bias.

Field water quality measurements were collected in-situ at all monitoring sites according to methods in the County QAPP. All in-situ parameters were measured with a YSI 6000 series multiprobe and the YSI650 data logging system except turbidity which was measured with a Hach 2100 Turbidimeter. Water quality equipment was regularly inspected, maintained and calibrated to ensure proper usage and accuracy of the readings. Calibration logs were kept by field crew leaders and checked by the project manager regularly.

Sample buckets contained internal and external labels. All chain-of-custody procedures were followed for transfer of the samples between the field and the identification lab.

Replicate (duplicate) samples were taken at ten percent of the overall sites (three sites). These QC samples were collected just upstream of the original sampling location to determine the consistency and repeatability of the sampling procedures and the intra-team adherence to those protocols. QC sites were field-selected rather than randomly selected to ensure that the QC sites maintained similar habitat conditions to the original site. Duplicate samples included collection and analysis of the benthic macroinvertebrate community, completion of the RBP and the PHI habitat assessments, and measurement of *in situ* water chemistry. Photographs were also taken at duplicate sites. Duplicate samples were collected at sites 10, 16, and 23.

Precision

Performance characteristics calculated for the consistency of field sampling and overall site assessments using intra-team site duplication were:

- Median Relative Percent Difference (mRPD)
- Coefficient of variability (CV)
- 90% Confidence Interval (CI)

Acceptable measurement quality objectives are listed in Table 1. DNR's MBSS protocols were used for the collection and analysis of macroinvertebrate data. In 2005, DNR updated their Benthic Index of Biotic Integrity (BIBI). These new metrics were used to calculate the BIBI presented in this report. The *Documentation of Method Performance Characteristics for the Anne Arundel County Biological Monitoring Program* (Hill et al. 2005) was completed using the original BIBI, and thus, does not include MQOs for all metrics used in the new BIBI. Therefore, provisional MQOs were used for those metrics (i.e., Number of Ephemeroptera Taxa , Percent Intolerant Urban, and Percent Climber) based on previous County approved MQOs (SAP, 2005).

Table 1 – Measurement Quality Objectives (Hill et al. 2005)

Attribute	MQO		
	Median RPD	CV	90% CI
Total Number of Taxa	<30	<20	±10
Number of EPT Taxa	<30	<20	±10
Number of Ephemeroptera Taxa	<30[1]	n/a	n/a
Percent Intolerant Urban	<30[1]	n/a	n/a
Percent Ephemeroptera	<30	<20	±10
Number of Scraper Taxa	<30	<70	±10
Percent Climber	<30[1]	n/a	n/a
B-IBI	<15	<10	±0.5

[1]Values derived from SAP (2005), n/a denotes not available

Results of performance characteristics using individual metric values are presented in Table 2. Results are shown for the sites where a duplicate sample (i.e., sample pair) was collected and analyzed (10, 16, and 23). Table 3 includes metric and BIBI scores and corresponding performance characteristics.

Table 2 – Individual Metric Values and Related Measures of Precision. Bold values exceed MQOs.

Site	Total Taxa	EPT Taxa	Ephem Taxa	% Intol Urban	% Ephem	Scraper Taxa	% Climbers
10	32	4	0	31.19	0.00	5	14.68
10-QC	33	5	2	8.26	4.96	4	14.88
16	31	5	0	11.43	0.00	5	26.67
16-QC	31	2	0	7.69	0.00	4	23.93
23	22	0	0	4.49	0.00	0	13.48
23-QC	20	0	0	2.33	0.00	3	10.47
CV	2.51	**35.36**	141.42	62.35	**141.42**	**33.67**	8.08
CI	1.16	1.55	0.77	11.15	1.92	1.93	2.30
mRPD	3.08	22.22	0.00	**63.60**	0.00	22.22	10.81

Table 3 –Metric and Index Scores and Related Measures of Precision. Bold values exceed MQOs.

Site	Total Taxa Score	EPT Taxa Score	Ephem Taxa Score	% Intol Urban Score	% Ephem Score	Scraper Taxa Score	% Climbers Score	BIBI Score
10	5	3	1	5	1	5	5	3.57
10-QC	5	5	5	1	3	5	5	4.14
16	5	5	1	3	1	5	5	3.57
16-QC	5	3	1	1	1	5	5	3.00
23	5	1	1	1	1	1	5	2.14
23-QC	3	1	1	1	1	5	5	2.43
CV	10.10	31.43	**56.57**	70.71	**35.36**	21.76	0	**10.71**
CI	0.77	1.55	1.55	2.32	0.77	1.55	0	**0.55**
mRPD	0.00	**50.00**	0.00	**100.00**	0.00	0.00	0	14.81

Both metric values and metric scores were compared to MQOs to determine exceedances. Only one metric value, Percent Intolerant Urban, exceeded the MQO for mRPD, due to fairly broad differences observed between sample pairs 10 and 16. While a broad difference in the percentage of intolerant individuals was observed for sample pair 10, a closer inspection of the intolerant taxa yielded greater similarity; both samples had seven taxa, only two of which were different. Two metric scores (i.e., Percent Intolerant Urban, and EPT Taxa) also exceeded the MQO for mRPD. Although the EPT Taxa values were very similar for sample pair 10 (4 and 5, respectively), they fell on either side of the scoring threshold (3 and 5, respectively), resulting in a larger difference between scores than actual measurement values. No metrics exceeded MQOs for the 90% CI, however, the BIBI index score did exceed the MQO for CI (0.5) by a very small margin (0.55). Several metric values (EPT Taxa and Percent Ephemeroptera Taxa) and metric/index scores (Number of Ephemeroptera Taxa, Percent Ephemeroptera Taxa, BIBI) exceeded the MQO for CV. Most of this variability can be attributed to the difference in Ephemeroptera taxa and percent abundance between one sample pair (10). Since the new BIBI relies quite heavily on the sensitive taxa Ephemeroptera for three of seven total metrics, small differences in this taxa alone can influence the variability of the entire BIBI. It should also be noted that both of these samples (10 and 10-QC) were subsampled post identification using the random subsampling routine described below, and that greater variability was observed in the sample pair following this procedure. A close examination of the original samples showed greater precision for a number of metrics and scores (Tables 4 and 5). More importantly, the overall BIBI scores showed considerably less variability and all precision measures for CV and CI fell within acceptable MQO ranges. Therefore, it is likely that a large portion of observed variability in metric scores and values can be attributed to subsampling procedures rather than field sampling procedures.

Table 4 –Individual Metric Values Prior to Subsampling (Sites 10 and 10 QC) and Revised Measures of Precision. Highlighted cells indicate updated values; bold values exceed MQOs.

Site	Total Taxa	EPT Taxa	Ephem Taxa	% Intol Urban	% Ephem	Scraper Taxa	% Climbers
10	34	5	1	30.0	0.77	6	16.9
10-QC	36	5	2	7.69	4.20	4	14.7
16	31	5	0	17.22	0	5	26.7
16-QC	31	2	0	7.69	0	4	23.9
23	22	0	0	4.49	0	0	13.5
23-QC	20	0	0	2.33	0	3	10.5
CV	3.25	**24.96**	47.14	61.11	**97.60**	38.57	10.65
CI	1.55	1.16	0.39	12.06	1.32	2.32	3.09
mRPD	5.71	0.00	0.00	**63.60**	0.00	**40.00**	14.16

Table 5 –Metric and Index Scores Prior to Subsampling (Sites 10 and 10 QC) and Revised Measures of Precision. Highlighted cells indicate updated scores; bold values exceed MQOs.

Site	Total Taxa Score	EPT Taxa Score	Ephem Taxa Score	% Intol Urban Score	% Ephem Score	Scraper Taxa Score	% Climbers Score	BIBI Score
10	5	5	3	5	1	5	5	4.14
10-QC	5	5	5	1	3	5	5	4.14
16	5	5	1	3	1	5	5	3.57
16-QC	5	3	1	1	1	5	5	3.00
23	5	1	1	1	1	1	5	2.14
23-QC	3	1	1	1	1	5	5	2.43
CV	10.10	14.14	23.57	70.71	**35.36**	21.76	0.00	6.24
CI	0.77	0.77	0.77	2.32	0.77	1.55	0.00	0.33
mRPD	0.00	0.00	0.00	**100.00**	0.00	0.00	0.00	12.50

Completeness

One hundred percent of the sampling effort was used at each of the sites samples, resulting in all field sampling data being complete.

Laboratory Sorting and Subsampling

Bias

All sorting was completed by Environmental Services and Consulting, LLC following the MBSS procedures and the QAPP. For these samples 10 percent (three samples) underwent quality control procedures for sorting. Table 4 shows the results of the sorting quality control checks. All samples passed the stated MQO of >90% for PSE.

Table 4 – Percent Sorting Efficiencies (PSE) Per Sample.

Sample	Organisms Found by Primary Sorter	Organisms Found in QC Check	Total No. of Organisms	Percent Sorting Efficiency
2683-A	161	4	165	97.6
2704-A	162	1	163	99.4
2713-A	138	2	140	98.6

Subsampling was conducted for those sites with greater than 120 organisms sorted and identified. A post-processing subsampling was conducted using a spreadsheet based method (Tetra Tech, 2006). This post-processing randomly subsamples the identified organisms to a desired target number for the sample. Each taxon is subsampled based on its original proportion to the entire sample. In this case, the desired sample size selected was 110 individuals. This allows for a final sample size of approximately 110 individuals (±20%) but keeps the total number of individuals below the 120 maximum.

Taxonomic Identification and Enumeration

Samples for sites 7, 25, and 27 were randomly selected for QC identification and enumeration by an independent lab. Original identification was completed by Environmental Services and Consulting, LLC[1] (ESC). Re-identification of the randomly selected sites was done by EcoAnalysts, Inc[2]. Each sample was identified to the genus level where possible. Individuals that were not able to be identified to genus level were identified to the lowest possible level, usually family, but in some cases order. For Chironomidae, individuals not identifiable to genus may have been identified to subfamily or tribe level.

Precision

Measures of precision were calculated for the identification consistency between the two randomly selected samples. These include percent difference in enumeration (PDE) and percent taxonomic disagreement (PTD).

The PDE compares the final specimen counts between the two taxonomy labs, whereas PTD compares the number of agreements in final specimen identifications between the two taxonomic labs. To meet required MQOs set by the QAPP, the PDE for each sample must be equal to or less than 5% , and the PTD must be equal to or less than 15%. Results for the taxonomic comparison and resulting values for PDE and PTD are found in Table 4.

The PDE was below the MQO value of 5% for all three samples. PTD was below the MQO value of 15% for samples 07 and 25. For sample 27, however, there was a single discrepancy between laboratories concerning the final identification of an abundant amphipod, which resulted in a considerably elevated PTD of 65.6% that exceeds the MQO. The primary taxonomic laboratory, ESC, identified 151 amphipods as *Crangonyx* (Order: Amphipoda, Family: Crangonyctidae)

[1] Address: 101 Professional Park Drive, STE 303, Blacksburg, VA
[2] Address: 105 East 2nd St.Suite 1, Moscow, ID

while EcoAnalysts identified 143 amphipods as *Gammarus* (Order: Amphipoda, Family: Gammaridae). *Crangonyx* and *Gammarus*, both in Order Amphipoda, are very similar morphologically and have the same habit (sprawler) and tolerance value (6.7). Correcting this single, albeit large, discrepancy would reduce the PTD significantly and would put the sample below the acceptable limit of 15%. To resolve this discrepancy, KCI requested that each laboratory take a second look at the questionable amphipods to verify initial identifications. Upon closer inspection, it was determined by both laboratories that the amphipods in question belonged to a different genus altogether, *Synurella* (Order: Amphipoda, Family: Crangonyctidae), which is commonly referred to as the Coastal Swamp Amphipod. *Synurella* is a much less commonly encountered genus typically found in coastal wetland and swamp habitats, but is very similar morphologically to the more commonly found amphipods *Crangonxy* and *Gammarus*. EcoAnalysts re-identified all 143 individuals as belonging to genus *Synurella,* while ESC identified 35 to the species level as *Synurella chamberlaini*, and the remaining 116 to the family level (Crangonyctidae) due to that the fact that those specimens were either too immature or damaged for positive identification at the genus level. Although, the specimens in question were identified to different hierarchical levels (i.e., Family, Genus, and Species), all were considered to be in agreement. It was ultimately decided that the more conservative final identification by ESC would be used for metric and BIBI score calculations.

Following the corrective actions to resolve the taxonomic discrepancy for sample 27, the PTD was reduced from 65.6% to 1.8%, which is below the acceptable limit of 15%. However, it should be noted that the updated identification resulted in a change in the metric score for percent intolerant to urban from 5.9% to 16.1% and a shift in the overall BIBI score from 1.6 to 1.9, due to *Synurella* having a significantly lower tolerance value (0.4) than either *Crangonyx* (6.7) or *Gammarus* (6.7). Nonetheless, the final biological rating for this site did not change from the original rating of ‘very poor’ prior to this exercise.

Data Entry

Accuracy

All data entered into EDAS, Excel, or any other program used for site analysis were reviewed and checked for entry error. Table 5 shows the percent error for each data type entered into the database. All errors were corrected and the database was deemed to be 100% accurate. Additionally all metric calculations were checked. Any errors found were corrected.

Table 5 – Percent Error for Database Entries.

Data Type	No. of Entries	No. of Errors	% Error
Water Chemistry	178	5	2.81
Habitat	767	3	0.39
Physical Characteristics	748	3	0.40
Benthic Macroinvertebrates	842	2	0.24

Table 3 - Taxonomic Identification and Enumeration Results

Order	Family	Subfamily	Tribe	EcoAnalysts Sample ID	Site 7			Site 25			Site 27		
					ES&C, LLC	EcoAnalysts, Inc.	# of agreements	ES&C, LLC	EcoAnalysts, Inc.	# of agreements	ES&C, LLC.	EcoAnalysts, Inc.	# of agreements
Odonata	Calopterygidae			Calopteryx sp.	0	0	0	3	3	3	0	0	0
	Ceratopogonidae			Ceratopogoninae	1	0	0	0	0	0	6	6	6
	Coenagrionidae			Ischnura sp.	1	1	1	0	0	0	0	0	0
Diptera	Chironomidae	Orthocladiinae		Chaetocladius sp.	0	0	0	0	5	0	0	0	0
	Chaoboridae			Chaoboridae	0	0	0	0	0	0	1	0	0
	Chironomidae	Chironominae	Chironomini	Chironomini	0	0	0	0	0	0	3	0	0
	Chironomidae	Chironominae	Chironomini	Chironomus sp.	3	3	3	1	1	1	2	5	5**
	Tabanidae			Chrysops	0	0	0	0	0	0	2	0	2
	Chironomidae	Orthocladiinae		Corynoneura sp.	0	0	0	1	1	1	0	0	0
	Chironomidae	Orthocladiinae		Cricotopus sp.	0	0	0	0	1	0	0	0	0
	Chironomidae	Orthocladiinae		Diplocladius sp.	1	1	1	0	1	0	22	22	22
	Dixidae			Dixidae	0	0	0	0	0	0	0	1	0
	Tipulidae			Erioptera sp.	0	0	0	0	1	0	0	0	0
	Tipulidae			Eriopterini	0	0	0	1	0	1**	0	0	0
	Chironomidae	Orthocladiinae		Eukiefferiella sp.	0	1	0	1	1	1	0	0	0
	Chironomidae	Orthocladiinae		Hydrobaenus sp.	1	0	0	5	0	0	3	3	3
	Chironomidae	Chironominae	Tanytarsini	Micropsectra sp.	0	0	0	2	2	2	1	1	1
	Stratiomyidae	Stratiomyinae	Prosopochrysini	Myxosargus sp.	1	1	1	0	0	0	0	0	0
	Chironomidae	Orthocladiinae		Nanocladius sp.	0	0	0	0	0	0	1	1	1
	Chironomidae	Orthocladiinae		Orthocladiinae	1	0	0	3	1	1	0	0	0
				Orthocladius Complex	0	1	1	0	0	0	0	0	0
	Chironomidae	Orthocladiinae		Orthocladius sp.	1	0	0	2	0	0	3	2	2
	Chironomidae	Orthocladiinae		Parachaetocladius	0	0	0	3	0	0	0	0	0
	Chironomidae	Orthocladiinae		Parametriocnemus sp.	0	0	0	1	2	1	0	0	0
	Chironomidae	Orthocladiinae		Paraphaenocladius sp.	0	1	0	0	0	0	0	0	0
	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus sp.	0	0	0	0	0	0	1	1	1
	Chironomidae	Chironominae	Chironomini	Paratendipes	1	0	0	0	0	0	0	0	0
	Chironomidae	Chironominae	Chironomini	Polypedilum sp.	10	10	10	5	5	5	0	0	0
	Chironomidae	Prodiamesinae		Prodiamesa sp.	0	0	0	1	1	1	0	0	0
	Chironomidae	Orthocladiinae		Psectrocladius	0	0	0	0	0	0	1	0	0
	Chironomidae	Orthocladiinae		Pseudorthocladius sp.	0	0	0	0	2	0	1	1	1
	Chironomidae	Orthocladiinae		Rheocricotopus sp.	0	0	0	61	63	61	3	5	3
	Chironomidae	Chironominae	Tanytarsini	Rheotanytarsus sp.	1	1	1	0	0	0	0	0	0
	Ceratopogonidae			Serromyia	0	0	0	0	0	0	1	0	0
	Simuliidae			Simulium sp.	15	15	15	0	0	0	9	9	9
	Chironomidae	Chironominae	Chironomini	Stenochironomus sp.	0	0	0	1	1	1	0	0	0
	Chironomidae	Chironominae	Tanytarsini	Tanytarsus sp.	0	0	0	0	0	0	1	1	1
	Chironomidae	Orthocladiinae		Thienemanniella sp.	0	0	0	3	3	3	0	0	0
	Chironomidae	Tanypodinae	Pentaneurini	Thienemannimyia gr. sp.	4	4	4	0	0	0	0	0	0
Trichoptera	Polycentropodidae			Polycentropus sp.	0	0	0	2	2	2	0	0	0
	Tabanidae			Tabanidae	0	0	0	0	0	0	0	2	0
Gastropoda	Planorbidae			Helisoma anceps	0	0	0	0	1	1**	0	0	0
	Planorbidae			Planorbella	0	0	0	1	0	0	0	0	0
Bivalvia	Sphaeriidae			Pisidiidae	21	0	0	0	0	0	8	0	0

Order	Family	Subfamily	Tribe	Final ID	Site 7 ES&C, LLC	Site 7 EcoAnalysts, Inc.	Site 7 # of agreements	Site 25 ES&C, LLC	Site 25 EcoAnalysts, Inc.	Site 25 # of agreements	Site 27 ES&C, LLC.	Site 27 EcoAnalysts, Inc.	Site 27 # of agreements
Bivalvia	Pisidiidae			Pisidium sp.	6	25	25	1	1	1	2	10	10
Annelida	Enchytraeidae			Enchytraeidae	1	2	1	2	2	2	0	0	0
				Lumbricina	0	0	0	1	1	1	0	0	0
	Tubificidae			Tubificidae	8	8	8	0	0	0	2	1	1
Isopoda	Asellidae			Caecidotea sp.	88	84	84	2	2	2	9	10	9
	Crangonyctidae			Crangonyctidae	0	0	0	0	0	0	116	0	0
	Crangonyctidae			Synurella	0	0	0	0	0	0	0	143	143**
	Crangonyctidae			Synurella chamberlaini	0	0	0	0	0	0	35	0	0
	Gammaridae			Gammarus sp.	0	0	0	1	1	1	0	0	0
				Total	165	158	155	104	104	92	233	224	220
				PDE			2.17			0.00			1.97
				PTD			1.90			11.54			1.79

* Data are not adjusted for subsampling
** Data are adjusted for SubFamily / Tribe/Species ID's

Appendix D: Site Photographs

Biological Assessment Photos

MAGO_01_02 Facing downstream at the midpoint of reach

MAGO_01_06 Facing upstream at the upstream end of reach

MAGO_02_02 Facing downstream at the midpoint of reach

MAGO_02_06 Facing upstream at the upstream end of reach

Biological Assessment Photos

MAGO_03_01 Facing downstream at the downstream end of reach

MAGO_03_06 Facing upstream at the upstream end of reach

MAGO_04_01 Facing downstream at the downstream end of reach

MAGO_04_06 Facing upstream at the upstream end of reach

Biological Assessment Photos

MAGO_05_01 Facing downstream at the downstream end of reach

MAGO_05_06 Facing upstream at the midpoint of reach

MAGO_06_03 Facing downstream at upstream end of reach

MAGO_06_05 Facing upstream at midpoint of reach

Biological Assessment Photos

MAGO_07_02 Facing downstream at midpoint of reach

MAGO_07_05 Facing upstream at midpoint of reach

MAGO_08_01 Facing downstream at downstream end of reach

MAGO_08_05 Facing upstream at the midpoint of reach

Biological Assessment Photos

MAGO_09_01 Facing downstream at the downstream end of reach

MAGO_09_06 Facing upstream at the upstream end of reach

MAGO_10_03 Facing downstream at the upstream end of reach

MAGO_10_04 Facing upstream at the downstream end of reach

Biological Assessment Photos

MAGO_10dup_04 Facing downstream at the upstream end of reach

MAGO_10dup_06 Facing upstream at the midpoint of reach

MAGO_11_01 Facing downstream at the downstream end of reach

MAGO_11_04 Facing upstream at the downstream end of reach

Biological Assessment Photos

MAGO_12_01 Facing downstream at the downstream end of reach

MAGO_12_07 Facing upstream at the upstream end of reach

MAGO_13_03 Facing downstream at the upstream end of reach

MAGO_13_06 Facing upstream at the upstream end of reach

Biological Assessment Photos

MAGO_14_02 Facing downstream at the midpoint of reach

MAGO_14_05 Facing upstream at the midpoint of reach

MAGO_15_02 Facing downstream at the midpoint of reach

MAGO_15_05 Facing upstream at the midpoint of reach

Biological Assessment Photos

MAGO_16_03 Facing downstream at the midpoint of reach

MAGO_16_02 Facing upstream at the downstream end of reach

MAGO_16dup_03 Facing downstream at the midpoint of reach

MAGO_16dup_05 Facing upstream at the midpoint of reach

Biological Assessment Photos

MAGO_17_03 Facing downstream at the downstream end of reach

MAGO_17_06 Facing upstream at the upstream end of reach

MAGO_18_01 Facing downstream at the downstream end of reach

MAGO_18_05 Facing upstream at the midpoint of reach

Biological Assessment Photos

MAGO_19_02 Facing downstream at the midpoint of reach

MAGO_19_06 Facing upstream at the upstream end of reach

MAGO_20_01 Facing downstream at the downstream end of reach

MAGO_20_08 Facing upstream at the midpoint of reach

Biological Assessment Photos

MAGO_21_01 Facing downstream at the downstream end of reach

MAGO_21_05 Facing upstream at the midpoint of reach

MAGO_22_02 Facing downstream at the midpoint of reach

MAGO_22_03 Facing upstream at the downstream end of reach

Biological Assessment Photos

MAGO_23_02 Facing downstream at the midpoint of reach

MAGO_23_06 Facing upstream at the upstream end of reach

MAGO_23dup_01 Facing downstream at the downstream end of reach

MAGO_23dup_05 Facing upstream at the midpoint of reach

Biological Assessment Photos

MAGO_24_01 Facing downstream at the downstream end of reach

MAGO_24_05 Facing upstream at the midpoint of reach

MAGO_25_02 Facing downstream at the midpoint of reach

MAGO_25_06 Facing upstream at the upstream end of reach

Biological Assessment Photos

MAGO_26_01 Facing downstream at the downstream end of reach

MAGO_26_05 Facing upstream at the midpoint of reach

MAGO_27_02 Facing downstream at the midpoint of reach

MAGO_27_05 Facing upstream at the midpoint of reach

KCI

KCI Technologies, Inc.
10 North Park Drive
Hunt Valley, Maryland 21030

APPENDIX C – PRIORITY PARCELS FOR PRESERVATION

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Table C.1 – Top 200 Parcel Priorities for Preservation

Rank	Study Parcel ID	Sub-watershed	Area (acres)	Ranking Score	Address	City
1	25933	MGI	14.5	62.0	1137 FERBER AVE	ARNOLD
2	8208	MG1	2.7	60.0	OAKWOOD RD	MILLERSVILLE
3	17459	MGI	0.6	59.0	COLLEGE PKW	ARNOLD
4	20470	MGH	1.0	59.0	JONES STATION RD	ARNOLD
5	34345	MGH	2.1	59.0	JONES STATION RD	ARNOLD
6	28017	MGI	29.0	59.0	RITCHIE HWY	ARNOLD
7	23995	MRM	321.4	59.0	ROMANY RD	GIBSON ISLAND
8	30171	MGV	0.2	59.0	1306 YORKTOWN RD	ANNAPOLIS
9	25314	MGI	13.5	59.0	1379 RITCHIE HWY	ARNOLD
10	13597	MRG	72.8	59.0	263 EAGLE HILL RD	PASADENA
11	35369	MGT	2.9	58.0		
12	13967	MR7	0.2	58.0	BALTIMORE ANNAPOLIS BLV	PASADENA
13	35073	MGV	22.3	58.0	BAY HEAD RD	ANNAPOLIS
14	26377	MGI	2.0	58.0	COLLINGTON CT	ARNOLD
15	12539	MR0	19.5	58.0	MOUNTAIN RD	PASADENA
16	21215	MGL	14.0	58.0	RESIDUE AREA	ARNOLD
17	25487	MGI	1.9	58.0	RITCHIE HWY	ARNOLD
18	519	MR3	13.7	58.0	8134 JUMPERS HOLE RD	MILLERSVILLE
19	35780	MGP	57.1	58.0	965 BAYBERRY DR	ARNOLD
20	36	MR3	2.5	57.4	75 WISHING ROCK RD	PASADENA
21	35411	MGT	26.1	57.0		
22	26546	MGT	2.3	57.0	BROADNECK RD	ANNAPOLIS
23	27788	MGT	10.3	57.0	COLLEGE PKW	ARNOLD
24	15930	MGH	12.4	57.0	JONES STATION RD	ARNOLD
25	32670	MRE	0.1	57.0	MARYLAND AVE	PASADENA
26	33272	MRE	0.1	57.0	MARYLAND AVE	PASADENA
27	33334	MRE	0.1	57.0	MARYLAND AVE	PASADENA
28	33411	MRE	0.1	57.0	MARYLAND AVE	PASADENA
29	4897	MG1	0.6	57.0	OBRECHT RD	MILLERSVILLE
30	6144	MR3	19.4	57.0	42 ARCADA RD	PASADENA
31	21964	MGT	10.9	57.0	551 COLLEGE PKY	ARNOLD
32	25513	MGT	1.2	57.0	583 SHORE ACRES RD	ARNOLD

Table C.1 – Top 200 Parcel Priorities for Preservation

Rank	Study Parcel ID	Sub-watershed	Area (acres)	Ranking Score	Address	City
33	20058	MGC	8.9	57.0	701 RITCHIE HWY	SEVERNA PARK
34	15677	MGC	4.2	57.0	731 BALTIMORE-ANNAPOLIS BLV	SEVERNA PARK
35	6799	MG1	6.5	57.0	8280 BROOKWOOD RD	MILLERSVILLE
36	27618	MGI	2.3	56.0		
37	26607	MGI	1.1	56.0		
38	28703	MGI	1.2	56.0	GREEN VALLEY RD	ARNOLD
39	25441	MGI	9.9	56.0	JOYCE LN	ARNOLD
40	12264	MGY	6.8	56.0	MOUNTAIN RD	PASADENA
41	8209	MG1	19.2	56.0	OAKWOOD RD	MILLERSVILLE
42	26609	MGL	6.6	56.0	REC AREA	ARNOLD
43	35660	MRO	7.8	56.0	RITCHIE HWY	PASADENA
44	26645	MGI	1.7	56.0	RITCHIE HWY	ARNOLD
45	30947	MGV	2.1	56.0	1400 STEPNEY RD	ANNAPOLIS
46	27624	MGI	1.1	56.0	1407 RITCHIE HWY	ARNOLD
47	24994	MGI	0.2	56.0	1438 RITCHIE HWY	ARNOLD
48	8206	MG1	0.2	56.0	402 OBRECHT RD	MILLERSVILLE
49	27123	MGI	3.6	56.0	459 COLLEGE PKW	ARNOLD
50	10716	MGY	0.3	56.0	808 WOODS RD	PASADENA
51	6949	MG1	1.2	56.0	8305 WOODLAND RD	MILLERSVILLE
52	3324	MRA	0.6	55.0		MILLERSVILLE
53	34712	MGY	0.9	55.0		
54	16118	MGI	0.3	55.0		
55	34343	MGH	4.4	55.0	MANHATTAN BEACH RD	SEVERNA PARK
56	34567	MRG	383.2	55.0	MOUNTAIN RD	PASADENA
57	15056	MR0	20.6	55.0	MOUNTAIN RD	PASADENA
58	6187	MRA	0.1	55.0	OPAR LN	MILLERSVILLE
59	3955	MRA	0.1	55.0	OPAR LN	MILLERSVILLE
60	4438	MRA	0.1	55.0	OPAR LN	SEVERNA PARK
61	6344	MRA	0.1	55.0	OPAR LN	SEVERNA PARK
62	5499	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
63	3275	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
64	4218	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE

Table C.1 – Top 200 Parcel Priorities for Preservation

Rank	Study Parcel ID	Sub-watershed	Area (acres)	Ranking Score	Address	City
65	3934	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
66	4883	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
67	7445	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
68	689	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
69	7253	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
70	4410	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
71	4110	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
72	7471	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
73	3516	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
74	4147	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
75	7278	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
76	8182	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
77	6648	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
78	6606	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
79	5815	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
80	5394	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
81	4618	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
82	3546	MRA	0.1	55.0	OVERLEA DR	MILLERSVILLE
83	5395	MRA	0.0	55.0	OVERLEA DR	MILLERSVILLE
84	7987	MRA	0.0	55.0	OVERLEA DR	MILLERSVILLE
85	25888	MGI	2.2	55.0	RITCHIE HWY	ARNOLD
86	4160	MRA	0.4	55.0	SILVERLOCH CT	MILLERSVILLE
87	7556	MRA	0.6	55.0	SILVERLOCH CT	MILLERSVILLE
88	7558	MRA	0.2	55.0	SYLVAN AVE	SEVERNA PARK
89	3558	MRA	0.3	55.0	SYLVAN RD	SEVERNA PARK
90	8170	MRA	0.1	55.0	SYLVAN RD	SEVERNA PARK
91	5149	MRA	0.1	55.0	SYLVAN RD	SEVERNA PARK
92	5152	MRA	0.1	55.0	SYLVAN RD	SEVERNA PARK
93	3940	MRA	0.1	55.0	SYLVAN RD	SEVERNA PARK
94	7926	MRA	0.1	55.0	SYLVAN RD	SEVERNA PARK
95	7523	MRA	0.1	55.0	SYLVAN RD	SEVERNA PARK
96	4576	MRA	0.1	55.0	SYLVAN RD	SEVERNA PARK

Table C.1 – Top 200 Parcel Priorities for Preservation

Rank	Study Parcel ID	Sub-watershed	Area (acres)	Ranking Score	Address	City
97	4270	MRA	0.1	55.0	SYLVAN RD	SEVERNA PARK
98	4373	MRA	0.1	55.0	105 SYLVAN DR	SEVERNA PARK
99	7988	MRA	0.1	55.0	105 SYLVAN DR	SEVERNA PARK
100	23560	MGH	11.1	55.0	1097 BALTIMORE-ANNAPOLIS BLV	ARNOLD
101	25942	MGI	0.6	55.0	1258 TIMBER TURN	ARNOLD
102	25971	MGI	2.1	55.0	1270 HARDY RD	ARNOLD
103	26062	MGI	0.4	55.0	1294 CIRCLE DR	ARNOLD
104	28201	MGI	0.3	55.0	1295 CIRCLE DR	ARNOLD
105	6332	MRA	0.1	55.0	134 OVERLEA DR	MILLERSVILLE
106	4316	MRA	0.1	55.0	134 OVERLEA DR	MILLERSVILLE
107	4269	MRA	0.1	55.0	138 OVERLEA DR	MILLERSVILLE
108	4575	MRA	0.1	55.0	138 OVERLEA DR	MILLERSVILLE
109	5668	MRA	0.1	55.0	1965 OVERLEA DR	SEVERNA PARK
110	7388	MRA	0.1	55.0	1965 OVERLEA DR	SEVERNA PARK
111	6212	MRA	0.1	55.0	1965 OVERLEA DR	SEVERNA PARK
112	5148	MRA	0.1	55.0	1965 OVERLEA DR	SEVERNA PARK
113	7414	MRA	0.1	55.0	1965 OVERLEA DR	SEVERNA PARK
114	7623	MRA	0.1	55.0	1965 OVERLEA DR	SEVERNA PARK
115	7446	MRA	0.1	55.0	1965 OVERLEA DR	SEVERNA PARK
116	3950	MRA	0.1	55.0	1965 OVERLEA DR	SEVERNA PARK
117	4631	MRA	0.1	55.0	1965 OVERLEA DR	SEVERNA PARK
118	1088	MR3	22.4	55.0	201 EMBER DR	PASADENA
119	5255	MRA	1.8	55.0	251 JUMPERS HOLE RD	MILLERSVILLE
120	33255	MRE	0.1	55.0	321 VIRGINIA AVE	PASADENA
121	32707	MRE	0.1	55.0	321 VIRGINIA AVE	PASADENA
122	33505	MRE	0.1	55.0	321 VIRGINIA AVE	PASADENA
123	33494	MRE	0.1	55.0	321 VIRGINIA AVE	PASADENA
124	32064	MRE	0.1	55.0	321 VIRGINIA AVE	PASADENA
125	31586	MRE	0.1	55.0	329 NORTH CAROLINA AVE	PASADENA
126	12954	MRL	11.3	55.0	485 LAKE SHORE DR	PASADENA
127	16266	MGC	3.8	55.0	700 RITCHIE HWY	SEVERNA PARK
128	35561	MGY	1.0	55.0	86 CORNISH LN	PASADENA

Table C.1 – Top 200 Parcel Priorities for Preservation

Rank	Study Parcel ID	Sub-watershed	Area (acres)	Ranking Score	Address	City
129	34594	MRO	0.2	54.0		
130	34593	MRO	0.2	54.0		
131	34602	MRO	0.3	54.0		
132	34710	MGY	0.6	54.0		
133	12741	MR7	0.1	54.0	BALTIMORE ANNAPOLIS BLV	PASADENA
134	5067	MRO	0.1	54.0	CLARENCE AVE	SEVERNA PARK
135	3547	MRO	0.1	54.0	CLARENCE AVE	SEVERNA PARK
136	5747	MRO	0.1	54.0	CLARENCE AVE	SEVERNA PARK
137	6978	MRO	0.1	54.0	CLARENCE AVE	SEVERNA PARK
138	5243	MRO	0.1	54.0	CLARENCE AVE	SEVERNA PARK
139	7064	MRO	0.1	54.0	CLARENCE AVE	SEVERNA PARK
140	7038	MRO	1.8	54.0	JENNINGS RD	SEVERNA PARK
141	8103	MRO	1.9	54.0	JENNINGS RD	SEVERNA PARK
142	207	MR3	0.4	54.0	LONG HILL RD	PASADENA
143	15101	MRE	166.9	54.0	NORTH SHORE RD	PASADENA
144	6465	MRO	0.1	54.0	PINEVIEW AVE	SEVERNA PARK
145	5869	MRO	0.1	54.0	PINEVIEW AVE	SEVERNA PARK
146	10062	MRG	2.6	54.0	RECREATION AREA	PASADENA
147	19549	MGI	5.9	54.0	RECREATION AREA	ARNOLD
148	19683	MGH	0.4	54.0	RITCHIE HWY	ARNOLD
149	16085	MRO	0.1	54.0	ROAD BEDS	SEVERNA PARK
150	16653	MRO	0.1	54.0	ROAD BEDS	SEVERNA PARK
151	3911	MRO	0.1	54.0	SABRINA LN	SEVERNA PARK
152	8050	MRO	0.1	54.0	SABRINA LN	SEVERNA PARK
153	8108	MRO	0.1	54.0	SABRINA LN	SEVERNA PARK
154	7526	MRO	0.1	54.0	SABRINA LN	SEVERNA PARK
155	3787	MRO	0.1	54.0	SABRINA LN	SEVERNA PARK
156	7975	MRO	0.1	54.0	SABRINA LN	SEVERNA PARK
157	8180	MRO	0.1	54.0	SABRINA LN	SEVERNA PARK
158	3604	MR9	7.7	54.0	SANDGATE CT	MILLERSVILLE
159	6436	MR7	0.3	54.0	WATERFORD MILL CT	PASADENA
160	5464	MRO	0.1	54.0	101 PINEVIEW AVE	SEVERNA PARK

Table C.1 – Top 200 Parcel Priorities for Preservation

Rank	Study Parcel ID	Sub-watershed	Area (acres)	Ranking Score	Address	City
161	3394	MRO	0.1	54.0	101 PINEVIEW AVE	SEVERNA PARK
162	5127	MRO	0.1	54.0	101 PINEVIEW AVE	SEVERNA PARK
163	3630	MRO	0.1	54.0	101 PINEVIEW AVE	SEVERNA PARK
164	5831	MRO	0.1	54.0	101 PINEVIEW AVE	SEVERNA PARK
165	5633	MRO	0.1	54.0	102 SABRINA LN	SEVERNA PARK
166	4533	MRO	0.1	54.0	102 SABRINA LN	SEVERNA PARK
167	7547	MR9	0.1	54.0	103 MISSION ST	PASADENA
168	35071	MGX	446.4	54.0	1100 COLLEGE PKW	ANNAPOLIS
169	34935	MR1	3.5	54.0	1210 WILL O BROOK DR	PASADENA
170	7020	MRO	1.7	54.0	124 JENNINGS RD	SEVERNA PARK
171	4815	MRO	1.1	54.0	143 JENNINGS RD	SEVERNA PARK
172	5299	MRO	2.1	54.0	146 TRUCK HOUSE RD	SEVERNA PARK
173	14390	MRG	3.0	54.0	271 PEAT BOG LN	PASADENA
174	4182	MR9	0.1	54.0	30 MULBERRY AVE	PASADENA
175	34894	MRO	0.3	54.0	301 LISTMAN CT	SEVERNA PARK
176	1274	MR4	0.1	54.0	3469 OLD CROWN DR	PASADENA
177	1668	MR4	0.0	54.0	3471 OLD CROWN DR	PASADENA
178	2634	MR4	0.0	54.0	3473 OLD CROWN DR	PASADENA
179	32355	MRE	0.1	54.0	420 GEORGIA AVE	PASADENA
180	31682	MRE	0.1	54.0	420 GEORGIA AVE	PASADENA
181	31684	MRE	0.1	54.0	420 GEORGIA AVE	PASADENA
182	15563	MR0	10.6	54.0	4959 MOUNTAIN RD	PASADENA
183	13293	MRJ	24.8	54.0	5075 MOUNTAIN RD	PASADENA
184	11932	MGY	1.1	54.0	508 MAGOTHY BEACH RD	PASADENA
185	16848	MRO	0.4	54.0	514 BENFIELD RD	SEVERNA PARK
186	11843	MR6	5.4	54.0	56 LAKE SHORE DR	PASADENA
187	34303	MR1	4.5	54.0	575 RIVERVIEW RD	PASADENA
188	24344	MGL	0.4	54.0	600 SALT MARSH LN	ARNOLD
189	23264	MGL	0.3	54.0	602 SALT MARSH LN	ARNOLD
190	20511	MGH	0.1	54.0	715 HILLTOP RD	ARNOLD
191	21168	MGC	3.0	54.0	759 BALTIMORE-ANNAPOLIS BLV	SEVERNA PARK
192	23036	MGC	2.9	54.0	761 BALTIMORE-ANNAPOLIS	SEVERNA PARK

Table C.1 – Top 200 Parcel Priorities for Preservation

Rank	Study Parcel ID	Sub-watershed	Area (acres)	Ranking Score	Address	City
					BLV	
193	395	MR3	0.1	54.0	7986 LONG HILL RD	PASADENA
194	227	MR3	1.0	54.0	8130 JUMPERS HOLE RD	PASADENA
195	34963	MR3	0.3	54.0	8287 BROOKWOOD RD	MILLERSVILLE
196	410	MR3	0.8	54.0	8447 ELVATON RD	MILLERSVILLE
197	15975	MRO	0.3	54.0	93 EASTWAY	SEVERNA PARK
198	18698	MGR	13.0	54.0	930 FOREST DR	ARNOLD
199	34336	MGH	0.4	54.0		
200	35503	MGH	0.3	54.0	80 MOORE RD	ARNOLD

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APPENDIX D – RESTORATION PROJECTS

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Table D.1- Potential Restoration and Retrofit Projects

Project ID	Project Name	Project Type	Shed Code	Status	Drainage Area (Acres)	Fecal Coliform Treated Area	TP Area Treated	TN Area Treated	TSS Area Treated	Reason for Implementing Proposed Project	Project Lead	Length Restored	Cost
1968	Barrensdale SWM Retrofit into Coastal Plain and Outfall/Stream Stabilization	Regenerative Step Pool Outfall Sand Filtration Device	MGC	Proposed	18	16.2	10.8	7.2	15.3	Countywide effort for targeted subwatershed Restoration	Public	400	$ 300,000
1930	Cypress Creek North Fork Stream Restoration	Shallow Marsh and Regenerative Wetland Seepage Systems	MGC	Q509401	448	380.8	201.6	89.6	268.8	Dredging Permit Regulatory Requirements	Public		$ 3,438,000
10125	Cypress Creek Tributary F Coastal Plain/Outfall Stabilization	Regenerative Step Pool Outfall Sand Filtration Device	MGC	Proposed	2.18	1.962	1.308	0.872	1.853	Countywide effort for targeted subwatershed Restoration	Public	100	$ 75,000
10127	Cypress Creek Tributary C Coastal Plain/Outfall Stabilization	Regenerative Step Pool Outfall Sand Filtration Device	MGC	Proposed	88.6	79.74	53.16	35.44	75.31	Countywide effort for targeted subwatershed Restoration	Public	100	$ 75,000
10119	Cypress Creek Recreation Area Bioretention	Enhanced Stormwater Retrofits (Bioretention Facilities)	MGC	Proposed	1.8	1.62	1.08	0.9	1.53	Countywide effort for targeted subwatershed Restoration	Private		$ 52,500
1974	Dunkeld Court SWM Retrofit	Dry Pond Retrofit	MGC	Proposed	19	17.1	11.4	7.6	16.15	Countywide effort for targeted subwatershed Restoration	Private		$ 120,000
10123	Holly Avenue Rain Garden	Enhanced Stormwater Retrofits (Bioretention Facilities)	MGC	Proposed	1.2	1.08	0.72	0.6	1.02	Countywide effort for targeted subwatershed Restoration	Private		$ 52,500
1948	Jones Elementary SWM Retrofit	Enhanced Stormwater Retrofits (Bioretention Facilities)	MGC	Proposed	2	1.8	1.2	1	1.7	Countywide effort for targeted subwatershed Restoration	Public		$ 52,500
10052	McKinsey Road Concrete Ditch Retrofit	Concrete Ditch Retrofit to Water Quality Swales	MGC	Proposed	208	187.2	124.8	83.2	176.8	Countywide effort for targeted subwatershed Restoration	Public	460	$ 517,500
1976	Old County SWM BMP	Enhanced Stormwater Retrofits (Bioretention Facilities)	MGC	Q516500	65.6	59.04	39.36	32.8	55.76	Countywide effort for targeted subwatershed Restoration	Public		$ 604,000
1970	Severna Park Elementary School SWM Retrofit	Enhanced Stormwater Retrofits (Bioretention Facilities)	MGC	Proposed	87	78.3	52.2	43.5	73.95	Countywide effort for targeted subwatershed Restoration	Public		$ 250,000
1994	Trinity Farm Pond Retrofit	Dry Pond Retrofit	MGC	Proposed	8.7	7.83	5.22	3.48	7.395	Countywide effort for targeted subwatershed Restoration	Public		$ 52,500
2014	Community College Outfall Retrofit 1	Regenerative Step Pool Outfall Sand Filtration Device	MGH	Proposed	7.93	7.137	4.758	3.172	6.7405	Countywide effort for targeted subwatershed Restoration	Public	150	$ 123,750

Table D.1- Potential Restoration and Retrofit Projects Continued

Project ID	Project Name	Project Type	Shed Code	Status	Drainage Area (Acres)	Fecal Coliform Treated Area	TP Area Treated	TN Area Treated	TSS Area Treated	Reason for Implementing Proposed Project	Project Lead	Length Restored	Cost
2016	Community College Outfall Retrofit 2	Regenerative Step Pool Outfall Sand Filtration Device	MGH	Proposed	10.07	9.063	6.042	4.028	8.5595	Countywide effort for targeted subwatershed Restoration	Public	150	$ 123,750
2018	Community College Outfall Retrofit 3	Regenerative Step Pool Outfall Sand Filtration Device	MGH	Proposed	21	18.9	12.6	8.4	17.85	Countywide effort for targeted subwatershed Restoration	Public	150	$ 123,750
2020	Community College Outfall Retrofit 4	Regenerative Step Pool Outfall Sand Filtration Device	MGH	Proposed	26	23.4	15.6	10.4	22.1	Countywide effort for targeted subwatershed Restoration	Public	250	$ 187,500
1926	Magothy/Severn Middle School SWM Retrofit	Enhanced Stormwater Retrofits (Bioretention Facilities)	MGH	Proposed	6.3	5.67	3.78	3.15	5.355	Countywide effort for targeted subwatershed Restoration	Public		$ 113,400
1984	Providence Center Pond Retrofit	Dry Pond Retrofit	MGH	Proposed	3	2.7	1.8	1.2	2.55	Countywide effort for targeted subwatershed Restoration	Public		$ 52,500
1958	Severna Park Golf Coastal Plain Outfall	Shallow Marsh and Regenerative Wetland Seepage Systems	MGH	Proposed	161	136.85	72.45	32.2	96.6	Countywide effort for targeted subwatershed Restoration	Public	325	$ 390,000
1964	Amoroso Stream Stabilization, Site 9	Regenerative Step Pool Outfall Sand Filtration Device	MGI	Proposed	56	50.4	33.6	22.4	47.6	Countywide effort for targeted subwatershed Restoration	Public	600	$ 450,000
1960	Arnold Elementary SWM Retrofit	Enhanced Stormwater Retrofits (Bioretention Facilities)	MGI	Proposed	9	8.1	5.4	4.5	7.65	Countywide effort for targeted subwatershed Restoration	Public		$ 162,000
1928	Divinity Cove Coastal Plain Outfall	Regenerative Step Pool Outfall Sand Filtration Device	MGI	Proposed	13.3	11.97	7.98	5.32	11.305	Countywide effort for targeted subwatershed Restoration	Private	150	$ 112,500
1986	Gloria Dei Lutheran Church Pond Retrofit	Dry Pond Retrofit	MGI	Proposed	7	6.3	4.2	2.8	5.95	Countywide effort for targeted subwatershed Restoration	Public		$ 52,500
1966	Haskell Reach Regenerative Conveyance Step Pool Outfall, Site 10	Regenerative Step Pool Outfall Sand Filtration Device	MGI	Proposed	11.4	10.26	6.84	4.56	9.69	Countywide effort for targeted subwatershed Restoration	Public	600	$ 450,000
	Mill Creek Mainstem Restoration	Shallow Marsh and Regenerative Wetland Seepage Systems	MGI	Proposed	0	0	0	0	0	Dredging Permit Regulatory Requirements	Public	250	$ 300,000
2004	Mill Creek Restoration Site # 3 Finneans Run	Regenerative Step Pool Outfall Sand Filtration Device	MGI	Proposed	20	18	12	8	17	Dredging Permit Regulatory Requirements	Public	150	$ 112,500

Table D.1- Potential Restoration and Retrofit Projects Continued

Project ID	Project Name	Project Type	Shed Code	Status	Drainage Area (Acres)	Fecal Coliform Treated Area	TP Area Treated	TN Area Treated	TSS Area Treated	Reason for Implementing Proposed Project	Project Lead	Length Restored	Cost
2000	Mill Creek Restoration Site #1 Upstream of Tree at Woodard Road	Regenerative Step Pool Outfall Sand Filtration Device	MGI	Proposed	101	90.9	60.6	40.4	85.85	Dredging Permit Regulatory Requirements	Public	650	$ 487,500
2002	Mill Creek Restoration Site #2 Joyce Lane South	Shallow Marsh and Regenerative Wetland Seepage Systems	MGI	Proposed	151	128.35	67.95	30.2	90.6	Dredging Permit Regulatory Requirements	Public	1350	$ 1,620,000
2006	Mill Creek Restoration Site #4 Tamarack Tail/Mainstem; Wickliffe Place	Shallow Marsh and Regenerative Wetland Seepage Systems	MGI	Proposed	526	447.1	236.7	105.2	315.6	Dredging Permit Regulatory Requirements	Public	800	$ 960,000
2008	Mill Creek Restoration Site #5 Nursing Home	Regenerative Step Pool Outfall Sand Filtration Device	MGI	Proposed	5.25	4.725	3.15	2.1	4.4625	Dredging Permit Regulatory Requirements	Public	150	$ 112,500
2010	Mill Creek Restoration Site #6 Downstream of Nursing Home Tributary	Shallow Marsh and Regenerative Wetland Seepage Systems	MGI	Proposed	706	600.1	317.7	141.2	423.6	Dredging Permit Regulatory Requirements	Public	970	$ 1,164,000
2012	Mill Creek Restoration Site #7 to SWM Pond	Regenerative Step Pool Outfall Sand Filtration Device	MGI	Proposed	121	108.9	72.6	48.4	102.85	Dredging Permit Regulatory Requirements	Public	250	$ 187,500
1982	Sheridan Road Pond Retrofit	Dry Pond Retrofit	MGI	Proposed	30	27	18	12	25.5	Countywide effort for targeted subwatershed Restoration	Public		$ 60,973
10047	Ambleside Dr. Concrete Concrete Ditch Retrofits (2 sites)	Concrete Ditch Retrofit to Water Quality Swales	MRF	Proposed	8.2	7.38	4.92	3.28	6.97	Countywide effort for targeted subwatershed Restoration	Public	200	$ 225,000
10102	Earleigh Heights 1 Concrete Ditch Retrofit	Concrete Ditch Retrofit to Water Quality Swales	MRF	Proposed	17	15.3	10.2	6.8	14.45	Countywide effort for targeted subwatershed Restoration	Public	200	$ 225,000
10098	Earleigh Heights 2 Concrete Ditch Retrofit	Concrete Ditch Retrofit to Water Quality Swales	MRF	Proposed	6	5.4	3.6	2.4	5.1	Countywide effort for targeted subwatershed Restoration	Public	100	$ 112,500
10099	Earleigh Heights 3 Concrete Ditch Retrofit	Concrete Ditch Retrofit to Water Quality Swales	MRF	Proposed	2	1.8	1.2	0.8	1.7	Countywide effort for targeted subwatershed Restoration	Public	100	$ 112,500
10101	Earleigh Heights 4 Concrete Ditch Retrofit	Concrete Ditch Retrofit to Water Quality Swales	MRF	Proposed	3	2.7	1.8	1.2	2.55	Countywide effort for targeted subwatershed Restoration	Public	100	$ 112,500
1990	Old Man's Creek Wetland Enhancement at B&A Blvd	Shallow Marsh and Regenerative Wetland Seepage Systems	MRF	Proposed	219	186.15	98.55	43.8	131.4	Countywide effort for targeted subwatershed Restoration	Private	300	$ 360,000

Table D.1- Potential Restoration and Retrofit Projects Continued

Project ID	Project Name	Project Type	Shed Code	Status	Drainage Area (Acres)	Fecal Coliform Treated Area	TP Area Treated	TN Area Treated	TSS Area Treated	Reason for Implementing Proposed Project	Project Lead	Length Restored	Cost
1952	Riverdale Glen Outfall Rehabilitation / Stream Restoration	Regenerative Step Pool Outfall Sand Filtration Device	MRF	Q526500	130	117	78	52	110.5	Countywide effort for targeted subwatershed Restoration	Public		$ 509,000
1996	Earleigh heights Shopping Center Pond Retrofit	Dry Pond Retrofit	MRI	Proposed	1.38	1.242	0.828	0.552	1.173	Countywide effort for targeted subwatershed Restoration	Public		$ 52,500
1988	Evon Ct. Pond Retrofit	Dry Pond Retrofit	MRI	Proposed	8	7.2	4.8	3.2	6.8	Countywide effort for targeted subwatershed Restoration	Public		$ 52,500
1932	Folger Mckinsey Elementary SWM Retrofit	Enhanced Stormwater Retrofits (Bioretention Facilities)	MRI	Proposed	3	2.7	1.8	1.5	2.55	Countywide effort for targeted subwatershed Restoration	Public		$ 54,000
1942	Oak Hill Elementary SWM Retrofit	Enhanced Stormwater Retrofits (Bioretention Facilities)	MRI	Proposed	1.2	1.08	0.72	0.6	1.02	Countywide effort for targeted subwatershed Restoration	Public		$ 52,500
1956	Severna Forest Outfall Stabilization	Regenerative Step Pool Outfall Sand Filtration Device	MRI	Proposed	74	66.6	44.4	29.6	62.9	Countywide effort for targeted subwatershed Restoration	Public	600	$ 450,000
1940	Severna Park High School Coastal Plain Outfall	Regenerative Step Pool Outfall Sand Filtration Device	MRI	Proposed	14	12.6	8.4	5.6	11.9	Countywide effort for targeted subwatershed Restoration	Public	300	$ 225,000
10045, 10060, 10044	Woodberry Farm Concrete Ditch Retrofits (3 sites on Carlyn Drive and Simmons Ln)	Concrete Ditch Retrofit to Water Quality Swales	MRI	Proposed	25	22.5	15	10	21.25	Countywide effort for targeted subwatershed Restoration	Public	600	$ 675,000
1978	Berrywood Community Area Wetland Creation 2	Shallow Marsh and Regenerative Wetland Seepage Systems	MRO	Proposed	1486	1263.1	668.7	297.2	891.6	Countywide effort for targeted subwatershed Restoration	Private	250	$ 600,000
1992	Severna Village Dry Pond Retrofit	Dry Pond Retrofit	MRO	Proposed	14	12.6	8.4	5.6	11.9	Countywide effort for targeted subwatershed Restoration	Public		$ 52,500
1954	Severndale SWM Retrofit	Dry Pond Retrofit	MRO	Proposed	19.4	17.5	11.6	7.8	16.5	Countywide effort for targeted subwatershed Restoration	Public		$ 52,500
9831	Magothy Branch Stream Restoration	Shallow Marsh and Regenerative Wetland Seepage Systems	MG1	Proposed	928	789.1	417.8	185.7	557.0	Countywide effort for targeted subwatershed Restoration	Public	3623	$ 4,347,914
9815	Manhattan Beach Wetland Seepage System	Shallow Marsh and Regenerative Wetland Seepage Systems	MGF	Proposed	107	91.3	48.4	21.5	64.5	Countywide effort for targeted subwatershed Restoration	Private	800	$ 960,000

Table D.1- Potential Restoration and Retrofit Projects Continued

Project ID	Project Name	Project Type	Shed Code	Status	Drainage Area (Acres)	Fecal Coliform Treated Area	TP Area Treated	TN Area Treated	TSS Area Treated	Reason for Implementing Proposed Project	Project Lead	Length Restored	Cost
9823	Manhattan Beach Bioretention	Enhanced Stormwater Retrofits (Bioretention Facilities)	MGF	Proposed	18	16.1	10.7	9.0	15.2	Countywide effort for targeted subwatershed Restoration	Public		$ 322,471
9851	Atlantis Outfall Restoration	Regenerative Step Pool Outfall Sand Filtration Device	MGT	Proposed	46	41.8	27.8	18.6	39.4	Countywide effort for targeted subwatershed Restoration	Public	475	$ 356,250
9859	Mount Alban Dr. Outfall Restoration	Regenerative Step Pool Outfall Sand Filtration Device	MGT	Proposed	31	27.9	18.6	12.4	26.3	Countywide effort for targeted subwatershed Restoration	Public	300	$ 225,000
9861	Hilltop Rd. Bioretention	Enhanced Stormwater Retrofits (Bioretention Facilities)	MGT	Proposed	8	7.1	4.7	4.0	6.7	Countywide effort for targeted subwatershed Restoration	Private		$ 142,332
9865	Hollyberry Woods Outfall Rehab/Stream Restoration	Shallow Marsh and Regenerative Wetland Seepage Systems	MGT	Proposed	86	73.5	38.9	17.3	51.9	Countywide effort for targeted subwatershed Restoration	Public	725	$ 870,000
9829	Cat Branch Stream Restoration	Shallow Marsh and Regenerative Wetland Seepage Systems	MGV	Proposed	417	354.3	187.6	83.4	250.1	Countywide effort for targeted subwatershed Restoration	Public	2670	$ 3,204,420
9855	Little Magothy Outfall Restoration	Regenerative Step Pool Outfall Sand Filtration Device	MGV	Proposed	85	76.6	51.1	34.0	72.4	Countywide effort for targeted subwatershed Restoration	Public	1290	$ 967,500
9857	Cape St Claire Rd. Outfall Restoration	Regenerative Step Pool Outfall Sand Filtration Device	MGV	Proposed	59	52.7	35.2	23.4	49.8	Countywide effort for targeted subwatershed Restoration	Public	200	$ 150,000
9843	Magothy Beach Rd. Outfall Restoration	Regenerative Step Pool Outfall Sand Filtration Device	MGW	Proposed	91	81.6	54.4	36.3	77.1	Countywide effort for targeted subwatershed Restoration	Public	300	$ 225,000
9847	Chelsea Beach Outfall Restoration	Regenerative Step Pool Outfall Sand Filtration Device	MGY	Proposed	144	129.4	86.3	57.5	122.3	Countywide effort for targeted subwatershed Restoration	Public	1200	$ 900,000
9849	Riverside Dr. Outfall Restoration	Regenerative Step Pool Outfall Sand Filtration Device	MR6	Proposed	32	28.6	19.0	12.7	27.0	Countywide effort for targeted subwatershed Restoration	Public	150	$ 112,500
9839	Wileys Ln. Ditch Retrofit	Concrete Ditch Retrofit to Water Quality Swales	MRD	Proposed	136	122.4	81.6	54.4	115.6	Countywide effort for targeted subwatershed Restoration	Public	2700	$ 2,025,000
9841	Circle Rd. Ditch Retrofit	Concrete Ditch Retrofit to Water Quality Swales	MRD	Proposed	23	21.0	14.0	9.3	19.8	Countywide effort for targeted subwatershed Restoration	Private	400	$ 300,000
9833	Puffin Ct. Bioretention	Enhanced Stormwater Retrofits (Bioretention Facilities)	MRD	Proposed	5	4.3	2.8	2.4	4.0	Countywide effort for targeted subwatershed Restoration	Private		$ 85,364
9835	Henshaw Ln. Biortention	Enhanced Stormwater Retrofits (Bioretention Facilities)	MRD	Proposed	4	3.9	2.6	2.2	3.7	Countywide effort for targeted subwatershed Restoration	Private		$ 78,621

Table D.2 - Summary of Restoration and Retrofit Projects by Subwatershed

																County Projects			Others/Private Projects		
Shed Code	Subwatershed	Area (Acres)	Current Condition TP (lb/Yr)	Current Condition TN (lb/Yr)	Current Condition TSS (Tons/Yr)	Stream Miles	Overall Subshed Assessment Score	# of Proposed County Projects	# of Proposed Others/Private Projects	Number of Regulatory Required Projects	Total Cost for County Lead Retrofit Projects	Total Cost for Others/Private Lead Retrofit Projects	County Land Drainage Area Treated	Others/Private Land Drainage Area Treated	Total Drainage Area Treated	Reduction in TP (lb)	Reduction in TN (lb)	Reduction in TSS (Tons)	Reduction in TP (lb)	Reduction in TN (lb)	Reduction in TSS (Tons)
MG1	Magothy Branch 2	574	340	7314	126	2.0	67	1	0	0	$ 4,347,914	$ -	99	476	574	247	2365	122	0	0	0
MGC	Cypress Creek	1154	958	10345	469	1.1	36	9	3	1	$ 5,364,500	$ 225,000	270	681	950	407	2663	275	11	82	8
MGF	Magothy River Tidal	138	126	1216	59	0.2	51	2	0	0	$ 322,471	$ 960,000	20	105	125	10	79	7	44	190	28
MGH	Dividing Creek	891	584	10585	259	3.1	51	7	0	0	$ 1,114,650	$ -	96	140	236	77	743	46	0	0	0
MGI	Mill Creek	1157	902	13991	424	4.5	42	13	1	1	$ 6,119,473	$ 112,500	415	1341	1756	654	5102	416	6	64	4
MGT	Deep Creek	1428	1061	14580	485	6.9	48	3	1	0	$ 1,451,250	$ 142,332	30	142	172	63	493	40	4	40	2
MGV	Little Magothy River	1229	872	8531	405	4.5	50	3	0	0	$ 4,321,920	$ -	222	339	561	194	977	123	0	0	0
MGW	Indian Village Branch	111	96	3425	38	0.2	45	1	0	0	$ 225,000	$ -	12	79	91	47	1116	26	0	0	0
MGY	Nannys Branch	485	289	7445	116	2.8	57	1	0	0	$ 900,000	$ -	0	144	144	51	884	29	0	0	0
MR6	Cockey Creek	1229	616	21077	219	2.5	64	1	0	0	$ 112,500	$ -	5	26	32	10	218	5	0	0	0
MRD	Hunters Harbor	197	138	6185	55	1.3	50	1	3	0	$ 2,025,000	$ 463,984	23	145	168	57	1707	32	14	435	8
MRF	Old Man's Creek	644	400	15166	167	2.0	49	6	1	0	$ 1,296,500	$ 360,000	47	338	385	62	1567	37	61	1032	34
MRI	Cattail Creek 1	886	562	8407	242		57	7	0	0	$ 1,561,500	$ -	10	27	37	48	484	29	0	0	0
MRO	Cattail Creek 2	1056	736	9283	350		52	2	1	0	$ 105,000	$ 600,000	418	1191	1609	14	117	9	466	2612	295
Total Cattail	Cattail Creek	1942	1298	17690	592	3.7	55	9	1	0	$ 1,666,500	$ 600,000	428	1218	1646	62	602	39	466	2612	295
Summary		11,179	7,680	137,550	3,414	35	51	57	10	2	$ 29,267,678	$ 2,863,817	1,667	5,173	6,840	1,941	18,515	1,197	606	4,455	379

Table D.2 - Summary of Restoration and Retrofit Projects by Subwatershed Continued

		All Projects			County Projects			Others/Private Projects			All Projects				Septic Retrofits			
Shed Code	Subwatershed	Reduction in TP (lb)	Reduction in TN (lb)	Reduction in TSS (Tons)	Cost ($) / lb of TP Removed	Cost ($) / Tons of TSS Removed	Cost ($) / lb of TN Removed	Cost ($) / lb of TP Removed	Cost ($) / Tons of TSS Removed	Cost ($) / lb of TN Removed	Cost ($) / lb of TP Removed	Cost ($) / Tons of TSS Removed	Cost ($) / lb of TN Removed	Average % Reduction in Nitrogen Loads	# of Septics Recommended for Sewer Connections	Septic Retrofit Cost to the County	Reduction in Nitrogen Load (lbs/year)	Average % Reduction in Nitrogen Loads
MG1	Magothy Branch 2	247	2365	122	$ 17,580	$ 35,650	$ 1,839	N/A	N/A	N/A	$ 17,580	$ 35,650	$ 1,839	32	315	$ 11,970,000	3191	44
MGC	Cypress Creek	417	2745	283	$ 13,196	$ 19,500	$ 2,014	$ 20,531	$ 29,603	$ 2,758	$ 13,389	$ 19,771	$ 2,036	27	107	$ 4,066,000	2600	25
MGF	Magothy River Tidal	54	268	34	$ 32,832	$ 49,401	$ 4,082	$ 21,729	$ 34,738	$ 5,066	$ 23,748	$ 37,539	$ 4,777	22	7	$ 266,000	125	10
MGH	Dividing Creek	77	743	46	$ 14,535	$ 23,987	$ 1,500	N/A	N/A	N/A	$ 14,535	$ 23,987	$ 1,500	7	218	$ 8,284,000	5663	54
MGI	Mill Creek	660	5166	421	$ 9,355	$ 14,695	$ 1,199	$ 18,077	$ 27,154	$ 1,748	$ 9,437	$ 14,817	$ 1,206	37	354	$ 13,452,000	6293	45
MGT	Deep Creek	67	533	42	$ 22,881	$ 36,316	$ 2,945	$ 40,371	$ 62,357	$ 3,525	$ 23,802	$ 37,723	$ 2,989	4	255	$ 9,690,000	5029	34
MGV	Little Magothy River	194	977	123	$ 22,256	$ 35,263	$ 4,422	N/A	N/A	N/A	$ 22,256	$ 35,263	$ 4,422	11	57	$ 2,166,000	1192	14
MGW	Indian Village Branch	47	1116	26	$ 4,793	$ 8,491	$ 202	N/A	N/A	N/A	$ 4,793	$ 8,491	$ 202	33	176	$ 6,688,000	2248	66
MGY	Nannys Branch	51	884	29	$ 17,489	$ 30,645	$ 1,018	N/A	N/A	N/A	$ 17,489	$ 30,645	$ 1,018	12	21	$ 798,000	4258	57
MR6	Cockey Creek	10	218	5	$ 11,788	$ 23,415	$ 517	N/A	N/A	N/A	$ 11,788	$ 23,415	$ 517	1	0	$ -	12418	59
MRD	Hunters Harbor	71	2142	40	$ 35,451	$ 63,262	$ 1,186	$ 34,088	$ 60,830	$ 1,066	$ 35,189	$ 62,794	$ 1,162	35	0	$ -	4457	72
MRF	Old Man's Creek	123	2599	71	$ 20,917	$ 35,334	$ 828	$ 5,877	$ 10,548	$ 349	$ 13,441	$ 23,390	$ 637	17	671	$ 25,498,000	11769	78
MRI	Cattail Creek 1	48	484	29	$ 32,410	$ 53,068	$ 3,223	N/A	N/A	N/A	$ 32,410	$ 53,068	$ 3,223	6	125	$ 4,750,000		
MRO	Cattail Creek 2	480	2729	305	$ 7,520	$ 11,171	$ 894	$ 1,288	$ 2,033	$ 230	$ 1,469	$ 2,315	$ 258	29	138	$ 5,244,000		
Total Cattail	Cattail Creek	528	3214	334	$ 39,930	$ 64,239	$ 4,117	$ 1,288	$ 2,033	$ 230	$ 33,879	$ 55,382	$ 3,481	18	263	$ 9,994,000	4744	27
Summary		2,547	22,971	1,576	$ 20,231	$ 33,861	$ 1,990	$ 20,280	$ 32,466	$ 2,106	$ 18,564	$ 31,451	$ 1,984	20	2444	$ 92,872,000	63987	45

APPENDIX E – CONCEPT DESIGN PLANS

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County Park And Ride Bioretention

Conceptual Design Plan

Project Overview

The drainage around an existing County-owned Park n Ride parking lot is poorly managed. The parking lot contributes drainage to the headwaters of a poorly rated tributary of Cypress Creek. This project will install two bioretention facilities near the parking lot to limit drainage and improve runoff water quality.

Project Type: Bioretention facilities

Watershed: Magothy River

Subwatershed: Cypress Creek (MGC)

Location: North of Arundel Beach Road, off of Ritchie Highway (Rte 2) in Severna Park, MD. (Figures 1 and 2)

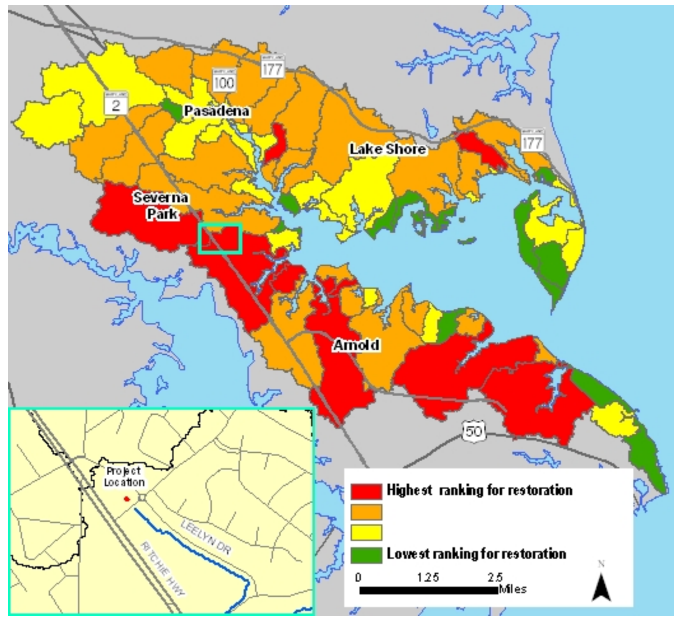


Figure 1 – Project Location Map

Drainage Area Characteristics

Land Use: Commercial

Drainage Area: 6.5 acres

Impervious Area: 3.8 acres

Surface Soils: Type B (2.0 acres): silt loam or loam, moderately well drained with moderate infiltration rate; Type D (4.5 acres): clay loam, silty clay loam, sandy clay loam, sandy clay or clay with very low infiltration rates

Hydrology:

Parameter	Value
Weighted Curve Number	84.9
Time of Concentration (hrs)	0.136
Flow 1-yr- Existing Cond (cfs)	12.0
Flow 2-yr- Existing Cond (cfs)	17.0
Runoff 1-yr- Existing Cond (in.)	1.33
Runoff 2-yr- Existing Cond (in.)	1.84
Flow 1-yr- Future Cond (cfs)	17.0
Flow 2-yr- Future Cond (cfs)	22.0
Runoff 1-yr- Future Cond (in.)	1.79
Runoff 2-yr- Future Cond (in.)	2.35

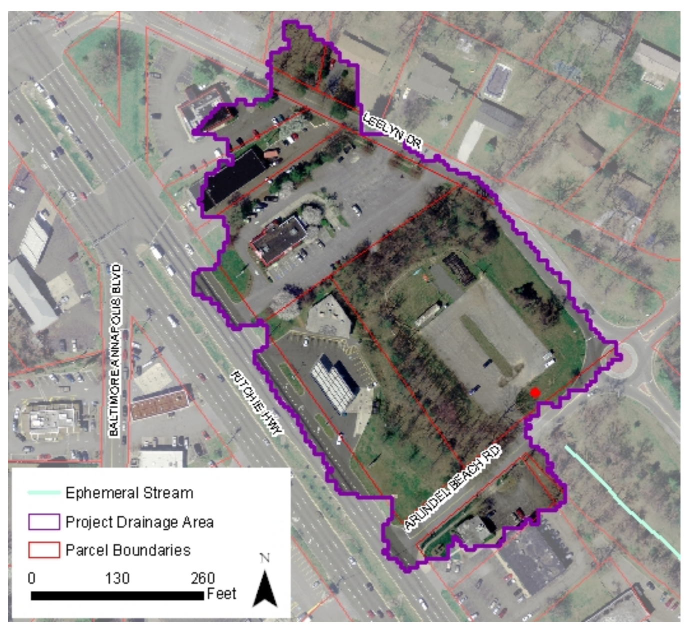


Figure 2 – Aerial Photo of Project Drainage Area

Project Benefits

Water Quality: Pollutant filtration and increased infiltration will enhance removal of runoff pollutants. Additionally, uptake of dissolved nutrients and adsorption of oils and greases by the plant material yield secondary water quality benefits above and beyond the benefits achieved by the filter media

	Existing Conditions						Future Conditions					
	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr
Pre-Install	10	70	23	1.22E10	5.1	7.0	10	78	24	1.38E10	6.0	8.0
Post-Install	4.0	42	23	1.22E9	0.8	1.1	4.0	47	24	1.38E9	0.9	1.2
% Diff.	60%	40%	0%	90%	84%	84%	60%	40%	0%	90%	85%	85%

Stream Stability: The bioretention facilities decrease peak and cumulative flows to downstream receiving waters and ultimately to Cypress Creek.

Conceptual Design

Given that the cumulative drainage area for this project is greater than 5 acres, two bioretention facilities will be required, per MDE guidance. The bioretention facilities are sized to manage the water quality volume (WQ_v) associated with a 1 inch storm. Bioretention facility #1 is proposed for the existing vegetated area in the center of the parking area. Bioretention facility #2 is proposed for the existing depression to the south of the parking lot. Both bioretention facilities are conceptualized primarily as filtration structures with underdrains due to predominantly poorly draining soils. Some infiltration will still occur and will be maximized to the extent practicable by the placement of underdrains. To meet pretreatment requirements, a perimeter sand filter, a gravel diaphragm, and a 2 to 3 inch mulch layer are proposed. A perimeter sand filter is proposed in lieu of a grass filter strip due to space constraints. The combined required area of the bioretention facilities is 9,650 sq ft. Due to space constraints Bioretention facility #1 is proposed to be 1,900 sq ft and Bioretention facility #2 is proposed to be 7,750 sq ft. Underdrains from Bioretention facility #1 will connect with underdrains from Bioretention facility #2. The combined filtered flow from these facilities will be conveyed under Arundel Beach Road through a modified culvert to the existing dry swale leading to further downstream BMPs.

Design Parameters	Value
Drainage area (acre)	6.46
Percent Impervious (%)	58.5
Volumetric runoff coefficient (R_v)	0.577
Soil specific recharge factor (S)	0.144
Water quality volume (WQ_v) (ft^3)	13,510
Recharge volume (Re_v) (ft^3)	1,950
Channel protection volume (Cp_v) (ft^3)	Not req'd
Overbank flood protection volume (Q_p) (ft^3)	Not req'd
Extreme flood volume (Q_f) (ft^3)	Not req'd
Temporary storage volume (V_{temp}) (ft)	10,132
Bioretention filter bed soil depth (d_f) (ft)	2.5
Stone reservoir depth (d) (ft)	0.5
Coefficient of permeability (k) (ft/day)	0.5
Ponding depth (h_f) (ft)	1.0
Bioretention filter bed drain time (t_f) (days)	2
Bioretention filter bed area (A_f) (ft^2)	9,650
Bioretention facility #1 footprint (ft^2)	1,900
Bioretention facility #2 footprint (ft^2)	7,750

Conceptual Design (continued)

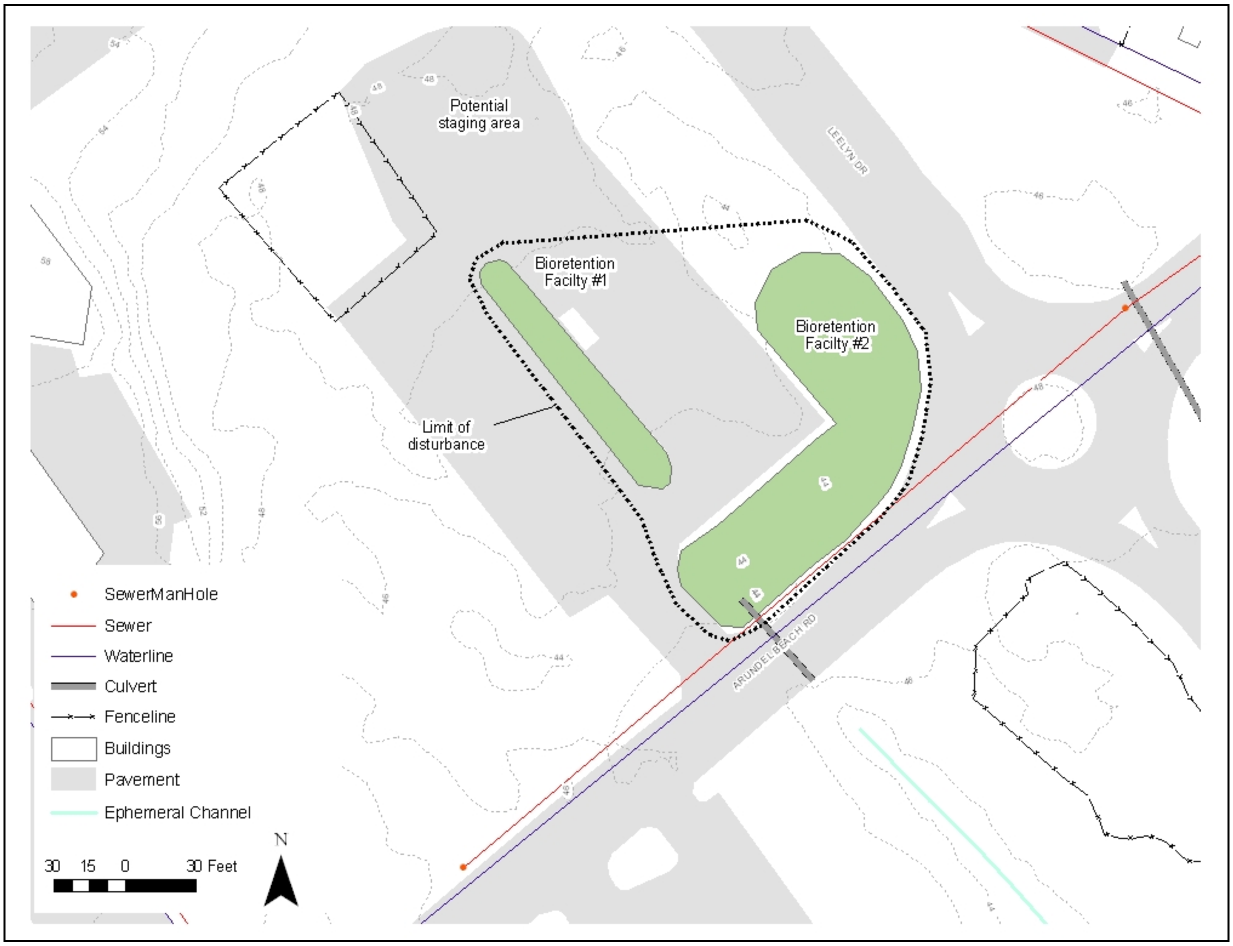


Figure 3 – Plan View of Bioretention Facilities

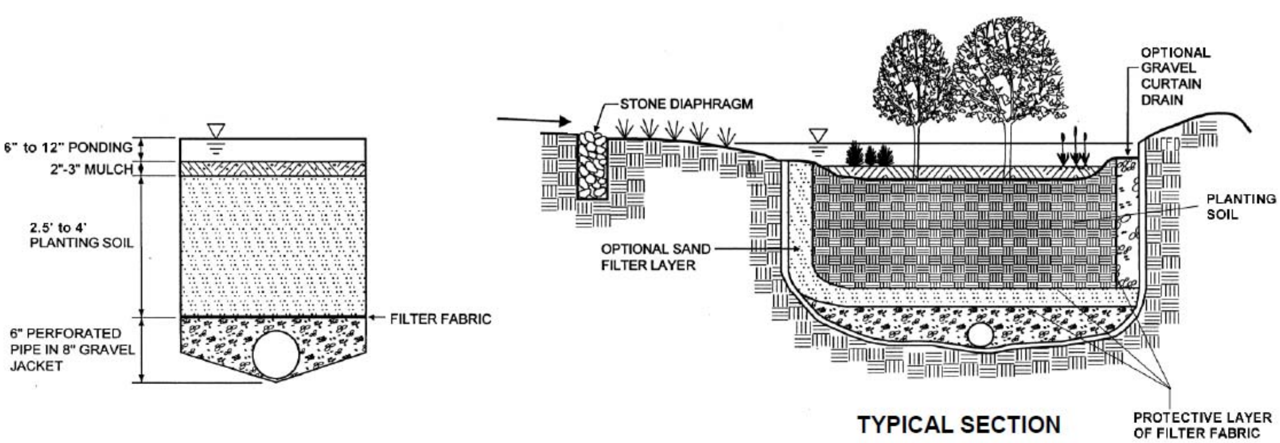


Figure 4 – Cross Section View of Typical Bioretention Facility (Source: Maryland Stormwater Manual)

Project Cost Estimate

Item Description	Quantity/Units		Unit Cost	Subtotal Cost
SITE PREP AND GRADING				
Mobilization/Demobilization	1	--	$1,500.00	$1,500.00
Erosion Control and Sedimenation	1072	sy	$4.00	$4,300.00
Blaze Orange Fence	640	lf	$8.00	$5,100.00
Grading, Excavation, Backfilling	1,200	cy	$20.00	$24,000.00
BIORETENTION FACILITY				
Engineered Soil Mix	890	cy	$15.00	$13,400.00
Geotextile	1,275	sy	$3.00	$3,800.00
Rock Fill	185	cy	$65.00	$12,000.00
Mulch	90	cy	$25.00	$2,300.00
Sand	185	cy	$65.00	$12,000.00
PIPES AND STRUCTURES				
Underdrain Pipes (6” PVC)	270	lf	$1.75	$500.00
PLANTING				
Plants (Trees, Shrubs, Herbs and SAV)	1000	sy	$10.00	$10,000.00
TOTAL CONSTRUCTION COSTS				**$67,600.00**
ENGINEERING AND MANAGEMENT				
Engineering (15% of Construction or $10,000 minimum)				$10,140.00
Construction Management (15% of Construction)				$10,140.00
Contingency (20% of Construction)				$13,520.00
TOTAL PROJECT COSTS				**$101,400.00**

Project Constraints

Site Access: The Park n Ride parking lot is owned by Anne Arundel County. The proposed limit of disturbance associated with the project lies entirely within the County right-of-way. Unencumbered access to the site can be made via Arundel Beach Road.

Design/Construction: A topographical survey is necessary, and a geotechnical survey should be completed to confirm the infiltration capacity of site soils. If the soils are well draining, it may be possible to refine the design to exfiltrate the entire WQ_v and eliminate the need for underdrains. Construction staging could occur within the parking lot.

Project Constraints (continued)

Utilities: Water and sewer lines are located near the limit of disturbance on the north side of Arundel Beach Road and south of the proposed Bioretention Facility #2. Miss Utility should be contacted prior to initiation of construction activities.

Environmental Impacts: Environmental impacts are not anticipated for this design.

Erosion and Sediment Control: Proper erosion and sediment controls are required including storm drain protection and silt fencing the construction boundary.

Project Photos

Photo 1 –Bioretention Facility #1 Location (North)

Photo 2 – Parking Lot (South)

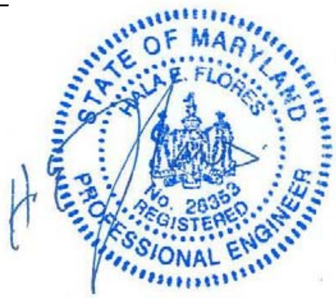
Photo 3 – Bioretention Facility #2 Location with Twin Culverts under Arundel Beach Road (Southwest)

Photo 4 – Bioretention Facility #2 Location (West)

Engineer Certification

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.
License No. 35612_, Expiration Date: 4/23/2010

License No. 26363_, Expiration Date: 1/2/2011



Cypress Creek Recreation Area Bioretention

Conceptual Design Plan

Project Overview

This project will install a bioretention facility near an existing storm drain on the north side of the overflow parking for the Cypress Creek Recreation Area. Poor drainage currently contributes to frequent flooding events of portions of the parking lot.

Project Type: Bioretention facility

Watershed: Magothy River

Subwatershed: Cypress Creek (MGC)

Location: North of Cypress Creek Road, off of Ritchie Highway (Rte 2) in Severna Park, MD. (Figures 1 and 2)

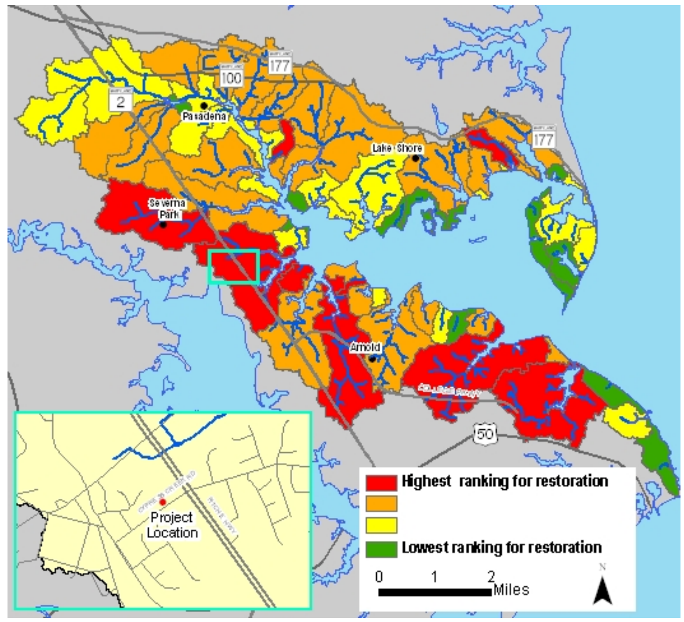


Figure 1 – Project Location Map

Drainage Area Characteristics

Land Use: Commercial, Residential

Drainage Area: 0.75 acres

Impervious Area: 0.45 acres

Dominant Soils: Type B (0.75 acres): silt loam or loam, moderately well drained with moderate infiltration rate

Hydrology:

Parameter	Value
Weighted Curve Number	87.44
Time of Concentration (hrs)	0.049
Flow 1-yr- Existing Cond (cfs)	2.0
Flow 2-yr- Existing Cond (cfs)	2.0
Runoff 1-yr- Existing Cond (in.)	1.50
Runoff 2-yr- Existing Cond (in.)	2.02
Flow 1-yr- Future Cond (cfs)	2.0
Flow 2-yr- Future Cond (cfs)	2.0
Runoff 1-yr- Future Cond (in.)	1.50
Runoff 2-yr- Future Cond (in.)	2.03

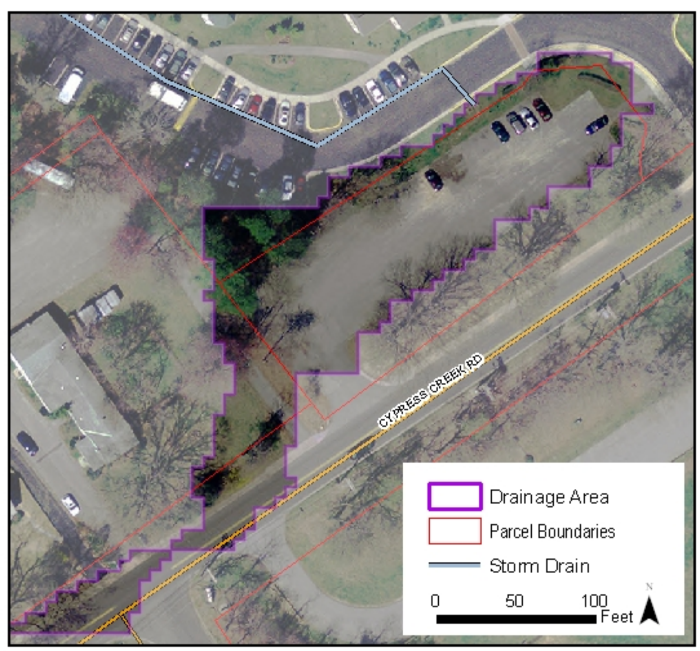


Figure 2 – Aerial Photo of Project Drainage Area

Project Benefits

Water Quality: Pollutant filtration and increased infiltration will enhance removal of runoff pollutants. Additionally, uptake of dissolved nutrients and adsorption of oils and greases by the plant material yield secondary water quality benefits above and beyond the benefits achieved the filter media

	Existing Conditions						Future Conditions					
	TP lbs/ yr	**TN lbs/yr**	**NOx lbs/yr**	**FC mpn/yr**	**TSS tons/ yr**	**Metal lbs/yr**	**TP lbs/yr**	**TN lbs/yr**	**NOx lbs/yr**	**FC mpn/yr**	**TSS tons/ yr**	**Metal lbs/yr**
Pre-Install	1	9	3	1.96E+09	1	1.0	1	9	3	1.94E+09	0.7	1.0
Post-Install	0.4	5.4	3	1.96E+08	0.2	0.2	.4	5.4	2	1.94E+08	0.1	0.2
% Diff.	60%	40%	0%	90%	80%	80%	60%	40%	33%	90%	86%	80%

Stream Stability: The bioretention facility will decrease peak and cumulative flows to downstream storm conveyance systems and BMPs and ultimately to Cypress Creek.

Conceptual Design

The bioretention facility will be located to the north of the existing parking lot. It is anticipated that grading activities within the bioretention facility will be performed with the intent of promoting more effective drainage of the parking lot; this will alleviate the potential for frequent ponding following rain events. A full topographic survey prior to final design may confirm the need for some additional lot regarding in addition to the concept discussed further herein.

The concept will serve primarily as a filtration structure with an underdrain. Some infiltration will still occur and will be maximized to the extent practicable by the placement of underdrains and presence of a groundwater recharge reservoir. Due to space limitations, in addition to a gravel diaphragm and a 2”-3” mulch layer, a perimeter sand filter layer is recommended for adequate pretreatment. The combined required area of the bioretention facility is 1,200 sq ft. An underdrain will convey water to the existing storm drain.

Design Parameters	Value
Drainage area (acre)	0.76
Percent Impervious (%)	59.7
Volumetric runoff coefficient (R_v)	0.588
Soil specific recharge factor (S)	0.290
Water quality volume (WQ_v) (cf)	1,617
Recharge volume (Re_v) (cf)	469
Channel protection volume (Cp_v) (cf)	Not req’d
Overbank flood protection volume (Q_p) (cf)	Not req’d
Extreme flood volume (Q_f) (cf)	Not req’d
Temporary storage volume (V_{temp}) (ft)	1,200
Bioretention filter bed soil depth (d_f) (ft)	1.5
Stone reservoir depth (d) (ft)	1
Coefficient of permeability (k) (ft/day)	0.5
Ponding depth (h_f) (ft)	.5
Bioretention filter bed drain time (t_f) (days)	2
Required bioretention filter bed area (A_f) (sf)	1,200
Pretreatment sand filter depth (d)(ft)	0.25
Pretreatment sand filter coefficient of permeability (k) (ft/day)	3.5

Conceptual Design (continued)

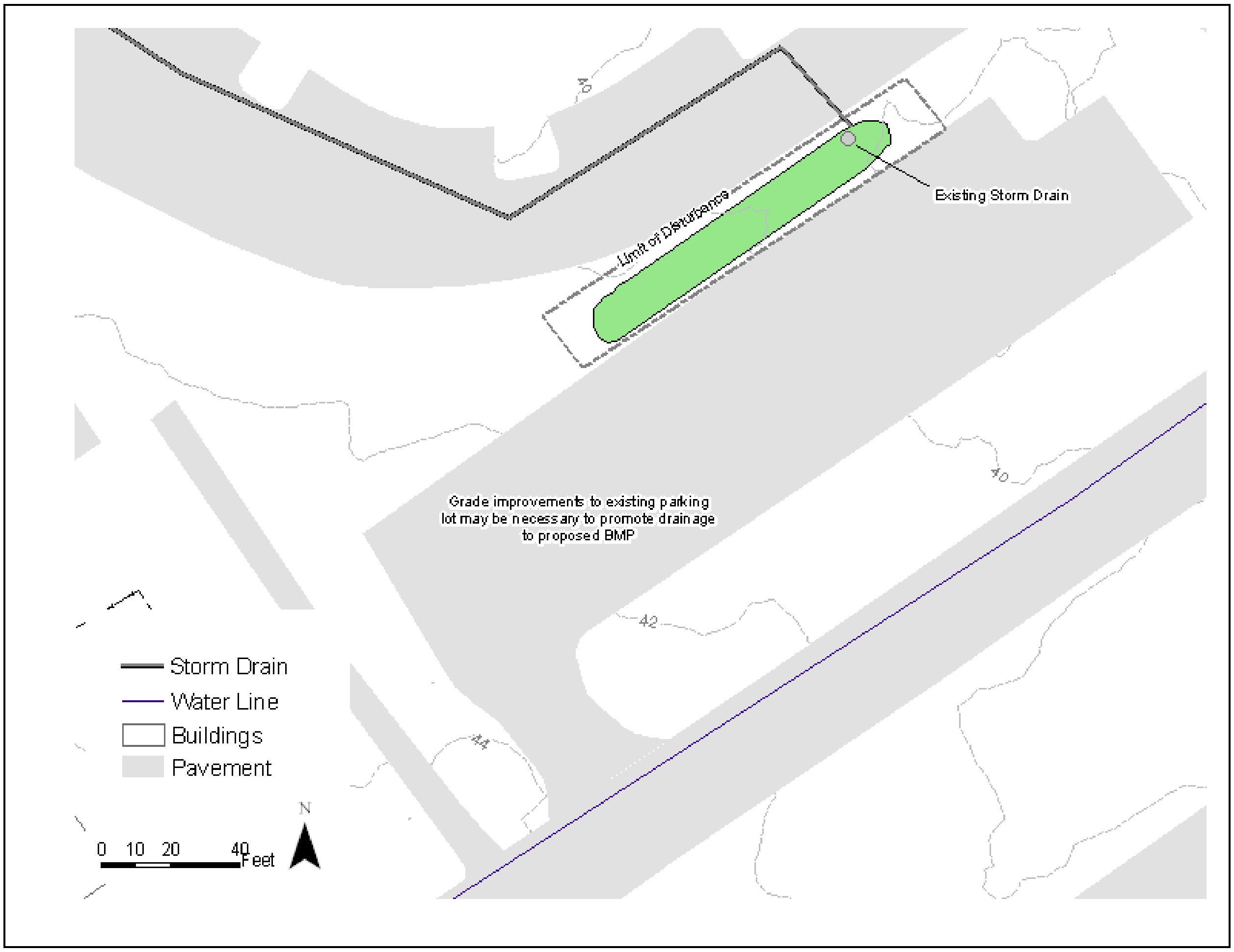


Figure 3 – Plan View of Bioretention Facility

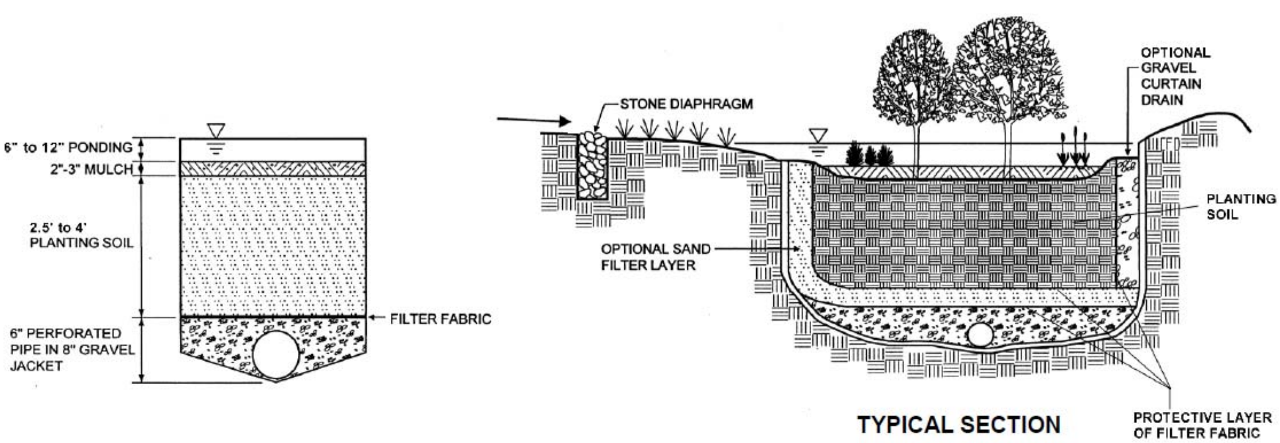


Figure 4 – Cross Section View of Typical Bioretention Facility (Source: Maryland Stormwater Manual)

Project Cost Estimate

Item Description	Quantity/Units		Unit Cost	Subtotal Cost
SITE PREP AND GRADING				
Mobilization/Demobilization	1	--	$1,500.00	$1,500.00
Erosion and Sediment Control	150	sy	$4.00	$600.00
Blaze Orange Fence	250	lf	$8.00	$2,000.00
Grading, Excavation, Backfilling	140	cy	$20.00	$2,800.00
BIORETENTION FACILITY				
Engineered Soil Mix	70	cy	$15.00	$1,050.00
Geotextile	135	sy	$3.00	$405.00
Rock Fill	28	cy	$65.00	$1,820.00
Mulch	14	cy	$25.00	$350.00
Sand	28	cy	$65.00	$1,820.00
PIPES AND STRUCTURES				
Underdrain Pipes (6" PVC)	90	lf	$1.75	$157.50
PLANTING				
Plants (Trees, Shrubs, Herbs and SAV)	170	sy	$10.00	$1,700.00
TOTAL CONSTRUCTION COSTS				**$14,202.50**
ENGINEERING AND MANAGEMENT				
Engineering (15% of Construction or $10,000 minimum)				$ 10,000.00
Construction Management (15% of Construction)				$2,130.38
Contingency (20% of Construction)				$2,840.50
TOTAL PROJECT COSTS				**$ 29,173.38**

Project Constraints

Site Access: The parking lot is owned by Anne Arundel County and the vegetated area where the bioretention area will be sited is privately owned. Access will need to be obtained and County right-of-way may need to be established. Unencumbered access to the site can be made the parking lot.

Design/Construction: A topographical survey is necessary, and a geotechnical survey should be completed to confirm the infiltration capacity of site soils. If the soils are well draining, it may be possible to refine the design to exfiltrate the entire WQ_v and eliminate the need for underdrains. Construction staging could occur within the parking lot.

Project Constraints (continued)

Utilities: It is unlikely that there will be any utility conflicts as no water and sewer lines exist near the proposed limit of disturbance. Miss Utility should be contacted prior to initiation of construction activities.

Environmental Impacts: Environmental impacts are not anticipated for this design.

Erosion and Sediment Control: Proper erosion and sediment controls are required including storm drain protection and silt fencing the construction boundary.

Project Photos

Photo 1 –Storm Drain

Photo 2 – Ponding in Parking Lot

Photo 3 – Parking Lot and Existing Storm Drain

Engineer Certification

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.
*License No. 35612_, Expiration Date: 4/23/2010_*

*License No. 26363_, Expiration Date: 1/2/2011_*

Project Overview

This conceptual plan consists of three separate projects related to restoring a portion of Dividing Creek located within the Anne Arundel Community College grounds:

A. Remove an existing outfall to the stream that originates at a stormwater management pond, relocate the pond outlet, and convey the pond outlet flow via a staggered regenerative storm conveyance system;
B. Retrofit an additional downstream stormwater outfall with another regenerative storm conveyance system; and
C. Restore the incised stream and reconnect it with the natural floodplain using a wetland seepage regime with a series of shallow pools and riffle weir grade controls.

Project Type: Regenerative storm conveyance retrofits and stream restoration

Watershed: Magothy River

Subwatershed: Dividing Creek (MGH)

Location: Anne Arundel Community College Campus; North of West Campus Road, off of College Parkway near Arnold, MD. (Figure 1)

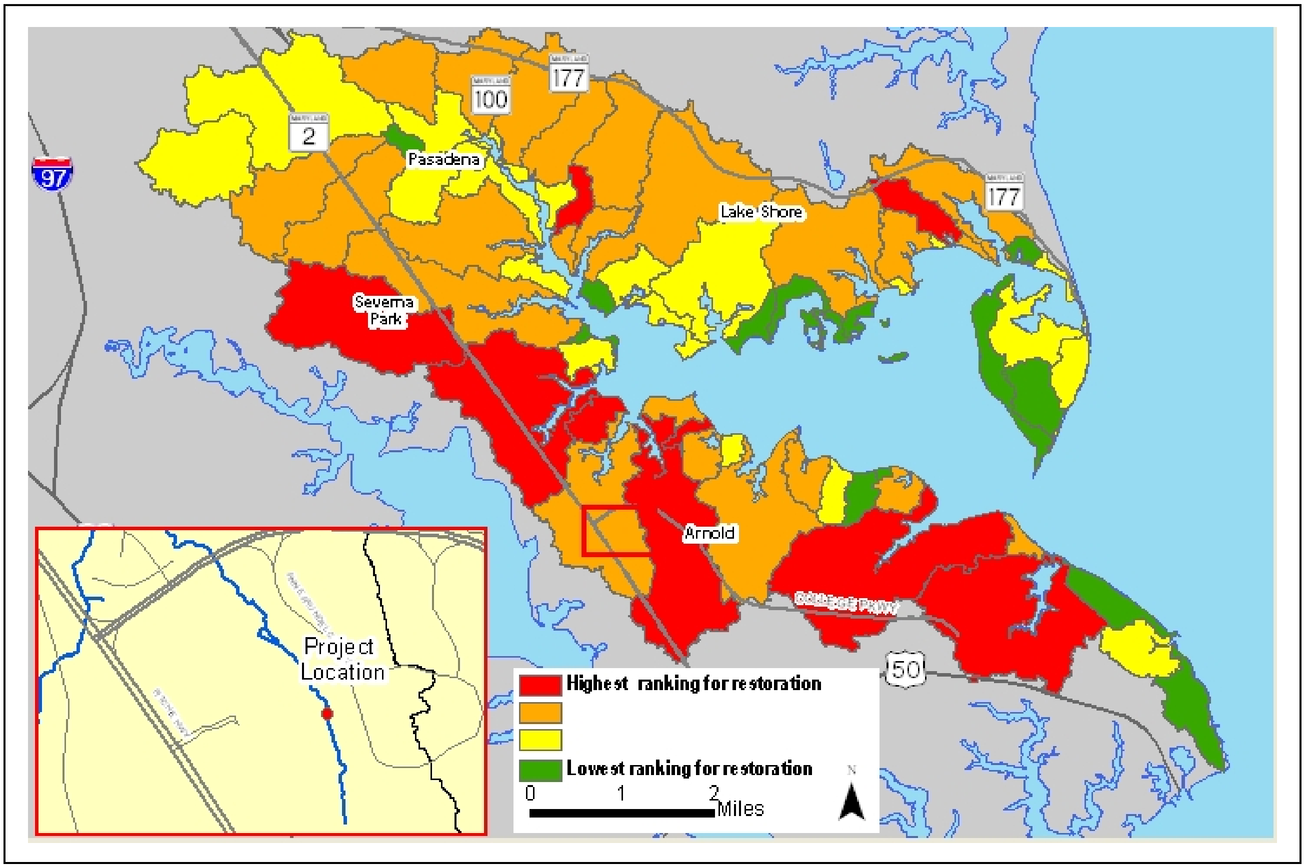


Figure 1 – Project Location Map

PROJECT A – Regenerative Storm Conveyance Retrofit #1

This project will remove an existing outfall to the stream that originates at a stormwater management pond, relocate the pond outlet, and convey the flow via a staggered regenerative storm conveyance system.

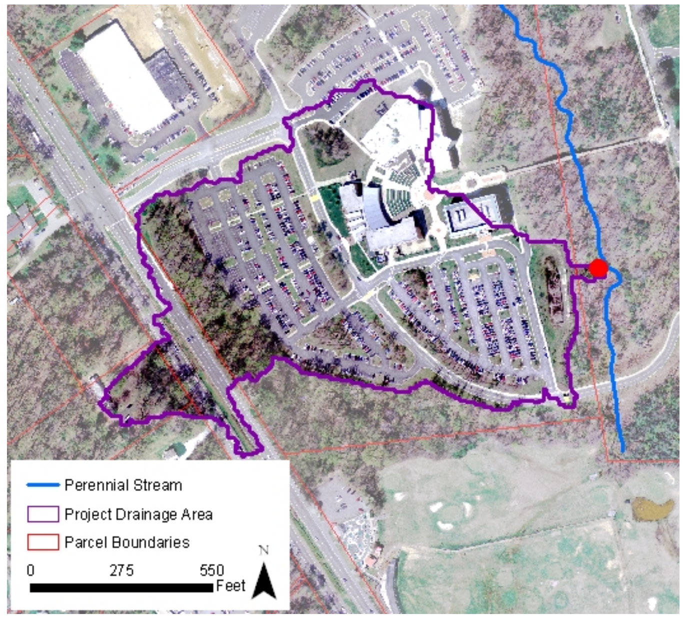


Figure 2 – Aerial Photo of Drainage Area (Project A)

Drainage Area Characteristics

Land Use: Institutional

Drainage Area: 21.0 acres

Impervious Area: 12.0 acres

Dominant Soils: Type A (2.0 ac): sandy loam, well drained with high infiltration rates; Type B (17.4 ac): silt loam or loam, moderate infiltration rate; Type C (1.6 ac): sandy clay loam, low infiltration rates

Hydrology:

	Weighted CN	Time of Conc (hrs)	Flow - 1 yr (cfs)	Flow - 2 yr (cfs)	Runoff - 1 yr (in)	Runoff - 2 yr (in)
Existing	84.0	0.258	32.0	44.0	1.27	1.77
Future	---	---	37.0	50.0	1.40	1.91

Project Benefits

Water Quality: Reduced velocity and increased infiltration will enhance removal of suspended particles and associated nutrients. Additionally, uptake of dissolved nutrients and adsorption of oils and greases by the plant material yield secondary water quality benefits above and beyond the benefits achieved through the primary water quality sand/woodchip mix filter.

	Existing Conditions						Future Conditions					
	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr
Pre-Install	9.0	2,530	2,470	2.29E10	2.2	4.0	9.0	2,530	2,470	2.29E10	2.2	4.0
Post-Install	3.6	1,520	2,470	4.59E9	0.3	1.6	3.6	1,520	2,470	4.59E9	0.3	1.6
% Diff.	60%	40%	0%	80%	86%	60%	60%	40%	0%	80%	86%	60%

Project Benefits (continued)

Stream Stability: Regenerative storm conveyances promote infiltration and decrease peak and cumulative flows, which decreases bed and bank erosion within Dividing Creek.

Aquatic Habitat: Reduction in erosion and pollutant loading improves instream aquatic habitat.

Conceptual Design

The existing outlet to an upgradient stormwater management pond will be removed and relocated to a topographic low point along the stream further to the south. A concrete headwall associated with the outfall from the existing outlet will be removed. Associated piping (80 ft of 30 inch reinforced concrete pipe (RCP), and 60 ft of 42 inch RCP) will be crushed and filled in place. A new outlet riser, manhole and outlet to the proposed system will be constructed. The new outlet from the pond will flow into a staggered regenerative storm conveyance system, which utilizes a series of shallow pools, riffle weir grade controls, native vegetation, and an underlying sand and compost filter to treat, detain, and safely convey runoff. The pools and riffles are designed to safely convey peak discharge from a 100-year storm, which is approximately 135 ft^3/s.

The length of the proposed system is 200 feet and will be staggered down an embankment to Dividing Creek. The elevation drop along the length is 16 feet. A 12-foot boulder cascade over the first 6 ft of elevation will be used to decrease the elevation drop prior to the step pools and riffles. The proposed cascade is followed by three additional and successive step pools each 10 feet long. Eight (8) pools and 8 riffles, each 10 feet long, are proposed to alternate down the remaining 10 foot elevation drop. The top of the riffle sections are proposed to be 16 feet wide. The proposed riffle depth is 1.7 feet.

Design Parameters	Value
Drainage area (acre)	21.0
Percent Impervious (%)	57.1
Volumetric runoff coefficient (R_v)	0.56
Water quality volume (WQ_v) (ft^3)	38,714
Peak discharge 100-year storm (ft^3/s)	135
Total length (ft)	200
Elevation drop over length (ft)	16.0
Cobble d_{50} size (ft)	0.5
Top width of riffle channel (ft)	16
Depth of riffle channel (D) (ft)	1.7
Depth of pools (h_f) (ft)	3.0
Length of pool segments (ft)	10
Length of riffle segments (ft)	10
Cascade length (ft)	12.0
Elevation drop over cascade (ft)	6.0
Cascade width (ft)	18.0
Cascade depth (ft)	0.85
Sand filter depth at pools (d_f(pool)) (ft)	1.5
Sand filter depth at riffles (d_f(riffle)) (ft)	3.5
Width of sand filter (W_{sand}) (ft)	12
Area of sand filter (A_f) (ft^2)	2,256

The filtration bed is sized to manage the water quality volume (WQ_v) associated with a 1 inch storm. The proposed size of the filtration bed is 2,256 sq ft with a depth at riffles of 3.5 feet and a depth at pools of 1.5 feet. The filtered flow from the system will discharge to Dividing Creek.

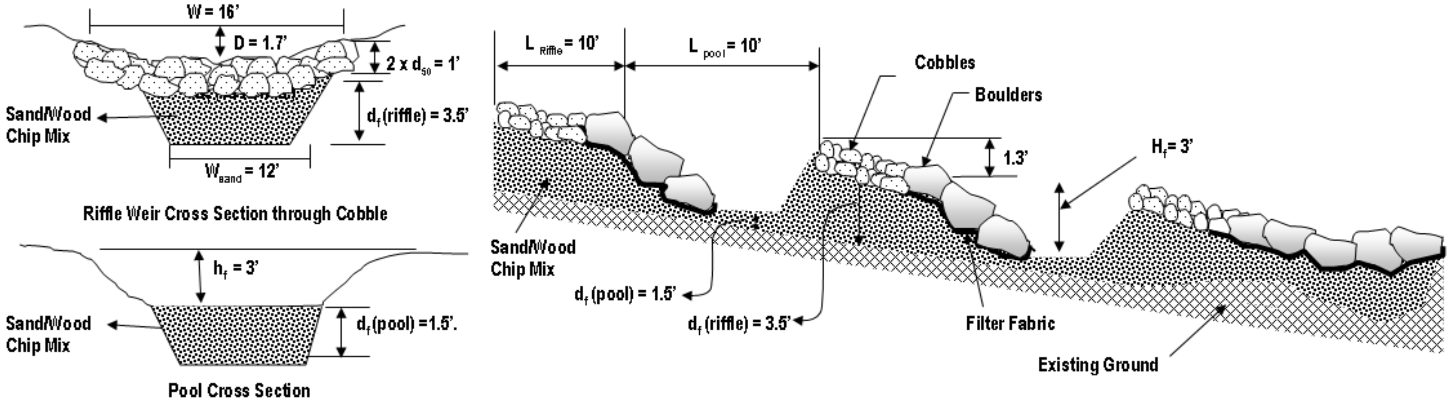


Figure 3 – Typical Profile and Cross Section of a Regenerative Storm Conveyance System (Source: Anne Arundel County)

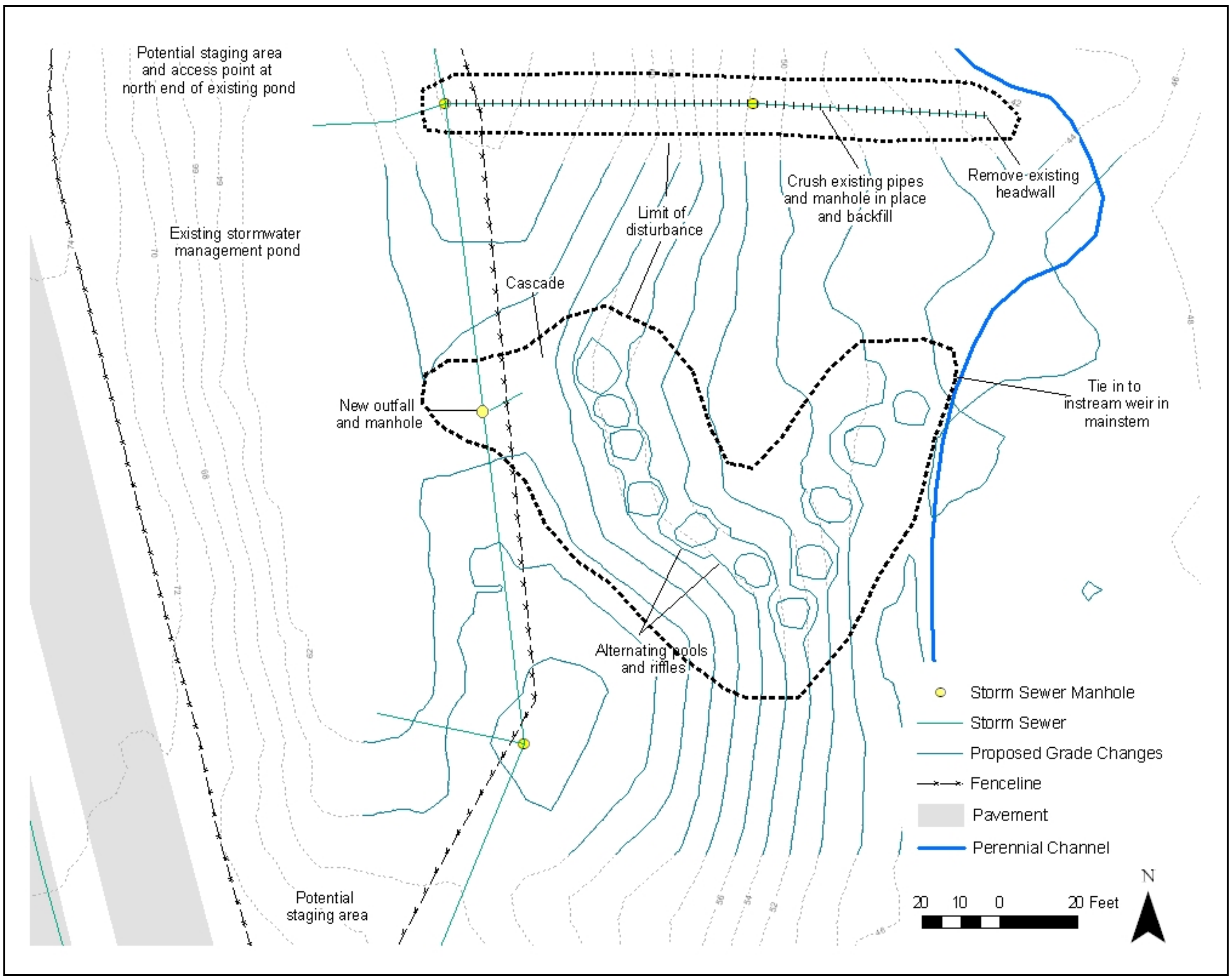


Figure 4 – Plan View of Regenerative Storm Conveyance System

Project Cost Estimate

Item Description	Quantity/Units		Unit Cost	Subtotal Cost
SITE PREP AND GRADING				
Mobilization/Demobilization (10% of total cost)	1	LS	---	$8,281.00
Survey Stake Out (5% of total cost)	1	LS	---	$4,140.50
Clearing/Tree Removal	650	sy	$4.00	$2,600.00
Erosion and Sediment Control	650	sy	$4.00	$2,600.00
Blaze Orange Fence	500	lf	$8.00	$4,000.00
Remove Headwall	100	sy	$50.00	$5,000.00
Grading, Excavation, Backfilling	1,600	cy	$20.00	$32,000.00
STEP POOLS AND RIFFLES				
Sandstone Boulders	40	cy	$240.00	$9,600.00
Cobble Weir (D50 = 6" Rock)	30	cy	$75.00	$2,250.00
Geotextile	90	sy	$4.00	$360.00
Wood Chips	40	cy	$25.00	$1,000.00
Sand Fill	100	cy	$60.00	$6,000.00
STRUCTURES				
New Pond Riser	1	LS	$12,000.00	$12,000.00
New Manhole and Outfall piping to Cascade	1	LS	$2,400	$2,400.00
PLANTING				
Plants (Trees, Shrubs, Herbs, and SAV)	300	sy	$10.00	$3,000.00
TOTAL CONSTRUCTION COSTS				**$95,231.50**
ENGINEERING AND MANAGEMENT				
Engineering				$50,000.00
Construction Management (15% of Construction)				$14,284.73
Contingency (20% of Total Construction)				$19,046.30
TOTAL PROJECT COSTS				**$178,562.53**

Project Constraints

Site Access: The property is owned by Anne Arundel Community College, so access agreements are needed along with establishing County easements for maintenance. Access to the site can be made via the parking lot off of West Campus Drive. A thickly vegetated steep embankment (14% grade) may limit heavy equipment access points. The right-of-way associated with the existing pond outlet pipe and outfall is largely unvegetated and could provide streamside access.

Project Constraints (continued)

Design/Construction: A topographical survey is necessary for final design. A geotechnical survey should be completed to confirm the infiltration capacity of site soils. Construction staging could occur on the north and/or south ends of the existing stormwater pond. Appropriate floodway/wetland construction permits will need to be acquired.

Utilities: It is unlikely that there will be any utility conflicts as no water or sewer lines exist near the proposed limit of disturbance. Miss Utility should be contacted prior to initiation of construction activities.

Environmental Impacts: Thick vegetation and several large trees may need to be removed. A tree protection plan is recommended. Other environmental impacts are not anticipated for this design.

Erosion and Sediment Control: Proper erosion and sediment controls are required including storm drain protection and silt fencing the construction boundary.

Project Photos

Photo 1 – Stormwater Management Pond

Photo 2 – Existing Outfall from Stormwater Management Pond

Photo 3 – Dividing Creek Downstream of Project A Outfall

PROJECT B – Regenerative Storm Conveyance Retrofit #2

This project will remove an existing stormwater outfall and retrofit it with a regenerative storm conveyance system to improve water quantity and quality management.

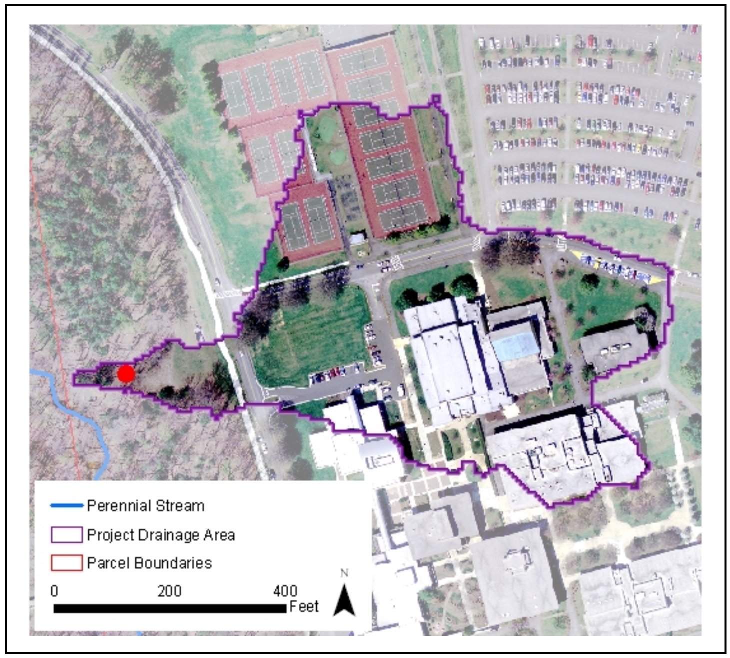


Figure 5 – Aerial Photo of Drainage Area (Project B)

Drainage Area Characteristics

Land Use: Institutional

Drainage Area: 7.9 acres

Impervious Area: 5.1 acres

Dominant Soils: Type B (7.89 ac): silt loam or loam, moderate infiltration rate; Type D (0.01 ac): clay loam, silty clay loam, sandy clay loam, sandy clay or clay with very low infiltration rates

Hydrology:

	Weighted CN	Time of Conc (hrs)	Flow - 1 yr (cfs)	Flow - 2 yr (cfs)	Runoff - 1 yr (in)	Runoff - 2 yr (in)
Existing	89.1	0.149	18.0	24.0	1.64	2.18
Future	---	---	19.0	25.0	1.69	2.24

Project Benefits

Water Quality: Reduced velocity and increased infiltration will enhance removal of suspended particles and associated nutrients. Additionally, uptake of dissolved nutrients and adsorption of oils and greases by the plant material yield secondary water quality benefits above and beyond the benefits achieved through the primary water quality sand/woodchip mix filter.

	Existing Conditions						Future Conditions					
	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr
Pre-Install	14.0	101	33.0	1.74E10	9.0	13.0	14.0	101	33.0	1.74E10	9.0	13.0
Post-Install	5.6	60.6	33	3.47E9	1.4	5.2	5.6	60.6	33	3.47E9	1.4	5.2
% Diff.	60%	40%	0%	80%	84%	60%	60%	40%	0%	80%	84%	60%

Project Benefits (continued)

Stream Stability: Regenerative storm conveyances promote infiltration and decrease peak and cumulative flows, which decreases bed and bank erosion within Dividing Creek.

Aquatic Habitat: Reduction in erosion and pollutant loading improves instream aquatic habitat.

Conceptual Design

The existing outfall at the Project B location will be removed and replaced with a staggered regenerative storm conveyance system, which utilizes a series of shallow pools, riffle weir grade controls, native vegetation, and an underlying sand and compost filter to treat, detain, and safely convey runoff. A concrete headwall and a sedimentation basin and approximately 125 ft of 48 inch diameter reinforced concrete pipe (RCP) associated with the outfall will be removed. Approximately 50 feet of RCP associated with the outfall will be crushed in place and backfilled. The pools and riffles are designed to safely convey peak discharge from a 100-year storm, which is approximately 64 ft^3/s.

Design Parameters	Value
Drainage area (acre)	7.9
Percent Impervious (%)	64.6
Volumetric runoff coefficient (R_v)	0.63
Water quality volume (WQ_v) (ft^3)	16,286
Peak discharge 100-year storm (ft^3/s)	64.0
Total length (ft)	320
Elevation drop over length (ft)	22.0
Cobble d_{50} size (ft)	0.5
Top width of riffle channel (ft)	10.0
Depth of riffle channel (D) (ft)	1.5
Depth of pools (h_f) (ft)	3.0
Length of pool segments (ft)	10.0
Length of riffle segments (ft)	10.0
Cascade length (ft)	12.0
Elevation drop over cascade (ft)	6.0
Cascade width (ft)	12.0
Cascade depth (ft)	0.7
Sand filter depth at pools (d_f(pool)) (ft)	1.5
Sand filter depth at riffles (d_f(riffle)) (ft)	3.5
Width of sand filter (W_{sand}) (ft)	4.0
Area of sand filter (A_f) (ft^2)	1,232

The length of the proposed system is 320 feet and will be staggered down an embankment to Dividing Creek. The elevation drop along the length is 22.0 feet. Fourteen (14) pools and 14 riffles, each 10 feet long, are proposed to alternate down the slope. A 12-ft long boulder cascade in the middle of the project length will be used to traverse a 6 ft elevation drop leading to the remaining step pools and riffles. The cascade is followed immediately by three additional and successive step pools. The top of the riffle sections are proposed to be 10 feet wide.

The proposed riffle depth is 1.5 feet. The filtration bed is sized to manage the water quality volume (WQ_v) associated with a 1 inch storm. The proposed size of the filtration bed is 1,232 sq ft with a depth at riffles of 3.5 feet and a depth at pools of 1.5 feet. The filtered flow from the system will discharge to Dividing Creek.

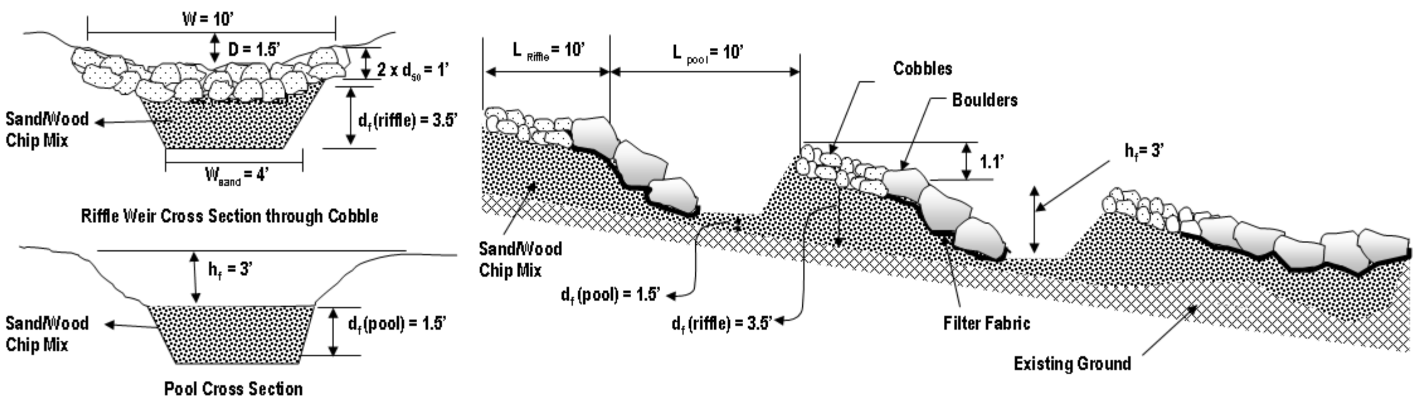


Figure 6 – Typical Profile and Cross Section of a Regenerative Storm Conveyance System (Source: Anne Arundel County)

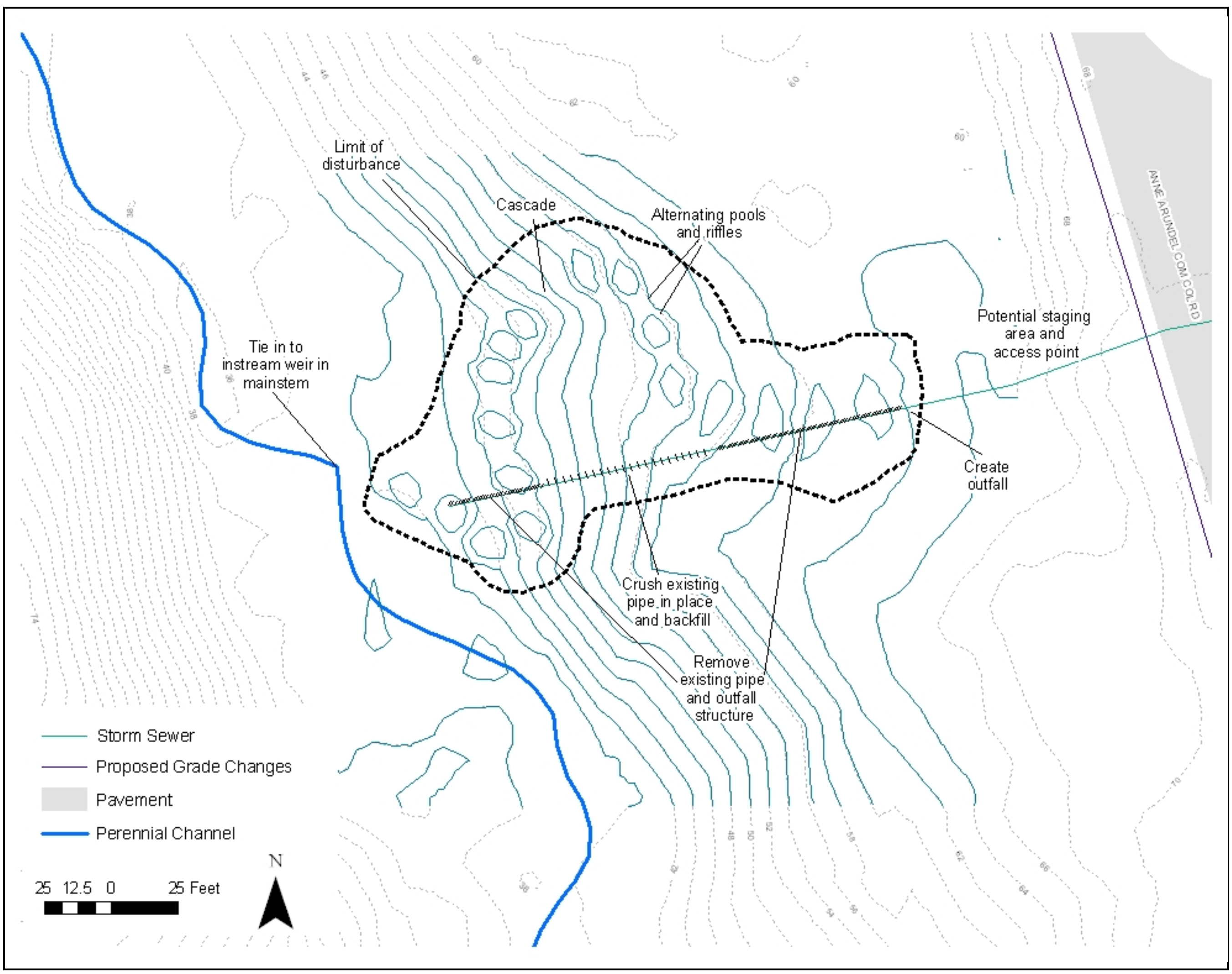


Figure 7 – Plan View of Regenerative Storm Conveyance System

Project Cost Estimate

Item Description	Quantity/Units		Unit Cost	Subtotal Cost
SITE PREP AND GRADING				
Mobilization/Demobilization (10% of total cost)	1	LS	---	$8,410.50
Survey Stake Out (5% of total cost)	1	LS	---	$4,205.25
Clearing/Tree Removal	1,300	sy	$4.00	$5,200.00
Erosion and Sediment Control	2,000	sy	$4.00	$8,000.00
Blaze Orange Fence	600	lf	$8.00	$4,800.00
Remove Concrete Pipe, Manhole, and Headwall	350	sy	$50.00	$17,500.00
Grading, Excavation, Backfilling	1,400	cy	$20.00	$28,000.00
STEP POOLS AND RIFFLES				
Sandstone Boulders	45	cy	$240.00	$10,800.00
Cobble Weir (D50 = 8" Rock)	40	cy	$75.00	$3,000.00
Filter Fabric	120	sy	$4.00	$480.00
Wood Chips	25	cy	$25.00	$625.00
Sand Fill	50	cy	$60.00	$3,000.00
STRUCTURES				
Outfall - Bell end	1	ea	$1,200.00	$1,200.00
PLANTING				
Plants (Trees, Shrubs, Herbs, and SAV)	150	sy	$10.00	$1,500.00
TOTAL CONSTRUCTION COSTS				**$96,720.75**
ENGINEERING AND MANAGEMENT				
Engineering (25% of Construction or $50,000 minimum)				$50,000.00
Construction Management (15% of Construction)				$14,508.11
Contingency (20% of Total Construction)				$19,344.15
TOTAL PROJECT COSTS				**$180,573.01**

Project Constraints

Site Access: The property is owned by Anne Arundel Community College, so access agreements are needed along with establishing County easements for maintenance. Access to the site can be made via Anne Arundel Community College Road. A thickly vegetated steep embankment (up to 20% grade) may limit heavy equipment access points. The right-of-way associated with the existing storm pipe and outfall could provide project access.

Project Constraints (continued)

Design/Construction: A topographical survey is necessary for final design. A geotechnical survey should be completed to confirm the infiltration capacity of site soils. Construction staging could occur in the unvegetated area above the new proposed outfall location. Appropriate floodway/wetland construction permits will need to be acquired.

Utilities: It is unlikely that there will be any utility conflicts as no water or sewer lines exist near the proposed limit of disturbance. Miss Utility should be contacted prior to initiation of construction activities.

Environmental Impacts: Thick vegetation and several large trees may need to be removed. A tree protection plan is recommended. Other environmental impacts are not anticipated for this design.

Erosion and Sediment Control: Proper erosion and sediment controls are required including storm drain protection and silt fencing the construction boundary.

Project Photos

Photo 4 – Existing Outfall at Project B

Photo 5 – Dividing Creek Downstream of Project B Outfall

PROJECT C – Stream Restoration

This project entails restoring an incised portion of Dividing Creek and reconnecting it with the natural floodplain using a wetland seepage regime. A series of shallow pools and riffle weir grade controls will be used to stabilize the channel, reduce wet-weather velocities, prevent further downcutting, and improve floodplain wetlands areas. This restoration, when further coupled with the outfall modifications proposed in Projects A and B, will improve stream character and habitat.

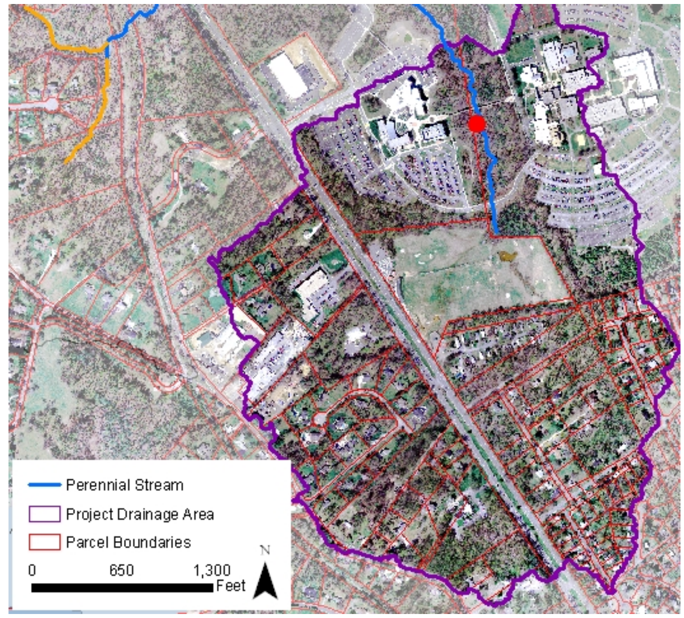


Figure 8 – Aerial Photo of Drainage Area (Project C)

Drainage Area Characteristics

Land Use: Commercial, institutional, residential

Drainage Area: 222.3 acres

Impervious Area: 68.0 acres

Surface Soils:
Type A (19.5 ac): sandy loam, well drained with high infiltration rates; Type B (148 ac): silt loam or loam, moderate infiltration rate; Type C (46.2 ac): sandy clay loam, low infiltration rates; Type D (8.6 ac): clay loam, silty clay loam, sandy clay loam, sandy clay or clay with very low infiltration rates

Hydrology:

	Weighted CN	Time of Conc (hrs)	Flow - 1 yr (cfs)	Flow - 2 yr (cfs)	Runoff - 1 yr (in)	Runoff - 2 yr (in)
Existing	70.2	0.977	56.0	98.0	0.56	0.90
Future	---	---	139	217	0.82	1.23

Project Benefits

Stream Stability: Grade and bed stabilization measures will reduce peak velocities for flows by reconnecting the streambed with the existing floodplain. This will greatly improve stability within the restored stream.

Aquatic Habitat: Reductions in peak velocities and pollutant loadings will improve aquatic habitat.

Water Quality: Reduced velocity will reduce downstream transport of suspended particles and associated nutrients.

Project Benefits (continued)

	Existing Conditions						Future Conditions					
	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr
Pre-Install	179	4,740	3,820	2.26E11	91.4	145	184	4,050	2,967	2.8E11	99.6	158
Post-Install	107	2,840	2,290	1.36E11	54.8	87.0	110	2,430	1,780	1.68E11	59.8	94.8
% Diff.	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%

Conceptual Design

The proposed plan will restore approximately 1,100 linear feet of Dividing Creek that has been actively downcutting due to increased flows associated with development. The proposed restoration reach begins on the north side of West Campus Drive and extends north approximately 1,100 feet.

Preliminary review of hydrology and hydraulics confirms grade controls are necessary to prevent further erosion following restoration. The conceptual plan for restoration entails filling the incised channel with a sand and gravel mix to raise the stream bed elevation. The restoration will use seepage wetland techniques consisting of a series of shallow pools and riffle weir grade controls.

Design Parameters	Value
Total length (ft)	1,100
Elevation drop over length (ft)	9.0
Cobble d_{50} size (ft)	0.5
Top width of riffle channel (ft)	50.0
Depth of riffle channel (D) (ft)	1.0
Depth of pools (h_f) (ft)	3.0
Length of pool segments (ft)	60.0
Length of riffle segments (ft)	60.0

The elevation drop along the stream length is 9.0 feet. Using sizing techniques developed by the County, nine (9) pools and 9 riffles, each 60 feet long, are proposed to alternate along the channel length. The top of riffle sections are proposed to be 50 feet wide. The proposed riffle depth is 1.0 feet to maximize connection with the existing floodplain. The maximum pool depth is proposed to be 3 feet. The regenerative storm conveyance retrofits associated with Projects A and B will be tied into the main stem restoration at the closest riffle weirs. As appropriate, wider floodplain areas could be graded to create floodplain moats that allow for additional water storage. These moats could be lined with sand seepage berms for additional water quality improvements. The need for and placement and sizing of these moats and sand seepage berms should be determined as part of the final design. Additionally a detailed survey of topography and trees followed by further hydrologic and hydraulic analyses is necessary, both to confirm preliminary flow estimates and to account for planned peak flow reductions associated with Projects A and B.

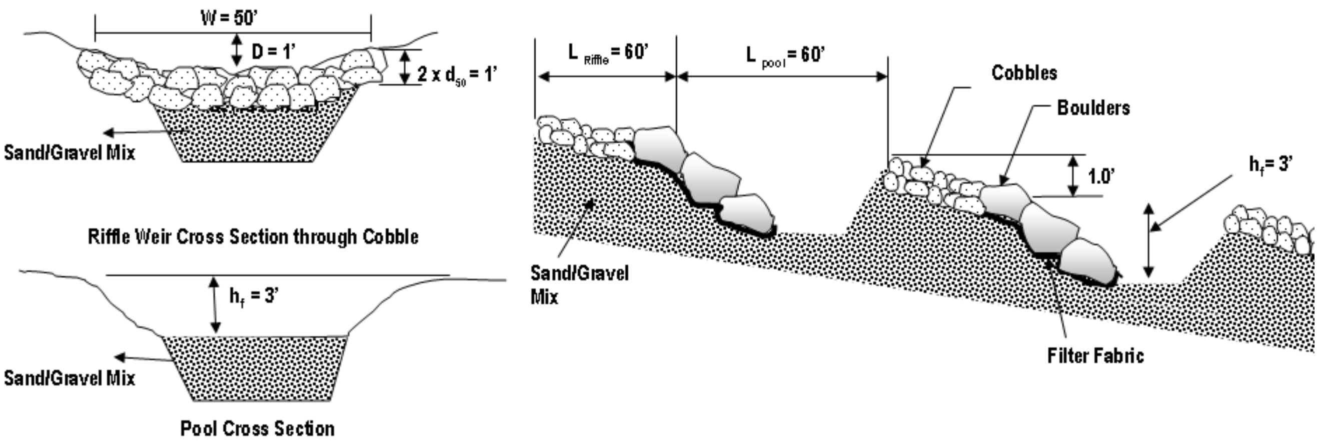


Figure 9 – Profile and Cross Section of Riffle and Pool Wetland Seepage System (Source: Anne Arundel County)

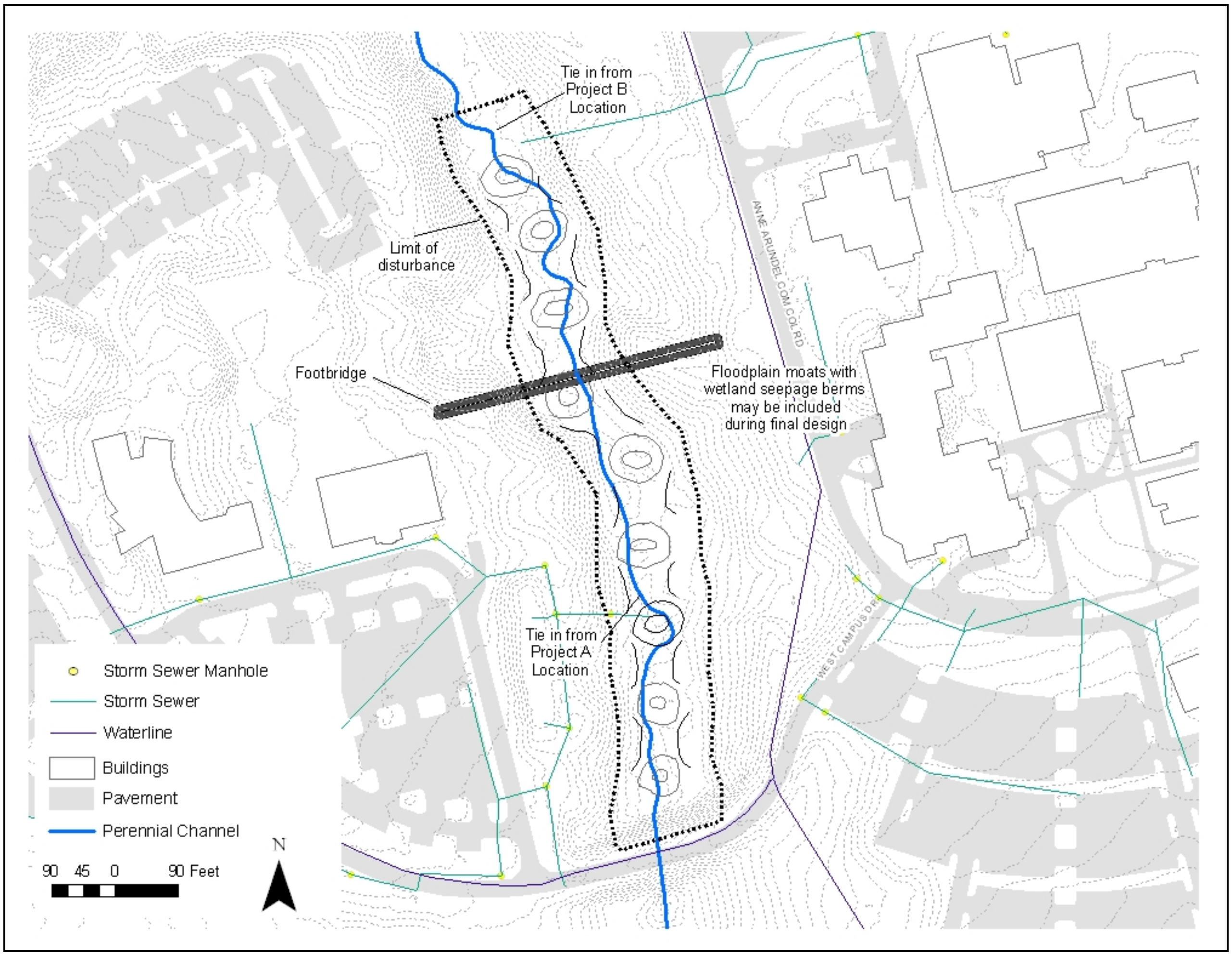


Figure 10 – Plan View of Reach Restoration

Project Cost Estimate

Item Description	Quantity/Units		Unit Cost	Subtotal Cost
SITE PREP AND GRADING				
Mobilization/Demobilization (10% of Total Costs)	1	LS		$27,150.00
Survey Stake Out (5% Total Costs)	1	LS		$13,575.00
Erosion and Sediment Control	7,000	sy	$4.00	$28,000.00
Blaze Orange Fence	2,500	lf	$8.00	$20,000.00
Clearing/Tree Removal	4,000	sy	$4.00	$16,000.00
Excavation, Grading and Filling	725	sy	$20.00	$14,500.00
STEP POOLS AND RIFFLES				
Sandstone Boulders	150	cy	$240.00	$36,000.00
Cobble Weir (D50 = 6" Rock)	1,000	cy	$75.00	$75,000.00
Sand Fill	700	cy	$60.00	$42,000.00
PLANTING				
Plants (Trees, Shrubs, Herbs, and SAV)	4,000	sy	$10.00	$40,000.00
TOTAL CONSTRUCTION COSTS				**$312,225.00**
ENGINEERING AND MANAGEMENT				
Engineering (25% of Construction)				$78,056.25
Construction Management (15% of Construction)				$46,833.75
Contingency (20% of Total Construction)				$62,445.00
TOTAL PROJECT COSTS				**$499,560.00**

Project Constraints

Site Access: The property is owned by Anne Arundel Community College, so access agreements are needed along with establishing County easements for maintenance. Access to the area can be made via Anne Arundel Community College Road or West Campus Drive. A thickly vegetated steep embankment (up to 20% grade) may limit heavy equipment access points. The areas cleared as part of construction of Projects A and B could provide project access.

Design/Construction: A topographical survey is necessary to confirm the potential extent of the conceptual design and to confirm that there are no conflicts with the existing Community College foot path along the stream valley. Construction staging could occur in the staging areas associated with Projects A and B. Appropriate floodway/wetland construction permits will need to be acquired.

Utilities: It is unlikely that there will be any utility conflicts as no water or sewer lines exist near the proposed limit of disturbance. Miss Utility should be contacted prior to initiation of construction activities.
Environmental Impacts: Thick vegetation and several large trees may need to be removed. A tree protection plan is recommended. Other environmental impacts are not anticipated for this design.

Erosion and Sediment Control: Proper erosion and sediment controls are required including downstream silt fencing. Stream diversion will likely be necessary during some restoration activities.

Project Photos

Photo 6 – Twin Culverts Conveying Flow From Under West Campus Drive

Photo 7 – Outfall on East Side of Stream Opposite Project A Outfall

Photo 8 – Dividing Creek Downstream of Project A Outfall

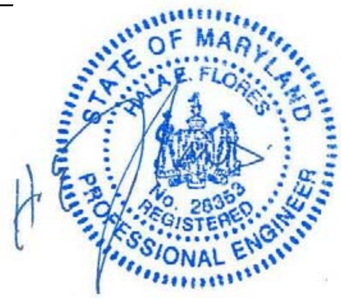
Photo 9 – Dividing Creek Upstream of Project A Outfall

Photo 10 – Dividing Creek Downstream of Project B Outfall

Engineer Certification

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.
*License No. 35612_, Expiration Date: 4/23/2010_*

*License No. 26363_, Expiration Date: 1/2/2011_*



Conceptual Design Plan

Project Overview

An existing infiltration basin in a residential area is no longer functioning as designed and is detaining water beyond an acceptable residence time. In addition, properties located downgradient of the basin reportedly experience occasional flooding issues. This project will retrofit the basin with a regenerative storm conveyance system to improve water quantity and water quality management to Cypress Creek and alleviate downgradient residential flooding issues.

Project Type: Regenerative storm conveyance retrofit

Watershed: Magothy River

Subwatershed: Cypress Creek (MGC)

Location: Between Isaiah Drive and Dunkeld Court, north of Cypress Creek Road in Severna Park, MD. (Figures 1 and 2)

Drainage Area Characteristics

Land Use: Residential

Drainage Area: 19.5 acres

Impervious Area: 8.6 acres

Dominant Soils: Type A (0.5 ac): sandy loam, well drained with high infiltration rates; Type B (1.7 ac): silt loam or loam, moderately well drained with moderate infiltration rate; Type C (17.2 ac): sandy clay loam, low infiltration rates

Hydrology:

Parameter	Value
Weighted Curve Number	81.6
Time of Concentration (hrs)	0.387
Flow 1-yr- Existing Cond (cfs)	21
Flow 2-yr- Existing Cond (cfs)	30
Runoff 1-yr- Existing Cond (in)	1.12
Runoff 2-yr- Existing Cond (in)	1.59
Flow 1-yr- Future Cond (cfs)	21
Flow 2-yr- Future Cond (cfs)	30
Runoff 1-yr- Future Cond (in)	1.12
Runoff 2-yr- Future Cond (in)	1.59

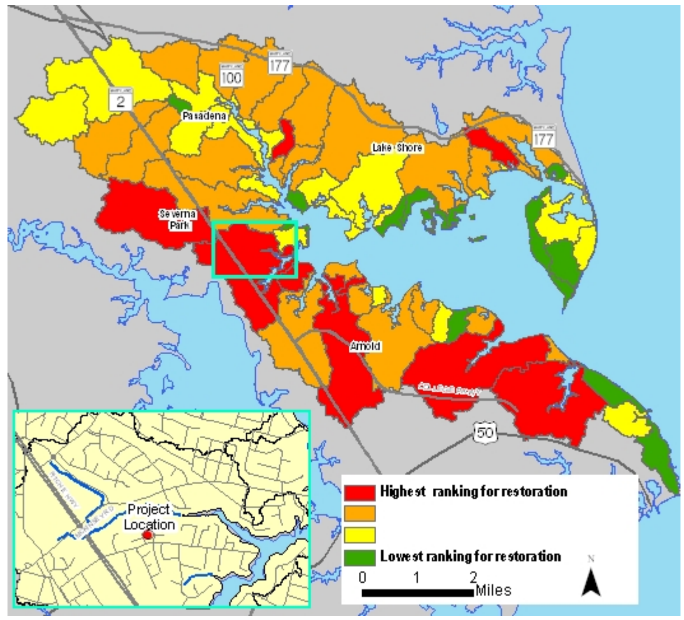


Figure 1 – Project Location Map

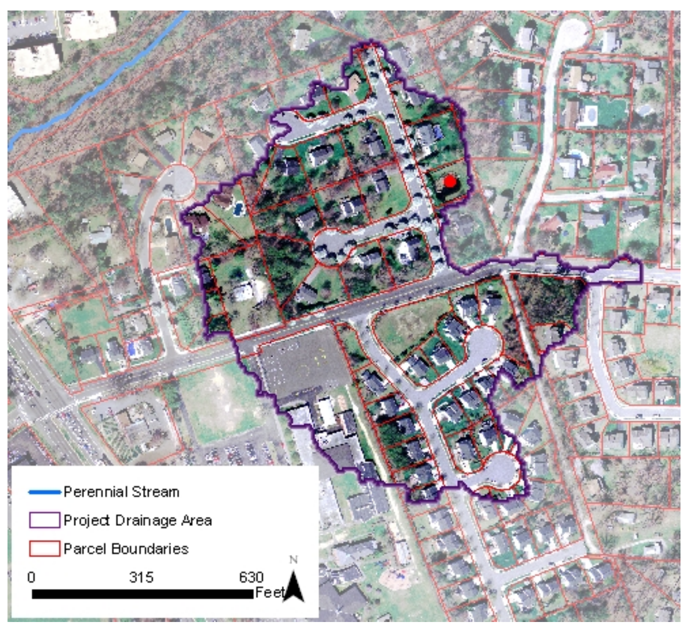


Figure 2 – Aerial Photo of Project Drainage Area

Project Benefits

Water Quality: Reduced velocity and increased infiltration will enhance removal of suspended particles and associated nutrients. Additionally, uptake of dissolved nutrients and adsorption of oils and greases by the plant material yield secondary water quality benefits above and beyond the benefits achieved through the primary water quality sand/woodchip mix filter.

	Existing Conditions						Future Conditions					
	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr
Pre-Install	24	643	509	5.41E10	11	11	24	643	509	5.41E10	11	11
Post-Install	9.6	386	509	1.08E10	1.7	4.4	9.6	386	509	1.08E10	1.7	4.4
% Diff	60%	40%	0%	80%	85%	60%	60%	40%	0%	80%	85%	60%

Stream Stability: A regenerative storm conveyance retrofit will decrease peak and cumulative flows to Cypress Creek thus decreasing downstream bed and bank erosion.

Aquatic Habitat: Reduction in erosion and pollutant loading improves instream aquatic habitat. A decrease in thermal pollution is also expected to improve biotic health and habitat.

Conceptual Design

The existing infiltration basin and a 110-foot section of 6-inch PVC pipe will be replaced with a regenerative storm conveyance system retrofit, which utilizes a series of shallow pools, riffle weir grade controls, native vegetation, and an underlying sand and compost filter to treat, detain, and safely convey drainage area runoff.

The length of the proposed system is 200 feet. The pools and riffles are designed to safely convey peak discharge from a 10-year storm, which is approximately 61 ft^3/s. Three pools and two riffles, on average 40 feet long, are proposed to alternate the length of the system. The elevation drop along the length is 3.5 feet. The proposed riffle width is 15 feet and the proposed riffle channel depth is 1.5 feet. The proposed size of the filtration bed is 3,000 sq ft with an average depth of 1.5 ft. Non-infiltrated flow is proposed to exit the system via a new 24-inch HDPE pipe that will convey flow 380 feet beneath downgradient properties where it will connect with an existing 24-inch by 30-inch RCP.

Design Parameters	Value
Drainage area (acre)	19.5
Percent Impervious (%)	43.9
Volumetric runoff coefficient (R_v)	2
Water quality volume (WQ_v) (ft^3)	132,860
Peak discharge 10-year storm (ft^3/s)	61
Total length (ft)	200
Elevation drop over length (ft)	3.5
Cobble d_{50} size (ft)	0.5
Top width of riffle channel (ft)	15
Depth of riffle channel (D) (ft)	1.5
Depth of pools (h_f) (ft)	1.5
Length of pool segments (ft)	30
Length of pool segments (ft)	30
Average depth of sand filter (d_f) (ft)	1.5
Width of sand filter (W_{sand}) (ft)	15
Area of sand filter (A_f) (ft^2)	3,000

Conceptual Design (continued)

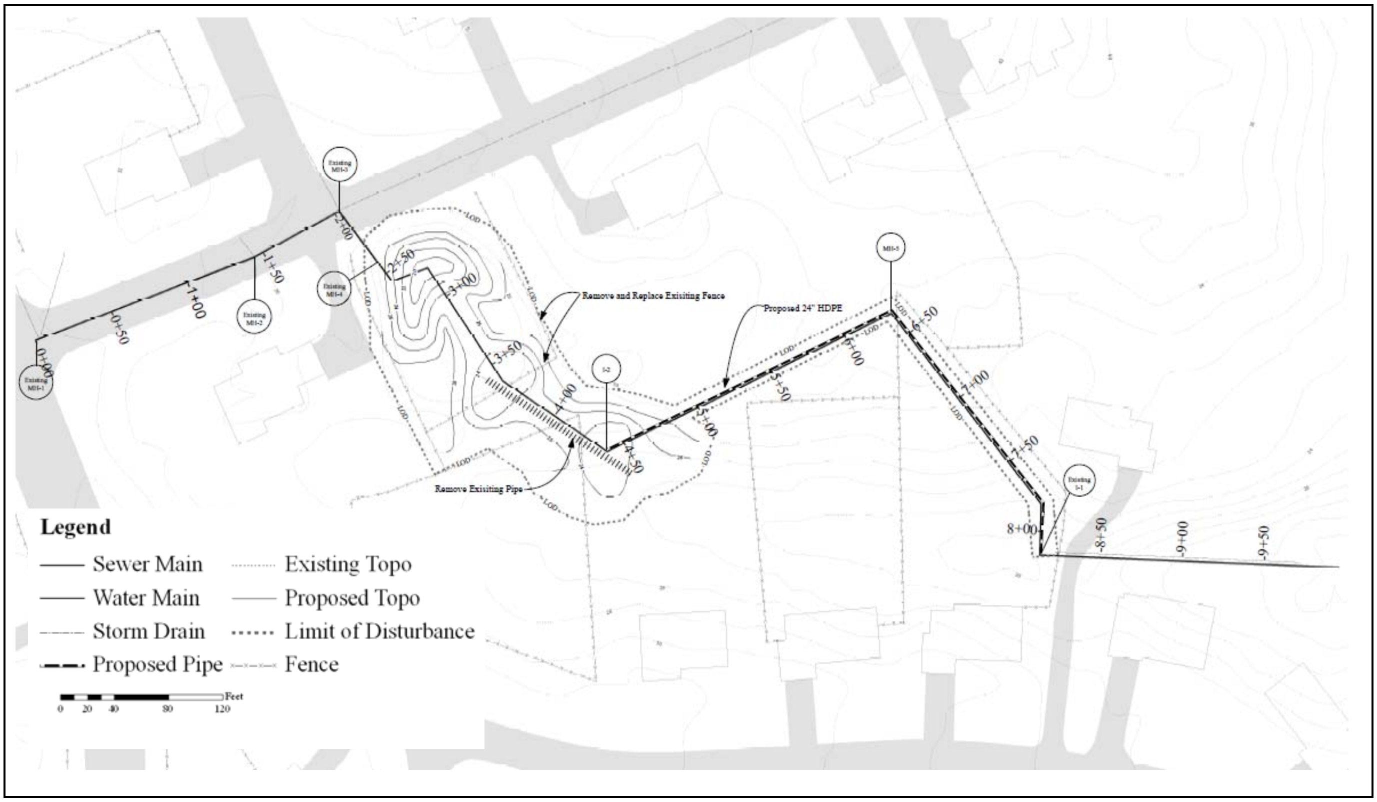


Figure 3 – Plan View of Regenerative Storm Conveyance System

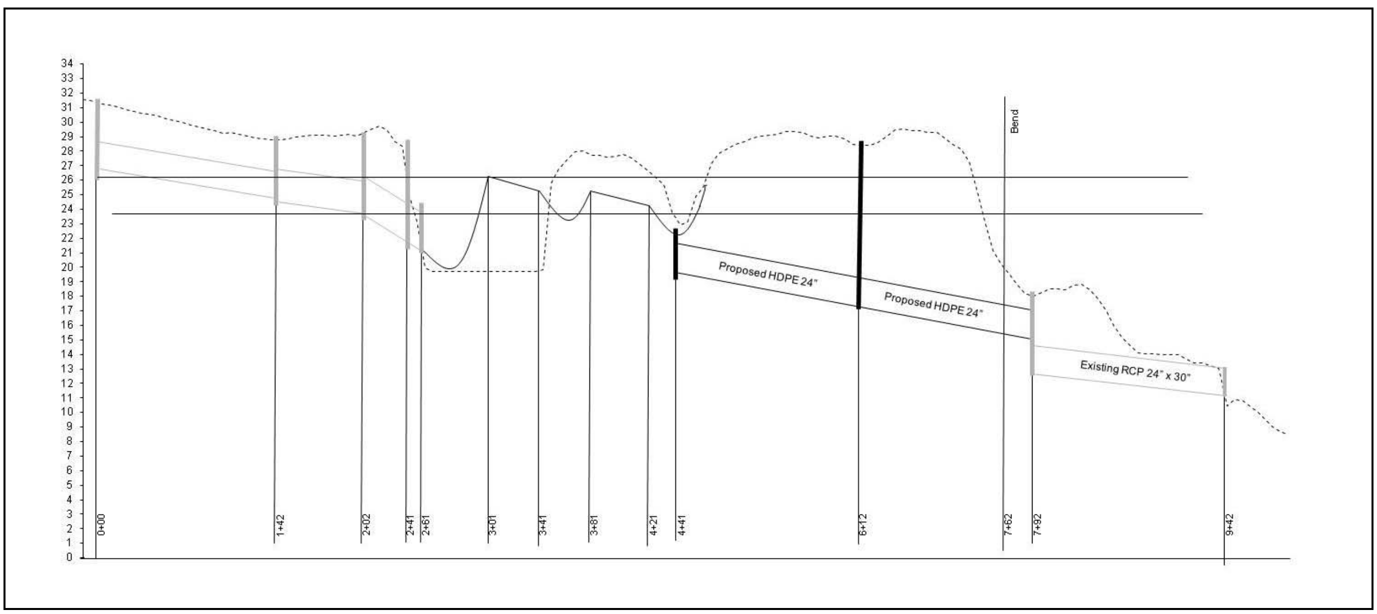


Figure 4 – Profile of Regenerative Storm Conveyance System

Project Cost Estimate

Item Description	Quantity/Units		Unit Cost	Subtotal Cost
SITE PREP AND GRADING				
Mobilization/Demobilization (10% Total Cost)	1	LS		$8,247.50
Survey Stake Out (5% Total Cost)	1	LS		$4,123.75
Clearing and Grubbing	1,600	sy	$2.00	$3,200.00
Erosion and Sediment Control	1,600	sy	$4.00	$6,400.00
Blaze Orange Fence	1,200	lf	$8.00	$9,600.00
Grading, Excavation, Backfilling	1,200	cy	$20.00	$24,000.00
STEP POOLS AND RIFFLES				
Sandstone Boulders	20	cy	$240.00	$4,800.00
Cobble Weir (D50 = 6" Rock)	35	cy	$75.00	$2,625.00
Geotextile	75	sy	$4.00	$300.00
Wood Chips	50	cy	$25.00	$1,250.00
Sand Fill	120	cy	$60.00	$7,200.00
STRUCTURES				
New HDPE Pipe	380	lf	$25.00	$9,500.00
New Manhole	1	LS	$3,600.00	$3,600.00
PLANTING				
Plants (Trees, Shrubs, Herbs, and SAV)	1,000	sy	$10.00	$10,000.00
TOTAL CONSTRUCTION COSTS				**$94,846.25**
ENGINEERING AND MANAGEMENT				
Engineering (20% of Construction)				$18,969.25
Construction Management (15% of Construction)				$14,226.94
Contingency (5% of Total Construction)				$4,742.31
TOTAL PROJECT COSTS				**$132,784.75**

Project Constraints

Site Access: The existing infiltration basin is owned by Anne Arundel County. The new pipe installation may encroach on private property. Access will need to be obtained and County right-of-way may need to be established. Unencumbered access to the site can be made via Isaiah Drive. Construction staging could occur on Isaiah Drive.

Design/Construction: A topographical survey is necessary, and a geotechnical survey should be completed to confirm the infiltration capacity of site soils. The existing fence around the existing infiltration basin and a landowner fence south of the basin will need to be removed to accommodate the regenerative storm conveyance system. The location of septic drainfields will need to be identified and avoided.

Utilities: Water lines are located near the limit of disturbance along Isaiah Drive. Miss Utility should be contacted prior to initiation of construction activities.

Environmental Impacts: Several small caliper trees may need to be removed. Other environmental impacts are not anticipated for this design.

Erosion and Sediment Control: Proper erosion and sediment controls are required including storm drain protection and silt fencing the construction boundary.

Project Photos

Photo 1 - Existing Infiltration Basin

Photo 2 – Existing Infiltration Basin

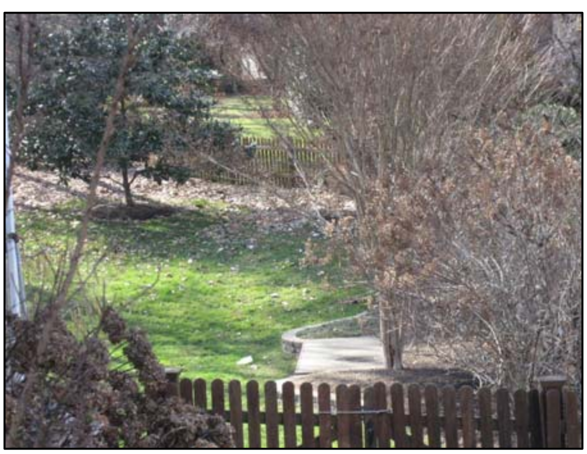
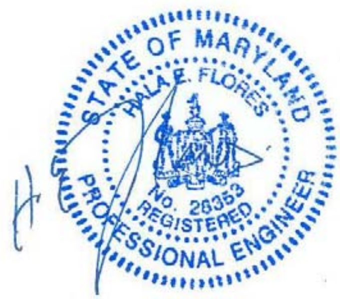


Photo 3 – Tie-in Location for Proposed Pipe

Engineer Certification

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.

*License No. 26363_, Expiration Date: 1/2/2011_*



North Cypress Creek Linear BMP Retrofit

Conceptual Design Plan

Project Overview

This project will retrofit an existing extended detention BMP that is located south of Leelyn Drive and north of the Village Square Shopping center and drains a largely residential area, with a regenerative storm conveyance (step-pool storm conveyance) system to improve water quantity and water quality management to Cypress Creek.

Project Type: Regenerative Storm Conveyance

Watershed: Magothy River

Subwatershed: Cypress Creek (MGC)

Location: South of Leelyn Drive; north of Village Square shopping plaza, near Ritchie Highway (Rte 2) in Severna Park, MD. (See Figures 1 and 2)

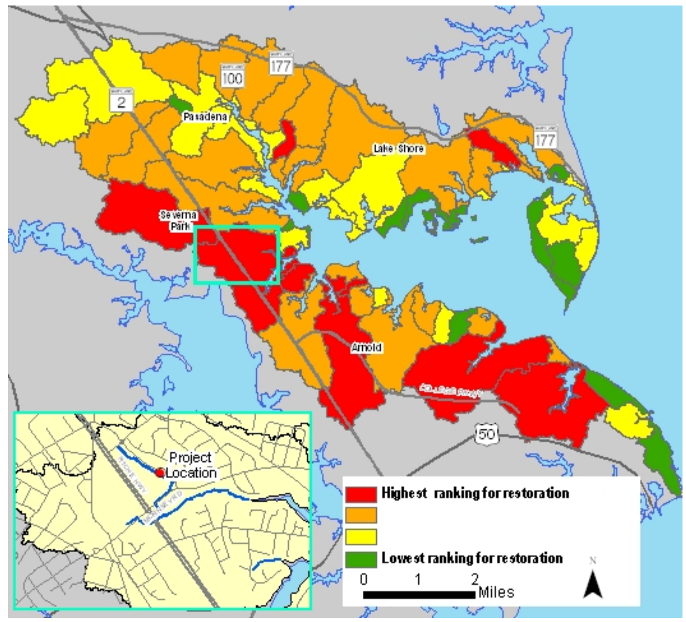


Figure 1– Project Location

Drainage Area Characteristics

Land Use: Residential, commercial

Drainage Area: 55.8 acres

Impervious Area: 23.9 acres

Dominant Soils: Type B (30.7 ac): silt loam or loam, moderately well drained with moderate infiltration rate; Type C (7.0 ac): sandy clay loam, low infiltration rates; Type D (18.1 ac): clay loam, silty clay loam, sandy clay loam, sandy clay or clay with very low infiltration rates

Hydrology:

Parameter	Value
Weighted Curve Number	75.9
Time of Concentration (hrs)	0.524
Flow 1-yr- Existing Cond (cfs)	35
Flow 2-yr- Existing Cond (cfs)	55
Runoff 1-yr- Existing Cond (in.)	0.82
Runoff 2-yr- Existing Cond (in.)	1.22
Flow 1-yr- Future Cond (cfs)	58
Flow 2-yr- Future Cond (cfs)	84
Runoff 1-yr- Future Cond (in.)	1.12
Runoff 2-yr Future Cond (in.)	1.59

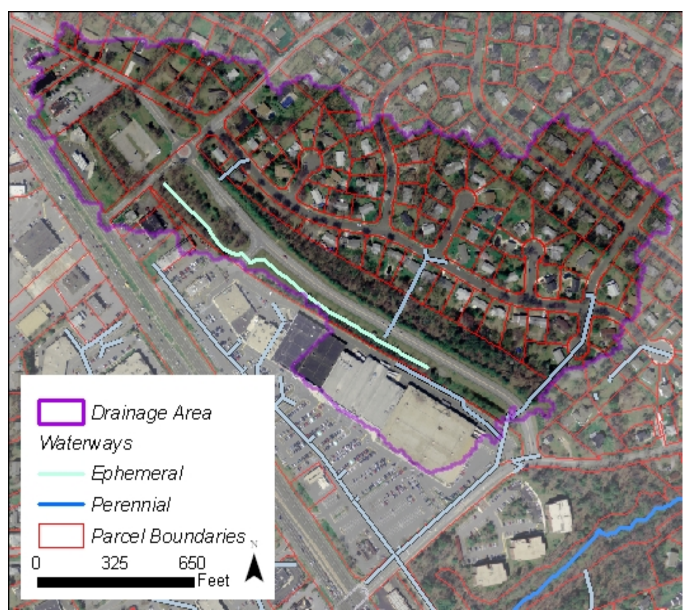


Figure 2 – Aerial Photo of Project Drainage Area

Project Benefits

Water Quality: Reduced velocity and increased infiltration will enhance removal of suspended particles and associated nutrients. Additionally, uptake of dissolved nutrients and adsorption of oils and greases by the plant material yield secondary water quality benefits above and beyond the benefits achieved through the primary water quality sand/woodchip mix filter.

	Existing Conditions						Future Conditions					
	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr
Pre-Install	61	487	176	9.71E10	30.5	36.0	61	520	179	1.09E11	31.8	39
Post-Install	24.4	292.2	176	1.94E10	4.6	14.4	24.4	312	179	2.17E10	4.8	15.6
% Diff.	60%	40%	0%	80%	85%	60%	60%	40%	0%	80%	85%	60%

Stream Stability: A regenerative storm conveyance retrofit will decrease peak and cumulative flows to Cypress Creek thus decreasing downstream bed and bank erosion.

Aquatic Habitat: Reduction in erosion and pollutant loading improves instream aquatic habitat. A decrease in thermal pollution is also expected to improve biotic health and habitat.

Conceptual Design

Step pool conveyance systems utilize a series of shallow pools, riffle grade controls, native vegetation, and an underlying sand and compost filter to treat, detain, and safely convey drainage area runoff. The pools and riffles are designed to safely convey peak discharge from a 100-year storm, which is approximately 217 ft^3/s. The length of the proposed system is 650 feet. Eight pools and eight riffles, each 40 feet long, are proposed. The elevation drop along the length is 7.3 feet. The proposed riffle width is 30 ft and the proposed riffle depth is 2.5 feet. The filtration bed is sized to manage the water quality volume (WQ_v) associated with a 1 inch storm. The proposed size of the filtration bed is 3,703 sq ft. The filtered flow from the system will enter the storm sewer system through an existing drain located at the terminus of the project area.

Design Parameters	Value
Drainage area (acre)	55.7
Percent Impervious (%)	43
Volumetric runoff coefficient (R_v)	0.436
Water quality volume (WQ_v) (ft^3)	79,372
Peak discharge 100-year storm (ft^3/s)	217
Total length (ft)	650
Elevation drop over length (ft)	7.3
Cobble d_{50} size (ft)	0.5
Top width of riffle channel (W) (ft)	30
Depth of riffle channel (D) (ft)	2.5
Depth of pools (h_f) (ft)	4.0
Length of riffle segments (ft)	40
Length of pool segments (ft)	40
Sand filter depth at pools (d_f(pool)) (ft)	1.5
Sand filter depth at riffles (d_f(riffle)) (ft)	4.5
Width of sand filter (W_{sand}) (ft)	6.0
Area of sand filter (A_f) (ft^2)	3,703

Conceptual Design (continued)

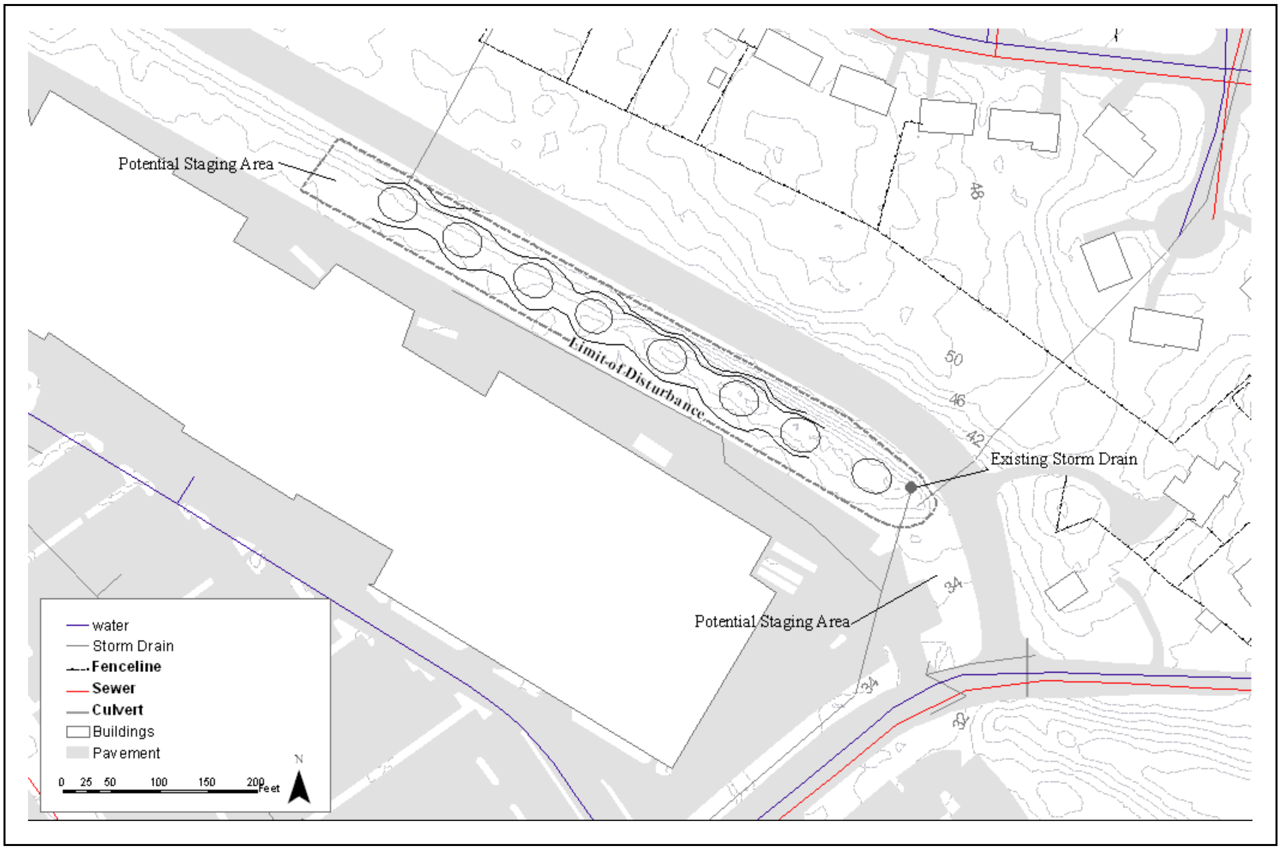


Figure 3 – Plan View of Regenerative Storm Conveyance System

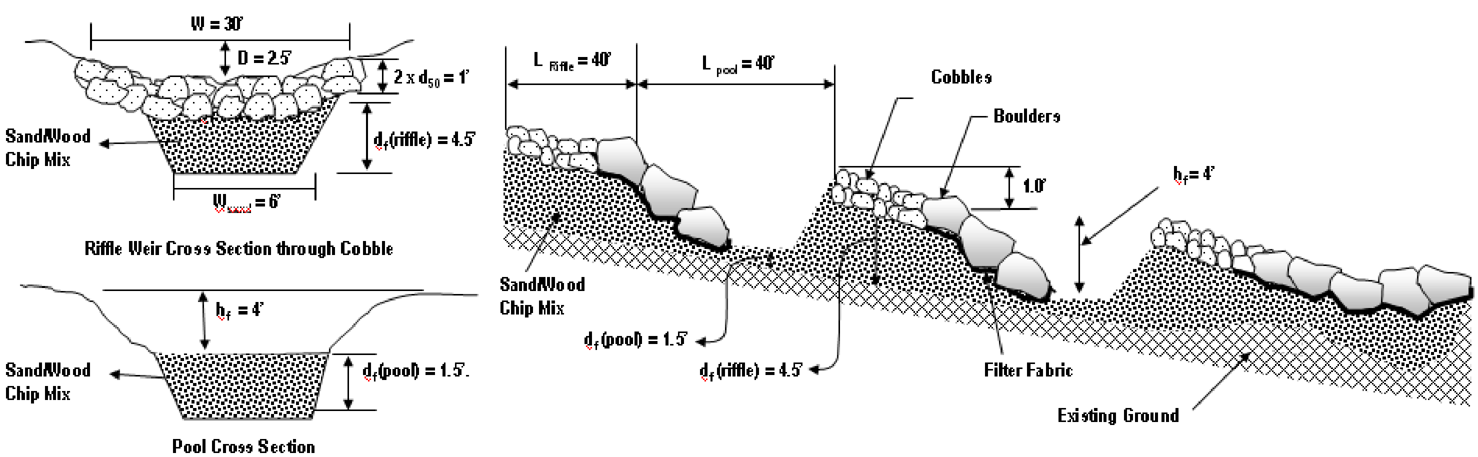


Figure 4 – Profile and Cross Section of Regenerative Storm Conveyance System (Source: Anne Arundel County)

Project Cost Estimate

Item Description	Quantity/Units		Unit Cost	Subtotal Cost
SITE PREP AND GRADING				
Mobilization/Demobilization (10% Total Cost)	1	LS		$16,370.00
Survey Stake Out (5% Total Cost)	1	LS		$8,185.00
Clearing and Grubbing	500	sy	$2.00	$1,000.00
Erosion and Sediment Control	3,500	sy	$4.00	$14,000.00
Blaze Orange Fence	1,600	lf	$8.00	$12,800.00
Grading, Excavation, Backfilling	1,500	cy	$20.00	$30,000.00
STEP POOLS AND RIFFLES				
Sandstone Boulders	230	cy	$240.00	$55,200.00
Cobble Weir (D50 = 6" Rock)	230	cy	$75.00	$17,250.00
Geotextile	700	sy	$4.00	$2,800.00
Wood Chips	130	cy	$25.00	$3,250.00
Sand Fill	290	cy	$60.00	$17,400.00
PLANTING				
Plants (Trees, Shrubs, Herbs, and SAV)	1,000	sy	$10.00	$10,000.00
TOTAL CONSTRUCTION COSTS				**$188,255.00**
ENGINEERING AND MANAGEMENT				
Engineering (20% of Construction)				$37,651.00
Construction Management (15% of Construction)				$28,238.25
Contingency (5% of Total Construction)				$9,412.75
TOTAL PROJECT COSTS				**$263,557.00**

Project Constraints

Site Access: The existing linear BMP is owned by Anne Arundel County. The proposed limit of disturbance associated with the project lies entirely within the County right-of-way. Unencumbered access to the site can be made via Leelyn Drive. Portions of a site fence may need to be removed during construction.

Design/Construction: A topographical survey is necessary to confirm the potential extent of the conceptual design. A geotechnical survey should be completed to confirm the infiltration capacity of site soils. Potential construction staging areas are located upstream and downstream of the project extent.

Project Constraints (continued)

Utilities: It is unlikely that there will be any utility conflicts as no water and sewer lines exist near the proposed limit of disturbance. Miss Utility should be contacted prior to initiation of construction activities.

Environmental Impacts: No environmental impacts are anticipated for this design.

Erosion and Sediment Control: Proper erosion and sediment controls are required including storm drain protection and silt fencing the construction boundary.

Project Photos

Photo 1 – Ditch looking down gradient

Photo 2 –Riser with bypass

Project Photos (continued)

Photo 3 – Ditch and riser looking up gradient

Engineer Certification

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.
*License No. 35612_, Expiration Date: 4/23/2010_*

*License No. 26363_, Expiration Date: 1/2/2011_*

STATE OF MARYLAND
PALA E. FLORES
No. 26363
REGISTERED
PROFESSIONAL ENGINEER

STATE OF MARYLAND
BRIAN E. BUSIEK
No. 35612
PROFESSIONAL ENGINEER

Conceptual Design Plan

Project Overview

A concrete lined ditch located within a commercial parking lot conveys vast quantities of untreated runoff from a large commercial and residential area to the headwaters of a poorly rated tributary of Cypress Creek. The ditch is approximately 360 feet long. This project will retrofit the ditch with a regenerative storm conveyance system to improve water quantity and water quality management to Cypress Creek.

Project Type: Regenerative storm conveyance retrofits

Watershed: Magothy River

Subwatershed: Cypress Creek (MGC)

Location: North of McKinsey Road, off of Ritchie Highway (Rte 2) in Severna Park, MD. (Figures 1 and 2)

Drainage Area Characteristics

Land Use: Commercial, residential

Drainage Area: 160.5 acres

Impervious Area: 67.9 acres

Dominant Soils: Type B (104.8 ac): silt loam or loam, moderately well drained with moderate infiltration rate; Type C (32.4 ac): sandy clay loam, low infiltration rates; Type D (23.3 ac): clay loam, silty clay loam, sandy clay loam, sandy clay or clay with very low infiltration rates

Hydrology:

Parameter	Value
Weighted Curve Number	80.7
Time of Concentration (hrs)	0.659
Flow 1-yr- Existing Cond (cfs)	121
Flow 2-yr- Existing Cond (cfs)	176
Runoff 1-yr- Existing Cond (in.)	1.07
Runoff 2-yr- Existing Cond (in.)	1.52
Flow 1-yr- Future Cond (cfs)	134
Flow 2-yr- Future Cond (cfs)	194
Runoff 1-yr- Future Cond (in.)	1.10
Runoff 2-yr- Future Cond (in.)	1.56

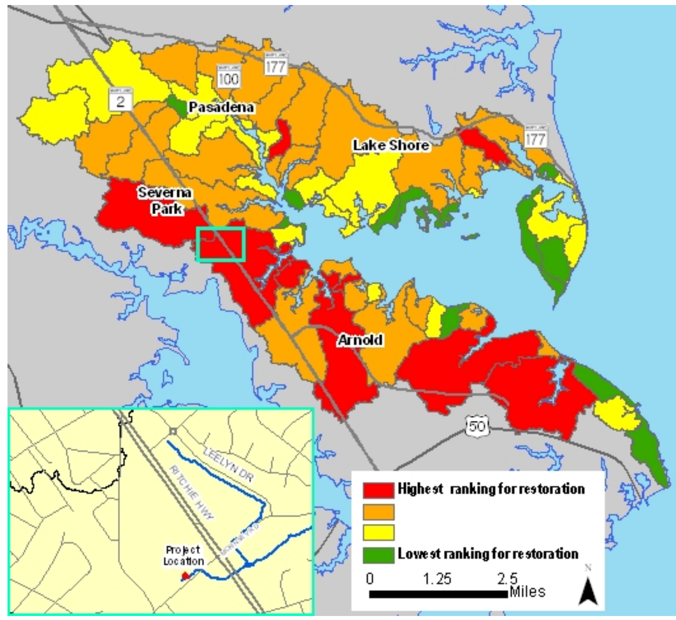


Figure 1 – Project Location Map

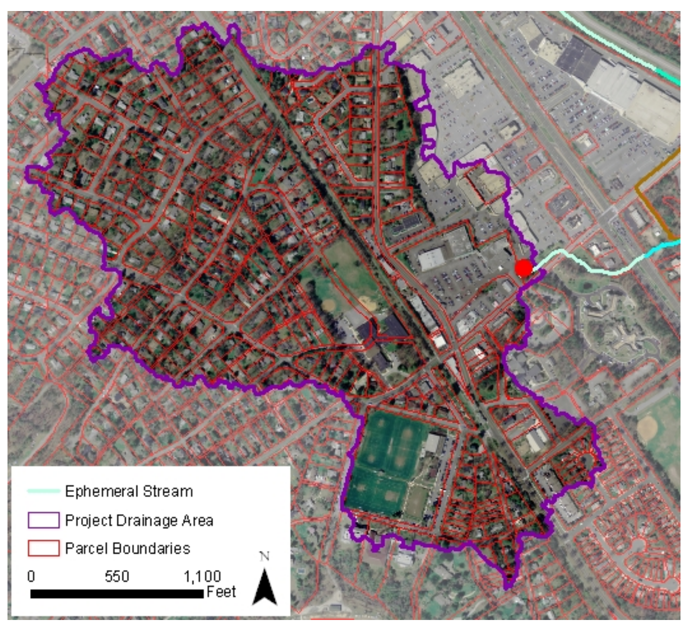


Figure 2 – Aerial Photo of Project Drainage Areas

Project Benefits

Water Quality: Reduced velocity and increased infiltration will enhance removal of suspended particles and associated nutrients. Additionally, uptake of dissolved nutrients and adsorption of oils and greases by the plant material yield secondary water quality benefits above and beyond the benefits achieved through the primary water quality sand/woodchip mix filter.

	Existing Conditions						Future Conditions					
	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr	TP lbs/yr	TN lbs/yr	NOx lbs/yr	FC mpn/yr	TSS tons/yr	Metal lbs/yr
Pre-Install	191	1,660	658	3.54E11	105	120	191	1,670	658	3.54E11	105	121
Post-Install	76.4	998	395	2.12E11	62.7	72.0	115	1,000	395	2.12E11	63.0	72.6
% Diff	60%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%

Stream Stability: A regenerative storm conveyance retrofit will decrease peak and cumulative flows to Cypress Creek thus decreasing downstream bed and bank erosion.

Aquatic Habitat: Reduction in erosion and pollutant loading improves instream aquatic habitat. A decrease in thermal pollution is also expected to improve biotic health and habitat.

Conceptual Design

The existing concrete ditch will be removed and replaced with a regenerative storm conveyance system retrofit, which utilizes a series of shallow pools, riffle weir grade controls, native vegetation, and an underlying sand and compost filter to treat, detain, and safely convey drainage area runoff. The pools and riffles are designed to safely convey peak discharge from a 100-year storm, which is approximately 600 ft^3/s. The length of the proposed system is 300 feet, which is approximately 60 feet shorter than the length of the existing concrete channel due to the presence of an additional downgradient outfall.

Five pools and five riffles, each 30 feet long, are proposed. The elevation drop along the length is 4.3 feet. The existing channel is approximately 70 feet wide at its narrowest, which provides sufficient space for the riffle sections proposed at 36 feet wide. The proposed riffle depth is 3.3 feet. The filtration bed is sized to manage the water quality volume (WQ_v) associated with a 1 inch storm. The proposed size of the filtration bed is 10,800 sq ft with a depth at riffles of 4.5 feet and a depth at pools of 1.5 feet. Filtered flow from the system will combine with existing flow from the downgradient outfall and be conveyed under McKinley Road through the existing culvert.

Design Parameters	Value
Drainage area (acre)	160.5
Percent Impervious (%)	42.3
Volumetric runoff coefficient (R_v)	0.43
Water quality volume (WQ_v) (ft^3)	225,864
Peak discharge 100-year storm (ft^3/s)	601
Total length (ft)	300
Elevation drop over length (ft)	4.3
Cobble d_{50} size (ft)	0.5
Top width of riffle channel (ft)	36
Depth of riffle channel (D) (ft)	3.3
Depth of pools (h_f) (ft)	4.0
Length of pool segments (ft)	30
Length of riffle segments (ft)	30
Sand filter depth at pools (d_f(pool)) (ft)	1.5
Sand filter depth at riffles (d_f(riffle)) (ft)	4.5
Width of sand filter (W_{sand}) (ft)	36
Area of sand filter (A_f) (ft^2)	10,800

Conceptual Design (continued)

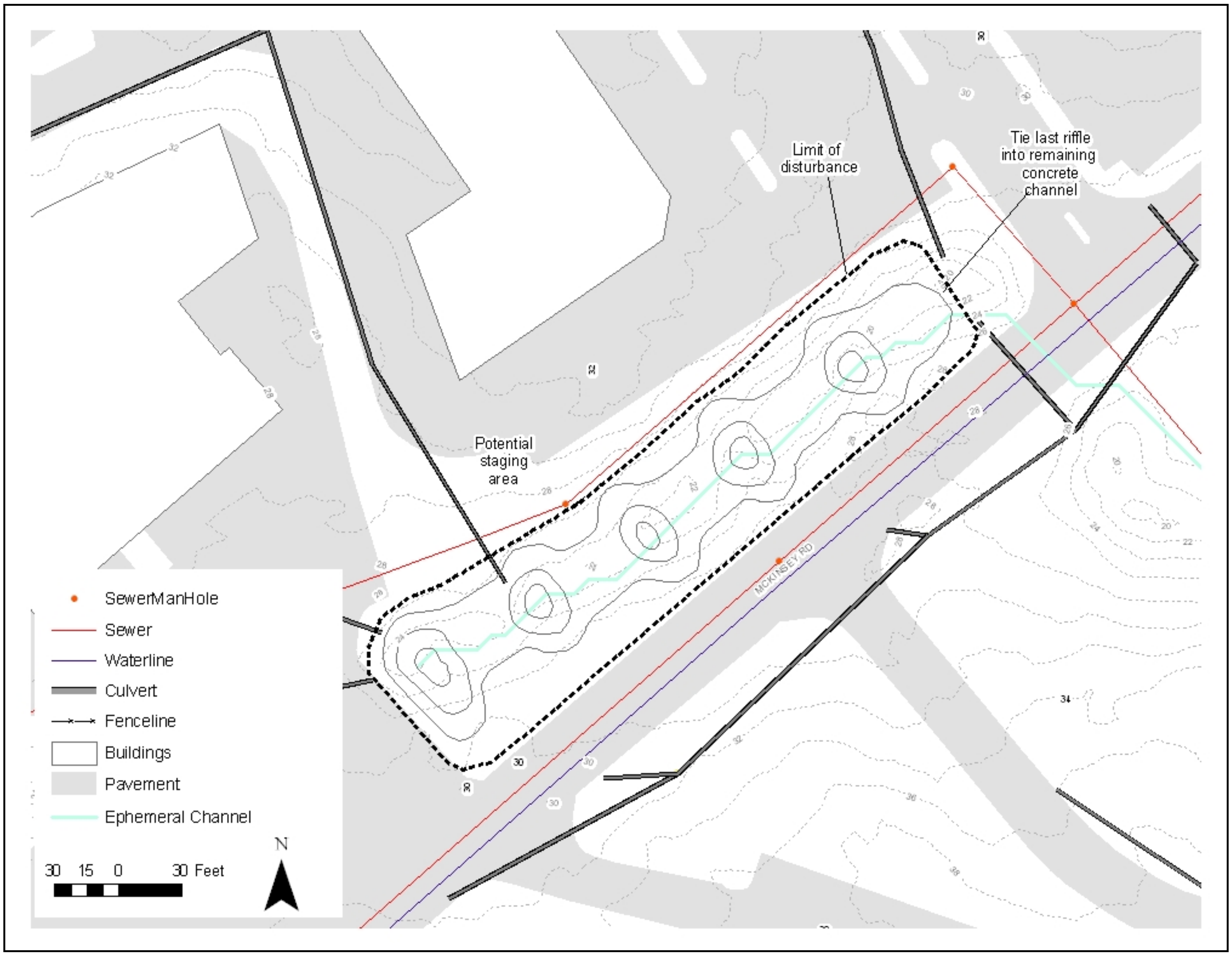


Figure 3 – Plan View of Regenerative Storm Conveyance System

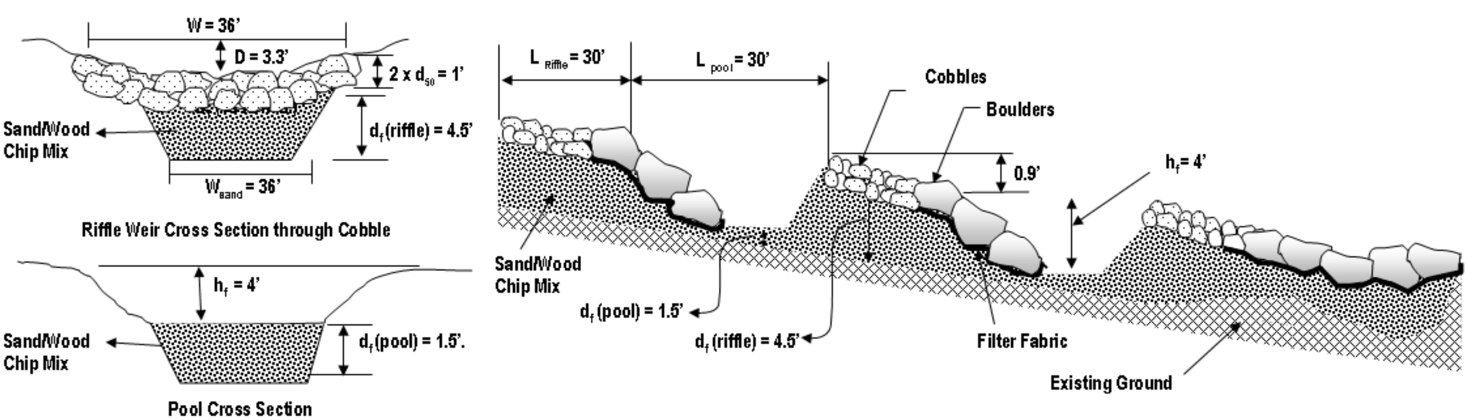


Figure 4 – Typical Profile and Cross Section of a Regenerative Storm Conveyance System (Source: Anne Arundel County)

Project Cost Estimate

Item Description	Quantity/Units		Unit Cost	Subtotal Cost
SITE PREP AND GRADING				
Mobilization/Demobilization (10% Total Cost)	1	LS		$17,430.00
Survey Stake Out (5% Total Cost)	1	LS		$8,715.00
Clearing and Grubbing	2,400	sy	$2.00	$4,800.00
Erosion and Sediment Control	2,400	sy	$4.00	$9,600.00
Removal of Concrete Ditch	1,000	sy	$50.00	$50,000.00
Blaze Orange Fence	900	lf	$8.00	$7,200.00
Grading, Excavation, Backfilling	1,800	cy	$20.00	$36,000.00
STEP POOLS AND RIFFLES				
Sandstone Boulders	100	cy	$240.00	$24,000.00
Cobble Weir (D50 = 6" Rock)	100	cy	$75.00	$7,500.00
Geotextile	300	sy	$4.00	$1,200.00
Wood Chips	200	cy	$25.00	$5,000.00
Sand Fill	400	cy	$60.00	$24,000.00
PLANTING				
Plants (Trees, Shrubs, Herbs, and SAV)	500	sy	$10.00	$5,000.00
TOTAL CONSTRUCTION COSTS				**$200,445.00**
ENGINEERING AND MANAGEMENT				
Engineering (20% of Construction or $10,000 minimum)				$40,089.00
Construction Management (15% of Construction)				$30,066.75
Contingency (5% of Total Construction)				$10,022.75
TOTAL PROJECT COSTS				**$280,623.00**

Project Constraints

Site Access: The property is privately owned, so access will need to be obtained, and County easement may need to be established. Unencumbered access is present at the site via the surrounding parking lot and McKinsey Road.

Project Constraints (continued)

Design/Construction: A topographical survey is necessary for final design. A geotechnical survey should be completed to confirm the infiltration capacity of site soils. Construction staging could occur in the parking lot to the north of the limit of disturbance (with owner approval) and in the vegetated area in the northwestern end of the limit of disturbance.

Utilities: Sewer lines are located on the northern side of the proposed regenerative storm conveyance system near the limit of disturbance. Miss Utility should be contacted prior to initiation of construction activities.

Environmental Impacts: Several small caliper trees may need to be removed. Other environmental impacts are not anticipated for this design.

Erosion and Sediment Control: Proper erosion and sediment controls are required including storm drain protection and silt fencing the construction boundary.

Project Photos

Photo 1 – Concrete Ditch (Looking East)

Photo 2 – Concrete Ditch (Looking West)

Photo 3 – Storm Outfall to Ditch near the End of the Proposed Retrofit

Photo 4 – Three Culverts Conveying Flow under McKinsey Road

Engineer Certification

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.
*License No. 35612_, Expiration Date: 4/23/2010_*

*License No. 26363_, Expiration Date: 1/2/2011_*

STATE OF MARYLAND
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