Howard County Biological Monitoring and Assessment

Dorsey Run, Hammond Branch, and Rocky Gorge Watersheds - 2016

Howard County, Maryland

Howard County MARYLAND

KCI Technologies, Inc.
December 2016

KCI TECHNOLOGIES

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Rocky Gorge Watersheds – 2016

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Prepared for:

Department of Public Works
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Howard County
MARYLAND

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Executive Summary

The Howard County Department of Public Works Stormwater Management Division initiated the Howard County Biological Monitoring and Assessment Program in the spring of 2001. The County initiated the monitoring program to establish a baseline ecological stream condition for all of the County's watersheds. The program involves monitoring the biological health and physical condition of the County's water resources and is designed on a five year rotating basis such that each of the County's 15 watersheds, or primary sampling units (PSU) will be sampled once every five years.

Round 1 was completed from 2001 to 2003, and Round 2 from 2005-2009 with 10 randomly selected sites sampled in each PSU. The current year sampling (2016) is the final year of Round 3 which began in 2012. To allow for paired site comparisons with both Rounds 1 and 2, 30 sites from Round 1 and 30 sites from Round 2 were randomly selected for repeat sampling in Round 3. The remaining 90 sites in Round 3 are newly selected random sites. More specifically, two sites in each Round 3 watershed were randomly chosen from the 10 Round 1 sites and two sites were randomly chosen from the 10 Round 2 sites; the remaining six sites are new random sites.

The Dorsey Run, Hammond Branch, and Rocky Gorge watersheds were re-sampled to fulfill the 2016 sampling requirements and complete Round 3 of the program. These watersheds were previously sampled and assessed by Tetra Tech, Inc, in 2003 during Round 1 (Pavlik and Stribling, 2005), and again by KCI Technologies Inc., in 2009 during Round 2 (Hill and Crunkleton, 2009). The monitoring in each round involved sampling instream water quality, collection and analysis of the biological community (benthic macroinvertebrates) using Maryland Biological Stream Survey (MBSS) protocols, cross section analysis, particle size distribution, and assessment of the physical habitat using the United States Environmental Protection Agency's (EPA) Rapid Bioassessment Protocols (RBP). The sampling methods used are compatible with those used in the second round (2005-2009) with updates where applicable.

The MBSS benthic metrics, scoring criteria, and individual species tolerance were updated by Maryland Department of Natural Resources (DNR) in 2005 (Southerland et al., 2005). The biological data collected in Round 1 sampling of the Dorsey Run, Hammond Branch, and Rocky Gorge watersheds was analyzed using the old metrics (Stribling et. al 1998), and as such, the results are not directly comparable to the current sampling data. Therefore, all data from the 2003 sampling effort were recalculated using the updated metrics to allow for direct comparison to the current data. For this report any mention of 2003 BIBI scores refer to these recalculated values.

All data collection occurred between March 1st and May 1st of 2016, as required by the MBSS protocols. Sampling sites were marked in the field using survey flagging at the upstream and downstream limits of the reach. The positions of the site midpoints were collected using a GPS unit accurate to within 1-meter.

Biological and physical habitat assessment results for 2016 in Rocky Gorge, Hammond Branch, and Dorsey Run indicate watersheds that are moderately to severely impaired. Only two out of thirty benthic macroinvertebrate samples received a rating of 'Good' and five received a 'Fair' rating. The remaining sites (77%) were rated as either 'Poor' or 'Very Poor.'

Overall, the average watershed physical habitat conditions were 'Partially Supporting' (Rocky Gorge, Dorsey Run) and 'Non-supporting'(Hammond Branch). The geomorphic assessment reveals a variable system. Using the Rosgen classification system for natural rivers (Rosgen, 1996), many of the channels sampled throughout the watersheds were classified as stable type B or C channels. However, a good portion of channels were classified as unstable, incised F channels with also a few channels classified as G channels. Gravel and sand were the dominant substrate types in the majority of sampling reaches, however, silt/clay and cobble dominate streams were also present.

The average percentage of impervious area in the Rocky Gorge, Hammond Branch, and Dorsey Run subwatersheds is 8.8, 12.5, and 33.2%, respectively. Imperviousness for the areas draining to each sampling site range from 7.5% in Hammond Branch to 38.5% in Dorsey run (see Appendix A for impervious values).

Pearson correlations between the BIBI scores and two parameters (percent imperviousness and specific conductivity) showed highly significant relationships. The percentage of imperviousness to each sampling site indicates a strong negative relationship (correlation coeff.= -0.648, $p < 0.001$) to BIBI scores, suggesting biological condition decreases with increased watershed imperviousness. Specific conductivity and BIBI scores also showed a strong negative correlation (correlation coeff.= -0.596, $p = 0.001$). These results support the notion that overall water quality and biological health are likely being affected by the amount of development, and hence imperviousness, in the watershed. A strong correlation was also observed between impervious percent and specific conductivity (correlation coeff.= 0.982, $p < 0.0001$), suggesting that increased conductivity is due in large part to urban runoff.

Results of the 2016 assessment indicate impaired biological conditions in all three watersheds, and statistically significant decreases in mean BIBI scores were observed in Dorsey Run since Round One. Physical habitat scores also showed some statistically significant changes, however, they do not match the trends observed in the BIBI results. Decreases in RBP scores were not observed where decreases in biological condition occurred, which suggests that changes in water quality and/or quantity may be responsible for the impairments.

1 Background and Objectives

The Howard County Biological Monitoring and Assessment Program was initiated in the spring of 2001 by the Howard County Department of Public Works Stormwater Management Division. The program involves monitoring the biological health and physical condition of the County's water resources to detect the status and trends at the stream level, the watershed level and ultimately at the County level.

The County initiated the program to establish a baseline ecological stream condition for all of the County's watersheds. The program is designed on a five year rotating basis such that each of the County's 15 watersheds or primary sampling units (PSU) will be sampled once every five years. In general three PSUs would be sampled each year with 10 sites sampled in each PSU. Table 1 includes the full list of PSUs sampled per year and per round and Figure 1 illustrates the program progress to date.

The first sampling rotation was completed in only three years (2001 to 2003). Requirements of the Patuxent Reservoir Watershed Group were addressed in 2001 with sampling conducted in PSUs 2, 5 and 3. This was in addition to sampling conducted in the Little Patuxent subwatersheds (PSUs 11, 12, and 13) under a Watershed Restoration Action Strategy (WRAS) grant. In 2002, only the Middle Patuxent sites (PSUs 6, 7 and 8) were sampled. Additional WRAS funding in 2003 allowed sampling to be completed in the Patapsco River Tributaries (PSUs 1, 4, and 10) in addition to Rocky Gorge, Hammond Branch, and Dorsey Run, which were sampled to supplement the data collected in 2001 for the Little Patuxent.

Upper and Lower Brighton Dam (PSUs 2 and 5, respectively) and Cattail Creek (PSU 3) were all sampled as part of the first year of the second round of sampling in 2005. The Little Patuxent River subwatersheds (PSUs 11, 12, and 13) were sampled in 2006 during year two of the second round of sampling. The Middle Patuxent subwatersheds (PSUs 6, 7, and 8) and the Patapsco River subwatersheds (PSUs 1, 4, and10) were re-sampled in 2007 and 2008, respectively. In 2009, 30 newly selected sites were sampled in the Rocky Gorge Dam (PSU 9), Hammond Branch (PSU 14), and Dorsey Run (PSU 15) subwatersheds to fulfill the 2009 sampling requirements. With the completion of Rocky Gorge Dam, Hammond Branch, and Dorsey Run subwatersheds.

Round 3 (2012 to 2016) of county-wide sampling began with sampling at Upper Brighton Dam (PSU 2), Lower Brighton Dam (PSU 5), and Cattail Creek (PSU 3) during 2012 and with the Little Patuxent River watersheds in 2013 (PSUs 11, 12, and 13). During 2014, Round 3 sampling continued with the sampling of the Middle Patuxent River subwatersheds (PSUs 6, 7, and 8). In 2015, the South Branch Patapsco, Patapsco River Lower Branch A, and Patapsco River Lower Branch B subwatersheds were sampled (PSUs 10, 1, and 4). In 2016, sampling continued in the same order as in Round 2, with Rocky Gorge Dam, Hammond Branch and Dorsey Run. Round 3 sampling includes a combination of repeat site samples and new random site samples to improve trend detection.

Assessment methods follow those developed by Maryland Department of Natural Resources' (DNR) Maryland Biological Stream Survey (MBSS) and the Standard Operating Procedures (SOPs) found in the Quality Assurance Project Plan (QAPP) for the Howard County Biological Monitoring and Assessment Program (Howard County, 2001). The sampling methods used in 2016 are compatible with those used in Round 1 and Round 2, with updates where applicable.

Table 1 – Summary of Bioassessment Progress

Year	Number of Sites	Primary Sampling Unit (code and name)
Round One		
2001	60	11 – Upper Little Patuxent 12 – Middle Little Patuxent 13 – Lower Little Patuxent 2 – Upper Brighton Dam 5 – Lower Brighton Dam 3 – Cattail Creek
2002	30	6 – Upper Middle Patuxent 7 – Middle Middle Patuxent 8 – Lower Middle Patuxent
2003	60	9 – Rocky Gorge Dam 14 – Hammond Branch 15 – Dorsey Run 10 – S Branch Patapsco River Tributaries 1 – Patapsco River L Branch A 4 – Patapsco River L Branch B
Round Two		
2005	30	2 – Upper Brighton Dam 5 – Lower Brighton Dam 3 – Cattail Creek
2006	30	11 – Upper Little Patuxent 12 – Middle Little Patuxent 13 – Lower Little Patuxent
2007	30	6 – Upper Middle Patuxent 7 – Middle Middle Patuxent 8 – Lower Middle Patuxent
2008	30	10 – S Branch Patapsco River Tributaries 1 – Patapsco River L Branch A 4 – Patapsco River L Branch B
2009	30	9 – Rocky Gorge Dam 14 – Hammond Branch 15 – Dorsey Run
Round Three		
2012	30	2 – Upper Brighton Dam 5 – Lower Brighton Dam 3 – Cattail Creek
2013	30	11 – Upper Little Patuxent 12 – Middle Little Patuxent 13 – Lower Little Patuxent
2014	30	6 – Upper Middle Patuxent 7 – Middle Middle Patuxent 8 – Lower Middle Patuxent
2015	30	10 – S Branch Patapsco River Tributaries 1 – Patapsco River L Branch A 4 – Patapsco River L Branch B
2016	30	9 – Rocky Gorge Dam 14 – Hammond Branch 15 – Dorsey Run

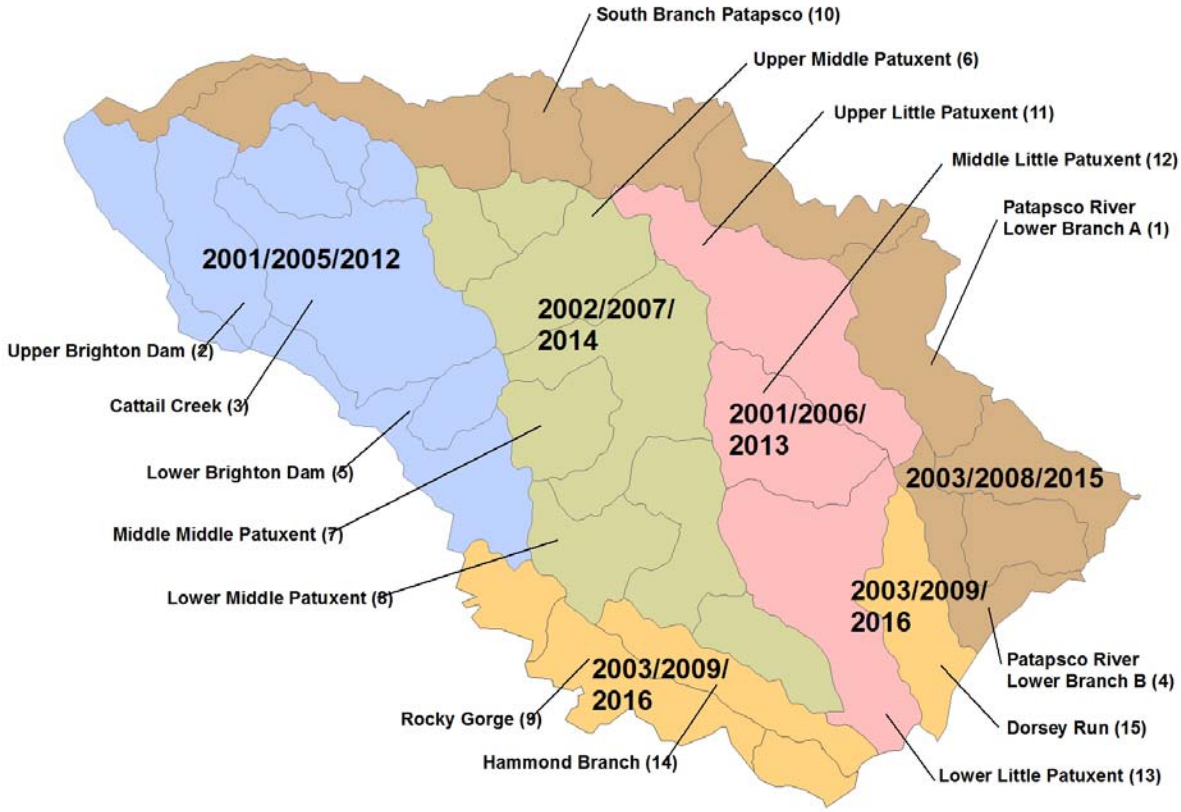

Figure 1 - Howard County Bioassessment

All three subwatersheds sampled in 2016 are located in the southeastern portion of the county and are crossed by several major transportation routes (Figure 2). Interstate I-95 bisects all three watersheds, and State Highway 216 (Scaggsville Road) runs roughly along the border between Hammond Branch and Rocky Gorge subwatersheds. Other major roadways include Clarksville Pike (Route 108), Washington Boulevard (Route 1), Little Patuxent Parkway (Route 175), and Waterloo Road (Route 957). The Rocky Gorge subwatershed is located along the Patuxent River just downstream of Brighton Dam and continues just below Rocky Gorge Dam.

The Rocky Gorge, Hammond Branch, and Dorsey Run subwatersheds are generally located in the transition zone (i.e., Fall Zone) between the piedmont and coastal plain regions. MBSS has developed strata for sampling and analysis of Maryland's streams based on broad physiographic regions, which include the coastal plain, piedmont and combined highlands regions. MBSS's physiographic region strata layer showed that all subwatersheds sampled in 2016 fell within the piedmont physiogeographic region (Figure 2).

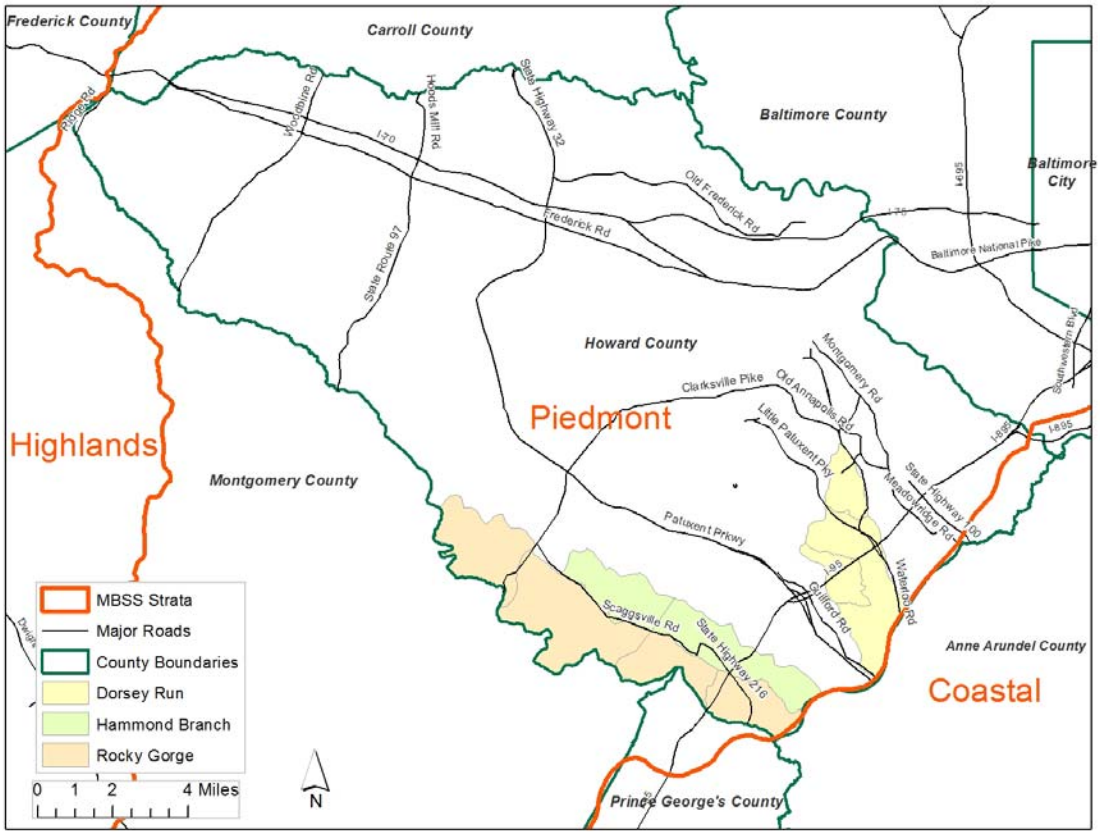

Figure 2 - Location Map of Dorsey Run, Hammond Branch and Rocky Gorge Watersheds

2 Methodologies

Stream monitoring was conducted throughout the watershed and involved measuring instream water quality, sampling and assessing the biological community (benthic macroinvertebrates), visually assessing the instream and riparian physical habitat, and performing cross sectional and substrate particle size measurement and analysis. Monitoring was conducted at 10 sites within each of the three PSUs (Rocky Gorge, Hammond Branch, and Dorsey Run). The assessment methods followed the current MBSS protocols (DNR, 2014) and the SOPs described in the County's QAPP (DPW, 2001). All data collection occurred between March 29 and April 29, 2016, within the Spring Index Period (March 1 to April 30) as required by the MBSS sampling protocols. Monitoring sites were marked in the field using tree tags (when possible) or survey flagging at the upstream and downstream limits of the reach. The position of each site was collected at the midpoint using a GPS unit accurate to within 2 meters. All field data were entered into a laptop directly in the field. Photographs were taken to document conditions at the time of data collection. A summary of the methods used and the results of the monitoring are documented in this report.

2.1 Selection of Sampling Sites

The sampling design employed both a repeat and randomized census approach stratified by stream order, with a total of 30 sites distributed among the three PSUs. Ten sites were located in each subwatershed.

To select primary and alternate sampling sites, stream lengths were summed by stream order within each subwatershed. The length of stream by stream order and its percentage of the total length within the subwatershed determined the number of sites selected on that order stream.

To allow for direct comparison of results over time and between sampling rounds, two sites from Round One (2003) and two sites from Round Two (2009) were selected for resampling in each PSU. The remaining six sites in each PSU were randomly selected. The randomized approach was then applied within each subwatershed. The National Hydrography Dataset (NHD) stream layer was divided into 1-meter reaches and each reach was assigned a number. A random number generator was used to select sampling reaches for 2015. Both primary and alternate sites were selected in case the primary site was ephemeral (dry), inaccessible, or unsafe to sample. Site codes contain the PSU code and initials of the watershed (09RG), stream order (1), a two-digit sequential number (01), either an "R" or an "F" indicating that the site is a randomly selected site (i.e., R) or a fixed "revisit" site (i.e., F), the year sampled (2016), and a letter used in the field to differentiate sampling sites (e.g., 09RG-102-R-2016A).

Three additional biological samples were collected as quality assurance/quality control (QA/QC) samples at duplicate sites, one in each of the three subwatersheds. Biological sampling, habitat assessments and water quality measurements were repeated at the duplicate sites. These sites were selected in the field. Duplicate sampling reaches were the same length as the paired sampling sites (75 meters), were located immediately upstream of their paired sampling sites, had similar habitat characteristics and were not impacted by road crossings or confluences.

2.2 Impervious Surface and Land Use Analysis

An analysis was conducted to derive the impervious surface acreage, percent impervious, and land use make up for each of the site drainage areas to evaluate their effect on biological condition. Drainage areas were first delineated to each sampling site using a combination of ArcGIS Hydro tools and two-foot contours. Land use was derived from Maryland Department of Planning (MDP) 2010 land use for Howard County. Since the Patuxent River is a large watershed draining several counties, additional GIS data from Montgomery County was also used to delineate drainage areas and calculate imperviousness based on land use. Impervious values were derived primarily using Howard County's 2014 planimetric impervious surface layer which includes detailed polygons of roadways, rooftops, parking lots, sidewalks etc. For portions of the Patuxent River that extend beyond Howard County for which the impervious layer was not available, values for percent impervious by land use were derived from the Natural Resources Conservation Services (NRCS) TR-55 (USDA, 1986). This approach was applied only to the six fourth-order sites in the Rocky Gorge PSU. A table with the percent of land use in each subwatershed and the calculated imperviousness is included in Appendix A.

2.3 Water Quality Sampling

To supplement the macroinvertebrate sampling and habitat assessment, instream water quality measurements were performed. Field water quality measurements were collected *in situ* at all sites according to methods in the County QAPP. Each parameter listed in Table 2 was recorded at the upstream portion of each sampling reach (including field QC sites). Most *in situ* parameters were measured using a YSI® Professional Plus series multiprobe water quality meter. Turbidity was

measured with a Hach® 2100 Turbidimeter. Water quality meters were 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.

The Maryland Department of the Environment (MDE) has established acceptable standards for several water quality parameters for each designated Stream Use Classification. These standards are listed in the *Code of Maryland Regulations (COMAR) 26.08.02.03-03 - Water Quality* (MDE, 1994). The Rocky Gorge, Hammond Branch, and Dorsey Run drainage areas are in *COMAR* Sub-Basin 02-13-11: Patuxent River Area. The Rocky Gorge subwatershed below Rocky Gorge Dam along with Hammond Branch and Dorsey Run subwatersheds are all classified as Use I-P, Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply. The Patuxent River below Brighton Dam and above Rocky Gorge Dam is classified as a Use IV-P water body, Recreational Trout Waters and Public Water Supply. The acceptable standards for Use I-P and IV-P streams are listed in Table 2. A comparison of these standards to data collected at each station is included in the site summary text in Section 3.1.

Table 2 - Water Quality Sampling and COMAR Standards, Use I-P and IV-P Waters

Parameter	Units	Acceptable COMAR Standard
pH	standard pH units	6.5 to 8.5
Temperature	degrees Celsius, °C	Use I-P: maximum of 90°F (32°C) or ambient temperature of the surface water, whichever is greater
		Use IV-P: maximum of 75°F (23.9°C) or ambient temperature of the surface water, whichever is greater
Dissolved Oxygen (DO)	milligrams per liter, mg/L	may not be less than 5 mg/L at any time
Conductivity	microSiemans per centimeter, µS/cm	no COMAR standard set
Turbidity	Nephelometer Turbidity Units, NTU	maximum of 150 NTUs and maximum monthly average of 50 NTUs

2.4 Biological Sampling

Biological monitoring was conducted throughout the Rocky Gorge, Hammond Branch, and Dorsey Run watersheds following methods detailed in the County's QAPP (DPW, 2001). Biological assessment methods within Howard 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). 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 to Maryland's physiographic regions and stream types. Because MBSS methods dictate that habitat assessments occur during the Summer Index Period while sampling fish communities, which the County does not complete, physical habitat condition was assessed using the EPA's Rapid Bioassessment Protocol (RBP) (Barbour et. al, 1999) habitat assessment for high-gradient streams. Certain MBSS habitat parameters, namely percent shading, require full leaf out to accurately assess, which is often misrepresented during the Spring Index Period when leaves typically have not yet opened. However, it should be noted that MBSS physical habitat data is collected to supplement RBP data, and potentially for use in future investigations or comparisons. Locations of the bioassessment sites are shown in Figure 3 with the (NHD) stream layer.

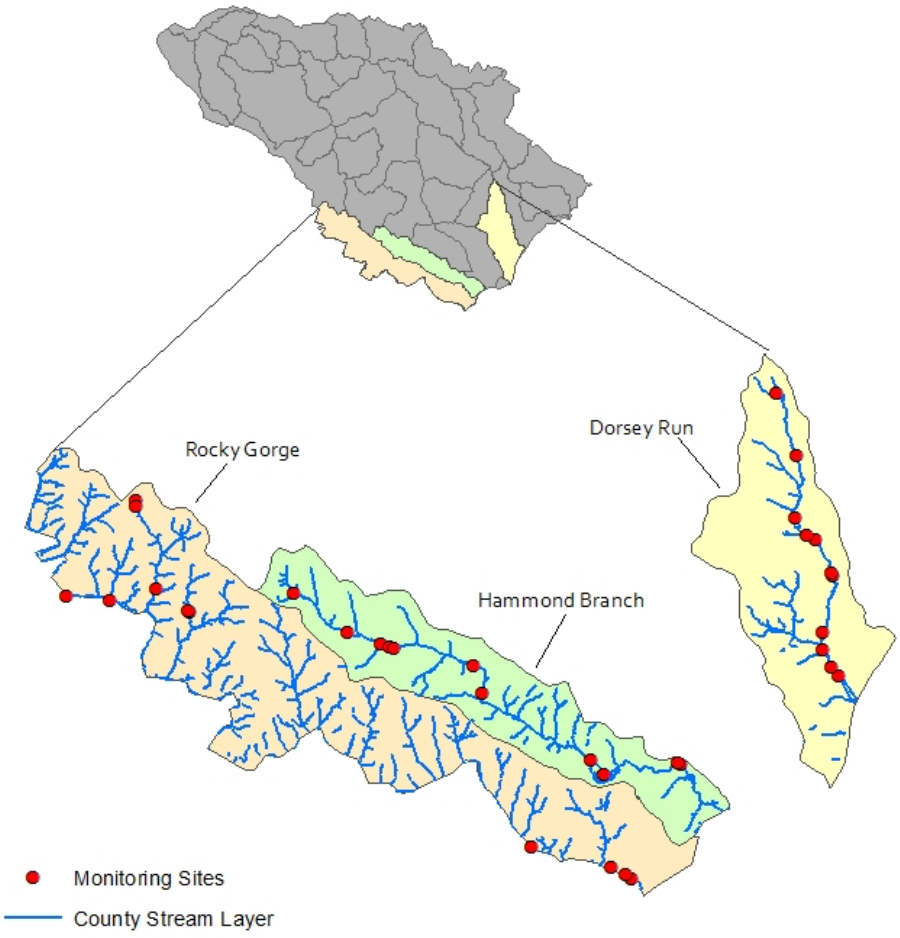

Figure 3 – Dorsey Run, Hammond Branch and Rocky Gorge Bioassessment Sampling Locations

2.4.1 Benthic Macroinvertebrate Sampling

Benthic macroinvertebrate collection followed the QAPP which closely mirrors MBSS procedures (DNR, 2014). Benthic macroinvertebrate sampling is conducted during the Spring Index Period (March 1st to April 30th) along a 75-meter reach. The multi-habitat D-frame net approach was used to sample a range of the most productive habitat types within the reach. In this sampling approach, a total of twenty jabs are distributed among all available habitats within the stream system and combined into one composite sample. Sampled habitats include submerged vegetation, overhanging bank vegetation, leaf packs, mats of organic matter, stream bed substrate, submerged materials (i.e., logs, stumps, snags, dead branches, and other debris) and rocks.

2.4.2 Sample Processing and Laboratory Identification

Benthic macroinvertebrate samples were processed and subsampled according to 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 sizes. In this method the sample is spread evenly across a gridded tray and each grid is picked clean of organisms until a count of 120 is reached. The 120-organism target is used to allow for specimens that are missing parts or are not a late enough instar for proper identification. If samples were sorted beyond the 120-organism target, the sample was spread in a petri dish subdivided into grids and re-subsampled by randomly selecting grids and counting all specimens in each grid until the sample was within an acceptable range.

The samples were sent to a lab (Aquatic Resources Center[1]) for identification. Identification of the samples was conducted to the genus level for most organisms. Groups including Oligochaeta and Nematomorpha were identified to the family level while Nematoda was left at phylum. Individuals of early instars or those that were damaged were identified to the lowest possible level, which in most cases was family. Chironomidae was further subsampled depending on the number of individuals in the sample and the numbers in each subfamily or tribe. Most taxa were identified using a stereoscope. Temporary slide mounts were used to identify Oligochaeta to family with a compound scope. Chironomid sorting to subfamily and tribe was also conducted using temporary slide mounts. Permanent slide mounts were then used for final genus level identification. Results were logged on a bench sheet and entered into a spreadsheet for analysis.

2.4.3 Biological Data Analysis

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, taxa composition, tolerance to perturbation, trophic (feeding) classification and taxa habit.

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 applied. 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 physiogeographic regions. The Rocky Gorge, Hammond Branch, and Dorsey Run subwatersheds are all located in the piedmont physiogeographic region (see Figure 2).

The benthic metrics, scoring criteria, and individual species tolerance were updated by DNR in 2005. The data collected in the first round of sampling of the Rocky Gorge, Hammond Branch, and Dorsey Run subwatersheds was analyzed using the old metrics (Stribling et. al 1998), and as such, the results were not directly comparable to the 2009 and 2016 sampling data. Therefore, all data from the 2003 sampling were recalculated using the updated metrics to allow for direct comparison to the current data (KCI, 2008). For this report, any mention of 2003 BIBI scores refer to these recalculated values.

The following metrics and BIBI scoring were used for data analysis:

Piedmont BIBI Metrics:

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.

[1] Address: 545 Cathy Jo Circle, Nashville, TN

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.

Percent Intolerant Urban – Equals the percentage of individuals in the sample that are considered intolerant to urbanization (tolerance values [TV] = 0 – 3). The percent of intolerant urban is expected to decrease with decreasing water quality.

Percent Chironomidae – Equals the percentage of individuals in the sample that are in the Chironomidae family. An increase in the percentage of Chironomidae is generally an indicator of decreasing water quality.

Percent Clingers – Equals the percentage of the total number of individuals who are adapted to attaching to surfaces in stream riffles. Higher percentages of clingers are representative of a decrease in stressors and higher 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 for the piedmont BIBI is shown below in Tables 3. The raw metric value ranges are given with the corresponding score of 1, 3 or 5. Table 4 provides the BIBI scoring ranges and corresponding biological condition ratings.

Table 3 – Biological Index Scoring for Piedmont Benthic Macroinvertebrates

Metric	Score		
	5	3	1
Total Number of Taxa	≥25	15 – 24	<15
Number of EPT Taxa	≥11	5 – 10	<5
Number of Ephemeroptera Taxa	≥4	2 – 3	<2
Percent Intolerant Urban	≥51	12 – 50	<12
Percent Chironomidae	≤4.6	4.7 – 63	>63
Percent Clingers	≥74	31 – 73	<31

Table 4 – 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

2.5 Physical Habitat Assessment

Each biological monitoring site is characterized based on physical characteristics and various habitat parameters following the Environmental Protection Agency's Rapid Bioassessment Protocol (RBP) habitat assessment for high gradient streams (Barbour et. al, 1999). The RBP habitat assessment consists of visually assessing ten biologically significant habitat parameters that evaluate 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 parameters assessed for high gradient streams are listed in Table 5.

Table 5 – RBP Habitat Parameters - High Gradient Streams

Parameters Assessed	
Epifaunal substrate/available cover	Channel alteration
Embeddedness	Frequency of riffles/bends
Velocity/depth regime	Bank stability
Sediment deposition	Vegetative protection
Channel flow status	Riparian vegetative zone width

The above parameters for each site (including QC sites) were summed to obtain a total habitat score. Since a reference score analysis has not been developed for Howard County watersheds, the percent comparability was calculated based on the highest attainable score (200). The percent of reference score, or percent comparability score, is then used to place each site into corresponding narrative rating categories as shown in Table 6.

Table 6 – RBP Habitat Score and Ratings

Percent of Reference	Narrative Rating
>90.0	Comparable to Reference
75.1 – 89.9	Supporting
60.1 – 75.0	Partially Supporting
<60.0	Non-supporting

2.6 Geomorphic Analysis

The goal of the physical monitoring was to create a geomorphic characterization of the stream channels in the watershed. Assessment techniques include the cross sectional survey, substrate particle size analysis and measurement of channel slope.

2.6.1 Cross Section Analysis

Cross sections were surveyed at each monitoring station to develop a channel characterization and measurement of cross sectional area and discharge. Methods followed the Howard County SOP. Each cross section was located on a representative cross-over reach and was surveyed with a laser level and stadia rod.

The cross sections include survey of the floodplain and all pertinent channel features including:

- Top of bank
- Bankfull elevation
- Edge of water
- Limits of point and instream depositional features
- Thalweg
- Floodprone elevation

Sinuosity was calculated based on the length of the field-surveyed profile and the straight-line distance between the top and bottom of each profile. The floodprone width is estimated at an elevation two times the bankfull depth.

Where possible, additional survey points were taken near the upstream, midpoint, and downstream end of the sampling reach to obtain the slope through the reach so that estimates of discharge could be derived. Survey points for slope calculations were typically taken at the top of riffle features, although this was not always possible, especially for sampling reaches on the Patuxent River mainstem that contained only one riffle in the vicinity of the sampling reach.

The stream cross section, bed and bank material data and profile information (including slope) were analyzed using the Ohio Department of Natural Resources Reference Reach Spreadsheet Version 4.3L (Mecklenburg, 2006). The following values and ratios were calculated:

Sinuosity	Entrenchment ratio	Bankfull cross section area
Slope	Bankfull height	Velocity
Floodprone width	Bankfull width	Discharge
Width / depth ratio	Mean depth	Shear stress

2.6.2 Particle Size Analysis

The channel bed and bank materials were characterized at each cross section using pebble count analysis. A single pebble count, modified from the technique developed by Wolman (1954), was conducted in each reach to determine the composition of channel materials and the median particle size for each site. The pebble count procedure was adapted from *Stream Channel Reference Sites: An Illustrated Guide to Field Technique* (Harrelson et al, 1994). The pebble count was conducted at 10 transects across the entire assessment reach. Transects were positioned based on the proportion of riffles/pools/runs in the assessment reach as estimated by visual inspection. The count was conducted within the entire bankfull channel. The pebble counts provide roughness values necessary for calculations of velocity and discharge.

2.6.3 Rosgen Classification

Additionally, a Rosgen Level II characterization (Rosgen, 1996) was completed for each stream reach based on field-collected data. Table 7 includes general descriptions for each channel type classification based on the Rosgen classification system for natural rivers (Rosgen, 1996).

Table 7 – Rosgen Level II Channel Type Description

Channel Type	General Description (from Rosgen, 1996)
Aa+	Very steep, deeply entrenched, debris transport, torrent streams.
A	Steep, entrenched, confined, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.
B	Moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools. Moderate width/depth ratio. Narrow, gently sloping valleys. Very stable plan and profile. Stable banks.
C	Low gradient, meandering, slightly entrenched, point-bar, riffle/pool, alluvial channels with broad, well-defined floodplains.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks. Active lateral adjustment, high bedload and bank erosion.
DA	Anastomosing (multiple channels) narrow and deep with extensive, well-vegetated floodplains and associated wetlands. Very gentle relief with highly variable sinuosities and width/depth ratios. Very stable streambanks.
E	Low gradient, Highly sinuous, riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander/width ratio.
F	Entrenched, meandering riffle/pool channel on low gradients with high width/depth ratio and high bank erosion rates.
G	Entrenched "gully" step/pool and low width/depth ratio on moderate gradients. Narrow valleys. Unstable, with grade control problems and high bank erosion rates.

3 Results

3.1 Subwatershed Summaries

A total of 30 sites were sampled in the Rocky Gorge, Hammond Branch, and Dorsey Run subwatersheds, ten within each individual subwatershed. Additionally, one biological QA/QC sample was collected in each subwatershed at stations where upstream habitat was considered similar. The summary results of the habitat assessment, biological assessment, land use, and Rosgen characterization (Rosgen, 1996) are divided among the three subwatersheds and presented in detail in this section. Maps of each subwatershed displaying the results of the RBP habitat assessment and BIBI are presented in Figures 4, 5 and 6. Summary data for each PSU is included in Tables 8, 9 and 10. Full data results are displayed in Appendices A through F.

3.1.1 Rocky Gorge

In 2016, five of the ten sampling sites in the Rocky Gorge subwatershed were on first order streams and five were on fourth order streams. The field QC sample was collected at site 09RG-102R-2016A-QC. The subwatershed had an average BIBI score of 2.77 and a 'Poor' condition rating, with scores ranging from 1.33 to 4.67. The average RBP habitat assessment comparability score is 67, or 'Partially-Supporting', with scores ranging from 58.5% ('Non-supporting') to 92% ('Comparable to Reference). Channels were generally classified as Rosgen type B, C, or F types with predominantly gravel/sand substrate. A summary of the results for the Rocky Gorge subwatershed is found in Table 8.

Rocky Gorge Site Descriptions:

09RG-102-R-2016A
This site is located on an unnamed tributary to Rocky Gorge Reservoir upstream of where it empties into the reservoir. Gravel was the dominant substrate type of this B4c channel. Within the 242-acre drainage area, the predominant land use is very low density residential (25.8%) followed by agriculture (25.9%), institutional (18.2%), and forest (15.4%). Impervious land cover accounted for 8.3% of the drainage area, in line with the subwatershed average of 8.8%. The RBP physical habitat assessment resulted in a score of 63.5, with a rating of 'Partially Supporting'. The banks were observed to be stable with suboptimal benthic substrate. The PHI score was a 68.3 with a rating of 'Partially Degraded.' There were a total of 25 taxa in the benthic macroinvertebrate sample with 12 EPT taxa present. Over half of the sample (68%) consisted of individuals intolerant to urban stressors, with 33 of the 68% being *Dolophilodes* with a (tolerance value [TV] = 1.7). At 18%, this station had one of the lowest percentages of individuals of the Chironomidae family (midges). This station received an overall BIBI score of 4.7 and a 'Good' biological classification. Water quality results indicated all parameters were within acceptable COMAR standards.

09RG-104-R-2016B
This site is located on an unnamed F4/5 stream that drains into the Patuxent River above Clarksville Pike. The site is surrounded by forest and low density wooded residential properties. However, water quality results indicated no parameters exceeding acceptable COMAR standards. The 721-acre drainage area had 7.3% impervious land cover. The predominant land use is very low density residential (37.6%) followed by low density residential (27.9%) and forest (15.4 %). RBP habitat was rated as 'Partially Supporting' and received a comparability score of 63.0 due to suboptimal habitat and moderately stable bank stability. The reach received a PHI score of 72.9, rating it as 'Partially Degraded.' Gravel and sand were the dominant substrate types for this sampling reach. The station received an overall BIBI score of 4.00 and a 'Good' classification. This is a result of the benthic macroinvertebrate sample consisting of a high total number of taxa (25 taxa) with eight EPT taxa present and a high percentage of individuals intolerant to urban stressors (51%).

09RG-119-F-2016G
This sampling reach is located on a small, B6 stream that drains a private pond and is located on farm land. The site was predominately silt/clay substrate. At 47 acres, this site has the smallest drainage area of the Rocky Gorge sites. Low density residential land use accounts for 48.5%, followed by very low density residential (40.7%) and forest land cover at 10.7%. The high percentage of low density residential land use results in a drainage area with 10.0% imperviousness, which is above the subwatershed average of 8.8%. The source of flow from this stream is a private pond and the sampling location was between two small farm properties. Water quality indicated elevated pH levels of 9.49 which is above the maximum COMAR standard of 8.5. Further investigation would need to be done to find the cause, but sampling occurred at the beginning of the growing season during a period when potential lime application to fields could cause a rise in pH. The RBP habitat assessment indicated a 'Non-supporting' habitat with a comparability score of 58.5 due to poor scores for epifaunal substrate/available cover, velocity/depth regime, frequency of riffles, and riparian zone width on the right bank. The PHI score was 37.4, the lowest in the subwatershed, and a narrative rating of 'Severely Degraded.' This station received the second lowest BIBI score of 1.67 with a narrative rating of 'Very Poor'. There were a total of 17 taxa present in this benthic macroinvertebrate sample and no EPT taxa. This station also had only 13% individuals intolerant to urban stressors, while having 83% Chironomids (midges).

09RG-124-F-2016I

This site is located on a small, F4b headwater stream downstream of site 09RG-119-F-2016G with a substrate consisting of mostly gravel and sand. This site is located next to a private pond and has a small pipe draining into the reach. This site drains an area of 77 acres. Very low density residential land use accounts for 42.1%, followed by low density residential at 41.5% and forest land cover at 16.4%. Impervious land cover for this subwatershed, is 8.9%, in line with the subwatershed average of 8.8%. This site received an RBP habitat score of 59.5 with a rating of 'Non- supporting'. The PHI score was a 58.1 with a rating of 'Degraded.' Water quality results indicated all parameters within acceptable COMAR standards. There were 31 taxa present in this benthic macroinvertebrate sample, with nine EPT taxa. Forty-three percent of the individuals were intolerant to urban stressors. As a result, this site received a BIBI score of 3.33 with a narrative rating of 'Fair.'

09RG-407-R-2016C

This site is located on a fourth-order primarily run segment of the Patuxent River, downstream of Route 216. This stream was classified as a B4/5c channel with predominately sand and gravel substrate. Impervious land cover accounted for 9.5% of the 87,675-acre drainage area, slightly above the subwatershed average. The predominant land use for this site is agriculture (30.8%) followed by forest land cover (30.0%) and low density residential (17.1%). Suboptimal habitat, optimal velocity/depth regime and channel flow status resulted in a RBP habitat score of 67.5 and a rating of 'Partially Supporting'. The PHI was scored at 68.1 with a narrative rating of 'Partially Degraded.' The benthic macroinvertebrate sample for this site was the lowest of all Rocky Gorge sites with 19 taxa, four of which were EPT taxa, and only one Ephemeroptera taxon present. Chironomids (midges) accounted for 74% of the sample, while only four percent consisted of individuals intolerant to urban stressors. Based on the BIBI score of 1.33, this site was given a 'Very Poor' biological condition rating. Water quality results indicated all parameters within acceptable COMAR standards.

09RG-410-R-2016D

This sampling reach is located on the Patuxent River mainstem downstream of I-95 and is classified as a B3c channel, with a substrate predominately consisting of cobble and gravel. At 86,280 acres, this site had the second largest drainage area for the entire Rocky Gorge subwatershed with 9.1% of the drainage area consisting of impervious land cover. Land use in the drainage area is primarily agriculture and forested land cover (31.3% and 30.1%, respectively) followed by low density residential (17.2%). This site scored the highest PHI in the watershed at 84.9 and a rating of 'Minimally Degraded.' For RBP habitat, this site scored the highest in the Rocky Gorge watershed. With optimal scores in every category, this reach received a habitat score of 92.0 with a 'Comparable to Reference' classification. 'Comparable to Reference' means that it received scores similar to the best quality streams possible. The water quality results indicated no parameters that exceeded acceptable COMAR standards. Due to the depth of the sampling reach, benthic macroinvertebrate sampling was performed entirely along one bank of the reach. There were a total of 17 taxa in the benthic macroinvertebrate sample, four of which were EPT taxa, with two Ephemeroptera taxa present. Close to half of this sample (42%) was comprised of Chironomids (midges). Only two percent of the sample consisted of individuals intolerant to urban stressors and no climbers were present in the sample. Although the habitat received very high scores, the low level of intolerant individuals and complete lack of climbers contributed to an overall BIBI score of 2.00 for this site, resulting in a 'Poor' biological condition rating.

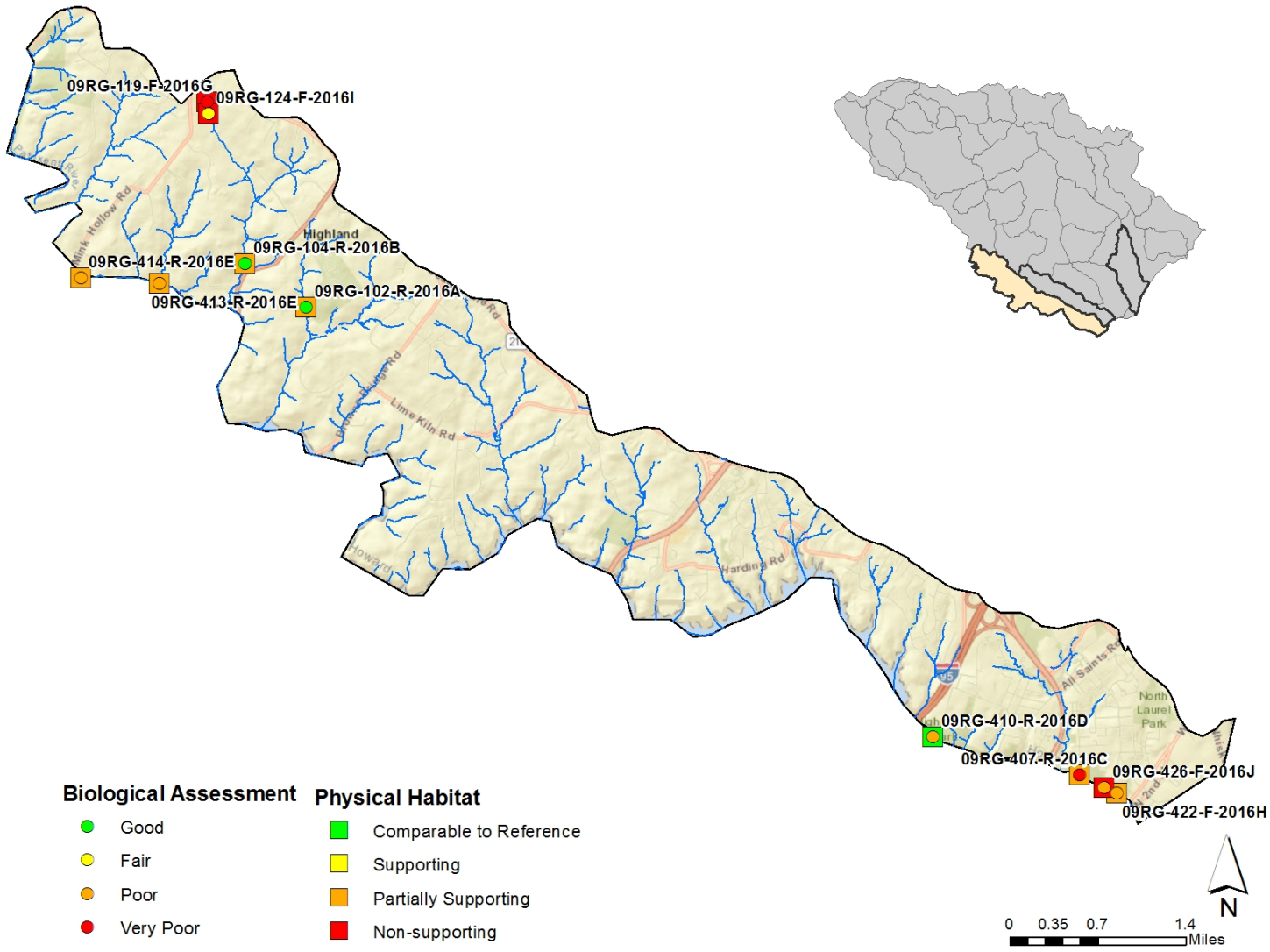

Figure 4 – Rocky Gorge PSU Sampling Results

Table 8 - Rocky Gorge Summary

Site ID	Drainage Area (ac)	Impervious Surface Percent	BIBI Score	BIBI Rating	RBP Comparability Score	RBP Rating	PHI Score	PHI Rating	Rosgen Channel Type
09RG-102-R-2016A*	243	8.3	4.67	Good	58.5	Non-supporting	68.3	Partially Degraded	B4c
09RG-104-R-2016B	721	7.3	3.67	Fair	67.5	Partially Supporting	72.9	Partially Degraded	F4/5
09RG-119-F-2016G	47	10.0	4.00	Good	92.0	Comparable to Reference	37.4	Severely Degraded	B6
09RG-124-F-2016I	77	8.9	1.67	Very Poor	74.0	Partially Supporting	58.1	Degraded	F4b
09RG-407-R-2016C	87,675	9.5	3.33	Fair	60.5	Partially Supporting	68.1	Partially Degraded	B4/5c
09RG-410-R-2016D	86,280	9.1	1.33	Very Poor	59.0	Non-supporting	84.9	Minimally Degraded	B3c
09RG-413-R-2016E	71,112	8.1	2.00	Poor	63.5	Partially Supporting	75.8	Partially Degraded	C4/5
09RG-414-R-2016E	70,729	8.1	2.67	Poor	65.0	Partially Supporting	74.2	Partially Degraded	F4/5
09RG-422-F-2016H	87,842	9.5	2.67	Poor	70.5	Partially Supporting	49.5	Severely Degraded	F4/5
09RG-426-F-2016J	87,801	9.5	2.67	Poor	59.5	Non-supporting	56.4	Degraded	F4/5
Minimum	47	7.3	1.33	Very Poor	58.5	Non-supporting	37.4	Severely Degraded	--
Maximum	87,842	10.0	4.67	Good	92.0	Comparable to Reference	84.9	Minimally Degraded	--
Mean	49,261	8.8	2.77	Poor	67.0	Partially Supporting	64.6	Degraded	--
Standard Deviation	42,641	0.9	1.02	--	10.2	--	14.2	--	--

*QC sampling was conducted at this site

09RG-413-R-2016E
This site, located on the Patuxent River mainstem above Clarksville Pike was classified as a C4/5 channel with predominately sand substrate. At 71,112 acres, 8.1%t of which was impervious land cover, this drainage area consisted primarily of agriculture (35.4%) and forested land cover (29.3%) followed by low density residential (16.1%). This site received a PHI score of 75.8 and a rating of 'Partially Degraded.' Suboptimal to optimal scores for RBP habitat were given for most parameters, with the exception of a marginal rating for sediment deposition, resulted in a score of 74.0 and a rating of 'Partially Supporting.' Water quality results indicated all parameters within acceptable COMAR standards. This station received a BIBI rating of 'Poor' with a score of 2.67. Seventeen total taxa were present in this benthic macroinvertebrate sample, five of which were EPT taxa and two of which were Ephemeroptera taxa. Only six percent of the sample consisted of individuals intolerant to urban stressors. The benthic sample consisted of 60% clingers and 28% tolerant midges

09RG-414-R-2016E
This sampling reach is located in a large, deep pool feature of the Patuxent River just downstream of Mink Hallow Road. The predominant land use is agriculture (35.6%), followed by forested land cover (29.2%) and low density residential (16.1%). Of the 70,729-acre drainage area, 8.1% was comprised of impervious land cover. This site received a PHI score of 74.2 resulting in a rating of 'Partially Degraded.' Classified as a F4/5 channel, this sampling reach is split evenly between silt/clay, sand, gravel and bedrock, each comprising 20-25% of bed substrate. This site received a habitat comparability score of 70.5 with a rating of 'Partially Supporting' due to suboptimal sediment deposition and marginal embeddedness. Due to the depth of the sampling reach, benthic macroinvertebrate sampling was performed along one bank of the reach. There were a total of 22 taxa present in this benthic macroinvertebrate sample, consisting of five EPT taxa and one Ephemeroptera. This sample had 22 total taxa with five EPT taxa and two of those Ephemeroptera. Forty-five percent of the sample consisted of midges while only six percent of individuals were intolerant to urban stressors resulting in a BIBI score of 2.67 with a rating of 'Poor'. Water quality results indicated all parameters were within acceptable COMAR standards.

09RG-422-F-2016H
This site is located on the Patuxent River mainstem, just upstream of Washington Boulevard. This reach was classified as a F4/5 channel type with a predominately sand and gravel substrate. Land use in the 87,842-acre drainage area is primarily agricultural (30.8%) and forested land cover (30.0%), with the majority of the remainder as low density residential (17.0%). The overall imperviousness in this drainage area is 9.5%, which is above average for the subwatershed. Because of a general lack of riffles and a minimal riparian zone on the right bank, this site received an RBP habitat assessment score of 60.5 with a rating of 'Partially Supporting.' For PHI, a score of 49.5 and a rating of 'Severely Degraded' was given. Water quality results indicated no parameters that exceeded acceptable COMAR standards. Due to the depth of the sampling reach, benthic macroinvertebrate sampling was performed entirely along one bank of the reach. There were a total of 31 taxa in the sample, the second most taxa present within all samples in the Rocky Gorge subwatershed. Within the benthic sample, five EPT taxa and three Ephemeroptera taxa were present. However, this site had a low percentage of individuals intolerant to urban stressors (7%) and a high percentage (58%) of individuals of the Chironomidae family (midges). Because of the low percentage of intolerant species, this site received a BIBI score of 2.67 and a biological rating of 'Poor.'

09RG-426-F-2016J
This sampling reach is located in a fourth-order section of the Patuxent River mainstem, upstream of site 09RG-422-F-2016H. Similar to site 09RG-422, the predominant land use for the 87,801 acre drainage area of this site is agriculture (30.8%) followed by forested land cover (30.0%), and low density residential (17.1%), which resulted in 9.5% imperviousness. This reach was classified as an

F4/5 channel and the substrate was dominated by gravel and sand with some silt/clay particles. Because this site was located in the middle of a large pool feature, the lack of riffles present resulted in a habitat assessment comparability score of 59.0 with 'Non-supporting' classification. A PHI score of 56.4 and rating of 'Degraded' was given to this site. Based on the BIBI score of 2.67, this site was given a 'Poor' biological condition rating. In this benthic macroinvertebrate sample, 33 taxa were present, the most of all Rocky Gorge watershed sites. Of the 33 taxa, eight were EPT taxa, one of which was Ephemeroptera. Individuals of the Chironomidae family (midges) made up 53% of the sample, and individuals intolerant to urban stressors accounted for only twelve percent of the sample. Water quality results indicated all parameters were within acceptable COMAR standards.

3.1.2 Hammond Branch

All ten sites sampled in 2016 within the Hammond Branch PSU were on first order streams as defined by the NHD stream layer. The field QC sample was collected immediately upstream of site 14HB-123-F-2016I. RBP habitat assessment scores ranged from 41.0%, with a classification of 'Not Supporting' to 78.0% and a classification of 'Supporting'. The mean RBP habitat score was 57.5 with a rating of 'Non-Supporting.' All sites were considered characteristic of piedmont streams and were assessed using the piedmont BIBI. There were only three sites that received biological condition ratings of 'Fair', with scores ranging from 3.00 to 3.33. The other seven sites received "Poor" scores that ranged from 2.00 to 2.67. The mean BIBI score was 2.70, with an average biological condition rating of 'Poor.' Stream reaches were classified as either B, C, G, E or F channels, with sand, gravel, or cobble dominated substrates. A summary of the results for the Hammond Branch subwatershed is found in Figure 5 and Table 9.

Hammond Branch Site Descriptions:

14HB-101-R-2016A This site is located on Hammond Branch downstream of Crabbury Ct. This sampling reach was classified as a G4/5c channel with gravel and sand substrate. Water quality results indicated no parameters that exceeded acceptable COMAR standards. The land use within the 153-acre drainage area is predominantly low density residential (52.6%) followed by forested land cover (32.1%) and agricultural use (15.3%). The percentage of impervious surface in the drainage area is 8.4%, which is below the subwatershed average of 12.5%. This sampling reach contained few riffles, high embeddedness, and poor vegetative protection. As a result, this site received an RBP habitat a score of 65.5 and a rating of 'Partially Supporting.' A PHI score of 64.6 was given to this site, resulting in a rating of 'Degraded.' The BIBI score was 2.67, with a biological rating of 'Poor.' Of the 29 taxa present, only two EPT taxa and no Ephemeroptera were present, with 14% of the sampling comprising individuals intolerant to urban stressors. The majority of the sample (48$) consisted of individuals of the Chironomidae family (midges).

14HB-106-R-2016B
Located behind Lime Kiln Middle School and Reservoir High school, this sampling reach is a C4/5 channel in a cleared powerline easement. The predominant substrate of this stream is gravel and sand. Poor bank stability, vegetative protection, and riparian zone attributed to the RBP habitat assessment rating of 'Non-supporting' with a score of 54.0. The PHI score was 56.9, resulting in a rating of 'Degraded.' A total of 7.8% of the 1,030 acre drainage area consists of impervious land cover, below the subwatershed average. The dominant land use for this drainage area is low density residential (38.6%) followed by agriculture (36.0%) and forested land cover (17.4%). There were 26 taxa in the benthic macroinvertebrate sample, six of which were EPT taxa and one of which was Ephemeroptera. Fifty-one percent of the individuals in this sample were of the Chironomidae family (midges), while 49% of the sample consisted of clingers and only three percent consisted of individuals intolerant to

urban stressors. Overall, this site received a BIBI score of 2.67 with a narrative rating of 'Poor.' Water quality results indicated all parameters within acceptable COMAR standards.

14HB-107-R-2016C

This site is located behind Reservoir High school in a powerline clearing. Classified as a C3/5 channel, the dominant substrate for this sampling reach is sand, with an abundance of cobble and silt/clay also present. Of the 1,259 acres, impervious surfaces comprised 9.6% of the drainage area. Agriculture is the predominant land use in this drainage area (38.6%) followed by low density residential (32.9%) and forested land cover (16.0%). Physical habitat was rated as 'Non-supporting' and received a RBP habitat score of 46.5 due to unstable banks and poor vegetative protection and riparian zone width. The lowest PHI score in the 2016 set of sites was given to this site with a score of 33.4 and a rating of 'Severely Degraded.' Water quality results indicated no parameters that exceeded acceptable COMAR standards. There were 23 taxa in this benthic macroinvertebrate sample with four EPT taxa and one Ephemeroptera taxa present. Only one percent of the sample consisted of individuals intolerant to urban stressors and individuals of the Chironomidae family (midges) accounted for 49% of the sample resulting in a score of 2.00 and a corresponding biological condition rating of 'Poor.'

14HB-110-R-2016D

Located behind Hammond Middle and Elementary schools, this sampling reach was classified as a F4/5 channel with a predominately gravel substrate. At this site, the majority of the surrounding land use in the 2,322-acre drainage area is agriculture (34.2%) followed by low density residential (27.5%) and forested land cover (15.1%). Impervious surface accounted for 16.2% of the drainage area, which is above the subwatershed average. This reach had unstable banks and poor vegetative protection, but with a habitat comparability score of 62.0, this site received a 'Partially Supporting' habitat rating. The PHI score was an 82.1 with a rating of 'Minimally Degraded.' This sampling reach also received a BIBI score of 2.67 and a biological rating of 'Poor.' A total of 28 taxa were in the sample, six of which were EPT taxa and one of which was Ephemeroptera. Individuals of the Chironomidae family (midges) made up the majority of this sample (50%) and only four percent of the sample consisted of individuals intolerant to urban stressors. Water quality results indicated all parameters within COMAR standards.

14HB-114-R-2016E

This site is located on a highly eroded B5c channel along a powerline clearing, with a predominately sand substrate along with a moderate amount of clay hardpan. Water quality results indicated no parameters that exceeded acceptable COMAR standards. The predominant land use in this drainage area is classified as agriculture (28.7%) with low density residential accounting for 22.4% and forested land cover accounting for 17.8%. The overall imperviousness within the 3,555-acre drainage area is 16.7%, which is above the subwatershed average of 12.5%. Because of marginal and poor scores for habitat, embeddedness, sediment deposition, bank stability, vegetative protection and riparian width, this sampling reach received one of the lowest RBP scores of 42.5 and corresponding rating of 'Non-supporting.' The PHI score was also one of the lowest in the subwatershed at 35.5 which results in a rating of 'Severely Degraded.' Of the 30 taxa present in this benthic macroinvertebrate sample, eight EPT taxa were present, three of which were Ephemeroptera taxa. Additionally, chironomids (midges) accounted for 45% of the sample and 12% consisted of individuals tolerant to urban stressors. This site received the highest BIBI scores within this subwatershed with a score of 3.33 and a narrative rating of 'Fair.'

14HB-116-R-2016F
This sampling site is located in a forested area behind Promise Ct. with very low flow. The reach was classified as a G6c channel dominated by silt/clay substrate. In the 3,708-acre drainage area to this site, the majority of the surrounding land use is agriculture (29.4%) and low density residential (21.5%), with 19.0% forested land cover. The percentage of impervious surface in the drainage area is 16.4%, which is above the subwatershed average. All water quality parameters were within COMAR limits. As a result of poor habitat, embeddedness, velocity/depth regime, frequency of riffles, and vegetative protection, this site received the lowest RBP score of 41.0 with a rating of 'Non-supporting'. The PHI score of 36.9 and rating of 'Severely Degraded' align with the RBP. This benthic macroinvertebrate sample had a low number of taxa (10) and EPT taxa were entirely absent. Individuals of the Tubificidae family (worms) dominated this sample at 84%, with *Spirosperma* (TV = 6.6) accounting for over a third of the sample. As a result of a large percentage of worms and a complete absence of individuals intolerant to urban stressors, this site received a BIBI score of 2.33 and a narrative rating of 'Poor.'

14HB-119-F-2016G
This site was located on the edge of a powerline clearing, between agriculture fields and residential homes on Wayneridge St. Classified as an E4/5 channel, the substrate of this sampling reach was predominantly gravel and sand. At 717-acres, this site had the smallest drainage area of the subwatershed. Low density residential land use dominates this drainage area at 37.9%, followed by agriculture (30.5%) and forest (22.8%), which results in 7.5% impervious land cover—the lowest percentage in this subwatershed. No water quality parameters exceeded acceptable COMAR standards. The PHI score was 67.3 with a rating of 'Partially Degraded.' The RBP habitat assessment indicated a 'Partially Supporting' habitat with a score of 61.0. A total of 35 taxa, the highest total taxa value in the subwatershed, were present in this benthic macroinvertebrate sample. Eight EPT taxa and four Ephemeroptera were present. Almost half of this sample consisted of chironomids (midges), accounting for 48% of the sample. Although this site had the most taxa, only eight percent were individuals intolerant to urban stressors. Overall, this sample received one of the highest BIBI scores for this subwatershed of 3.00, with a rating of 'Fair' (tied with site 14HB-121-F-2016H).

14HB-121-F-2016H
Located in a forested buffer between Graeloch Rd and Bubbling Spring, this sampling reach was classified as a C4/5 channel dominated by gravel with some silt/clay substrate. Water quality results indicated no parameters that exceeded acceptable COMAR standards. While there was marginal bank stability and marginal riffle frequency, this site received a RBP habitat score of 67.0 with a rating of 'Partially Supporting.' A PHI score of 75.6 resulted in a rating of 'Partially Degraded.' In this 2,152-acre drainage area, agriculture was the predominant land use (36.9%) followed by low density residential (27.3%) and 14.4% consisting of forested land cover. The overall impervious drainage is 16.2%, which exceeds the subwatershed average. This site received a BIBI score of 3.00 with a narrative rating of 'Fair,' which is the 2nd highest rating in the subshed (tied with site 14HB-119-F-2016G). There were 25 taxa in this benthic macroinvertebrate sample, five of which were EPT taxa but with only two Ephemeroptera taxa present. The Chironomidae family (midges) made up 48% of the sample, while only five percent of this sample consisted of individuals intolerant to urban stressors.

14HB-123-F-2016I
This site is located in a riparian zone between Stebbing Way and Steeple Ct. This sampling reach was classified as a C3 channel. Cobble is the dominate substrate type for this channel. At 4,088 acres, this is the largest drainage area of this subwatershed. Although 29.4% of the drainage area is agriculture and 19.0% is forested land cover, combined low/ medium/high density residential accounts for over 36% of the drainage area. As a result, the drainage area has 16.8% impervious surface, which is the

highest in the subwatershed. RBP Habitat was rated as 'Supporting' with a score of 78.0. This site was the only location in this subwatershed that received a 'Supporting' habitat condition rating. The PHI score was also a 78.0, which resulted in a rating of 'Partially Degraded.' While there was a moderately high number of total taxa (27), there was a low number of EPT taxa present (four), and only two Ephemeroptera taxa present in the benthic macroinvertebrate sample. Additionally, chironomids (midges) dominated this sample at 55%. Seventeen percent of this sample comprised of individuals intolerant to urban stressors. This site received a BIBI score of 2.67, which resulted in a 'Poor' biological condition rating. A QC sample was completed in the adjacent 75-meters reach upstream of this site, where water conditions and habitat resembled the original reach. The QC reach received a BIBI score of 2.00, resulting in a 'Poor' biological condition rating. RBP habitat was also conducted at the QC site which received a score of 76.5 and a rating of 'Supporting.'

14HB-125-F-2016J

Located in a powerline clearing, between a newly developed residential community and Reservoir high school. This sampling reach was classified as a C4/5 channel with a mix of sand and gravel substrates. Water quality results indicated all parameters within acceptable COMAR standards. Because of suboptimal habitat and embeddedness along with marginal sediment deposition, bank stability and vegetative protection, this reach received a habitat comparability score of 57.5 with a 'Non-supporting' classification. A PHI score of 49.6 and corresponding 'Severely Degraded' rating was applied to this reach. Over one-third of the land use in the 1,251-acres draining to the site is agricultural land use (38.7%), with an additional 33.1% as low density residential and 15.6% as forested land cover. The percentage of impervious surface in the drainage area is 9.6%, which is below the subwatershed average. Of the 28 total taxa identified in this sample, only four were EPT taxa and two were Ephemeroptera taxa. Individuals of the Chironomidae family (midges) dominated this sample at 53%, with *Cricotopus/Orthocladius* (TV = 7.7) accounting for 26% of the sample. Only five percent of this sample consisted of individuals intolerant to urban stressors. The site received a BIBI score of 2.67 with a corresponding biological rating of 'Poor.'

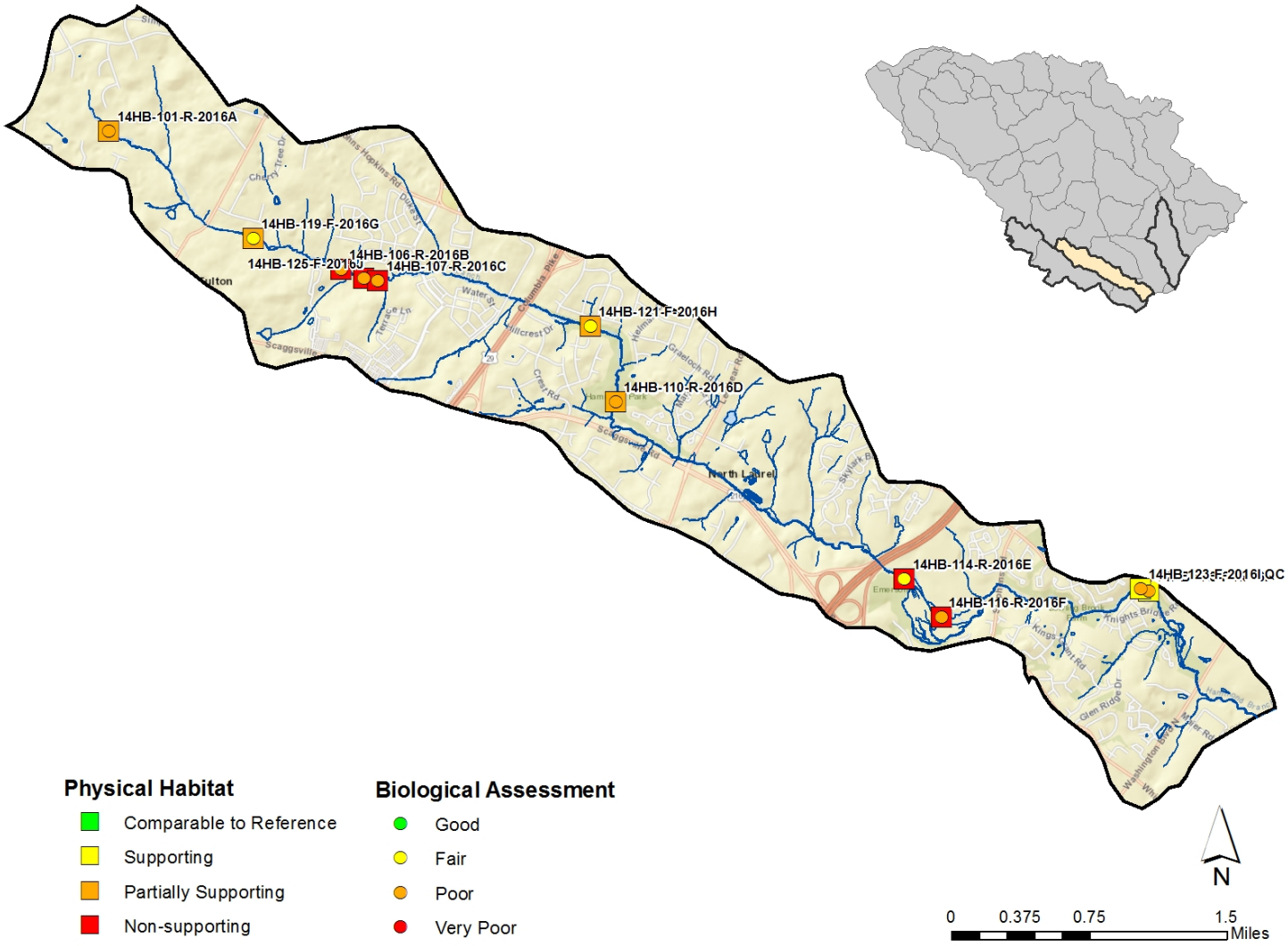

Figure 5 - Hammond Branch PSU Sampling Results

Table 9 - Hammond Branch Summary

Site ID	Drainage Area (ac)	Impervious Surface Percent	BIBI Score	BIBI Rating	RBP Comparability Score	RBP Rating	PHI Score	PHI Rating	Rosgen Channel Type
14HB-101-R-2016A	153	8.4	2.67	Poor	65.5	Partially Supporting	64.6	Degraded	G4/5c
14HB-106-5-2016B	1,031	7.8	2.67	Poor	54.0	Non-supporting	56.9	Degraded	C4/5
14HB-107-R-2016C	1,259	9.6	2.00	Poor	46.5	Non-supporting	33.4	Severely Degraded	C3/5
14HB-110-R-2016D	2,322	16.2	2.67	Poor	62.0	Partially Supporting	82.1	Minimally Degraded	F4/5
14HB-114-R-2016E	3,555	16.7	3.33	Fair	42.5	Non-supporting	35.5	Severely Degraded	B5c
14HB-116-R-2016F	3,708	16.4	2.33	Poor	41.0	Non-supporting	36.9	Severely Degraded	G6c
14HB-119-F-2016G	717	7.5	3.00	Fair	61.0	Partially Supporting	67.3	Partially Degraded	E4/5
14HB-121-F-2016H	2,153	16.2	3.00	Fair	67.0	Partially Supporting	75.6	Partially Degraded	C4/5
14HB-123-F-2016I*	4,088	16.8	2.67	Poor	78.0	Supporting	78.0	Partially Degraded	C3
14HB-125-F-2016J	1,251	9.6	2.67	Poor	57.5	Non-supporting	49.6	Severely Degraded	C4/5
Minimum	153	7.5	2.00	Poor	41.0	Non-supporting	33.4	Severely Degraded	--
Maximum	4,088	16.8	3.33	Fair	78.0	Supporting	82.1	Minimally Degraded	--
Mean	2,024	12.5	2.70	Poor	57.5	Non-supporting	58.0	Degraded	--
Standard Deviation	1,371	4.2	0.37	--	11.7	--	18.4	--	--

*QC sampling was conducted at this site

3.1.3 Dorsey Run

All ten sites sampled in the Dorsey Run subwatershed in 2016 were located on first-order streams as defined by the NHD stream layer. The field QC sample was collected at site 15DR-123-F-2016I. All stream reaches were classified as C or F channels, with sand or gravel dominated substrates. A summary of the results for the Dorsey Run subwatershed is presented in Figure 6 and Table 10.

Three sites within the Dorsey Run PSU were rated as 'Supporting' and five sites were rated as 'Partially Supporting' based on the RBP habitat assessment scores. The mean RBP habitat comparability score of 66.9 for the subwatershed resulted in a 'Partially Supporting' rating.

Eight of the ten sites sampled in the Dorsey Run subwatershed received biological condition ratings of 'Very Poor.' The remaining two sites received 'Poor' biological ratings. BIBI scores ranged from a low of 1.00 to 2.33, which resulted in a mean BIBI score of 1.40 and an overall biological condition rating of 'Very Poor' for the subwatershed.

Dorsey Run Site Descriptions:

15DR-102-R-2016A
This site runs parallel to railroad tracks with a large bridge culvert (Dorsey Run Road) spanning the middle portion of the reach. The stream was classified as a F5 channel with sand as the dominant substrate. A high measurement of conductivity (762.0 µS/cm) was observed at this site, but water quality results indicated no parameters that exceeded acceptable COMAR standards. Of the 4,154-acre drainage area, the dominant land use is commercial and industrial (42.%) followed by forested land cover (23.4%). Low, medium, and high density residential land use, when combined, account for nearly 20% of the drainage area, contributing to an impervious percentage of 36.8% that exceeds the subwatershed average of 33.2%. This sampling reach received the lowest RBP habitat score of 41.5 and a rating of 'Non-supporting' due to poor instream habitat, embeddedness, sediment deposition, and riffle frequency. The PHI also shows a 'Severely Degraded' channel with a score of 41.5, the lowest in the subwatershed. The BIBI score of 2.33 was the highest in Dorsey Run, although the biological condition was rated as 'Poor.' Of the 20 total taxa identified in the sample, only two were EPT taxa and two Ephemeroptera taxa were present. Fifty-six individuals (or 57%) were Oligochaeta (worms) with tolerance values ranging from 8.4 to 9.1. Only 11% of the individuals were intolerant to urban stressors.

15DR-104-R-2016B
This site is located on a F4/5 channel with predominately gravel and sand substrate. The reach runs in a forested area between a mobile home community on Inwood Ct. and railroad tracks near Tar Bay Dr. Water quality results indicated no parameters that exceeded acceptable COMAR standards, but the site did have high specific conductivity (787.0 µS/cm). Because of marginal scores for instream habitat, embeddedness, sediment deposition, and bank stability this site received a habitat assessment score of 59.0 and a 'Non-supporting' classification. A PHI score 64.9 resulted in a 'Degraded' condition rating. The dominant land use in the 1,357-acres drainage area is commercial and industrial (40.2%) followed by forested land cover (31.8%). Impervious surface accounted for 30.9% of the drainage area, which is slightly below the subwatershed average of 33.2%. There were 14 total taxa identified in the benthic macroinvertebrate sample, although EPT taxa were absent. Ephemeroptera and individuals intolerant to urban stressors were also absent from this sample. Individuals of the Chironomidae family (midges) dominated this sample at 66%. Only seven percent of the sample consisted of clingers. As a result, this site received the lowest BIBI score possible (1.00) with a corresponding biological rating of 'Very Poor.'

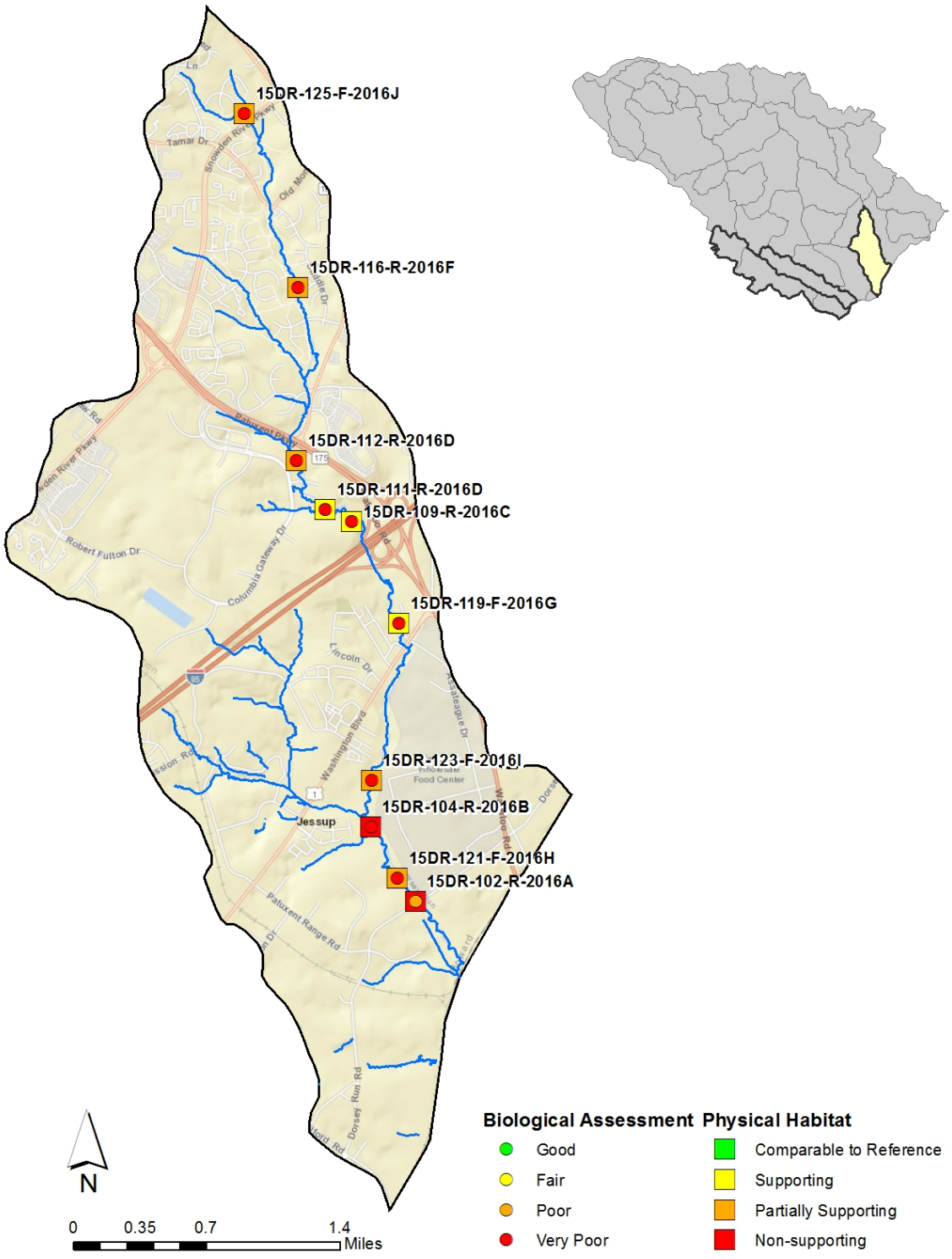

Figure 6 - Dorsey Run PSU Sampling Results

15DR-109-R-2016C
This site is located upstream of a stormwater management pond which drains office buildings and parking lots off of Benjamin Franklin Dr. The site is also upstream of a ramp from Route 175 to I-95 S. While no water quality parameters exceeded acceptable COMAR standards, high specific conductivity (821 µS/cm) was measured at this site. With a predominantly gravel and sandy substrate, the sampling reach was classified as a C4/5 channel. Optimal habitat, sediment deposition, riffle frequency, bank stability, and vegetative protection led to the highest RBP habitat score in the watershed (80.5) and a habitat rating of 'Supporting.' The PHI score was 79.3, the highest in the subwatershed, which resulted in a rating of 'Partially Degraded.' This site had a drainage area of 1,661-acres with 35.9% classified as commercial and industrial land use, 35.6% as combined low, medium, and high density residential, and 18.3% as forested land cover. Impervious surface percentage exceeded the subwatershed average at 36.7%. Of the 20 total taxa identified, four EPT taxa were present in the sample, one of which was Ephemeroptera. Individuals intolerant to urban stressors accounted for just one percent of the sample while 11% of the sample consisted of clingers. Eighty-four percent of the sample was made up of Chironomids (midges). Based on the BIBI score of 1.33, this site was given a 'Very Poor' biological condition rating.

15DR-111-R-2016D
This site is located approximately 800 feet upstream from 15DR-109-R-2016C on a F4/5 channel with a gravel and sand substrate. Optimal sediment deposition, riffle frequency, and bank stability led to a habitat assessment rating of 'Supporting' with a percent comparability score of 76.0. The predominant land use in the 1.636-acre drainage area is commercial and industrial (36.4%) followed by medium density residential (19.8%) and forested land cover (17.6%). Overall, the drainage area has 37.1%impervious surfaces, which is above the average for the Dorsey Run subwatershed. The benthic macroinvertebrate sample was dominated by individuals of the Chironomidae family (79%), with *Cricotopus/Orthocladius* (TV = 7.7) accounting for 41% of the sample. There were 18 total taxa in this sample with three EPT taxa and only one Ephemeroptera taxa. Only two percent of the individuals were considered intolerant to urban stressors—resulting in a BIBI score of 1.33 and a biological condition rating of 'Very poor.' While, water quality results indicated no parameters that exceeded acceptable COMAR standards, this site had the highest conductivity readings in this subwatershed at 833.0 µS/cm.

15DR-112-R-2016D
This site is located upstream of John McAdams Dr. and downstream of Route 175. High specific conductivity (819 µS/cm) was recorded at this site, but the remaining water quality parameters were within acceptable COMAR standards. Classified as a F4/5 channel, the substrate of this sampling reach was dominated by gravel. This sampling reach received an RBP habitat score of 70.5 and rating of 'Partially Supporting.' The 1,464-acre drainage area is predominantly commercial and industrial land use (33.4%) with low and medium density residential collectively accounting for over 40% of the land use, resulting in 36.9% impervious surface. There were 19 total taxa in this sample, three of which were an EPT taxa. There was one Ephemeroptera taxa and two total individuals intolerant to urban stressors identified in this sample. Individuals of the Chironomidae family (midges) dominated this sample at 71%. This site received a BIBI score of 1.33 with a corresponding biological condition rating of 'Very Poor.'

Table 10 - Dorsey Run Summary

Site ID	Drainage Area (ac)	Impervious Surface Percent	BIBI Score	BIBI Rating	RBP Comparability Score	RBP Rating	PHI Score	PHI Rating	Rosgen Channel Type
15DR-102-R-2016A	4,155	36.8	2.33	Poor	41.50	Non-supporting	41.5	Severely Degraded	F5
15DR-104-R-2016B	1,357	30.9	1.00	Very Poor	59.00	Non-supporting	64.9	Degraded	F4/5
15DR-109-R-2016C	1,662	36.7	1.33	Very Poor	80.50	Supporting	79.3	Partially Degraded	C4/5
15DR-111-R-2016D	1,636	37.1	1.33	Very Poor	76.00	Supporting	75.3	Partially Degraded	F4/5
15DR-112-R-2016D	1,464	36.9	1.33	Very Poor	70.50	Partially Supporting	76.2	Partially Degraded	F4/5
15DR-116-R-2016F	511	25.0	1.33	Very Poor	73.00	Partially Supporting	78.0	Partially Degraded	F4/5
15DR-119-F-2016G*	2,053	34.0	1.33	Very Poor	78.00	Supporting	75.2	Partially Degraded	F4/5
15DR-121-F-2016H	4,073	36.4	1.00	Very Poor	64.50	Partially Supporting	66.4	Partially Degraded	F4/5
15DR-123-F-2016I	2,475	38.5	1.67	Very Poor	62.00	Partially Supporting	62.6	Degraded	F4/5
15DR-125-F-2016J	125	19.7	1.33	Very Poor	64.00	Partially Supporting	65.1	Degraded	C4/5
Minimum	125	19.7	1.00	Very Poor	41.50	Non-supporting	41.5	Severely Degraded	--
Maximum	4,155	38.5	2.33	Poor	80.5	Supporting	79.3	Partially Degraded	--
Mean	1,951	33.2	1.40	Very Poor	66.9	Partially Supporting	68.5	Minimally Degraded	--
Standard Deviation	1,326	6.21	0.38	--	11.5	--	11.3	--	--

*QC sampling was conducted at this site

15DR-116-R-2016F
Located in a densely a narrowly forested area behind Distant Rock Path, this sampling reach was classified as a F4/5 channel with a predominately sand and gravel substrate. High average conductivity (617.4 µS/cm) was measured at this site, but water quality results indicated all parameters within acceptable COMAR standards. This site received an RBP habitat assessment score of 73.0 and a rating of 'Partially Supporting.' Land use in the 511-acre drainage area is primarily medium density residential (34.0%) and high density residential (28.0%), with 13.1% forest land cover. The overall imperviousness is 25.0%, well below the subwatershed average of 33.2%. There were 18 total taxa identified in the benthic macroinvertebrate sample, two of which were EPT taxa. Individuals of the Chironomidae family (midges) dominated this sample at 82%, with *Cricotopus/Orthocladius* (TV = 7.7) comprising 32% of the sample. There was one Ephemeroptera taxa and four individuals intolerant to urban stressors identified in the sample. Only 11% of the sample consisted of clingers. As a result, this site received a BIBI score of 1.33 with a biological condition rating of 'Very Poor.'

15DR-119-F-2016G
This site is located behind the apartment complex on Crestmount Rd. The reach was classified as a F4/5 channel type with a predominantly gravel substrate. High specific conductivity (655 µS/cm) was measured at this site, but water quality results indicated all parameters within acceptable COMAR standards. The habitat assessment indicated a 'Supporting' habitat with a score of 78.0 due to optimal sediment deposition and riffle frequency, with all other parameters in the suboptimal range. Within the 2,053-acre drainage area, the predominant surrounding land use is commercial and industrial (30.9%), followed by forest (20.8%) and medium density residential (19.0%). Overall, the drainage area has 34.0% impervious surface—slightly above the subwatershed average. The BIBI score for this site was 1.33, resulting in a narrative rating of 'Very Poor.' Of the 21 total taxa identified in this sample, three were EPT taxa, and only four percent of the sample consisted of individuals intolerant of urban stressors. Ephemeroptera taxa were completely absent. Individuals of the Chironomidae family (midges) dominated this sample at 77%, with *Cricotopus/Orthocladius* (TV = 7.7) accounting for 36% of the sample. A QC site was completed immediately upstream of this site and received a slightly lower habitat assessment score of 74.5 with the rating of 'Partially Supporting.' The QC site had 20 total taxa with two EPT, no Ephemeroptera, and five percent individuals intolerant to urban stressors identified. Ultimately, the QC site received the same BIBI score as 15DR-119-F-2016G (1.33) with a rating of 'Very Poor'.

15DR-121-F-2016H
Located approximately 600 feet upstream of 15DR-102-R-2016A, this sampling reach is classified as a F4/5 channel with a predominately gravel substrate. Water quality results indicated no parameters that exceeded acceptable COMAR standards, but did show elevated conductivity (679 µS/cm). The drainage area to this site is 4,073 acres and is comprised primarily of commercial and industrial (41.3%), forest (23.3%) and medium density residential (11.2%). Imperviousness in the drainage area is 36.4%, above the subwatershed average of 33.2%. Because of marginal scores for embeddedness, sediment deposition, channel flow status, and bank stability, this site received an RBP habitat comparability score of 64.5 and a rating of 'Partially Supporting.' There were 13 total taxa in this sample, one of which was an EPT taxon and in the order Ephemeroptera. Only one individual intolerant to urban stressors was identified in this sample. Individuals of the Chironomidae family (midges) dominated this sample at 70%. This site received the lowest possible BIBI score of 1.00 with a corresponding biological rating of 'Very Poor'.

15DR-123-F-2016I
This reach runs parallel with a railroad track and is located behind Cherry Hill Construction Company. While no water quality parameters exceeded acceptable COMAR standards, conductivity values were elevated (748 µS/cm). The stream was classified as a F4/5 channel with gravel and sand as the dominant substrates. Of the 2,475-acres draining to this site, 38.5% is impervious, which is the highest in the subwatershed. The predominant land use for the drainage area is commercial and industrial (39.1%) followed by forested land cover (18.7%) and medium density residential (16.4%). The RBP habitat assessment resulted in a comparability score of 62.0, or 'Partially Supporting', with marginal scores received for embeddedness, sediment deposition, and channel flow status. This sampling reach received a BIBI score of 1.67 and a biological rating of 'Very Poor.' There were 17 total taxa in the sample with no EPT taxa, no Ephemeroptera taxa, and only one scraper present. Clingers accounted for 15% of the sample with only three percent of the sample consisting of individuals intolerant to urban stressors. Forty-four percent of the sample consisted of Chironomids (midges) and 46% were Oligochaetes (worms).

15DR-125-F-2016J
This site is located on Dorsey Run just upstream of the Snowden River Parkway culvert. The reach was classified as a C4/5 channel with a predominately sand and gravel substrate. While no water quality parameters exceeded acceptable COMAR standards, slightly elevated conductivity (386 µS/cm) was measured at this site but was the lowest of all reaches in the Dorsey Run subwatershed. The RBP habitat assessment resulted in a comparability score of 64.0, or 'Partially Supporting', with marginal scores received for instream habitat, embeddedness, velocity/depth regime, sediment deposition, and channel flow status. At 125-acres, this is the smallest drainage area in the subwatershed with 19.7% impervious surface, the lowest in the subwatershed. Land use in the drainage area is primarily medium density residential (54.7%) followed by high density residential (15.6%) and forested land cover (13.5%). Of the 22 total taxa identified in the benthic macroinvertebrate sample, two EPT taxa were present, but no Ephemeroptera were found. Only eight percent individuals intolerant to urban stressors were present. A total of 87% of the sample was dominated by Chironomids (midges). The overall BIBI score was 1.33, resulting in a biological condition rating of 'Very Poor.'

4 Discussion and Comparison

4.1 Discussion

4.1.1 2016 Assessment Results

Bioassessment

Biological and physical habitat assessment results for 2016 in Rocky Gorge, Hammond Branch, and Dorsey Run indicate subwatersheds that are moderately to severely impaired. Only two of the thirty benthic macroinvertebrate samples received a rating of 'Good' and five received a 'Fair' rating. The remaining sites (77%) were rated as either 'Poor' or 'Very Poor.' Site 09RG-102-R-2016A and 09RG-104-R-2016B were the only sites to receive a biological condition rating of 'Good.' No sites received a 'Good' or 'Fair' biological condition ratings in the Dorsey Run subwatershed.

Physical Habitat

RBP habitat assessment results indicate average subwatershed physical habitat conditions that were 'Partially Supporting' (Rocky Gorge, Dorsey Run) and 'Non-supporting' (Hammond Branch). Only four sites received 'Supporting' physical habitat ratings (i.e., 14HB-123-F-2016I, 15DR-109-R-

2016C, 15DR-111-R-2016D and 15DR-119-F-2016G) located within the Hammond Branch and Dorsey Run subwatersheds.

Water Quality

All but one site (09RG-119-F-2016G) showed pH readings within the allowable COMAR range. Specific conductivity was elevated at many sites throughout the watersheds with values ranging from 142 to 833 µS/cm. A site-by-site breakdown of field-measured water quality parameters is included in Appendix B. While no COMAR standard for conductivity currently exists, a threshold for biological impairment in Maryland streams has been established at 247 µS/cm (Morgan et al., 2007). Thus, PSUs with mean values exceeding 247 µS/cm are not only indicative of increased anthropogenic disturbance, but also likely to see degraded biological conditions. Within this range of values, less than one third (23%) sampled in 2016 had a value less than 200 µS/cm. Average subwatershed conductivity values were 213 µS/cm, 307 µS/cm, and 725 µS/cm, for Rocky Gorge, Hammond Branch, and Dorsey Run, respectively.

Specific conductivity is related to the type and concentrations of inorganic ions in solution. Natural sources within a watershed can include salt from poorly drained soils, salt from ground water, and erosion from geologic formations of marine origin. Increased stream inorganic ion concentrations (i.e., conductivity) in urban systems typically results from runoff over impervious surfaces, passage through pipes, and exposure to other infrastructure (Cushman, 2006). Roadway pollutants tend to concentrate along the edge of a road, making them susceptible to runoff to streams from rainfall or snow melt and flow-off from wind or vehicle turbulence. While elevated conductivity may not directly affect stream biota, its constituents (e.g., chloride, metals, and nutrients) may be present at levels that can cause considerable biological impairment.

Geomorphology

The geomorphic assessment results indicate a variable system. Less than half of the channels sampled throughout the subwatersheds were classified as stable type B or C channels, the majority were classified as unstable, incised F channels. Gravel and sand were the dominant substrate types in the majority of sampling reaches, however silt/clay and cobble dominate streams were also present.

Imperviousness

The average percentage of impervious area in the Rocky Gorge, Hammond Branch, and Dorsey Run subwatersheds is 8.8%, 12.5%, and 33.2%, respectively. Imperviousness for the areas draining to each sampling site range from 7.5% in Hammond Branch to 38.5% in Dorsey run (see Appendix A for impervious values). The benthic community in a freshwater stream can be adversely affected by impervious cover and associated runoff at values as low as 10% (CWP, 2003). A statistical correlation between imperviousness and the BIBI was identified and is discussed in the following section.

Results Correlations

The Pearson correlation coefficient measures the linear association between two variables. Values of the coefficient range from -1 to 1. Negative values indicate an inverse relationship between the two values (i.e., when one variable increases the other decreases), while positive values indicate a positive relationship (i.e., both variables increase). The Pearson correlation coefficient indicates the strength of the association, with larger absolute values indicating stronger associations between the two variables. The significance level is a measure of the likelihood that the two variables are related, with smaller values indicating a stronger likelihood of relation. A significance level of 0.05 is typically used as a cutoff for strong correlations. The interpretation of a correlation is somewhat arbitrary, especially as values move away from +/- 1. Table 11 includes Pearson correlation coefficients and significance values. Figures 7 through 9 provide a visual display of the relationships between data variables and the best fit line, including R^2 values, associated with the correlation.

Pearson correlations between the BIBI scores and two parameters (percent imperviousness and specific conductivity) showed highly significant relationships. The percentage of imperviousness to each sampling site indicates a strong negative relationship (correlation coeff.= -0.648, p <0.001) to BIBI scores, suggesting biological condition decreases with increased watershed imperviousness (Figure 7.)

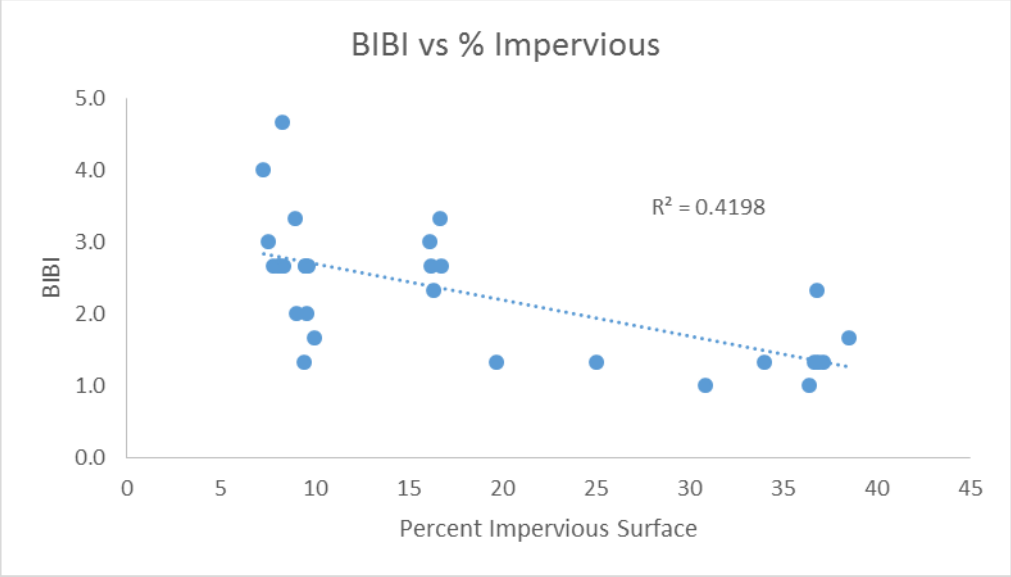

Figure 7 - Relationship between the Benthic Index of Biotic Integrity (BIBI) and impervious surface in PSUs sampled during 2016 Howard County Biological Monitoring

Specific conductivity and BIBI scores also showed a strong negative correlation (correlation coeff.= -0.596, p = 0.001, Figure 8). These results support the notion that overall water quality and biological health are likely being affected by the amount of development, and hence imperviousness, in the watershed. These findings are in concurrence with the Impervious Cover Model (CWP, 2003) which suggests that overall stream quality decreases with increased watershed impervious cover. A strong correlation was also observed between impervious percent and specific conductivity (correlation coeff.= 0.982, p <0.0001), suggesting that increased conductivity is due in large part to urban runoff.

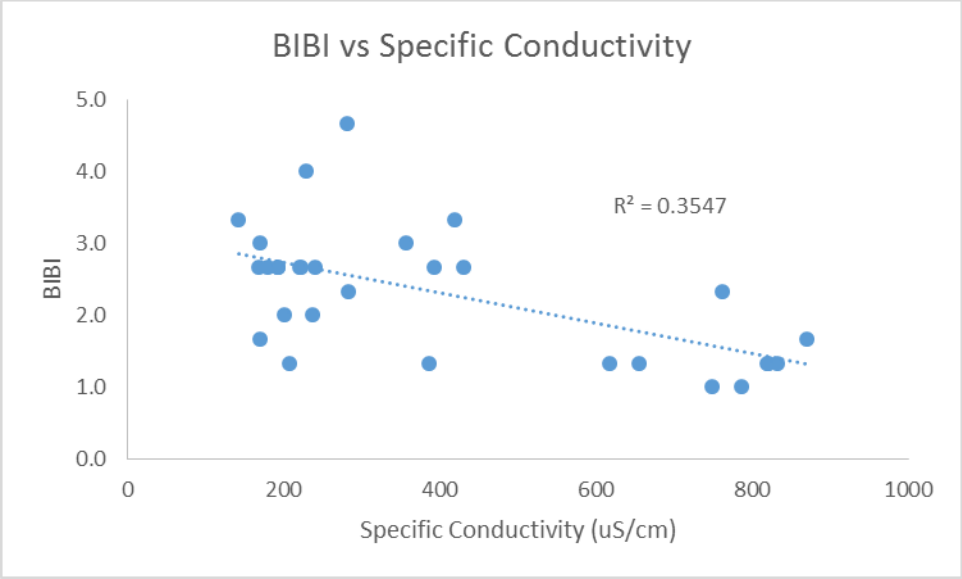

Figure 8 - Relationship between the Benthic Index of Biotic Integrity (BIBI) and specific conductivity in PSUs sampled during 2016 Howard County Biological Monitoring

The correlation with RBP habitat scores and BIBI scores (correlation coeff.= -0.255, p = 0.174) was not significant, nor was the correlation between PHI scores and BIBI (correlation of -0.122, p = 0.521) (Figure 9) suggesting that physical habitat assessments are not the best predictor of biological condition in these watersheds. Water quality and imperviousness are better predictors of biological condition.

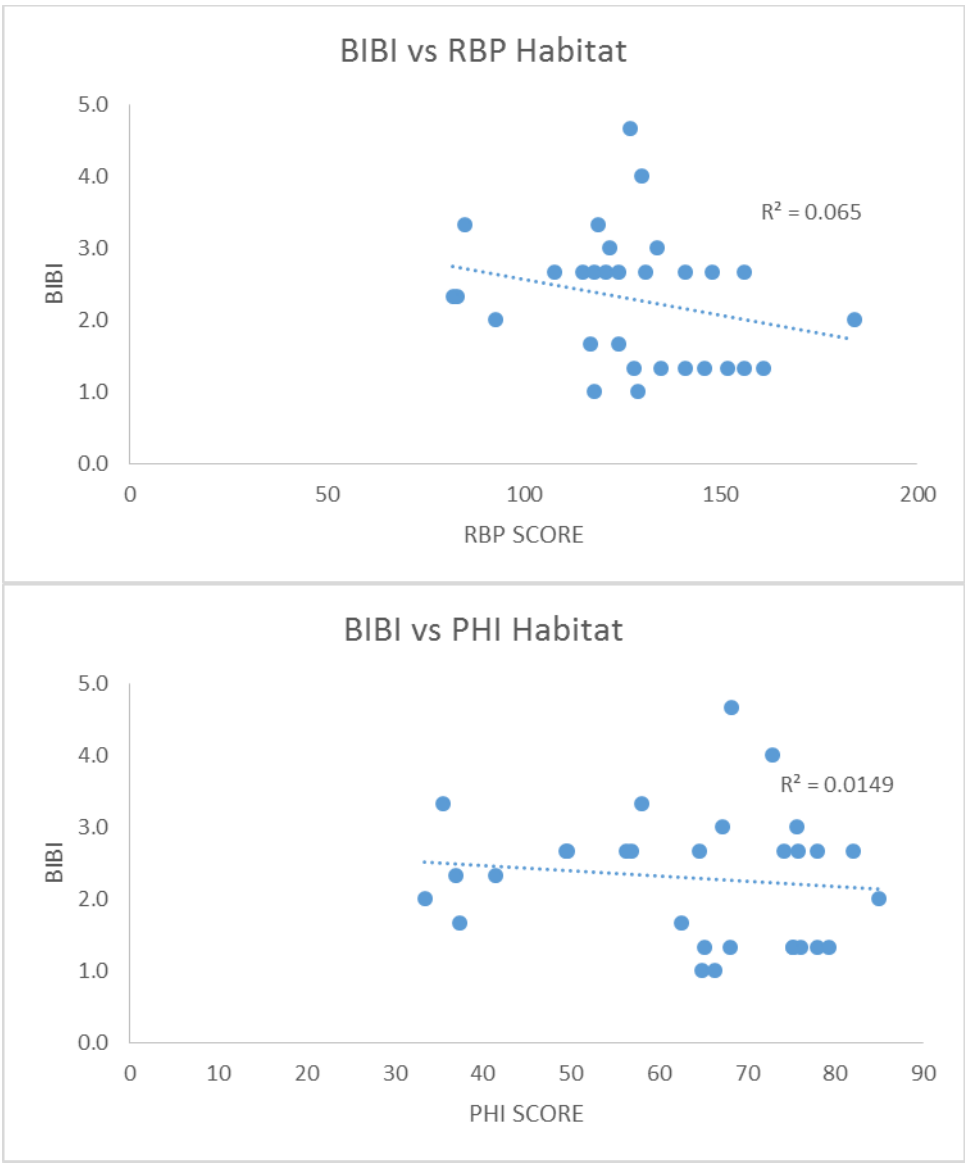

Figure 9 - Relationship between the Benthic Index of Biotic Integrity (BIBI) and physical habitat in PSUs sampled during 2016 Howard County Biological Monitoring

Table 11 - Pearson Correlations

		RBP Habitat	PHI Habitat	Specific Conductance	Percent Impervious
BIBI n=30	Correlation	-0.255	-0.122	**-0.596**	**-0.648**
	Significance	0.174	0.521	**0.001**	**<0.001**
RBP Habitat n=30	Correlation		**0.871**	0.148	0.127
	Significance		**< 0.0001**	0.436	0.502
PHI Habitat n=30	Correlation			0.227	0.180
	Significance			0.228	0.341
Specific Conductance n=30	Correlation				**0.982**
	Significance				**< 0.0001**

Bold values are significant at the 0.05 level

4.1.2 Comparison of 2003, 2009, and 2016 Bioassessment data

BIBI

A summary of the results for 2003, 2009 and 2016 biological index data is shown in Table 12, and a box plot comparing BIBI scores for each subwatershed is displayed in Figure 10. It should be noted that current BIBI calculation methods were used for all rounds. An Analysis of Variance (ANOVA) was performed to evaluate differences in mean BIBI scores amongst the years. Significance testing was performed using Tukey's HSD (Honestly Significant Difference) test with a confidence interval of 95%. Results of Tukey's HSD test are presented in Table 13.

Table 12 - Comparison of 2003, 2009, and 2016 BIBI Data

Sampling Year	Patapsco Subwatershed	Number of sites sampled	Min. BIBI	Max. BIBI	Median BIBI	Mean BIBI	Narrative Rating	Standard Deviation
2003	Rocky Gorge	10	1.33	4.00	3.00	2.83	Poor	0.84
	Hammond Branch	10	1.00	4.00	3.00	2.93	Poor	0.80
	Dorsey Run	10	1.67	3.00	2.17	2.20	Poor	0.48
2009	Rocky Gorge	10	1.67	4.33	3.00	2.94	Poor	0.86
	Hammond Branch	10	1.33	2.67	2.17	2.10	Poor	0.52
	Dorsey Run	10	1.00	2.14	1.17	1.40	Very Poor	0.49
2016	Rocky Gorge	10	1.33	4.67	2.67	2.77	Poor	1.02
	Hammond Branch	10	2.00	3.33	2.67	2.70	Poor	0.37
	Dorsey Run	10	1.00	2.33	1.33	1.40	Very Poor	0.38

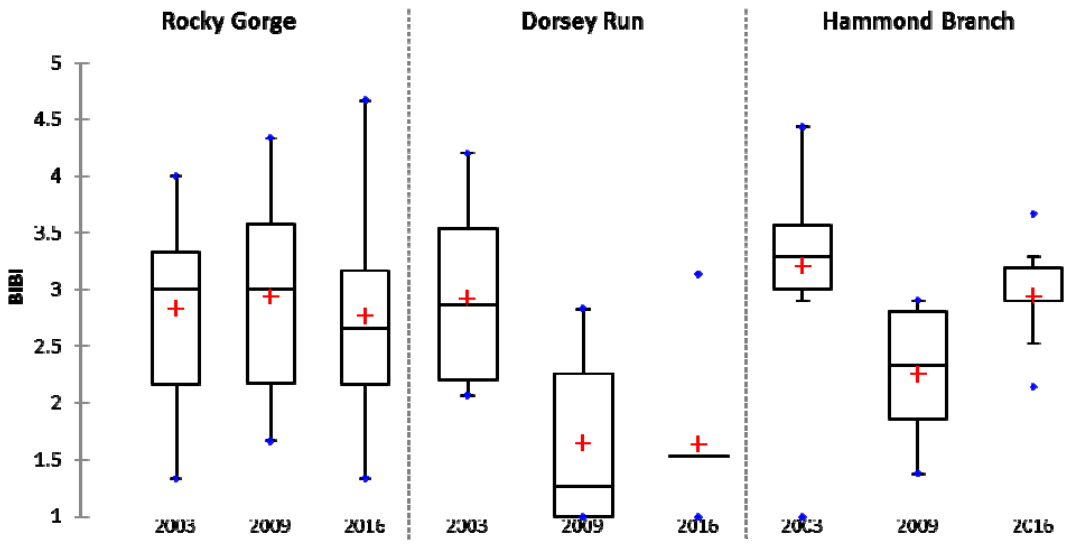

Figure 10 - Comparison of 2003, 2009, and 2016 BIBI scores.

Results from the Round 1 assessment (2003) indicated that the Rocky Gorge subwatershed was in a 'Poor' overall biological condition, according to the updated BIBI scores (BIBI = 2.83 ± 0.84). Round Two results (2009) show a similar 'Poor' biological condition (BIBI = 2.94 ± 0.86). Round 3 results also show a 'Poor' biological condition (BIBI = 2.77 ± 1.02) and a small decline in score compared to the 2009 score. Tukey's HSD test showed that the three Rounds were not significantly different from each other (Table 13).

In the Hammond Branch subwatershed, the mean BIBI score declined significantly between 2003 (BIBI = 2.93 ± 0.80) and 2009 (BIBI = 2.10 ± 0.52), although the narrative rating of 'Poor' did not change (Hill and Crunkleton, 2009). Results from 2016 show an increase (BIBI = 2.70 ± 0.37) that is closer to what was observed in 2003. Tukey's HSD test showed a significant difference between 2003 and 2009, but not between 2009 and 2016 or 2003 and 2016 (Table 13).

Table 13. Tukey (HSD) / Analysis of the differences between years with a confidence interval of 95%

Subwatershed	Contrast	Difference	Standardized difference	Critical value	Pr > Diff	Significant
Rocky Gorge	2009 vs 2016	0.17	0.42	2.48	0.91	No
	2009 vs 2003	0.10	0.26	2.48	0.96	No
	2003 vs 2016	0.07	0.16	2.48	0.99	No
Hammond Branch	2003 vs 2009	0.83	3.16	2.48	0.01	Yes
	2003 vs 2016	0.23	0.88	2.48	0.65	No
	2016 vs 2009	0.60	2.27	2.48	0.08	No
Dorsey Run	2003 vs 2016	0.80	3.97	2.48	0.00	Yes
	2003 vs 2009	0.80	3.95	2.48	0.00	Yes
	2009 vs 2016	0.00	0.02	2.48	1.00	No

Tukey's d critical value: 3.507

Similar to Hammond Branch, the Dorsey Run subwatershed saw BIBI scores significantly decline between 2003 (BIBI = 2.20 ± 0.48) and 2009 (BIBI = 1.40 ± 0.49), dropping a full narrative rating to 'Very Poor' biological condition (Hill and Crunkleton, 2009). In 2016, the mean BIBI was calculated at 1.40 ± 0.38, the same as 2009, and also received a 'Very Poor' biological condition rating. Tukey's HSD test showed a significant difference between 2003 and 2009, and 2003 and 2016, but not between 2009 and 2016 (Table 13).

RBP Physical Habitat Assessment

A summary of the results for 2003, 2009 and 2016 RBP physical habitat assessment data is shown in Table 14, and a box plot comparing RBP percent comparability scores for each subwatershed is displayed in Figure 11. An Analysis of Variance (ANOVA) was performed to evaluate differences in mean RBP scores amongst the years. Significance testing was performed using Tukey's HSD (Honestly Significant Difference) test with a confidence interval of 95%. Results of Tukey's HSD test are presented in Table 14.

Results from the Round 1 assessment (2003) indicated that the Rocky Gorge subwatershed was 'Non-Supporting' (RBP = 57.2 ± 9.7). Round 2 results (2009) show improved habitat conditions of 'Partially Supporting' (RBP = 61.7 ± 5.1), and Round 3 results also show a 'Partially Supporting' habitat condition (RBP = 67.0 ± 10.2). Tukey's HSD test showed a significant difference between 2003 and 2016, but not between 2009 and 2003 or 2009 and 2016 (Table 14).

Table 14 - Comparison of 2003, 2009, and 2016 RBP Physical Habitat Assessment Data

Sampling Year	Patapsco Subwatershed	Number of sites Assessed	Min. RBP %	Max. RBP %	Median RBP %	Mean RBP %	Narrative Rating	Standard Deviation
2003	Rocky Gorge	10	44	73	58	57.2	Non-Supporting	9.7%
	Hammond Branch	10	44	71	58	57.6	Non-Supporting	8.1%
	Dorsey Run	10	34	73	49	50.2	Non-Supporting	12.5%
2009	Rocky Gorge	10	56	72	60	61.7	Partially Supporting	5.1%
	Hammond Branch	10	38	80	62	62.8	Partially Supporting	13.3%
	Dorsey Run	10	35	65	57	53.5	Non-Supporting	9.8%
2016	Rocky Gorge	10	59	92	64	67.0	Partially Supporting	10.2%
	Hammond Branch	10	41	78	59	57.5	Non-Supporting	11.7%
	Dorsey Run	10	42	81	68	66.9	Partially Supporting	11.5%

Results from the Round 1 assessment (2003) indicated that the Hammond Branch subwatershed was 'Non-Supporting' (RBP = 57.6 ± 8.1). Round 2 results (2009) show improved habitat conditions of 'Partially Supporting' (RBP = 62.8 ± 13.3), while Round Three results showed a decline back to 'Non-Supporting' habitat condition (RBP = 57.5 ± 11.7). Tukey's HSD test showed that the three Rounds were not significantly different from each other (Table 14).

The Dorsey Run subwatershed saw 'Non-Supporting' RBP conditions in both 2003 (RBP = 50.2 ± 12.5) and in 2009 (RBP = 53.5 ± 9.8). However, RBP conditions increased from 'Non-Supporting' in 2009 to 'Partially Supporting' in 2016 (RBP = 66.9 ± 11.5). Tukey's HSD test showed a significant difference between 2003 and 2016 and 2009 and 2016, but not between 2009 and 2003 (Table 14).

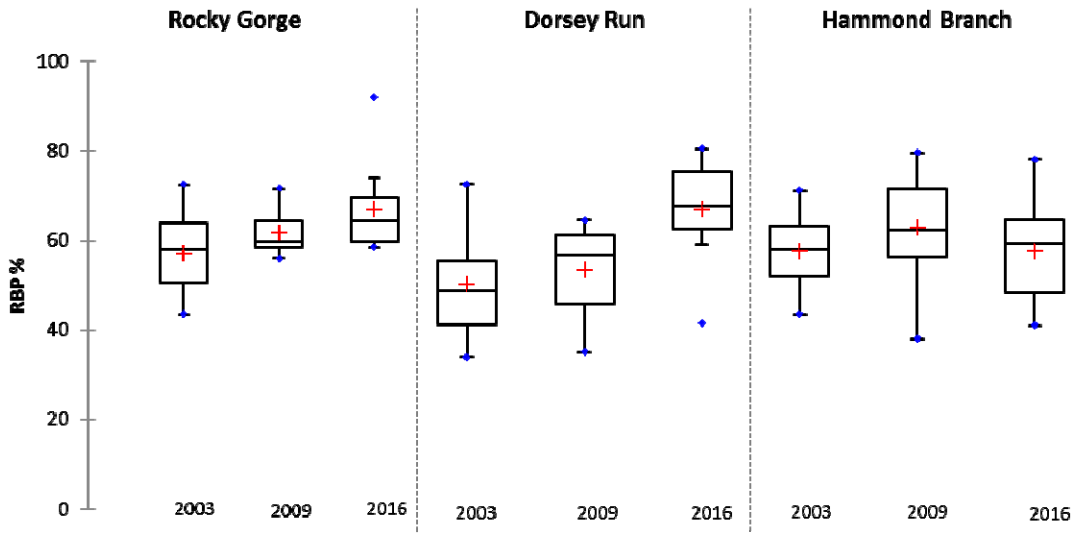

Figure 11 - Comparison of 2003, 2009 and 2016 RBP Physical Habitat Assessment scores.

5 Conclusion and Recommendations

This report is the final annual report that concludes Round 3 (2012-2016) of the Howard County Biological Monitoring and Assessment Program. These conclusions and recommendations provide context for interpreting results and identifying possible future revisions.

Results of the 2016 assessment indicate impaired biological conditions in all three watersheds, and statistically significant decreases in mean BIBI scores were observed in Dorsey Run since Round One. Physical habitat scores also showed some statistically significant changes, however, they do not match the trends observed in the BIBI results. Decreases in RBP scores were not observed where decreases in biological condition occurred, which suggests that changes in water quality and/or quantity may be responsible for the impairments. Furthermore, strong correlations were found between biological condition and both imperviousness and conductivity, strengthening the weight of evidence toward water quality/hydrologic stressors.

Increasing residential and commercial development in Howard County is leading to rising levels of impervious surface. Continued monitoring is critical to determining whether these changes in land use will detrimentally impact the health of the watersheds, and more importantly, to what extent. In addition, it would be useful to conduct impervious drainage analysis on Round One data to allow for direct comparisons regarding increases in impervious cover since Round One and whether observed changes in biological condition can be correlated to such changes.

Biological communities respond to a combination of environmental factors, commonly referred to as stressors. Stressors can be organized according to the five major determinants of biological integrity in aquatic ecosystems, which include water chemistry, energy source, habitat structure, flow regime, and biotic interactions (Karr et al., 1986; Angermeier and Karr, 1994; Karr and Chu, 1998). The cumulative effects of human activities within the County's sampling units often results in an alteration of at least one, if not several, of these factors with detrimental consequences for the aquatic biota. Determining which specific stressors are responsible for the observed degradation within a stream or PSU is a challenging task, given that many stressors co-exist and synergistic effects can occur. Furthermore, an added challenge in identifying the stressors affecting stream biota is that the water

quality and physical habitat data collected by the County's monitoring program are not comprehensive (i.e., they do not include many possible stressors). For instance, virtually no data are available regarding biotic interactions and energy sources and only limited data regarding flow regime variables, such as land use and impervious cover, are included. Stressor relationships with stream biotic components, and their derived indices (i.e., BIBI), are often difficult to partition from complex temporal–spatial data sets primarily due to the potential array of multiple stressors working at the reach to landscape scale in small streams (Helms et al. 2005; Miltner et al., 2004; Morgan and Cushman, 2005; Volstad et al., 2003; Morgan et al., 2007). Therefore, it should be noted that the current level of analysis cannot identify all stressors for the impaired watersheds, nor will the stressors identified include all of the stressors present.

5.1 Recommendations for Future Program Development

Additional Water Quality Sampling

The 'Supporting' and 'Partially Supporting' habitat conditions identified were not always substantiated by a healthy benthic community. This can be an indication of degraded water quality conditions. Although very few of the water quality parameters measured (pH only) were outside of the acceptable COMAR standards, additional sampling is recommended, especially on those streams rated as 'Poor' or 'Very Poor' for biological condition, in order to determine whether there are other chemical stressors affecting the biota.

In 2016, conductivity levels were the only measured parameter considered high across many of the sites. However, the limited number of water quality parameters measured during the spring sampling season decreases the ability to identify specific stressors. A more in-depth analysis of water quality could be performed to determine the types and potential sources of pollutants. Supplementary sampling should evaluate additional parameters such as nutrients and metals, which may potentially be of concern.

Because the biological monitoring is conducted generally under baseflow conditions there is the potential for missing pollutants associated with stormwater runoff, specifically in more urbanized portions of the watershed. Wet weather monitoring in these watersheds could also be conducted to determine the presence of additional water quality stressors.

While water quality sampling would add considerable costs to the monitoring program, the added benefit would greatly enhance the County's ability to identify predominant water quality stressors and sources. Additionally the program would be positioned well to monitor changes in water chemistry as it relates to tracking progress towards meeting total maximum daily load (TMDL) requirements, both for specific impaired water bodies and for the Chesapeake Bay-wide TMDL.

Comparability with Statewide Methods

Howard County adopted the DNR's MBSS methods in 2001. The MBSS program continues to evolve and refine their sampling design, field procedures, and data analysis protocols, with the most recent field sampling protocols having been updated in 2014. While no changes have occurred to the benthic macroinvertebrate collection methods implemented herein, additional surveys have been added to the data collection efforts (i.e., vernal pool search, invasive vegetation search), which may be of interest to the County. The County should continue to update their methods in the future to stay current with the latest MBSS sampling protocols, especially with regard to benthic macroinvertebrate sampling. In addition, the County should continue to ensure that all personnel collecting macroinvertebrate samples have been certified by MBSS in benthic macroinvertebrate sample collection procedures.

Quality Assurance and Quality Control

The QA/QC procedures outlined in the Quality Assurance Project Plan (QAPP) for the Howard County Biological Monitoring and Assessment Program (Howard County, 2001) should be re-evaluated considering the evolution of the metric scoring system, which may not be appropriate for incremental data such as that found in the scaled BIBI metrics.

The BIBI scoring system is not continuous. That is, each metric is assigned a value of 1, 3, or 5 and then averaged for a final BIBI score. This means that scores increase incrementally by 0.3 or 0.4. Additionally, the relative percent difference (RPD) between low scores (2.0 and 2.3) will be higher than a comparison of higher scores (4.7 and 5.0). This can lead to a site not meeting the measurement quality objective (MQO) despite the scores being only one scoring increment apart. A relatively minor difference between samples can lead to the MQO not being met.

Fish Community Assessments

MBSS conducts fish sampling during the summer index period, which provides additional information regarding stream biodiversity. Fish species exhibit diverse morphological, ecological, and behavioral adaptations to their natural habitat and, consequently, are particularly effective indicators of the condition of aquatic systems (Karr et al., 1986; Fausch et al., 1990; Simon and Lyons, 1995; McCormick et al., 2001). Given that fish assemblages respond differently to some stressors than benthic macroinvertebrate assemblages, data from fish sampling can assist in identifying stressors that may be impacting specific streams as well as provide an improved understanding of the biological condition of streams throughout the County via the combined index of biotic integrity (CIBI), which incorporates both BIBI and fish IBI (FIBI) results into a single biological index. Furthermore, fish sampling data can be used to evaluate biotic interactions, particularly the effects of non-native and invasive species on native fauna. It is recommended that the County consider the addition of fish sampling to their program to not only allow for a more comprehensive assessment of the biological condition of the County's streams, but also to assist in the identification of additional stressors impacting their streams. Furthermore, the addition of fish sampling will allow for improved data sharing between the County and State agencies (i.e., DNR, MDE), which is essential to the protection and preservation of the Chesapeake Bay.

Geomorphic Assessments

While Rosgen Level II assessments provide useful information for characterizing the overall channel morphology, stream classification was not shown to be a useful predictor of biological condition or current land use characteristics in neighboring Anne Arundel County (Hill and Pieper, 2011; Hill et al., 2014). It is likely that the dominant geomorphological processes (i.e., erosion, transport, or deposition) are more important to the condition of the benthic macroinvertebrate communities than the current stream type as classified by the Rosgen approach. Perhaps a more rapid assessment of each reach using the channel evolution model (CEM; Schumm et al. 1984, Simon and Hupp 1986, and Simon 1989) would provide sufficient data regarding the geomorphological processes in each stream. The CEM identifies distinct stages of a channel's progression from a pre-modified condition through incising, widening, aggrading, re-stabilizing, and back to a quasi-equilibrium state, which may be observed in one reach overtime or various stages may be observed within an entire drainage network at a given time.

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Appendix A: Land Use and Imperviousness

Site ID	Drainage Area (Acres)[1]	VLDR	LDR	MDR	HDR	CI	INST	OUL	AGR	FOR	OW	WET	BG	TR	% Impervious[2]
Rocky Gorge															
09RG-102R-2016A	243	25.8%	14.6%	0%	0%	0%	18.2%	0%	25.9%	15.4%	0%	0%	0%	0%	8.3
09RG-104-R-2016B	721	37.6%	27.9%	0%	0%	0.4%	0.5%	0%	14.5%	19.1%	0%	0%	0%	0%	7.3
09RG-119-F-2016G	47	40.7%	48.5%	0%	0%	0%	0%	0%	0%	10.7%	0%	0%	0%	0%	10.0
09RG-124-F-2016I	77	42.1%	41.5%	0%	0%	0%	0%	0%	0%	16.4%	0%	0%	0%	0%	8.9
09RG-407-R-2016C	87,675	13.2%	17.1%	3.4%	0.8%	0.6%	0.9%	0.9%	30.8%	30.0%	1.8%	0.0%	0.1%	0.34%	**9.5**
09RG-410-2016D	86,280	13.4%	17.2%	3.1%	0.4%	0.6%	0.9%	0.8%	31.3%	30.1%	1.8%	0.0%	0.0%	0.29%	**9.1**
09RG-413-R-2016E	71,112	12.7%	16.1%	2.1%	0.4%	0.5%	0.8%	1.0%	35.4%	29.3%	1.3%	0.0%	0.0%	0.12%	**8.1**
09RG-414-R-2016E	70,729	12.6%	16.1%	2.2%	0.4%	0.5%	0.8%	1.0%	35.6%	29.2%	1.3%	0.0%	0.0%	0.13%	**8.1**
09RG-422-2016H	87,842	13.2%	17.0%	3.5%	0.8%	0.6%	0.9%	0.9%	30.8%	30.0%	1.8%	0.0%	0.1%	0.34%	**9.5**
09RG-426-F-2016J	87,801	13.2%	17.1%	3.5%	0.8%	0.6%	0.9%	0.9%	30.8%	30.0%	1.8%	0.0%	0.1%	0.34%	**9.5**
Hammond Branch															
14HB-101-R-2016A	153	0%	52.6%	0%	0%	0%	0%	0%	15.3%	32.1%	0%	0%	0%	0%	8.4
14HB-106-R-2016B	1,031	6.5%	38.6%	0%	0%	0%	1.5%	0%	36.0%	17.4%	0%	0%	0.0%	0%	7.8
14HB-107-R-2016C	1,259	5.4%	32.9%	0%	0%	0.5%	6.6%	0%	38.6%	16.0%	0%	0%	0.0%	0%	9.6
14HB-110-R-2016D	2,322	4.2%	27.5%	6.2%	1.3%	3.4%	4.2%	0%	34.2%	15.1%	0%	0%	1.8%	2.1%	16.2
14HB-114-R-2016E	3,555	3.6%	22.4%	10.5%	3.4%	4.8%	3.7%	0.6%	28.7%	17.8%	0%	0%	1.2%	3.3%	16.7
14HB-116-R-2016F	3,708	3.4%	21.5%	10.4%	3.2%	4.6%	3.5%	0.6%	29.4%	19.0%	0%	0%	1.1%	3.2%	16.4
14HB-119-F-2016G	717	8.7%	37.9%	0%	0%	0%	0%	0%	30.5%	22.8%	0%	0%	0.0%	0%	7.5
14HB-121-F-2016H	2,153	4.5%	27.3%	3.3%	1.4%	3.5%	4.3%	0%	36.9%	14.4%	0%	0%	2.0%	2.3%	16.2
14HB-123-F-2016I	4,088	3.1%	19.9%	11.7%	5.0%	4.2%	3.4%	0.6%	26.8%	21.3%	0%	0%	1.1%	2.9%	16.8
14HB-125-F-2016J	1,251	5.4%	33.1%	0%	0%	0.5%	6.6%	0%	38.7%	15.6%	0%	0%	0.0%	0%	9.6
Dorsey Run															
15DR-102-R-2016A	4,155	0.2%	1.1%	10.9%	7.8%	42.0%	2.4%	1.9%	0.2%	23.4%	0%	0%	2.2%	3.2%	36.8
15DR-104-R-2016B	1,357	0.5%	0.4%	3.6%	5.6%	40.2%	0%	1.9%	0%	31.8%	0%	0%	0%	1.4%	30.9
15DR-109-R-2016C	1,662	0%	2.5%	19.5%	13.6%	35.9%	4.2%	1.1%	0.4%	18.3%	0%	0%	1.4%	3.0%	36.7
15DR-111-R-2016D	1,636	0%	2.5%	19.8%	13.8%	36.4%	4.2%	1.1%	0.4%	17.6%	0%	0%	0.9%	3.1%	37.1
15DR-112-R-2016D	1,464	0%	2.8%	22.1%	15.5%	33.4%	4.6%	1.3%	0.5%	15.9%	0%	0%	0.6%	3.3%	36.9
15DR-116-R-2016F	511	0%	5.0%	34.0%	28.0%	4.1%	11.0%	3.3%	1.4%	13.1%	0%	0%	0%	0%	25.0
15DR-119-F-2016G	2,053	0%	2.0%	19.0%	11.1%	30.9%	3.5%	2.5%	0.4%	20.8%	0%	0%	4.4%	5.5%	34.0
15DR-121-F-2016H	4,073	0.2%	1.1%	11.2%	7.9%	41.3%	2.5%	2.0%	0.2%	23.3%	0%	0%	2.2%	3.2%	36.4
15DR-123-F-2016I	2,475	0%	1.7%	16.4%	9.4%	39.1%	4.1%	2.2%	0.3%	18.7%	0%	0%	3.6%	4.6%	38.5
15DR-125-F-2016J	125	0%	0.0%	54.7%	15.6%	1.0%	0%	9.3%	5.8%	13.5%	0%	0%	0%	0%	19.7

VLDR: Very Low Density Residential (191,192)[3,4]
LDR: Low Density Residential (11)
MDR: Medium Density Residential (12)
HDR: High Density Residential (13)
CI: Commercial & Industrial (14, 15)
INST: Institutional (16)
TR: Transportation (80)

OUL: Open Urban Land (18)
AGR: Agriculture (21, 22, 23, 25, 241, 242)
FOR: Forest (41 - 44)
OW: Open Water (50)
WET: Wetlands (60)
BG: Bare Ground (73)
TR: Transportation (80)

1 Drainage areas provided are delineated to each sampling site.
2 See text for discussion of impervious percent. Bold values derived from land use and land cover.
3 Land use is based on Maryland Department of Planning (MDP) 2010 data.
4 Numbers in parentheses correspond to MDP land use codes.

Appendix B: Water Quality Data

Site ID	Collection Date	pH	Water Temperature *°C*	Dissolved Oxygen *mg/l*	Turbidity *NTU*	Conductivity *µS/cm*
Rocky Gorge						
09RG-102-R-2016A	4/19/2016	**7.09**	**12.70**	**10.76**	**1.1**	**280.4**
09RG-102-R-2016A QC	4/19/2016	**7.32**	**13.00**	**11.03**	**2.1**	**285.5**
09RG-104-R-2016B	4/19/2016	**7.66**	**16.50**	**10.27**	**0.9**	**227.7**
09RG-119-F-2016G	4/20/2016	**9.49**	**15.90**	**10.69**	**5.5**	**169.3**
09RG-124-F-2016I	4/20/2016	**6.78**	**11.40**	**9.94**	**2.3**	**142.1**
09RG-407-R-2016C	4/14/2016	**6.86**	**12.30**	**10.09**	**4.4**	**206.7**
09RG-413-R-2016E	4/18/2016	**6.73**	**12.20**	**10.31**	**5.1**	**192.0**
09RG-414-R-2016E	4/19/2016	**6.86**	**15.60**	**10.37**	**1.2**	**191.6**
09RG-422-F-2016H	4/18/2016	**6.73**	**14.90**	**11.53**	**4.3**	**222.6**
09RG-426-F-2016J	4/18/2016	**6.70**	**15.80**	**10.63**	**4.3**	**220.7**
Hammond Branch						
14HB-101-R-2016A	4/13/2016	**6.53**	**9.60**	**12.20**	**10.6**	**168.4**
14HB-106-R-2016B	3/29/2016	**7.06**	**13.60**	**12.32**	**7.3**	**179.2**
14HB-107-R-2016C	3/29/2016	**7.18**	**9.10**	**11.84**	**7.5**	**236.6**
14HB-110-R-2016D	3/30/2016	**7.08**	**11.50**	**13.24**	**2.4**	**393.0**
14HB-114-R-2016E	4/14/2016	**6.98**	**9.10**	**10.38**	**3.0**	**419.1**
14HB-116-R-2016F	3/30/2016	**6.93**	**10.30**	**7.47**	**6.4**	**282.0**
14HB-119-F-2016G	4/13/2016	**6.56**	**8.60**	**11.02**	**5.0**	**169.9**
14HB-121-F-2016H	4/13/2016	**7.51**	**12.40**	**13.88**	**3.0**	**357.0**
14HB-123-F-2016I	3/30/2016	**7.58**	**8.20**	**12.26**	**3.0**	**429.7**
14HB-123-F-2016I QC	3/29/2016	**7.57**	**16.70**	**10.10**	**3.3**	**436.8**
Dorsey Run						
15DR-102-R-2016A	4/20/2016	**7.56**	**17.40**	**12.73**	**5.5**	**762.0**
15DR-104-R-2016B	4/21/2016	**7.26**	**13.10**	**9.38**	**5.8**	**787.0**
15DR-109-R-2016C	4/22/2016	**7.66**	**16.30**	**8.59**	**2.0**	**821.0**
15DR-111-R-2016D	4/22/2016	**7.55**	**16.10**	**10.24**	**2.2**	**833.0**
15DR-112-R-2016D	4/29/2016	**7.47**	**11.20**	**10.29**	**3.0**	**819.0**
15DR-116-R-2016F	4/29/2016	**7.50**	**11.00**	**11.30**	**1.8**	**617.4**
15DR-119-F-2016G	4/22/2016	**7.69**	**15.10**	**10.54**	**2.3**	**655.0**
15DR-119-F-2016G-QC	4/22/2016	**7.95**	**15.50**	**10.75**	**2.3**	**679.0**
15DR-121-F-2016H	4/21/2016	**7.14**	**13.00**	**9.52**	**5.5**	**748.0**
15DR-125-F-2016J	4/29/2016	**7.19**	**11.00**	**10.34**	**1.5**	**386.0**

Appendix C: Benthic Macroinvertebrate Data

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Metric	09RG-102-R-2016A	09RG-102-R-2016A QC	09RG-104-R-2016B	09RG-119-F-2016G	09RG-124-F-2016I	09RG-407-R-2016C	09RG-410-R-2016D	09RG-413-R-2016E	09RG-414-R-2016E	09RG-422-F-2016H	09RG-426-F-2016J
Raw Scores	**Raw Scores**										
Total Number of Taxa	25	22	25	17	31	19	17	17	22	31	33
Number of EPT Taxa	12	7	8	0	9	4	4	5	5	5	8
Number of Ephemeroptera Taxa	3	2	2	0	3	1	2	2	2	3	1
Percent Intolerant Urban	68.0	59.8	51.5	13.0	43.3	3.6	1.8	5.7	5.6	6.6	12.4
Percent Chironomidae	18.4	29.5	35.9	82.9	39.2	73.6	42.2	28.3	45.2	58.5	53.3
Percent Clingers	89.3	77.7	80.6	12.2	54.2	7.3	23.9	60.4	36.3	20.8	18.1
BIBI Scores	**BIBI Scores**										
Total Number of Taxa	5	3	5	3	5	3	3	3	3	5	5
Number of EPT Taxa	5	3	3	1	3	1	1	3	3	3	3
Number of Ephemeroptera Taxa	3	3	3	1	3	1	3	3	3	3	1
Percent Intolerant Urban	5	5	5	3	3	1	1	1	1	1	3
Percent Chironomidae	5	3	3	1	3	1	3	3	3	3	3
Percent Clingers	5	5	5	1	3	1	1	3	3	1	1
BIBI Score	***4.7***	***3.7***	***4.0***	***1.7***	***3.3***	***1.3***	***2.0***	***2.7***	***2.7***	***2.7***	***2.7***
Narrative Rating	***Good***	***Fair***	***Good***	***Very Poor***	***Fair***	***Very Poor***	***Poor***	***Poor***	***Poor***	***Poor***	***Poor***

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Rocky Gorge Dam BIBI.xlsx
Version: 1
Site Name: 09RG-102-R-2016A

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Ephemeroptera	Ephemerellidae	Ephemerella	Ephemerella	I	6	Collector	cn, sw	2.3
Insecta	Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	I	5	Scraper	cn	3
Insecta	Ephemeroptera	Leptophlebiidae	not identified	Leptophlebiidae	I	1	Collector	sw, cn	1.7
Insecta	Plecoptera	Perlidae	Eccoptura	Eccoptura	I	1	Predator	cn	0.6
Insecta	Plecoptera	Nemouridae	Amphinemura	Amphinemura	I	9	Shredder	sp, cn	3
Insecta	Megaloptera	Corydalidae	Nigronia	Nigronia	I	1	Predator	cn, cb	1.4
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	1	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	I	1	Filterer	cn	2.7
Insecta	Trichoptera	Rhyacophilidae	Rhyacophila	Rhyacophila	I	2	Predator	cn	2.1
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	1	Filterer	cn	7.5
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	1	Filterer	cn	4.4
Insecta	Trichoptera	Philopotamidae	Dolophilodes	Dolophilodes	I	33	Filterer	cn	1.7
Insecta	Trichoptera	Uenoidae	Neophylax	Neophylax	I	8	Scraper	cn	2.7
Insecta	Coleoptera	Ptilodactylidae	Anchytarsus	Anchytarsus	I	3	Shredder	cn	3.1
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	A	2	Scraper	cn	2.7
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	2	Filterer	cn	5.7
Insecta	Diptera	Simuliidae	not identified	Simuliidae	P	4	Filterer	cn	3.2
Oligochaeta	Haplotaxida	Lumbricidae	not identified	Lumbricidae	A	1	Collector	0	10
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	1	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	2	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	7	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	3	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	3	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Microtendipes	Microtendipes	P	1	Filterer	cn	4.9
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	P	1	Shredder	cb, cn	6.3
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	I	1	Scraper	cn	2.7

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Rocky Gorge Dam BIBI.xlsx
Version: 1
Site Name: 09RG-102-R-2016A QC

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Ephemeroptera	Heptageniidae	not identified	Heptageniidae	I	4	Scraper	cn	2.6
Insecta	Ephemeroptera	Ephemerellidae	Ephemerella	Ephemerella	I	2	Collector	cn, sw	2.3
Insecta	Plecoptera	Nemouridae	Amphinemura	Amphinemura	I	6	Shredder	sp, cn	3
Insecta	Megaloptera	Corydalidae	Nigronia	Nigronia	I	2	Predator	cn, cb	1.4
Insecta	Trichoptera	Philopotamidae	Dolophilodes	Dolophilodes	I	43	Filterer	cn	1.7
Insecta	Trichoptera	Uenoidae	Neophylax	Neophylax	I	2	Scraper	cn	2.7
Insecta	Trichoptera	Rhyacophilidae	Rhyacophila	Rhyacophila	I	1	Predator	cn	2.1
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	2	Filterer	cn	7.5
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	I	5	Scraper	cn	2.7
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	A	2	Scraper	cn	2.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	2	Scraper	cn	7.1
Insecta	Diptera	Tipulidae	Antocha	Antocha	I	1	Collector	cn	8
Bivalvia	Veneroida	Pisidiidae	Pisidium	Pisidium	A	1	Filterer	bu	5.7
Gastropoda	Basommatophora	Ancylidae	Ferrissia	Ferrissia	A	1	Scraper	cb	7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	5	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	3	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	P	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	5	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Microtendipes	Microtendipes	I	1	Filterer	cn	4.9
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Insecta	Diptera	Chironomidae	Thienemannimyia gro	Thienemannimyia group	I	2	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	12	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	P	2	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Cricotopus/Orthoclad	Cricotopus/Orthocladius	I	4	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	2	Collector	sp	5.1

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Rocky Gorge Dam BIBI.xlsx
Version: 1
Site Name: 09RG-104-R-2016B

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Ephemeroptera	Ephemerellidae	Ephemerella	Ephemerella	I	17	Collector	cn, sw	2.3
Insecta	Ephemeroptera	Baetidae	Acentrella	Acentrella	I	1	Collector	sw, cn	4.9
Insecta	Plecoptera	Nemouridae	Amphinemura	Amphinemura	I	2	Shredder	sp, cn	3
Insecta	Plecoptera	Leuctridae	Leuctra	Leuctra	I	1	Shredder	cn	0.4
Insecta	Megaloptera	Corydalidae	Nigronia	Nigronia	I	1	Predator	cn, cb	1.4
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	3	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	1	Filterer	cn	7.5
Insecta	Trichoptera	Philopotamidae	Dolophilodes	Dolophilodes	I	26	Filterer	cn	1.7
Insecta	Trichoptera	Glossosomatidae	Agapetus	Agapetus	I	1	Scraper	cn	2
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	I	1	Scraper	cn	2.7
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	A	2	Scraper	cn	2.7
Insecta	Coleoptera	Psephenidae	Ectopria	Ectopria	I	1	Scraper	cn	2.2
Insecta	Diptera	Tipulidae	Pseudolimnophila	Pseudolimnophila	I	1	Predator	bu	2.8
Insecta	Diptera	Simuliidae	not identified	Simuliidae	P	1	Filterer	cn	3.2
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	4	Collector	bu	8.5
Oligochaeta	Tubificida	Tubificidae	Spirosperma	Spirosperma	A	2	Collector	cn	6.6
Oligochaeta	Tubificida	Tubificidae	not identified	Tubificidae	U	1	Collector	cn	8.4
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	1	Collector	sp	5.9
Insecta	Diptera	Chironomidae	Cladotanytarsus	Cladotanytarsus	I	2	Filterer	-	6.6
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	16	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	2	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Labrundinia	Labrundinia	I	1	Predator	sp	6.6
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	2	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	1	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	5	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	I	3	Collector	sp	4
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	2	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	P	2	Shredder	cb, cn	6.3

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Rocky Gorge Dam BIBI.xlsx
Version: 1
Site Name: 09RG-119-F-2016G

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Diptera	Ceratopogonidae	not identified	Bezzia/Palpomyia	I	2	0	0	na
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	13	Filterer	cn	5.7
Insecta	Diptera	Simuliidae	not identified	Simuliidae	P	1	Filterer	cn	3.2
Bivalvia	Veneroida	Pisidiidae	not identified	Sphaeriidae	A	1	Filterer	bu	6.5
Gastropoda	Basommatophora	Physidae	Physa	Physa	A	2	Scraper	cb	7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	2	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	3	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	3	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	2	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	47	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	8	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	13	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	P	3	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Chaetocladius	Chaetocladius	I	3	Collector	sp	7
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	12	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	P	1	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Microtendipes	Microtendipes	I	1	Filterer	cn	4.9
Insecta	Diptera	Chironomidae	Limnophyes	Limnophyes	I	1	Collector	sp	8.6
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	3	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	I	2	Predator	sp	5.3

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Rocky Gorge Dam BIBI.xlsx
Version: 1
Site Name: 09RG-124-F-2016I

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Amphipoda	Hyalellidae	Hyalella	Hyalella	A	2	Shredder	sp	4.2
Turbellaria	Tricladida	Planariidae	not identified	Planariidae	A	2	Predator	sp	8.4
Insecta	Ephemeroptera	Leptophlebiidae	not identified	Leptophlebiidae	I	2	Collector	sw, cn	1.7
Insecta	Ephemeroptera	Caenidae	Caenis	Caenis	I	1	Collector	sp	2.1
Insecta	Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	I	4	Scraper	cn	3
Insecta	Odonata	Gomphidae	not identified	Gomphidae	I	3	Predator	bu	2.2
Insecta	Plecoptera	Nemouridae	Amphinemura	Amphinemura	I	7	Shredder	sp, cn	3
Insecta	Plecoptera	Leuctridae	not identified	Leuctridae	I	5	Shredder	sp, cn	0.8
Insecta	Hemiptera	Veliidae	not identified	Veliidae	I	1	0	0	6
Insecta	Trichoptera	Uenoidae	Neophylax	Neophylax	I	3	Scraper	cn	2.7
Insecta	Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	I	7	Filterer	cn	2.7
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	1	Filterer	cn	7.5
Insecta	Trichoptera	Philopotamidae	Dolophilodes	Dolophilodes	I	16	Filterer	cn	1.7
Insecta	Trichoptera	Philopotamidae	not identified	Philopotamidae	P	1	Filterer	cn	2.6
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	I	1	Scraper	cn	2.7
Insecta	Coleoptera	Elmidae	Macronychus	Macronychus	I	1	Scraper	cn	6.8
Insecta	Coleoptera	Ptilodactylidae	Anchytarsus	Anchytarsus	I	2	Shredder	cn	3.1
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	3	Shredder	bu	6.7
Oligochaeta	Tubificida	Tubificidae	not identified	Tubificidae	U	2	Collector	cn	8.4
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	8	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	8	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	2	Shredder	bu, sp	7.4
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	3	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	3	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	2	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	11	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	P	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	1	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	P	1	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Chaetocladius	Chaetocladius	I	1	Collector	sp	7
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	12	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	I	1	Predator	sp	5.3
Insecta	Diptera	Chironomidae	Nilotanypus	Nilotanypus	I	1	Predator	sp	6.6

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Rocky Gorge Dam BIBI.xlsx
Version: 1
Site Name: 09RG-407-R-2016C

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	A	2	Collector	sp	6.7
Malacostraca	Isopoda	Asellidae	Caecidotea	Caecidotea	A	1	Collector	sp	2.6
Insecta	Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	I	2	Scraper	cn	3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	1	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	1	Filterer	cn	7.5
Insecta	Trichoptera	Philopotamidae	Dolophilodes	Dolophilodes	I	1	Filterer	cn	1.7
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Bivalvia	Veneroida	not identified	not identified	Veneroida	A	1	0	0	na
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	19	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	1	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	58	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	I	1	Collector	sp	4
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	5	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	1	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Limnophyes	Limnophyes	I	1	Collector	sp	8.6
Insecta	Diptera	Chironomidae	Nanocladius	Nanocladius	I	1	Collector	sp	7.6
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	3	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	6	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	P	1	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	P	1	Collector	sp	7.7

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Rocky Gorge Dam BIBI.xlsx
Version: 1
Site Name: 09RG-410-R-2016D

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	A	1	Collector	sp	6.7
Nematomorpha	not identified	not identified	not identified	Nematomorpha	A	1	0	bu	na
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	A	1	Predator	0	7.3
Insecta	Ephemeroptera	Caenidae	Caenis	Caenis	I	1	Collector	sp	2.1
Insecta	Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	I	1	Scraper	cn	3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	14	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	10	Filterer	cn	7.5
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	1	Predator	sp, bu	7.9
Bivalvia	Veneroida	Pisidiidae	Musculium	Musculium	A	24	Filterer	0	5.5
Bivalvia	Veneroida	Pisidiidae	not identified	Sphaeriidae	A	2	Filterer	bu	6.5
Gastropoda	Basommatophora	Physidae	not identified	Physidae	A	1	Scraper	cb	7
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	2	Collector	bu	9.1
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	4	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	26	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	2	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Chironomus	Chironomus	I	1	Collector	bu	4.6
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	14	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	P	2	Scraper	sp	7.2

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Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Rocky Gorge Dam BIBI.xlsx
Version: 1
Site Name: 09RG-413-R-2016E

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Ephemeroptera	Ephemerellidae	Ephemerella	Ephemerella	I	2	Collector	cn, sw	2.3
Insecta	Ephemeroptera	Heptageniidae	not identified	Heptageniidae	I	3	Scraper	cn	2.6
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	27	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	27	Filterer	cn	7.5
Insecta	Trichoptera	Brachycentridae	Micrasema	Micrasema	I	1	Shredder	cn, sp	2.3
Insecta	Coleoptera	Dryopidae	Helichus	Helichus	A	1	Scraper	cn	6.4
Insecta	Diptera	Empididae	Neoplasta	Neoplasta	I	2	Predator	0	na
Bivalvia	Veneroida	not identified	not identified	Veneroida	A	3	0	0	na
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	9	Collector	bu	8.5
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	1	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	18	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	3	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	1	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	1	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	P	1	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	P	2	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	P	1	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	3	Shredder	0	7.7

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Rocky Gorge Dam BIBI.xlsx
Version: 1
Site Name: 09RG-414-R-2016E

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	A	1	Predator	0	7.3
Insecta	Ephemeroptera	Ephemerellidae	Ephemerella	Ephemerella	I	4	Collector	cn, sw	2.3
Insecta	Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	I	3	Scraper	cn	3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	19	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	10	Filterer	cn	7.5
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	1	Filterer	cn	4.4
Insecta	Coleoptera	Elmidae	Optioservus	Optioservus	I	1	Scraper	cn	5.4
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	1	Scraper	cn	7.1
Insecta	Coleoptera	Psephenidae	Psephenus	Psephenus	I	1	Scraper	cn	4.4
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	2	Predator	sp, bu	7.9
Insecta	Diptera	Empididae	Neoplasta	Neoplasta	I	1	Predator	0	na
Insecta	Diptera	Empididae	not identified	Empididae	P	1	Predator	sp, bu	7.5
Bivalvia	Veneroida	Corbiculidae	Corbicula	Corbicula	A	4	Filterer	bu	6
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	19	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	20	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	I	10	Collector	sp	4
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	5	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	4	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	2	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	4	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	7	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	1	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	1	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	1	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	P	1	Collector	sp	7.7

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Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Rocky Gorge Dam BIBI.xlsx
Version: 1
Site Name: 09RG-422-F-2016H

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Turbellaria	Tricladida	Planariidae	not identified	Planariidae	A	1	Predator	sp	8.4
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	A	1	Predator	0	7.3
Insecta	Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	A	3	Scraper	cn	3
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	2	Collector	sw, cn	2.3
Insecta	Ephemeroptera	Heptageniidae	not identified	Heptageniidae	I	1	Scraper	cn	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3
Insecta	Trichoptera	Hydropsychidae	not identified	Hydropsychidae	I	2	Filterer	cn	5.7
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	P	4	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	4	Filterer	cn	7.5
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	5	Predator	sp, bu	7.9
Insecta	Diptera	Empididae	Neoplasta	Neoplasta	I	1	Predator	0	na
Insecta	Diptera	Tipulidae	Antocha	Antocha	I	1	Collector	cn	8
Bivalvia	Veneroida	Corbiculidae	Corbicula	Corbicula	I	5	Filterer	bu	6
Bivalvia	Veneroida	Pisidiidae	not identified	Sphaeriidae	A	2	Filterer	bu	6.5
Bivalvia	Veneroida	not identified	not identified	Veneroida	A	2	0	0	na
Gastropoda	Basommatophora	Lymnaeidae	Fossaria	Fossaria	A	1	Scraper	cb	6.9
Gastropoda	Basommatophora	Physidae	Physa	Physa	A	1	Scraper	cb	7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	1	Scraper	cn	7.1
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	I	5	Collector	bu	8.5
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	1	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	A	1	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	A	2	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Cladotanytarsus	Cladotanytarsus	I	1	Filterer	-	6.6
Insecta	Diptera	Chironomidae	Chaetocladius	Chaetocladius	I	1	Collector	sp	7
Insecta	Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	I	1	Predator	sp	8.1
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	36	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Potthastia	Potthastia	I	1	Collector	sp	0.01
Insecta	Diptera	Chironomidae	Robackia	Robackia	I	2	Collector	0	na
Insecta	Diptera	Chironomidae	Cardiocladius	Cardiocladius	I	1	Predator	bu, cn	10
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	P	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	13	Shredder	0	7.7

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Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO QC by: CRH
Prepared date: 8/10/2016 QC date: 9/15/2016

Rocky Gorge Dam BIBI.xlsx
Version: 1
Site Name: 09RG-426-F-2016J

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	A	2	Collector	sp	6.7
Malacostraca	Isopoda	Asellidae	Caecidotea	Caecidotea	A	3	Collector	sp	2.6
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	A	1	Predator	0	7.3
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	5	Collector	sw, cn	2.3
Insecta	Odonata	Coenagrionidae	Argia	Argia	I	1	Predator	cn, cb, sp	9.3
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3
Insecta	Plecoptera	Perlidae	not identified	Perlidae	I	1	Predator	cn	2.2
Insecta	Plecoptera	Taeniopterygidae	Taeniopteryx	Taeniopteryx	I	1	Shredder	sp, cn	4.8
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	1	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	1	Filterer	cn	7.5
Insecta	Trichoptera	Philopotamidae	Dolophilodes	Dolophilodes	I	1	Filterer	cn	1.7
Insecta	Trichoptera	Polycentropodida	Polycentropus	Polycentropus	I	3	Filterer	cn	1.1
Insecta	Trichoptera	Leptoceridae	Triaenodes	Triaenodes	I	1	Shredder	sw, cb	5
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	4	Predator	sp, bu	7.9
Insecta	Diptera	Ephydridae	not identified	Ephydridae	I	1	Collector	bu, sp	na
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	1	Shredder	bu	6.7
Bivalvia	Veneroida	not identified	not identified	Veneroida	A	6	0	0	na
Bivalvia	Veneroida	Corbiculidae	Corbicula	Corbicula	A	1	Filterer	bu	6
Bivalvia	Veneroida	Pisidiidae	not identified	Sphaeriidae	A	4	Filterer	bu	6.5
Gastropoda	Basommatophora	Planorbidae	Menetus	Menetus	A	1	Scraper	cb	7.6
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	5	Collector	bu	8.5
Oligochaeta	Tubificida	Naididae	Chaetogaster	Chaetogaster	A	1	0	0	na
Oligochaeta	Tubificida	Tubificidae	not identified	Tubificidae	U	2	Collector	cn	8.4
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	1	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	31	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	10	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	1	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	2	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Chaetocladius	Chaetocladius	I	1	Collector	sp	7
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	2	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	P	2	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Dicrotendipes	Dicrotendipes	I	1	Collector	bu	9
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	1	Collector	sp	5.9
Insecta	Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	I	1	Predator	sp	8.1
Insecta	Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	P	2	Predator	sp	8.1
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	1	Predator	sp	8.2

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Biomonitoring
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Metric	14HB-101-R-2016A	14HB-106-5-2016B	14HB-107-R-2016C	14HB-110-R-2016D	14HB-114-R-2016E	14HB-116-R-2016F	14HB-119-F-2016G	14HB-121-F-2016H	14HB-123-F-2016I	14HB-123-F-2016I QC	14HB-125-F-2016J
Raw Scores	**Raw Scores**										
Total Number of Taxa	29	26	23	28	30	10	35	25	27	29	28
Number of EPT Taxa	2	6	4	6	8	0	8	5	4	5	4
Number of Ephemeroptera Taxa	0	1	1	1	3	0	4	2	2	1	2
Percent Intolerant Urban	13.9	3.0	0.9	3.7	11.9	0.0	7.8	4.7	17.4	8.5	4.5
Percent Chironomidae	48.1	51.0	49.1	50.5	45.0	3.8	48.3	45.3	55.0	67.8	52.7
Percent Clingers	32.4	48.0	51.9	46.7	44.0	75.0	28.4	57.5	21.1	22.9	40.9
BIBI Scores	**BIBI Scores**										
Total Number of Taxa	5	5	3	5	5	1	5	5	5	5	5
Number of EPT Taxa	1	3	1	3	3	1	3	3	1	3	1
Number of Ephemeroptera Taxa	1	1	1	1	3	1	5	3	3	1	3
Percent Intolerant Urban	3	1	1	1	3	1	1	1	3	1	1
Percent Chironomidae	3	3	3	3	3	5	3	3	3	1	3
Percent Clingers	3	3	3	3	3	5	1	3	1	1	3
BIBI Score	***2.7***	***2.7***	***2.0***	***2.7***	***3.3***	***2.3***	***3.0***	***3.0***	***2.7***	***2.0***	***2.7***
Narrative Rating	***Poor***	***Poor***	***Poor***	***Poor***	***Fair***	***Poor***	***Fair***	***Fair***	***Poor***	***Poor***	***Poor***

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/10/2016 Checked date: 9/15/2016

Hammond Branch BIBI.xlsx
Version: 1
Site Name: 14HB-101-R-2016A

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	A	1	Predator	0	7.3
Insecta	Plecoptera	Nemouridae	Amphinemura	Amphinemura	I	6	Shredder	sp, cn	3
Insecta	Odonata	Aeshnidae	not identified	Aeshnidae	I	1	Predator	cb	6.2
Insecta	Trichoptera	Limnephilidae	Ironoquia	Ironoquia	I	3	Shredder	sp	4.9
Insecta	Coleoptera	Elmidae	Dubiraphia	Dubiraphia	I	1	Scraper	cn, cb	5.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	11	Scraper	cn	7.1
Insecta	Diptera	Ceratopogonidae	Dasyhelea	Dasyhelea	I	1	Collector	sp	3.6
Insecta	Diptera	Simuliidae	Prosimulium	Prosimulium	I	2	Filterer	cn	2.4
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	7	Filterer	cn	5.7
Insecta	Diptera	Simuliidae	Stegopterna	Stegopterna	I	5	Filterer	cn	2.4
Insecta	Diptera	Tipulidae	Tipula	Tipula	I	1	Shredder	bu	6.7
Gastropoda	Basommatophora	Lymnaeidae	Fossaria	Fossaria	A	1	Scraper	cb	6.9
Gastropoda	Basommatophora	Physidae	Physa	Physa	A	1	Scraper	cb	7
Oligochaeta	Haplotaxida	Lumbricidae	not identified	Lumbricidae	A	3	Collector	0	10
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	5	Collector	bu	8.5
Oligochaeta	Tubificida	Haplotaxidae	not identified	haplotaxidae	A	2	0	0	na
Oligochaeta	Tubificida	Tubificidae	Spirosperma	Spirosperma	A	2	Collector	cn	6.6
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	3	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	A	6	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Limnophyes	Limnophyes	I	1	Collector	sp	8.6
Insecta	Diptera	Chironomidae	Cladotanytarsus	Cladotanytarsus	I	1	Filterer	-	6.6
Insecta	Diptera	Chironomidae	Diplocladius	Diplocladius	I	1	Collector	sp	5.9
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	26	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	2	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Heterotrissocladius	Heterotrissocladius	I	1	Collector	sp, bu	2
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	3	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	1	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	3	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	1	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	P	5	Scraper	sp	7.2

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/10/2016 Checked date: 9/15/2016

Hammond Branch BIBI.xlsx
Version: 1
Site Name: 14HB-106-R-2016B

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Turbellaria	not identified	not identified	not identified	Turbellaria	A	1	Predator	sp	4
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	A	2	Predator	0	7.3
Insecta	Ephemeroptera	Ephemerellidae	not identified	Ephemerellidae	I	1	0	cn, sp, sw	2.6
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	7	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	12	Filterer	cn	7.5
Insecta	Trichoptera	Hydropsychidae	not identified	Hydropsychidae	P	1	Filterer	cn	5.7
Insecta	Trichoptera	Uenoidae	Neophylax	Neophylax	I	2	Scraper	cn	2.7
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	1	Filterer	cn	4.4
Insecta	Trichoptera	Hydroptilidae	Hydroptila	Hydroptila	I	1	Scraper	cn	6
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	4	Scraper	cn	7.1
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	1	Predator	sp, bu	7.9
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	3	Filterer	cn	5.7
Insecta	Diptera	Simuliidae	not identified	Simuliidae	P	1	Filterer	cn	3.2
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	7	Collector	bu	8.5
Oligochaeta	Tubificida	Tubificidae	Spirosperma	Spirosperma	A	1	Collector	cn	6.6
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	2	Collector	bu	9.1
Oligochaeta	Haplotaxida	Lumbricidae	not identified	Lumbricidae	A	1	Collector	0	10
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	23	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Stilocladius	Stilocladius	I	1	Collector	sp	6.6
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	5	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Krenosmittia	Krenosmittia	I	1	Collector	sp	na
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	8	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	1	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	1	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	1	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	4	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	5	Shredder	0	7.7

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
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Prepared date: 8/10/2016 Checked date: 9/15/2016

Hammond Branch BIBI.xlsx
Version: 1
Site Name: 14HB-107-R-2016C

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Amphipoda	Crangonyctidae	not identified	Crangonyctidae	A	1	Collector	sp	6.5
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	A	1	Predator	0	7.3
Insecta	Ephemeroptera	Heptageniidae	not identified	Heptageniidae	I	1	Scraper	cn	2.6
Insecta	Trichoptera	Hydroptilidae	Hydroptila	Hydroptila	I	3	Scraper	cn	6
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	13	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	8	Filterer	cn	7.5
Insecta	Coleoptera	Elmidae	Dubiraphia	Dubiraphia	I	1	Scraper	cn, cb	5.7
Insecta	Coleoptera	Elmidae	Optioservus	Optioservus	I	1	Scraper	cn	5.4
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	9	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	4	Scraper	cn	7.1
Insecta	Diptera	Tipulidae	Antocha	Antocha	I	1	Collector	cn	8
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	1	Predator	sp, bu	7.9
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	1	Collector	bu	9.1
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	8	Collector	bu	8.5
Oligochaeta	Tubificida	Tubificidae	Spirosperma	Spirosperma	A	1	Collector	cn	6.6
Oligochaeta	Tubificida	Tubificidae	not identified	Tubificidae	U	1	Collector	cn	8.4
Insecta	Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	I	2	Collector	sp	4
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	1	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	20	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	10	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Dicrotendipes	Dicrotendipes	I	4	Collector	bu	9
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	2	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	I	1	Predator	sp	8.1
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	4	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	6	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Dicrotendipes	Dicrotendipes	P	1	Collector	bu	9
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	P	1	Filterer	cb, cn	4.9

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Project Number: 16158563.11
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Hammond Branch BIBI.xlsx
Version: 1
Site Name: 14HB-110-R-2016D

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Nematomorpha	not identified	not identified	not identified	Nematomorpha	A	1	0	bu	na
Insecta	Ephemeroptera	Baetidae	Acentrella	Acentrella	I	1	Collector	sw, cn	4.9
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	1	Collector	sw, cn	2.3
Insecta	Plecoptera	Perlidae	not identified	Perlidae	I	1	Predator	cn	2.2
Insecta	Trichoptera	Glossosomatidae	Glossosoma	Glossosoma	I	1	Scraper	cn	0.01
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	7	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	3	Filterer	cn	7.5
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	4	Filterer	cn	4.4
Insecta	Odonata	Aeshnidae	not identified	Aeshnidae	I	1	Predator	cb	6.2
Insecta	Coleoptera	Elmidae	Ancyronyx	Ancyronyx	I	1	Scraper	cn, sp	7.8
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	I	1	Scraper	cn	2.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	3	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	5	Scraper	cn	7.1
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	1	Predator	sp, bu	7.9
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	3	Filterer	cn	5.7
Bivalvia	Veneroida	not identified	not identified	Veneroida	A	1	0	0	na
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	13	Collector	bu	8.5
Oligochaeta	Tubificida	Tubificidae	Spirosperma	Spirosperma	A	3	Collector	cn	6.6
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	2	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	16	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	6	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	2	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	10	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	1	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	1	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Microtendipes	Microtendipes	I	2	Filterer	cn	4.9
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	2	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	1	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	7	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	P	2	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	P	1	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	P	1	Predator	sp	8.2

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Hammond Branch BIBI.xlsx
Version: 1
Site Name: 14HB-114-R-2016E

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	A	1	Collector	sp	6.7
Malacostraca	Isopoda	Asellidae	Caecidotea	Caecidotea	A	7	Collector	sp	2.6
Insecta	Ephemeroptera	Heptageniidae	not identified	Heptageniidae	I	1	Scraper	cn	2.6
Insecta	Ephemeroptera	Caenidae	Caenis	Caenis	I	1	Collector	sp	2.1
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	3	Collector	sw, cn	2.3
Insecta	Plecoptera	Perlidae	not identified	Perlidae	I	1	Predator	cn	2.2
Insecta	Trichoptera	Hydroptilidae	Hydroptila	Hydroptila	I	2	Scraper	cn	6
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	4	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	5	Filterer	cn	7.5
Insecta	Trichoptera	Hydropsychidae	not identified	Hydropsychidae	P	1	Filterer	cn	5.7
Insecta	Coleoptera	Elmidae	Dubiraphia	Dubiraphia	A	2	Scraper	cn, cb	5.7
Insecta	Coleoptera	Elmidae	Macronychus	Macronychus	I	1	Scraper	cn	6.8
Insecta	Coleoptera	Elmidae	Macronychus	Macronychus	A	1	Scraper	cn	6.8
Insecta	Coleoptera	Elmidae	Optioservus	Optioservus	I	1	Scraper	cn	5.4
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	1	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	9	Scraper	cn	7.1
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	2	Predator	sp, bu	7.9
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	2	Filterer	cn	5.7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	15	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	12	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Limnophyes	Limnophyes	I	2	Collector	sp	8.6
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	8	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	I	1	Collector	sp	4
Insecta	Diptera	Chironomidae	Cladotanytarsus	Cladotanytarsus	I	1	Filterer	-	6.6
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	3	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	3	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Stenochironomus	Stenochironomus	I	1	Shredder	bu	7.9
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	1	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	1	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	8	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	3	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Limnophyes	Limnophyes	P	1	Collector	sp	8.6
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	P	2	Filterer	cb, cn	4.9

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Hammond Branch BIBI.xlsx
Version: 1
Site Name: 14HB-116-R-2016F

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	A	1	Predator	0	7.3
Insecta	Coleoptera	Dytiscidae	not identified	Dytiscidae	I	1	Predator	sw, dv	5.4
Bivalvia	Veneroida	Pisidiidae	Pisidium	Pisidium	A	9	Filterer	bu	5.7
Gastropoda	Basommatophora	Physidae	not identified	Physidae	A	1	Scraper	cb	7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	11	Collector	bu	8.5
Oligochaeta	Tubificida	Tubificidae	Spirosperma	Spirosperma	A	76	Collector	cn	6.6
Oligochaeta	Tubificida	Tubificidae	Limnodrilus	Limnodrilus	A	1	Collector	cn	8.6
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	2	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	P	1	Scraper	sp	7.2

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
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Hammond Branch BIBI.xlsx
Version: 1
Site Name: 14HB-119-F-2016G

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Nematomorpha	not identified	not identified	not identified	Nematomorpha	A	1	0	bu	na
Turbellaria	Tricladida	Planariidae	not identified	Planariidae	A	1	Predator	sp	8.4
Insecta	Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	I	3	Scraper	cn	3
Insecta	Ephemeroptera	Heptageniidae	not identified	Heptageniidae	I	1	Scraper	cn	2.6
Insecta	Ephemeroptera	Ephemerellidae	Teloganopsis	Teloganopsis	I	1	Collector	0	na
Insecta	Ephemeroptera	Baetidae	Acerpenna	Acerpenna	I	1	Collector	sw, cn	2.6
Insecta	Ephemeroptera	Baetidae	Plauditus	Plauditus	I	4	0	0	na
Insecta	Plecoptera	Perlidae	not identified	Perlidae	I	2	Predator	cn	2.2
Insecta	Megaloptera	Corydalidae	Nigronia	Nigronia	I	1	Predator	cn, cb	1.4
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	3	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	2	Filterer	cn	7.5
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	1	Filterer	cn	4.4
Insecta	Coleoptera	Elmidae	Dubiraphia	Dubiraphia	A	6	Scraper	cn, cb	5.7
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	I	1	Scraper	cn	2.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	2	Scraper	cn	7.1
Bivalvia	Veneroida	not identified	not identified	Veneroida	A	1	0	0	na
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	29	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	1	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	4	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	2	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	2	Shredder	bu, sp	7.4
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	3	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	2	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Limnophyes	Limnophyes	I	1	Collector	sp	8.6
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	5	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	2	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	3	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocla	I	9	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	1	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	1	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Dicrotendipes	Dicrotendipes	I	2	Collector	bu	9
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	3	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Chaetocladius	Chaetocladius	I	1	Collector	sp	7
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia gr	I	7	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	I	1	Predator	sp	8.1
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	P	1	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	P	1	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	P	3	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocla	P	1	Shredder	0	7.7

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

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Hammond Branch BIBI.xlsx
Version: 1
Site Name: 14HB-121-F-2016H

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	A	3	Collector	sp	6.7
Turbellaria	Tricladida	Planariidae	not identified	Planariidae	A	2	Predator	sp	8.4
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	1	Collector	sw, cn	2.3
Insecta	Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	I	1	Scraper	cn	3
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3
Insecta	Neuroptera	Sisyridae	Climacia	Climacia	I	1	Predator	cb	na
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	17	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	8	Filterer	cn	7.5
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	5	Filterer	cn	4.4
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	9	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	3	Scraper	cn	7.1
Insecta	Diptera	Tipulidae	Antocha	Antocha	I	2	Collector	cn	8
Insecta	Diptera	Empididae	Neoplasta	Neoplasta	I	2	Predator	0	na
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	2	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	3	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	10	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	1	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Chaetocladius	Chaetocladius	I	1	Collector	sp	7
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	6	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	3	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	2	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Synorthocladius	Synorthocladius	I	1	Collector	0	6.6
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	11	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	P	2	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	2	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	P	1	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia Group	I	3	Predator	sp	8.2
Insecta	Diptera	Chironomidae	not identified	Orthocladiinae	P	1	Collector	0	7.6

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Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Hammond Branch BIBI.xlsx
Version: 1
Site Name: 14HB-123-F-2016I QC

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	A	2	Collector	sp	6.7
Malacostraca	Isopoda	Asellidae	Caecidotea	Caecidotea	A	8	Collector	sp	2.6
Insecta	Ephemeroptera	Isonychiidae	Isonychia	Isonychia	I	1	Filterer	sw, cn	2.5
Insecta	Plecoptera	Perlidae	not identified	Perlidae	I	1	Predator	cn	2.2
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	5	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	1	Filterer	cn	7.5
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	1	Filterer	cn	4.4
Insecta	Coleoptera	Elmidae	Microcylloepus	Microcylloepus	I	1	Collector	0	4.8
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	1	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	1	Scraper	cn	7.1
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	1	Predator	sp, bu	7.9
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Insecta	Diptera	Tipulidae	Antocha	Antocha	I	2	Collector	cn	8
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	12	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	3	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	5	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	3	Shredder	cn, bu	9.6
Insecta	Diptera	Chironomidae	Limnophyes	Limnophyes	I	1	Collector	sp	8.6
Insecta	Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	I	2	Collector	sp	4
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthoclad	I	23	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	3	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	1	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	1	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	1	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	6	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	2	Predator	sp	6.7
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	P	1	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	P	3	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthoclad	P	12	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	P	2	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	P	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	P	7	Collector	sp	8.5

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Project Name: Howard County Countywide Bioassessment
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Hammond Branch BIBI.xlsx
Version: 1
Site Name: 14HB-123-F-2016I

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	A	2	Collector	sp	6.7
Malacostraca	Isopoda	Asellidae	Caecidotea	Caecidotea	A	9	Collector	sp	2.6
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	A	2	Predator	0	7.3
Turbellaria	Tricladida	Planariidae	not identified	Planariidae	A	1	Predator	sp	8.4
Insecta	Ephemeroptera	Isonychiidae	Isonychia	Isonychia	I	1	Filterer	sw, cn	2.5
Insecta	Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	I	2	Scraper	cn	3
Insecta	Ephemeroptera	Heptageniidae	not identified	Heptageniidae	I	3	Scraper	cn	2.6
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	4	Filterer	cn	4.4
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	3	Filterer	cn	6.5
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	I	1	Scraper	cn	2.7
Insecta	Coleoptera	Elmidae	Macronychus	Macronychus	I	3	Scraper	cn	6.8
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	1	Scraper	cn	7.1
Insecta	Coleoptera	Dryopidae	Helichus	Helichus	A	1	Scraper	cn	6.4
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	2	Filterer	cn	5.7
Bivalvia	Veneroida	Corbiculidae	Corbicula	Corbicula	A	1	Filterer	bu	6
Gastropoda	Basommatophora	Planorbidae	Menetus	Menetus	A	1	Scraper	cb	7.6
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	12	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	20	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Nanocladius	Nanocladius	I	1	Collector	sp	7.6
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	3	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	2	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Synorthocladius	Synorthocladius	I	1	Collector	0	6.6
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	1	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	1	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	9	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	8	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	P	8	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	P	2	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	P	1	Collector	sp	6.2

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Hammond Branch BIBI.xlsx
Version: 1
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KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Isopoda	Asellidae	Caecidotea	Caecidotea	A	1	Collector	sp	2.6
Insecta	Ephemeroptera	Ephemerellidae	Teloganopsis	Teloganopsis	I	1	Collector	0	na
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	1	Collector	sw, cn	2.3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	6	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	10	Filterer	cn	7.5
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	I	2	Scraper	cn	2.7
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	A	1	Scraper	cn	2.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	3	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	6	Scraper	cn	7.1
Insecta	Diptera	Ceratopogonidae	not identified	Bezzia/Palpomyia	I	1	0	0	na
Insecta	Diptera	Empididae	Clinocera	Clinocera	I	2	Predator	cn	7.4
Gastropoda	Basommatophora	Planorbidae	Menetus	Menetus	A	1	Scraper	cb	7.6
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	15	Collector	bu	8.5
Oligochaeta	Tubificida	Tubificidae	Limnodrilus	Limnodrilus	A	1	Collector	cn	8.6
Oligochaeta	Tubificida	Tubificidae	Spirosperma	Spirosperma	A	1	Collector	cn	6.6
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	2	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Stilocladius	Stilocladius	I	1	Collector	sp	6.6
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	1	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	7	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Dicrotendipes	Dicrotendipes	I	1	Collector	bu	9
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	22	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	1	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Microtendipes	Microtendipes	I	4	Filterer	cn	4.9
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	2	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	2	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	3	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	1	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	P	1	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	7	Shredder	0	7.7

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Biomonitoring
Project Number: 16158563
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Metric	15DR-102-R-2016A	15DR-104-R-2016B	15DR-109-R-2016C	15DR-111-R-2016D	15DR-112-R-2016D	15DR-116-R-2016F	15DR-119-F-2016G	15DR-119-2016G QC	15DR-121-F-2016H	15DR-123-F-2016I	15DR-125-F-2016J
Raw Scores	**Raw Scores**										
Total Number of Taxa	20	14	20	18	19	18	21	20	13	17	22
Number of EPT Taxa	2	0	4	3	3	2	3	2	1	0	2
Number of Ephemeroptera Taxa	2	0	1	1	1	1	0	0	1	0	0
Percent Intolerant Urban	11	0	1	2	2	4	4	5	1	3	8
Percent Chironomidae	23	66	84	79	71	82	77	68	70	44	87
Percent Clingers	19	7	13	21	18	11	15	16	10	15	8
BIBI Scores	**BIBI Scores**										
Total Number of Taxa	3	1	3	3	3	3	3	3	1	3	3
Number of EPT Taxa	1	1	1	1	1	1	1	1	1	1	1
Number of Ephemeroptera Taxa	3	1	1	1	1	1	1	1	1	1	1
Percent Intolerant Urban	1	1	1	1	1	1	1	1	1	1	1
Percent Chironomidae	5	1	1	1	1	1	1	1	1	3	1
Percent Clingers	1	1	1	1	1	1	1	1	1	1	1
BIBI Score	***2.3***	***1.0***	***1.3***	***1.3***	***1.3***	***1.3***	***1.3***	***1.3***	***1.0***	***1.7***	***1.3***
Narrative Rating	***Poor***	***Very Poor***	***Very Poor***	***Very Poor***	***Very Poor***	***Very Poor***	***Very Poor***	***Very Poor***	***Very Poor***	***Very Poor***	***Very Poor***

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Dorsey Run BIBI.xlsx
Version: 1
Site Name: 15DR-102-R-2016A

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Amphipoda	Hyalellidae	Hyalella	Hyalella	A	2	Shredder	sp	4.2
Malacostraca	Isopoda	Asellidae	Caecidotea	Caecidotea	A	3	Collector	sp	2.6
Insecta	Ephemeroptera	Caenidae	Caenis	Caenis	I	4	Collector	sp	2.1
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	1	Collector	sw, cn	2.3
Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3
Insecta	Odonata	Coenagrionidae	Argia	Argia	I	6	Predator	cn, cb, sp	9.3
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	1	Scraper	cn	7.1
Insecta	Coleoptera	Haliplidae	Peltodytes	Peltodytes	A	1	Shredder	cb, cn	8.9
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	47	Collector	bu	8.5
Oligochaeta	Tubificida	Tubificidae	not identified	Tubificidae	U	8	Collector	cn	8.4
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	1	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	4	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	1	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Parakiefferiella	Parakiefferiella	I	2	Collector	sp	2.1
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	9	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	1	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	P	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Procladius	Procladius	I	1	Predator	sp	1.2
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Dorsey Run BIBI.xlsx
Version: 1
Site Name: 15DR-104-R-2016B

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Nematomorpha	not identified	not identified	not identified	Nematomorpha	A	1	0	bu	na
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	1	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	1	Scraper	cn	7.1
Insecta	Diptera	Empididae	Clinocera	Clinocera	I	1	Predator	cn	7.4
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	28	Collector	bu	8.5
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	1	Collector	bu	9.1
Oligochaeta	Tubificida	Tubificidae	not identified	Tubificidae	U	2	Collector	cn	8.4
Oligochaeta	Tubificida	Tubificidae	Limnodrilus	Limnodrilus	A	1	Collector	cn	8.6
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthoclad	I	44	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	11	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	8	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	P	2	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	1	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Dicrotendipes	Dicrotendipes	I	2	Collector	bu	9
Insecta	Diptera	Chironomidae	Natarsia	Natarsia	I	1	Predator	sp	6.6

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Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Dorsey Run BIBI.xlsx
Version: 1
Site Name: 15DR-109-R-2016C

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	1	Collector	sw, cn	2.3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	1	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	1	Filterer	cn	7.5
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	2	Filterer	cn	4.4
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	1	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	2	Scraper	cn	7.1
Insecta	Diptera	Tipulidae	Antocha	Antocha	I	1	Collector	cn	8
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	6	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	3	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	1	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	I	15	Collector	sp	4
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	9	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	3	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	41	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	2	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	2	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	I	1	Predator	sp	6.7
Insecta	Diptera	Chironomidae	Krenosmittia	Krenosmittia	P	1	Collector	sp	na
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	P	3	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	P	1	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	P	2	Collector	sp	7.7

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Dorsey Run BIBI.xlsx
Version: 1
Site Name: 15DR-111-R-2016D

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	1	Collector	sw, cn	2.3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	3	Filterer	cn	6.5
Insecta	Trichoptera	Hydropsychidae	not identified	Hydropsychidae	P	1	Filterer	cn	5.7
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	3	Filterer	cn	4.4
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	3	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	2	Scraper	cn	7.1
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	2	Predator	sp, bu	7.9
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	8	Filterer	cn	5.7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	3	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	5	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	P	2	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	18	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	P	1	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	48	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	2	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	2	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	I	1	Collector	sp	4
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	2	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	P	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	2	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	1	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	3	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	5	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	2	Predator	sp	8.2

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
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Dorsey Run BIBI.xlsx
Version: 1
Site Name: 15DR-112-R-2016D

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	1	Collector	sw, cn	2.3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	2	Filterer	cn	6.5
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	5	Filterer	cn	4.4
Insecta	Trichoptera	Hydropsychidae	not identified	Hydropsychidae	I	1	Filterer	cn	5.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	3	Scraper	cn	7.1
Insecta	Diptera	Empididae	not identified	Empididae	P	1	Predator	sp, bu	7.5
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	14	Collector	bu	8.5
Oligochaeta	Tubificida	Tubificidae	not identified	Tubificidae	U	1	Collector	cn	8.4
Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	2	Filterer	cn	7.2
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	1	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	19	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	3	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	23	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	15	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Limnophyes	Limnophyes	I	1	Collector	sp	8.6
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	1	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	P	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Potthastia	Potthastia	I	1	Collector	sp	0.01
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	2	Predator	sp	8.2

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Dorsey Run BIBI.xlsx
Version: 1
Site Name: 15DR-116-R-2016F

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Amphipoda	Hyalellidae	Hyalella	Hyalella	A	1	Shredder	sp	4.2
Nematomorpha	not identified	not identified	not identified	Nematomorpha	A	1	0	bu	na
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	3	Collector	sw, cn	2.3
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	3	Filterer	cn	4.4
Insecta	Trichoptera	Philopotamidae	not identified	Philopotamidae	P	1	Filterer	cn	2.6
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	1	Scraper	cn	7.1
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	4	Filterer	cn	5.7
Insecta	Diptera	Empididae	not identified	Empididae	P	1	Predator	sp, bu	7.5
Gastropoda	Basommatophora	Physidae	not identified	Physidae	A	2	Scraper	cb	7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	4	Collector	bu	8.5
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	20	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	P	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	1	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	27	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	P	2	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthoclad	I	37	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Insecta	Diptera	Chironomidae	Nanocladius	Nanocladius	I	1	Collector	sp	7.6
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	I	1	Predator	sp	5.3

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Dorsey Run BIBI.xlsx
Version: 1
Site Name: 15DR-119-F-2016G QC

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Isopoda	Asellidae	Caecidotea	Caecidotea	A	4	Collector	sp	2.6
Enopla	Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	A	1	Predator	0	7.3
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	5	Filterer	cn	6.5
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	1	Filterer	cn	4.4
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	6	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	2	Scraper	cn	7.1
Insecta	Diptera	Empididae	Hemerodromia	Hemerodromia	I	1	Predator	sp, bu	7.9
Insecta	Diptera	Empididae	not identified	Empididae	P	1	Predator	sp, bu	7.5
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	2	Filterer	cn	5.7
Insecta	Diptera	Simuliidae	not identified	Simuliidae	P	1	Filterer	cn	3.2
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	12	Collector	bu	8.5
Oligochaeta	Tubificida	Naididae	Chaetogaster	Chaetogaster	A	1	0	0	na
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	10	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	P	2	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	27	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	28	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	2	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Parakiefferiella	Parakiefferiella	I	1	Collector	sp	2.1
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	1	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	P	1	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	1	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	P	1	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	P	3	Collector	sp	5.1

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Dorsey Run BIBI.xlsx
Version: 1
Site Name: 15DR-119-F-2016G

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Isopoda	Asellidae	Caecidotea	Caecidotea	A	1	Collector	sp	2.6
Insecta	Plecoptera	Taeniopterygidae	Taeniopteryx	Taeniopteryx	I	1	Shredder	sp, cn	4.8
Insecta	Trichoptera	Philopotamidae	Dolophilodes	Dolophilodes	I	2	Filterer	cn	1.7
Insecta	Trichoptera	Philopotamidae	Chimarra	Chimarra	I	1	Filterer	cn	4.4
Insecta	Coleoptera	Elmidae	Oulimnius	Oulimnius	I	1	Scraper	cn	2.7
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	4	Scraper	cn	7.1
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	2	Filterer	cn	5.7
Insecta	Diptera	Empididae	not identified	Empididae	P	1	Predator	sp, bu	7.5
Gastropoda	Basommatophora	Physidae	not identified	Physidae	A	1	Scraper	cb	7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	8	Collector	bu	8.5
Oligochaeta	Tubificida	Tubificidae	Spirosperma	Spirosperma	A	4	Collector	cn	6.6
Oligochaeta	Haplotaxida	Lumbricidae	not identified	Lumbricidae	A	1	Collector	0	10
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	24	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Tanytarsus	Tanytarsus	I	1	Filterer	cb, cn	4.9
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	4	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	42	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	10	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Parakiefferiella	Parakiefferiella	I	1	Collector	sp	2.1
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	1	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	P	4	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	P	1	Predator	sp	8.2

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Dorsey Run BIBI.xlsx
Version: 1
Site Name: 15DR-121-F-2016H

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Ephemeroptera	Baetidae	not identified	Baetidae	I	1	Collector	sw, cn	2.3
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	I	1	Scraper	cn	7.1
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	A	1	Scraper	cn	7.1
Insecta	Diptera	Simuliidae	Simulium	Simulium	I	1	Filterer	cn	5.7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	26	Collector	bu	8.5
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	1	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	59	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	P	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	2	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	6	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Insecta	Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	I	1	Collector	sp	6.2
Insecta	Diptera	Chironomidae	Chaetocladius	Chaetocladius	I	1	Collector	sp	7
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	2	Predator	sp	8.2

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/10/2016 Checked date: 9/15/2016

Dorsey Run BIBI.xlsx
Version: 1
Site Name: 15DR-123-F-2016l

KCI TECHNOLOGIES

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Malacostraca	Isopoda	Asellidae	Caecidotea	Caecidotea	A	3	Collector	sp	2.6
Nematomorpha	not identified	not identified	not identified	Nematomorpha	A	1	0	bu	na
Insecta	Odonata	Coenagrionidae	Argia	Argia	I	2	Predator	cn, cb, sp	9.3
Insecta	Diptera	Tipulidae	Erioptera	Erioptera	I	1	Collector	bu	4.8
Gastropoda	Basommatophora	Physidae	not identified	Physidae	A	1	Scraper	cb	7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	46	Collector	bu	8.5
Oligochaeta	Tubificida	Tubificidae	Limnodrilus	Limnodrilus	A	1	Collector	cn	8.6
Oligochaeta	Tubificida	Tubificidae	not identified	Tubificidae	U	2	Collector	cn	8.4
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	A	3	Collector	bu	9.1
Insecta	Diptera	Chironomidae	Brillia	Brillia	I	1	Shredder	bu, sp	7.4
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	27	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	9	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	I	2	Scraper	sp	7.2
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	1	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	1	Collector	sp	6.1
Insecta	Diptera	Chironomidae	Pentaneura	Pentaneura	I	1	Predator	sp	6.6
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	1	Predator	sp	8.2
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	1	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	P	2	Shredder	cb, cn	6.3

1 Life Stage, I - Immature, P- Pupa, A - Adult, U - Undetermined; 2 Functional Feeding Group; 3 Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland. An entry of "0" indicates information for the particular taxa was not available.

Project Name: Howard County Countywide Bioassessment
Project Number: 16158563.11
Prepared by: RAO Checked by: CRH
Prepared date: 8/11/2016 Checked date: 9/15/2016

Dorsey Run BIBI.xlsx
Version: 1
Site Name: 15DR-125-F-2016J

Subphylum/ Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]
Insecta	Hemiptera	Veliidae	not identified	Veliidae	I	1	0	0	6
Insecta	Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	I	1	Filterer	cn	2.7
Insecta	Trichoptera	Philopotamidae	Dolophilodes	Dolophilodes	I	1	Filterer	cn	1.7
Insecta	Diptera	Tipulidae	Dicranota	Dicranota	I	1	Predator	sp, bu	1.1
Insecta	Diptera	Ephydridae	not identified	Ephydridae	I	1	Collector	bu, sp	na
Gastropoda	Basommatophora	Physidae	not identified	Physidae	A	2	Scraper	cb	7
Oligochaeta	Haplotaxida	Naididae	not identified	Naididae	A	4	Collector	bu	8.5
Oligochaeta	Tubificida	Tubificidae	not identified	Tubificidae	U	4	Collector	cn	8.4
Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	6	Collector	cb, sp	2.1
Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	3	Shredder	cb, cn	6.3
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	I	35	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	P	4	Shredder	0	7.7
Insecta	Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	I	1	Collector	sp	7.7
Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	1	Collector	sp	4.1
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	I	4	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Thienemanniella	Thienemanniella	P	2	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	14	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	P	1	Collector	sp	5.1
Insecta	Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	I	16	Collector	sp	4.6
Insecta	Diptera	Chironomidae	Limnophyes	Limnophyes	I	1	Collector	sp	8.6
Insecta	Diptera	Chironomidae	Stictochironomus	Stictochironomus	I	3	Collector	bu	9.2
Insecta	Diptera	Chironomidae	Chaetocladius	Chaetocladius	I	5	Collector	sp	7
Insecta	Diptera	Chironomidae	Diamesa	Diamesa	I	1	Collector	sp	8.5
Insecta	Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	I	2	Predator	sp	5.3
Insecta	Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	P	1	Predator	sp	5.3
Insecta	Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	I	2	Predator	sp	8.2

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Appendix D: Habitat Assessment Data

Project Name: Howard County Countywide Bioassessement
Project Number: 1615856311
Prepared by: CRH Checked by: RAO
Prepared date: 6/17/2016 Checked date: 11/1/2016

RBP_High_Gradient_v1.xlsx
Version: 1
Site Name:

KCI TECHNOLOGIES

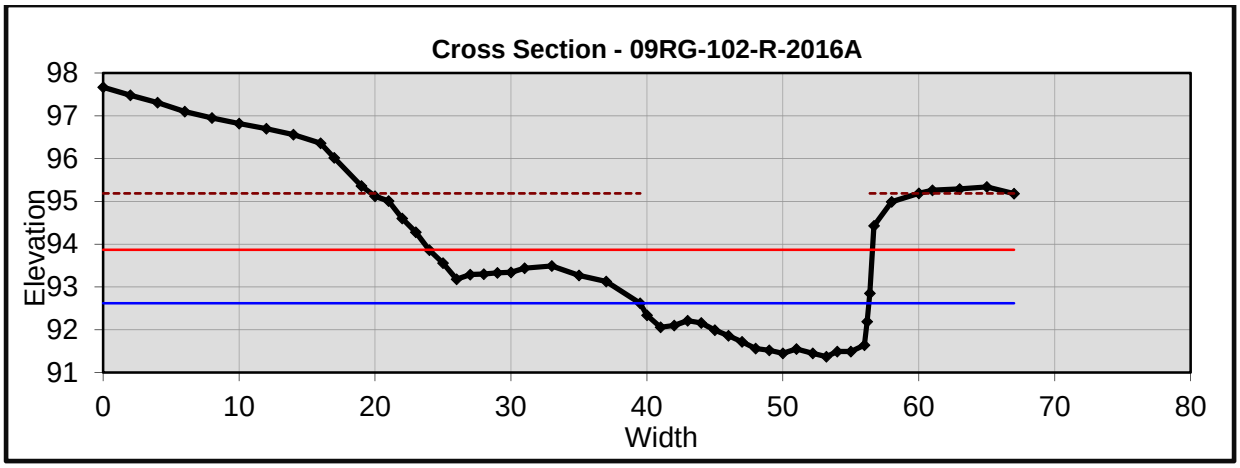
Site ID	Sample Date	Total RBP Habitat Score	RBP Score	RBP Rating	Epifaunal Substrate/ Cover	Embedded-ness	Velocity/ Depth Regime	Sediment Deposition	Channel Flow Status	Channel Alteration	Frequency of Rifles	Bank Stability - Left	Bank Stability - Right	Vegetative Protection - Left	Vegetative Protection - Right	Riparian Vegetative Zone Width - Left	Riparian Vegetative Zone Width - Right
Rocky Gorge Dam																	
09RG-102R-2016A	4/19/2016	127	64	Partially Supporting	14	12	12	8	11	17	14	6	6	3	4	10	10
09RG-102R-2016A QC	4/19/2016	126	63	Partially Supporting	14	13	12	7	9	18	13	6	6	4	4	10	10
09RG-104-R-2016B	4/19/2016	130	65	Partially Supporting	15	14	14	9	8	20	14	7	3	6	6	4	10
09RG-119-F-2016G	4/20/2016	117	59	Not Supporting	2	9	4	17	15	18	3	10	10	9	9	10	1
09RG-124-F-2016I	4/20/2016	119	60	Not Supporting	11	13	7	15	7	15	16	7	8	8	8	2	2
09RG-407-R-2016C	4/14/2016	135	68	Partially Supporting	11	8	17	11	17	20	8	3	6	7	7	10	10
09RG-410-2016D	4/14/2016	184	92	Comparable to Reference	19	17	19	18	18	20	17	10	8	9	9	10	10
09RG-413-R-2016E	4/18/2016	148	74	Partially Supporting	15	14	12	10	18	20	9	9	7	8	6	10	10
09RG-414-R-2016E	4/19/2016	141	71	Partially Supporting	16	8	11	11	19	20	5	9	8	7	7	10	10
09RG-426-F-2016J	4/18/2016	118	59	Not Supporting	7	9	11	8	18	18	2	9	8	8	8	10	2
09RG-442-2016H	4/18/2016	121	61	Partially Supporting	9	10	16	7	10	20	4	8	9	8	8	10	2
Hammond Branch																	
14HB-101-R-2016A	4/13/2016	131	66	Partially Supporting	10	8	11	11	13	20	16	8	6	4	4	10	10
14HB-106-R-2016B	3/29/2016	108	54	Not Supporting	11	13	15	8	13	18	10	3	3	2	4	0	8
14HB-107-R-2016C	3/29/2016	93	47	Not Supporting	9	12	12	9	19	17	4	3	2	3	2	1	0
14HB-110-R-2016D	3/30/2016	124	62	Partially Supporting	15	12	16	10	14	20	8	3	3	2	3	8	10
14HB-114-R-2016E	4/14/2016	85	43	Not Supporting	6	4	17	6	13	19	15	1	1	1	1	0	1
14HB-116-R-2016F	3/30/2016	82	41	Not Supporting	2	1	1	11	6	19	2	7	7	3	3	10	10
14HB-119-F-2016G	4/13/2016	122	61	Partially Supporting	12	13	11	10	14	20	12	7	7	5	5	5	1
14HB-121-F-2016H	4/13/2016	134	67	Partially Supporting	13	14	13	15	15	20	6	5	5	8	8	10	2
14HB-123-F-2016I	3/30/2016	156	78	Supporting	16	17	17	12	12	20	15	9	7	8	8	10	5
14HB-123-F-2016I QC	3/29/2016	153	77	Supporting	17	17	15	12	12	19	16	8	6	8	8	10	5
14HB-125-F-2016J	3/29/2016	115	58	Not Supporting	11	11	12	7	16	18	13	4	6	3	3	1	10
Dorsey Run																	
15DR-102-R-2016A	4/20/2016	83	42	Not Supporting	4	1	7	5	17	12	1	6	4	6	6	7	7
15DR-104-R-2016B	4/21/2016	118	59	Not Supporting	9	8	12	5	7	20	10	5	8	7	7	10	10
15DR-109-R-2016C	4/22/2016	161	81	Supporting	16	12	13	18	15	20	16	10	8	9	9	10	5
15DR-111-R-2016D	4/22/2016	152	76	Supporting	14	12	14	17	14	18	17	7	9	8	8	5	9
15DR-112-R-2016D	4/29/2016	141	71	Partially Supporting	14	14	12	16	9	14	16	7	6	6	7	10	10
15DR-116-R-2016F	4/29/2016	146	73	Partially Supporting	14	12	13	14	14	15	15	8	8	10	10	10	3
15DR-119-F-2016G	4/22/2016	156	78	Supporting	14	13	13	17	14	20	16	8	9	8	8	6	10
15DR-119-F-2016G-QC	4/22/2016	149	75	Partially Supporting	14	11	9	18	11	20	18	10	7	7	7	7	10
15DR-121-F-2016H	4/21/2016	129	65	Partially Supporting	14	7	14	6	7	20	13	6	6	8	8	10	10
15DR-123-F-2016I	4/21/2016	124	62	Partially Supporting	10	7	13	6	9	20	10	9	5	7	8	10	10
15DR-125-F-2016J	4/29/2016	128	64	Partially Supporting	6	8	7	10	7	20	15	9	9	9	9	10	9

Project Name: Howard County Countywide Bioassessement
Project Number: 1615856311 PHI_Piedmont_v3_HCcountywide.xlsx
Prepared by: RAO Checked by: CRH Version: 2
Prepared date: 11/4/2016 Checked date: 11/4/2016 Site Name:

		RAW DATA						Calculated Value		SCORES	
Site	Subshed Area (ac)*	Instream Habitat	Epibenthic Substrate	Embeddedness	Percent Shading	# Woody Debris/ Rootwads	Riffle Quality	Bank Stability	Remoteness Score	PHI	PHI Rating
Rocky Gorge											
09RG-102-R-2016A	242.9	9	14	45	70	10	10	13	10	68.3	Partially Degraded
09RG-102-R-2016A QC	229.0	11	14	40	70	9	10	13	10	69.6	Partially Degraded
09RG-104-R-2016B	721.0	12	15	30	70	14	12	9	8	72.9	Partially Degraded
09RG-119-F-2016G	47.4	1	2	55	30	2	3	20	8	37.4	Severely Degraded
09RG-124-F-2016I	77.2	2	11	45	80	8	6	18	7	58.1	Degraded
09RG-407-R-2016C	87693.5	17	11	70	50	20	17	12	6	68.1	Partially Degraded
09RG-410-R-2016D	86298.5	19	19	20	60	7	18	20	11	84.9	Minimally Degraded
09RG-413-R-2016E	71114.0	14	16	40	40	11	16	10	13	75.8	Partially Degraded
09RG-414-R-2016E	70731.4	16	11	65	90	15	14	18	10	74.2	Partially Degraded
09RG-426-F-2016J	87819.5	6	8	60	40	9	7	18	4	49.5	Severely Degraded
09RG-442-2016H	87860.6	8	10	50	30	9	10	19	6	56.4	Degraded
Hammond Branch											
14HB-101-R-2016A	152.7	10	10	60	80	8	8	16	11	64.6	Degraded
14HB-106-R-2016B	1030.7	12	11	30	20	3	9	14	8	56.9	Degraded
14HB-107-R-2016C	1259.4	7	9	30	0	1	6	2	8	33.4	Severely Degraded
14HB-110-R-2016D	2321.6	15	15	40	65	18	13	13	17	82.1	Minimally Degraded
14HB-114-R-2016E	3554.9	11	6	80	0	4	12	0	11	35.5	Severely Degraded
14HB-116-R-2016F	3708.2	1	2	100	85	1	1	19	12	36.9	Severely Degraded
14HB-119-F-2016G	717.2	12	13	40	50	8	13	16	6	67.3	Partially Degraded
14HB-121-F-2016H	2152.7	15	12	30	75	20	13	12	8	75.6	Partially Degraded
14HB-123-F-2016I	4087.8	16	17	20	90	6	15	17	5	78.0	Partially Degraded
14HB-123-F-2016I QC	4083.7	15	17	20	90	8	15	17	4	78.7	Partially Degraded
14HB-125-F-2016J	1251.3	9	11	35	10	1	8	14	8	49.6	Severely Degraded
Dorsey Run											
15DR-102-R-2016A	4154.6	5	4	95	75	17	5	12	1	41.5	Severely Degraded
15DR-104-R-2016B	1356.7	14	9	70	65	17	10	13	8	64.9	Degraded
15DR-109-R-2016C	1661.7	10	16	35	85	16	16	19	7	79.3	Partially Degraded
15DR-111-R-2016D	1636.1	14	14	40	90	7	14	19	8	75.3	Partially Degraded
15DR-112-R-2016D	1464.4	12	14	40	95	17	13	12	8	76.2	Partially Degraded
15DR-116-R-2016F	510.6	15	14	35	70	10	12	18	10	78.0	Partially Degraded
15DR-119-F-2016G	2052.6	10	14	40	95	13	14	19	4	75.2	Partially Degraded
15DR-119-F-2016G-QC	2015.2	6	14	50	95	3	15	19	5	62.2	Degraded
15DR-121-F-2016H	4073.3	14	10	70	85	16	9	13	8	66.4	Partially Degraded
15DR-123-F-2016I	2474.8	10	10	70	65	21	9	15	8	62.6	Degraded
15DR-125-F-2016J	124.5	9	6	60	90	16	8	19	8	65.1	Degraded

Score	Narrative Rating
81-100	Minimally Degraded
66.0-80.9	Partially Degraded
51.0-65.9	Degraded
0-50.9	Severely Degraded

Appendix E: Geomorphologic Data



Bankfull Dimensions	
14.2	x-section area (ft.sq.)
16.8	width (ft)
0.8	mean depth (ft)
1.3	max depth (ft)
17.7	wetted parimeter (ft)
0.8	hyd radi (ft)
20.0	width-depth ratio

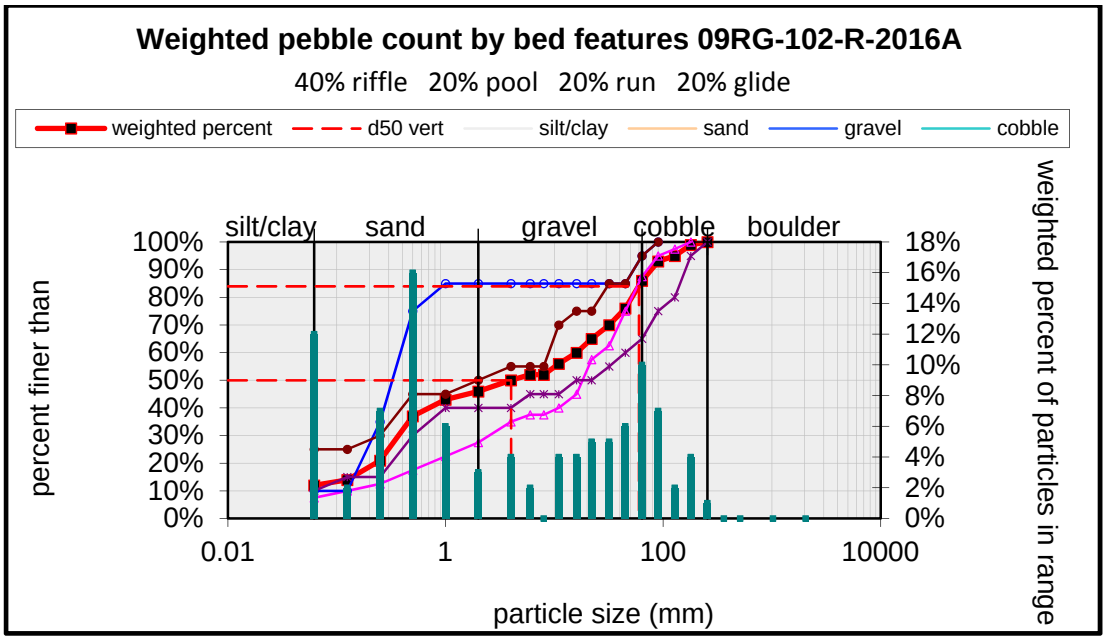
Flood Dimensions	
32.6	W flood prone area (ft)
1.9	entrenchment ratio
3.8	low bank height (ft)
3.1	low bank height ratio

Bankfull Flow	
2.9	velocity (ft/s)
41.1	discharge rate (cfs)
0.57	Froude number

Flow Resistance	
0.038	Manning's roughness

Sinuosity
1.6

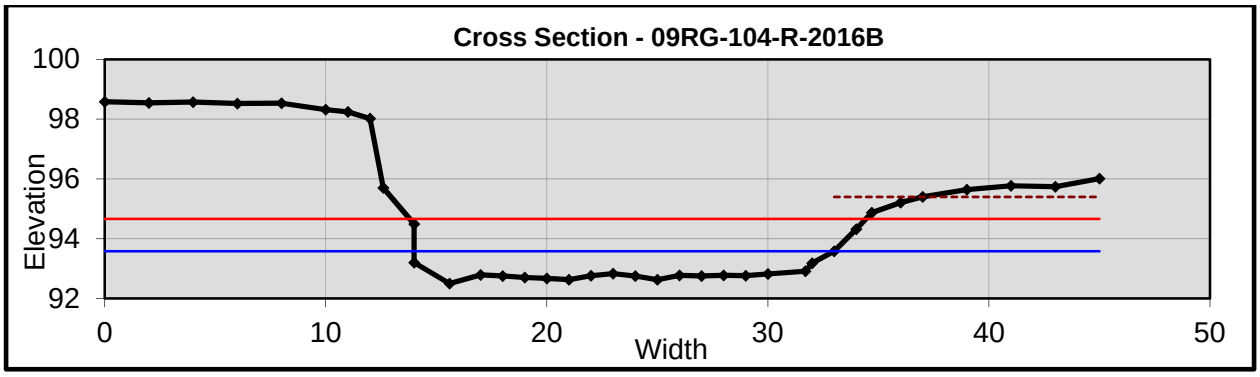
Channel Type
B4c



Size (mm)	
D16	0.15
D35	0.46
D50	4
D65	22
D84	60
D95	130

Size Distribution	
mean	3.0
dispersion	20.8
skewness	-0.08

Type	
silt/clay	12%
sand	34%
gravel	40%
cobble	14%
boulder	0%



Bankfull Dimensions	
15.0	x-section area (ft.sq.)
19.0	width (ft)
0.8	mean depth (ft)
1.1	max depth (ft)
19.8	wetted parimeter (ft)
0.8	hyd radi (ft)
24.0	width-depth ratio

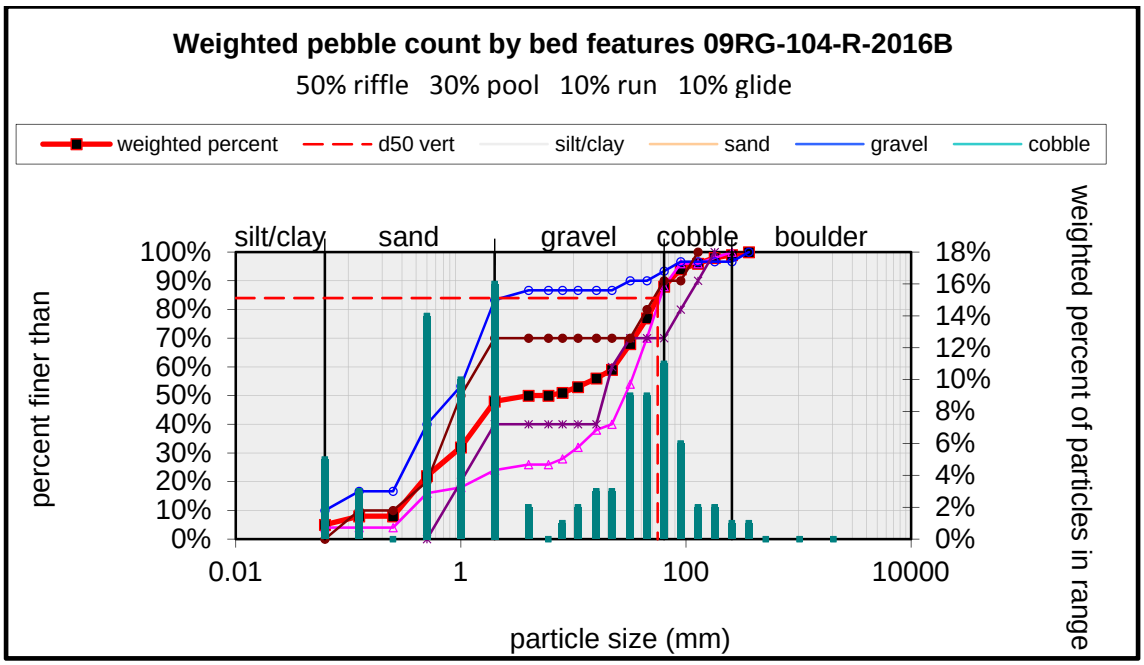
Flood Dimensions	
20.6	W flood prone area (ft)
1.1	entrenchment ratio
2.9	low bank height (ft)
2.7	low bank height ratio

Bankfull Flow	
3.5	velocity (ft/s)
52.2	discharge rate (cfs)
0.70	Froude number

Flow Resistance	
0.037	Manning's roughness

Sinuosity
1.5

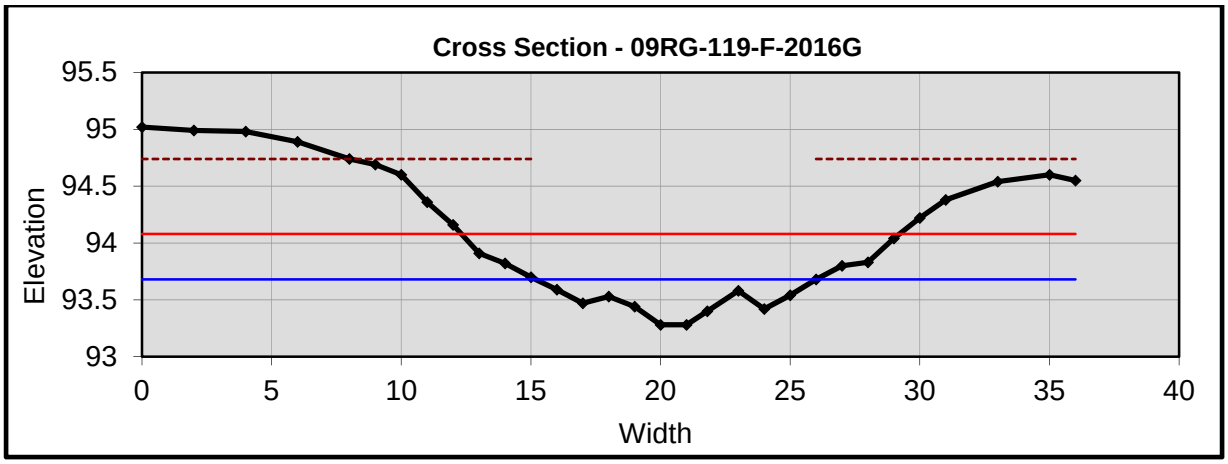
Channel Type
F4/5



Size (mm)	
D16	0.38
D35	1.2
D50	7.1
D65	29
D84	56
D95	110

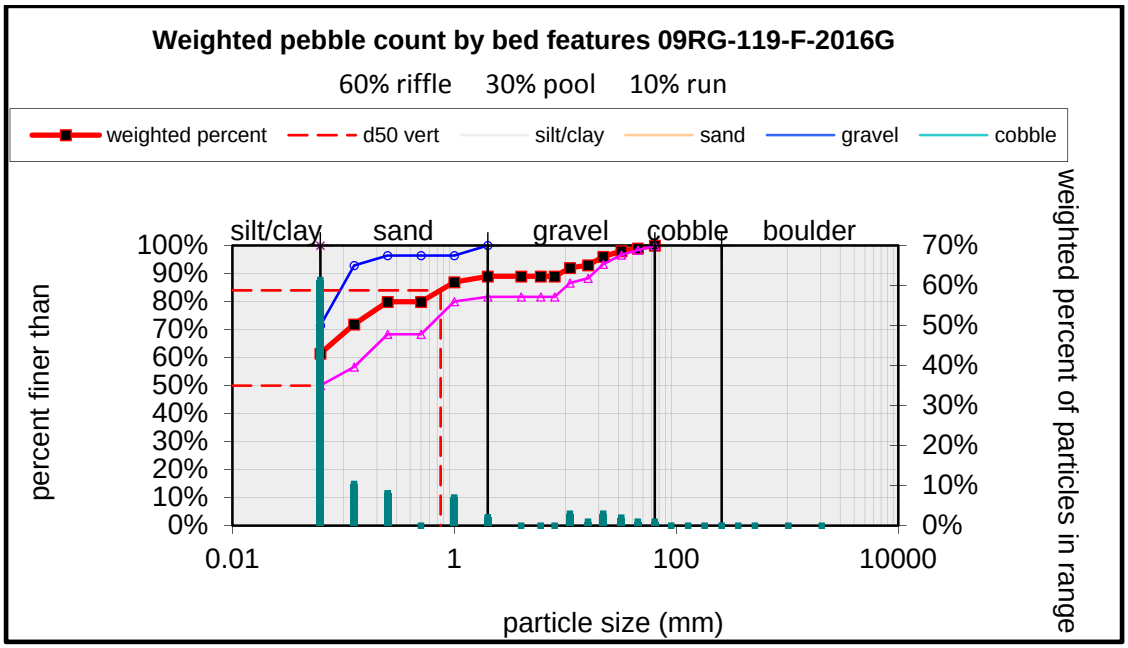
Size Distribution	
mean	4.6
dispersion	13.3
skew ness	-0.13

Type	
silt/clay	5%
sand	42%
gravel	41%
cobble	11%
boulder	1%

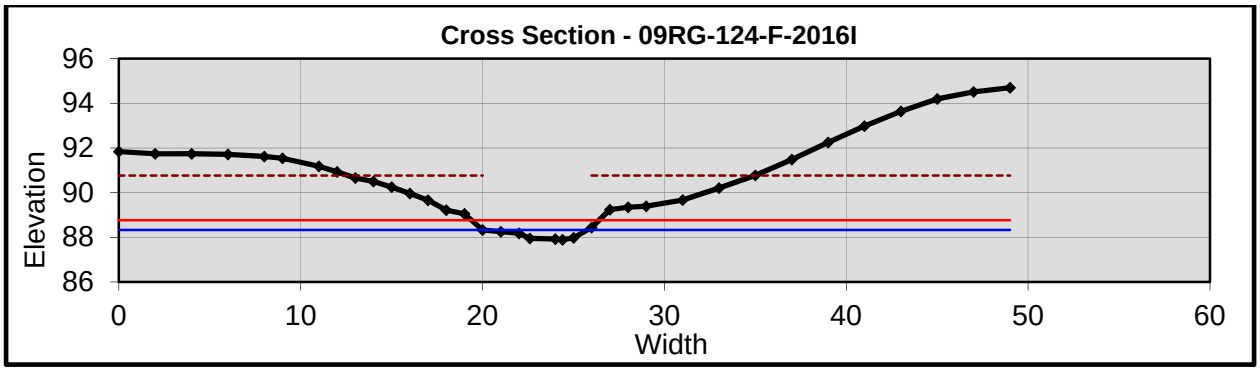


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
2.2	x-section area (ft.sq.)	17.0	W flood prone area (ft)	5.4	velocity (ft/s)
10.8	width (ft)	1.6	entrenchment ratio	12.0	discharge rate (cfs)
0.2	mean depth (ft)	1.5	low bank height (ft)	2.09	Froude number
0.4	max depth (ft)	3.6	low bank height ratio		
10.9	wetted parimeter (ft)				
0.2	hyd radi (ft)				
52.4	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.014	Manning's roughness	1.2	**B6**

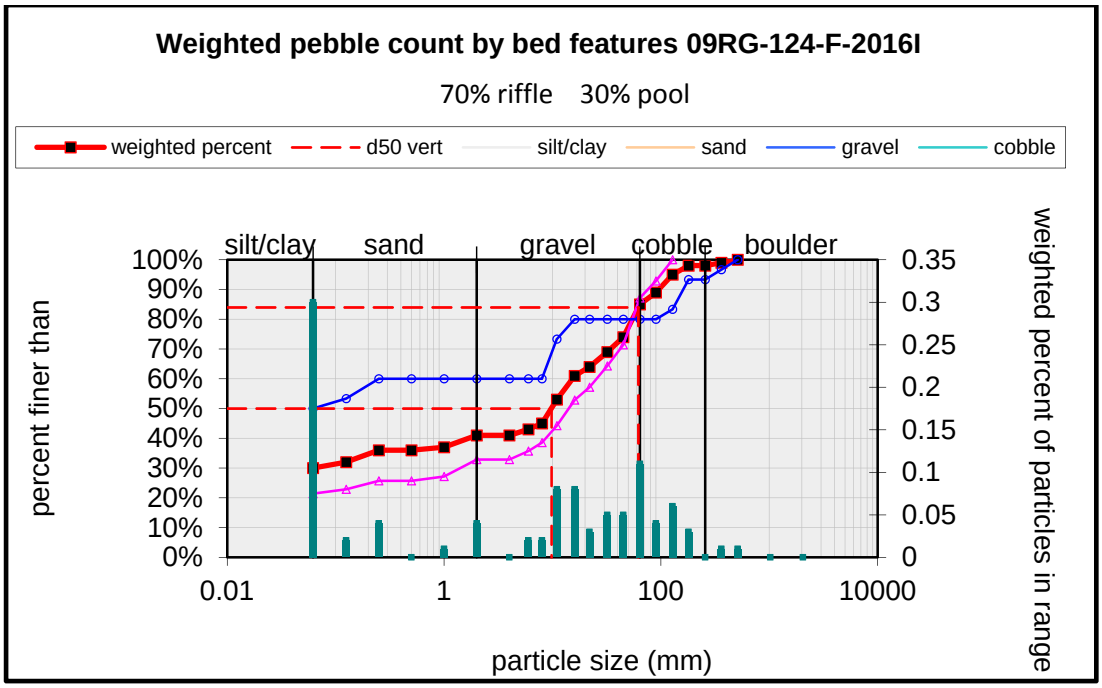


Size (mm)		Size Distribution		Type			
D16	0.062	mean	0.2	silt/clay	60%		
D35	0.062	dispersion	6.5	sand	27%	hardpan	2%
D50	0.062	skewness	0.52	gravel	11%		
D65	0.079			cobble	0%		
D84	0.75			boulder	0%		
D95	20						

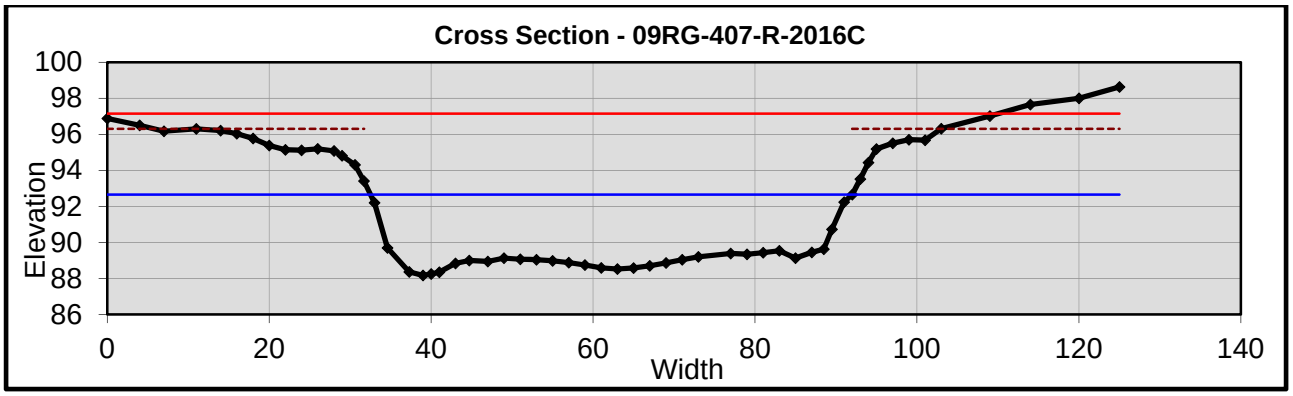


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
1.4	x-section area (ft.sq.)	7.0	W flood prone area (ft)	1.8	velocity (ft/s)
5.8	width (ft)	1.2	entrenchment ratio	2.6	discharge rate (cfs)
0.2	mean depth (ft)	2.9	low bank height (ft)	0.66	Froude number
0.4	max depth (ft)	6.5	low bank height ratio		
5.9	wetted parimeter (ft)				
0.2	hyd radi (ft)				
23.6	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.055	Manning's roughness	1.1	**F4b**



Size (mm)		Size Distribution		Type	
D16	0.062	mean	2.0	silt/clay	30%
D35	0.21	dispersion	82.2	sand	11%
D50	9.8	skewness	-0.40	gravel	44%
D65	24			cobble	13%
D84	62			boulder	2%
D95	130				



Bankfull Dimensions	
206.1	x-section area (ft.sq.)
59.5	width (ft)
3.5	mean depth (ft)
4.5	max depth (ft)
62.8	wetted parimeter (ft)
3.3	hyd radi (ft)
17.2	width-depth ratio

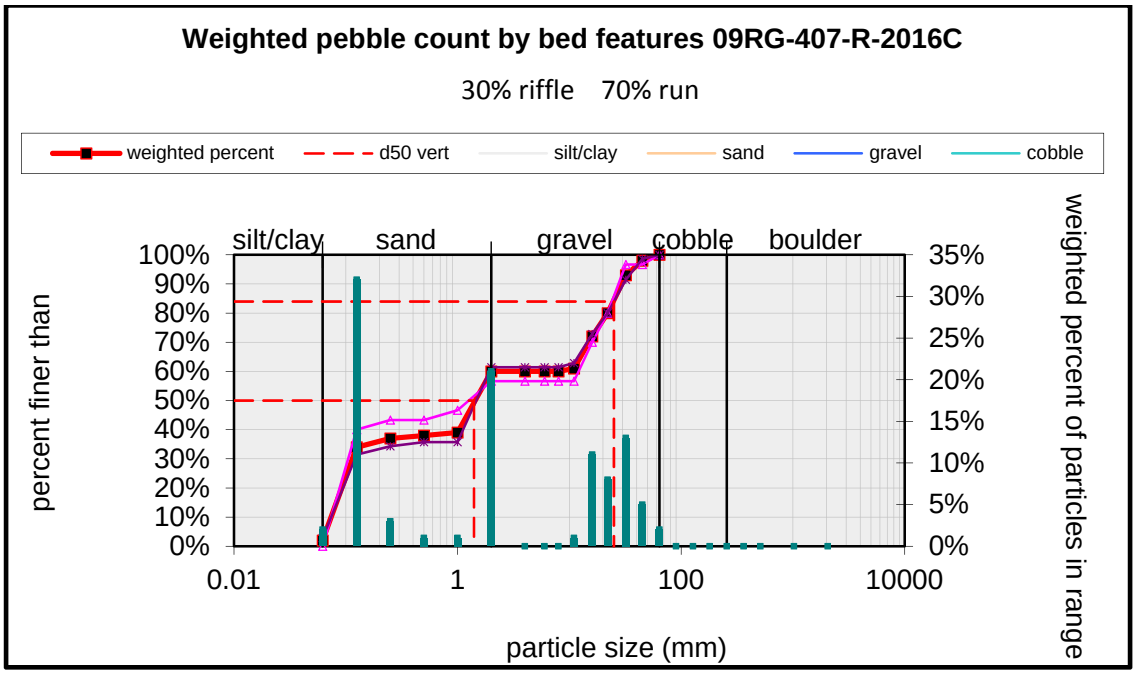
Flood Dimensions	
102.0	W flood prone area (ft)
1.7	entrenchment ratio
8.1	low bank height (ft)
1.8	low bank height ratio

Bankfull Flow	
4.6	velocity (ft/s)
942.1	discharge rate (cfs)
0.44	Froude number

Flow Resistance	
0.026	Manning's roughness

Sinuosity
1.2

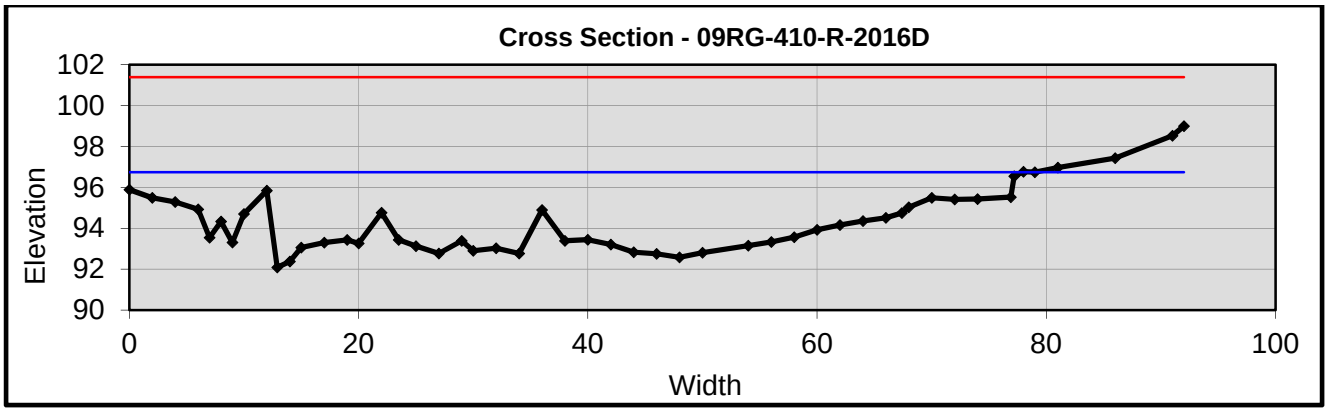
Channel Type
B4/5c



Size (mm)	
D16	0.084
D35	0.16
D50	1.4
D65	13
D84	25
D95	37

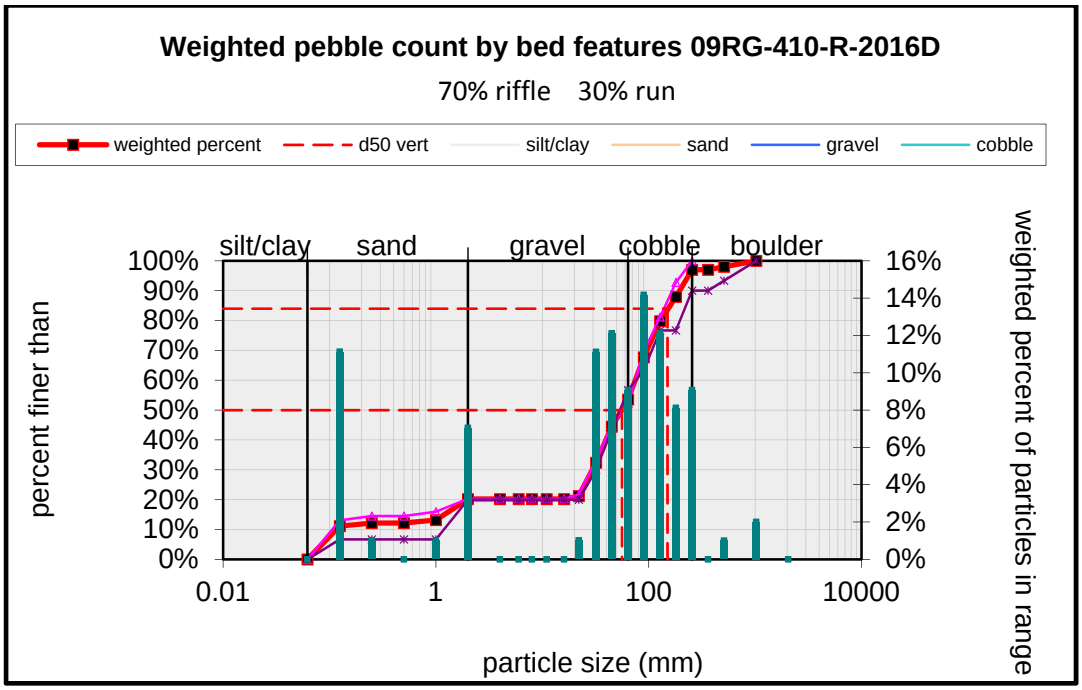
Size Distribution	
mean	1.4
dispersion	17.3
skewness	0.01

Type	
silt/clay	2%
sand	58%
gravel	40%
cobble	0%
boulder	0%



Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
211.9	x-section area (ft.sq.)	120.0	W flood prone area (ft)	6.6	velocity (ft/s)
75.8	width (ft)	1.6	entrenchment ratio	1406.8	discharge rate (cfs)
2.8	mean depth (ft)	---	low bank height (ft)	0.74	Froude number
4.6	max depth (ft)	---	low bank height ratio		
85.1	wetted parimeter (ft)				
2.5	hyd radi (ft)				
27.1	width-depth ratio				

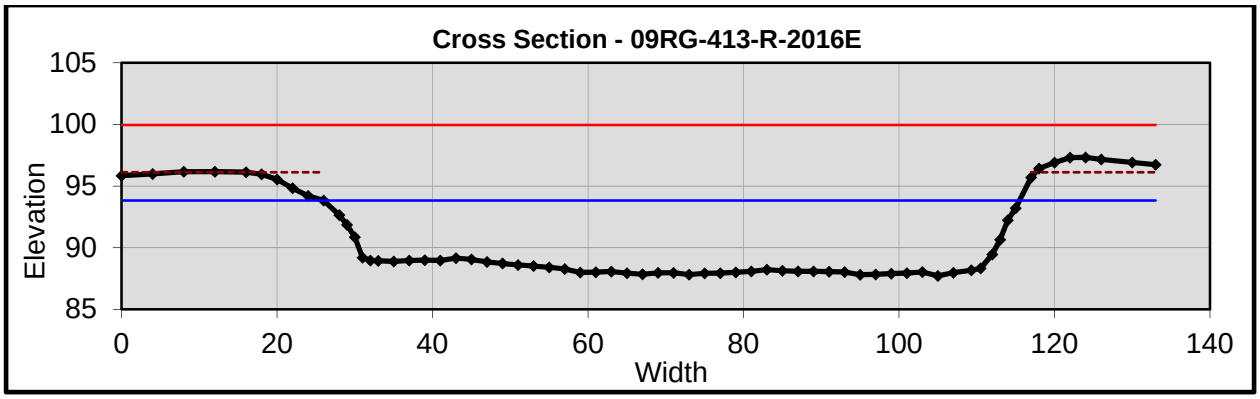
Flow Resistance		Sinuosity	Channel Type
0.041	Manning's roughness	1.2	**B3c**



Size (mm)	
D16	1.3
D35	34
D50	56
D65	84
D84	150
D95	240

Size Distribution	
mean	14.0
dispersion	22.9
skewness	-0.42

Type			
silt/clay	0%		
sand	20%	hardpan	1%
gravel	33%		
cobble	43%		
boulder	3%		



Bankfull Dimensions	
466.6	x-section area (ft.sq.)
89.5	width (ft)
5.2	mean depth (ft)
6.1	max depth (ft)
94.2	wetted parimeter (ft)
5.0	hyd radi (ft)
17.2	width-depth ratio

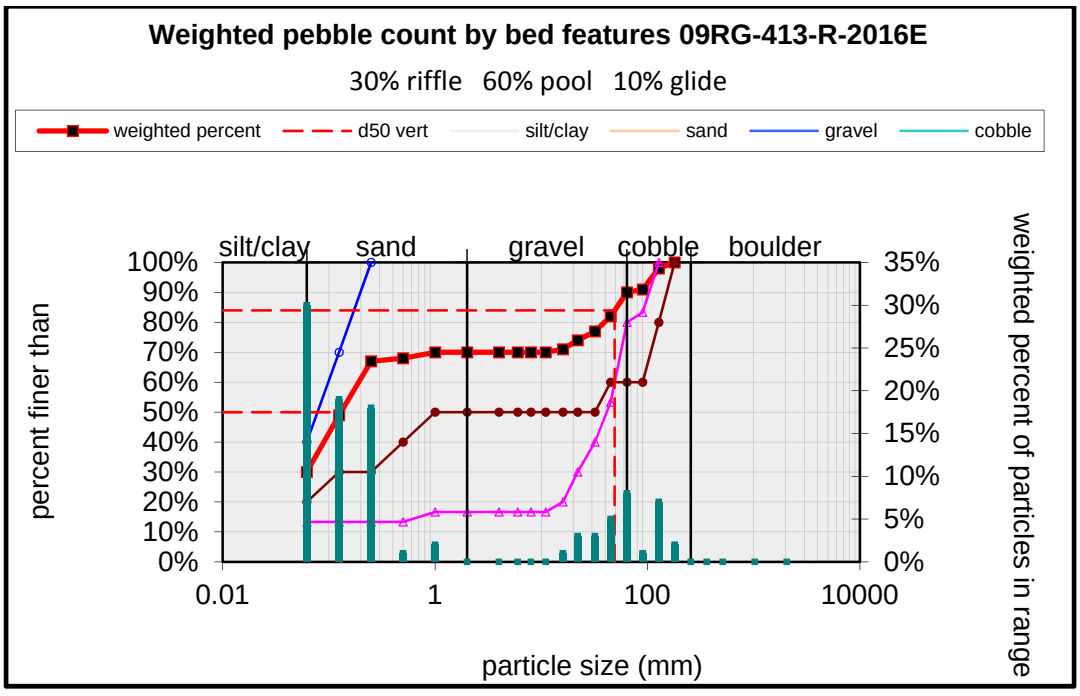
Flood Dimensions	
200.0	W flood prone area (ft)
2.2	entrenchment ratio
8.4	low bank height (ft)
1.4	low bank height ratio

Bankfull Flow	
7.6	velocity (ft/s)
3551.8	discharge rate (cfs)
0.60	Froude number

Flow Resistance	
0.030	Manning's roughness

Sinuosity
1.2

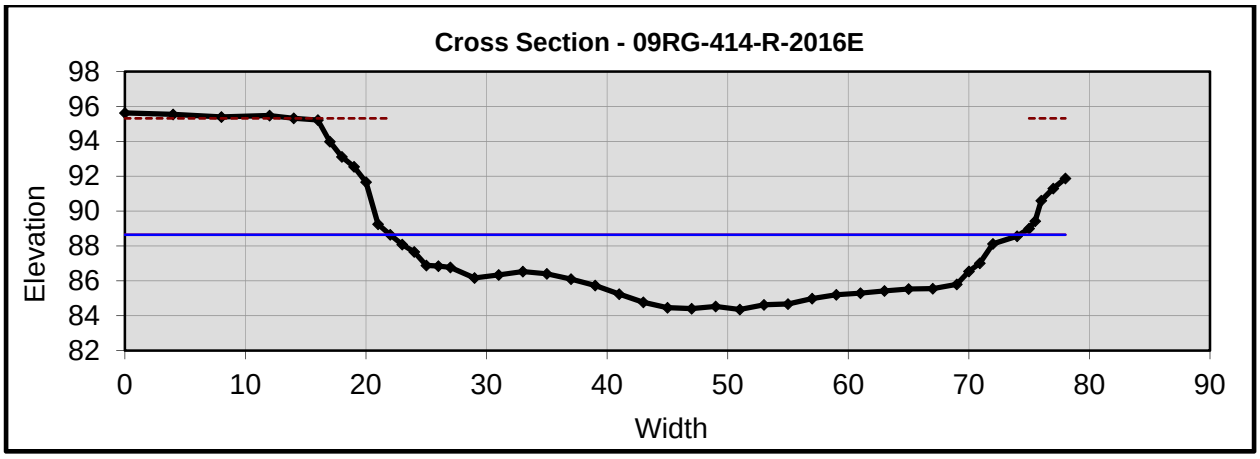
Channel Type
C4/5



Size (mm)	
D16	0.062
D35	0.075
D50	0.13
D65	0.23
D84	49
D95	110

Size Distribution	
mean	1.7
dispersion	189.5
skewness	0.66

Type	
silt/clay	30%
sand	40%
gravel	20%
cobble	10%
boulder	0%



Bankfull Dimensions	
149.7	x-section area (ft.sq.)
52.2	width (ft)
2.9	mean depth (ft)
4.3	max depth (ft)
54.0	wetted parimeter (ft)
2.8	hyd radi (ft)
18.2	width-depth ratio

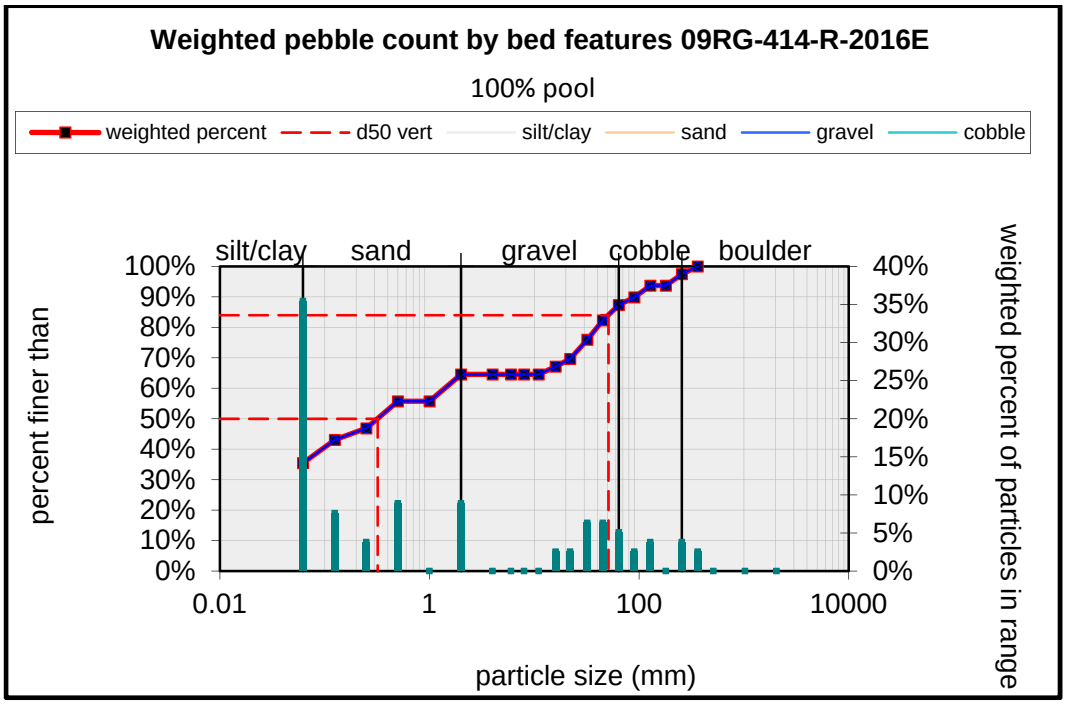
Flood Dimensions	
59.7	W flood prone area (ft)
1.1	entrenchment ratio
11.0	low bank height (ft)
2.6	low bank height ratio

Bankfull Flow	
2.2	velocity (ft/s)
323.7	discharge rate (cfs)
0.23	Froude number

Flow Resistance	
0.030	Manning's roughness

Sinuosity
1.3

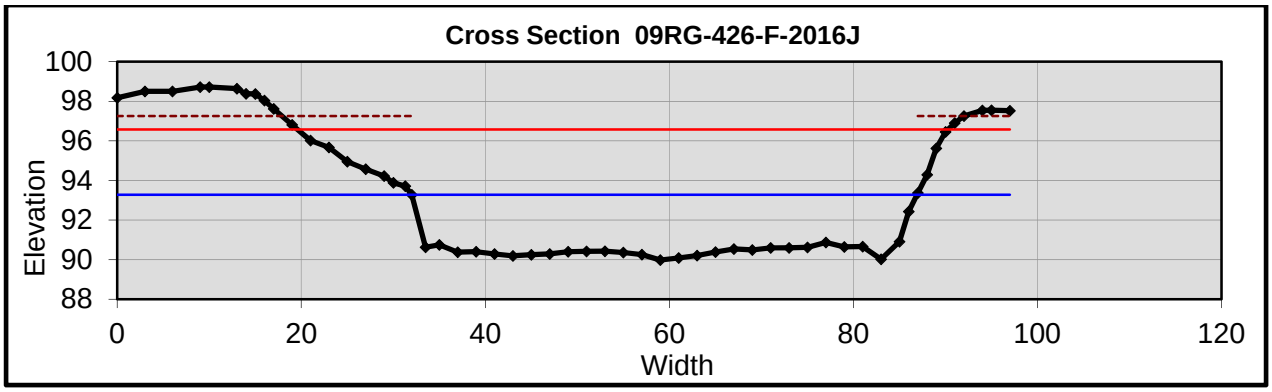
Channel Type
F4/5



Size (mm)	
D16	0.062
D35	0.062
D50	0.32
D65	12
D84	51
D95	200

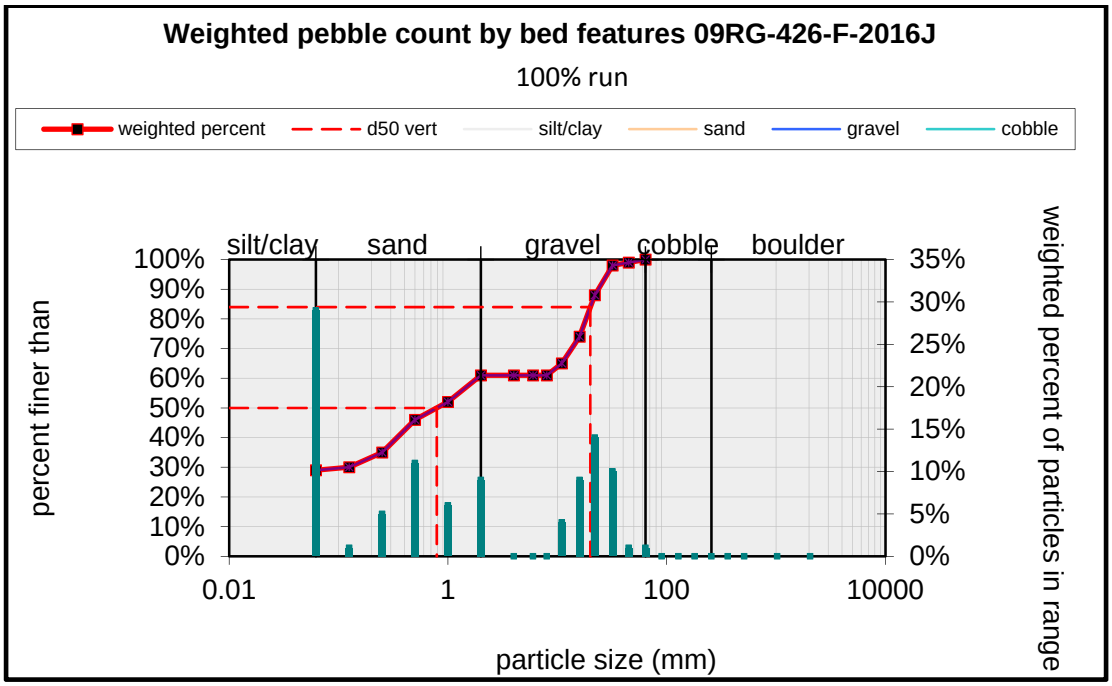
Size Distribution	
mean	1.8
dispersion	82.3
skewness	0.44

Type			
silt/clay	28%	bedrock	20%
sand	23%		
gravel	18%		
cobble	8%		
boulder	2%		

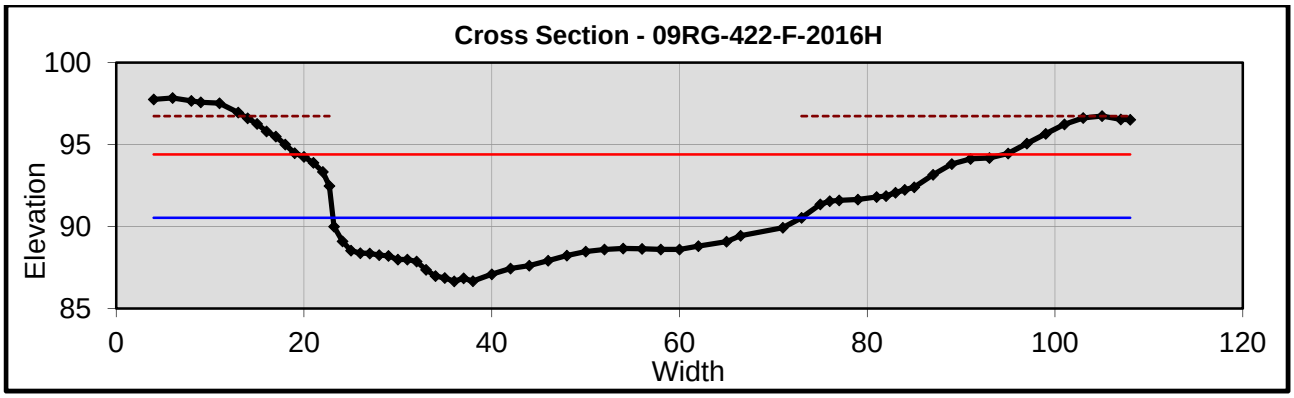


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
151.4	x-section area (ft.sq.)	70.7	W flood prone area (ft)	2.6	velocity (ft/s)
54.9	width (ft)	1.3	entrenchment ratio	399.0	discharge rate (cfs)
2.8	mean depth (ft)	7.3	low bank height (ft)	0.29	Froude number
3.3	max depth (ft)	2.2	low bank height ratio		
58.0	wetted parimeter (ft)				
2.6	hyd radi (ft)				
19.9	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.025	Manning's roughness	1	**F4/5**

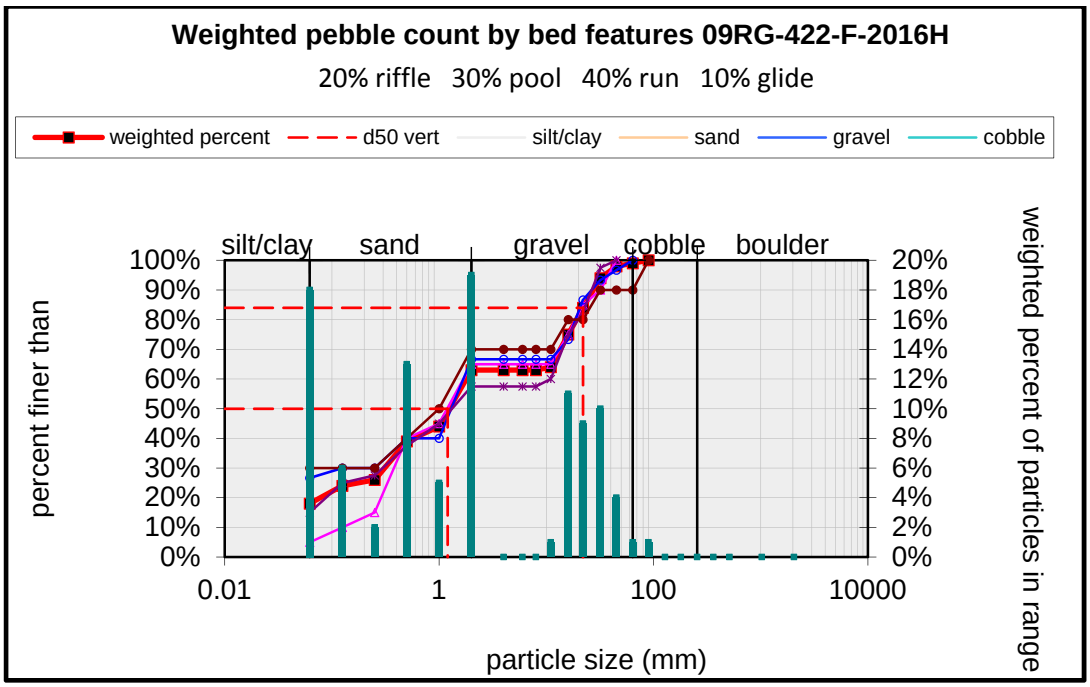


Size (mm)		Size Distribution		Type	
D16	0.062	mean	1.1	silt/clay	29%
D35	0.25	dispersion	19.0	sand	32%
D50	0.79	skewness	0.09	gravel	39%
D65	11			cobble	0%
D84	20			boulder	0%
D95	29				

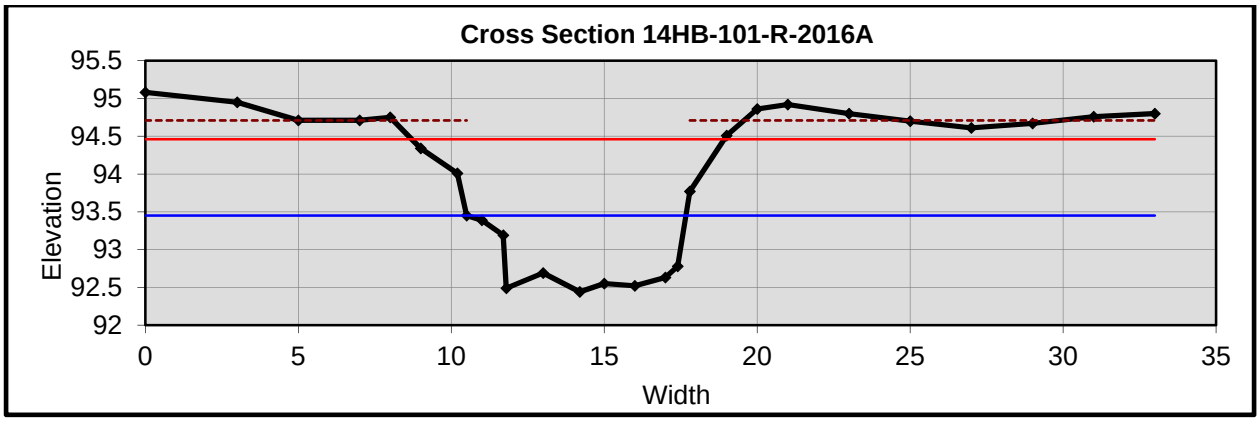


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
108.5	x-section area (ft.sq.)	75.2	W flood prone area (ft)	4.3	velocity (ft/s)
49.9	width (ft)	1.5	entrenchment ratio	471.0	discharge rate (cfs)
2.2	mean depth (ft)	10.1	low bank height (ft)	0.53	Froude number
3.9	max depth (ft)	2.6	low bank height ratio		
51.5	wetted parimeter (ft)				
2.1	hyd radi (ft)				
22.9	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.025	Manning's roughness	1.1	**F4/5**



Size (mm)		Size Distribution		Type	
D16	0.062	mean	1.2	silt/clay	18%
D35	0.4	dispersion	18.8	sand	45%
D50	1.2	skewness	-0.01	gravel	36%
D65	11			cobble	1%
D84	22			boulder	0%
D95	35				



Bankfull Dimensions	
5.2	x-section area (ft.sq.)
7.2	width (ft)
0.7	mean depth (ft)
1.0	max depth (ft)
8.3	wetted parimeter (ft)
0.6	hyd radi (ft)
9.8	width-depth ratio

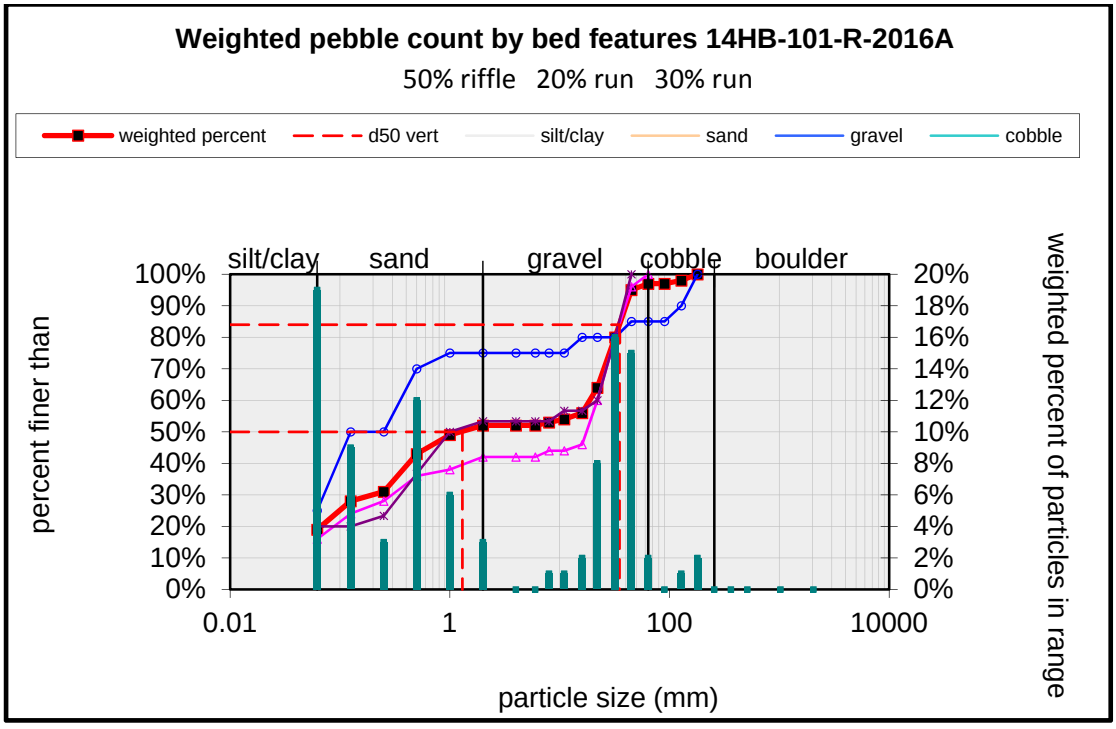
Flood Dimensions	
10.2	W flood prone area (ft)
1.4	entrenchment ratio
2.3	low bank height (ft)
2.2	low bank height ratio

Bankfull Flow	
3.6	velocity (ft/s)
18.6	discharge rate (cfs)
0.79	Froude number

Flow Resistance	
0.032	Manning's roughness

Sinuosity
1.1

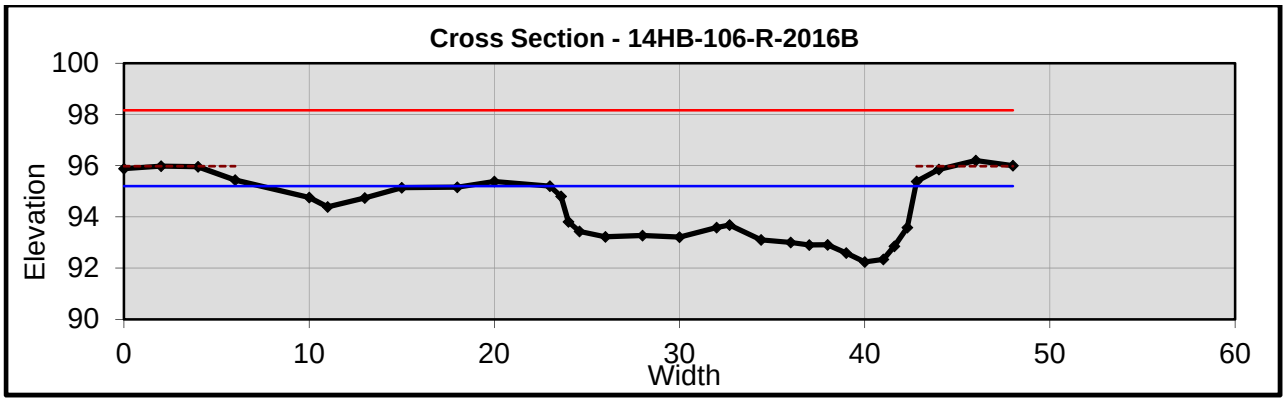
Channel Type
G4/5c



Size (mm)	
D16	0.062
D35	0.31
D50	1.3
D65	23
D84	35
D95	45

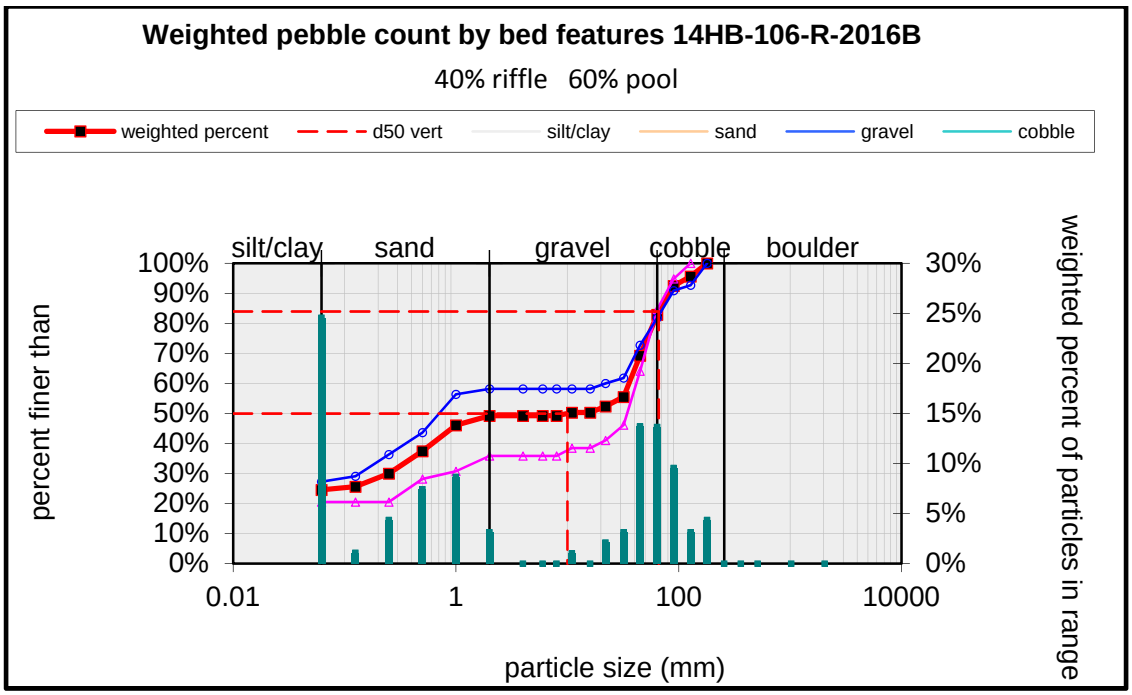
Size Distribution	
mean	1.5
dispersion	23.9
skewness	0.03

Type	
silt/clay	19%
sand	33%
gravel	45%
cobble	3%
boulder	0%



Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
42.3	x-section area (ft.sq.)	261.0	W flood prone area (ft)	3.4	velocity (ft/s)
30.7	width (ft)	8.5	entrenchment ratio	142.8	discharge rate (cfs)
1.4	mean depth (ft)	3.7	low bank height (ft)	0.53	Froude number
3.0	max depth (ft)	1.3	low bank height ratio		
33.8	wetted parimeter (ft)				
1.3	hyd radi (ft)				
22.3	width-depth ratio				

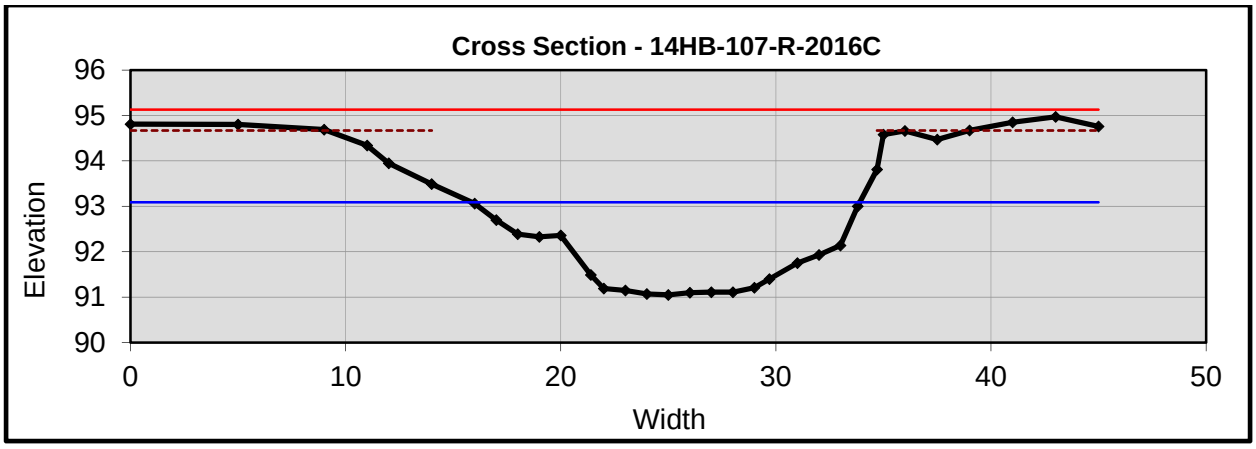
Flow Resistance		Sinuosity	Channel Type
0.034	Manning's roughness	1.2	**C4/5**



Size (mm)	
D16	0.062
D35	0.4
D50	10
D65	40
D84	66
D95	120

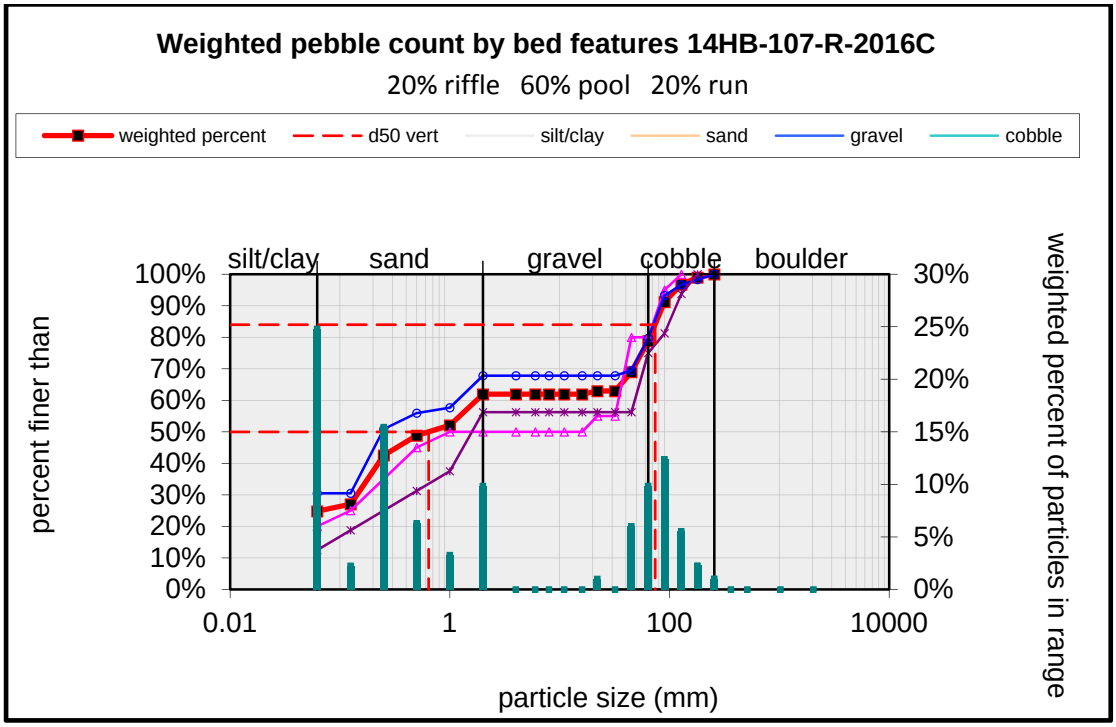
Size Distribution	
mean	2.0
dispersion	83.9
skewness	-0.40

Type			
silt/clay	23%		
sand	23%	hardpan	6%
gravel	32%		
cobble	16%		
boulder	0%		



Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
24.7	x-section area (ft.sq.)	91.0	W flood prone area (ft)	2.7	velocity (ft/s)
18.0	width (ft)	5.0	entrenchment ratio	67.4	discharge rate (cfs)
1.4	mean depth (ft)	3.6	low bank height (ft)	0.42	Froude number
2.0	max depth (ft)	1.8	low bank height ratio		
19.0	wetted parimeter (ft)				
1.3	hyd radi (ft)				
13.2	width-depth ratio				

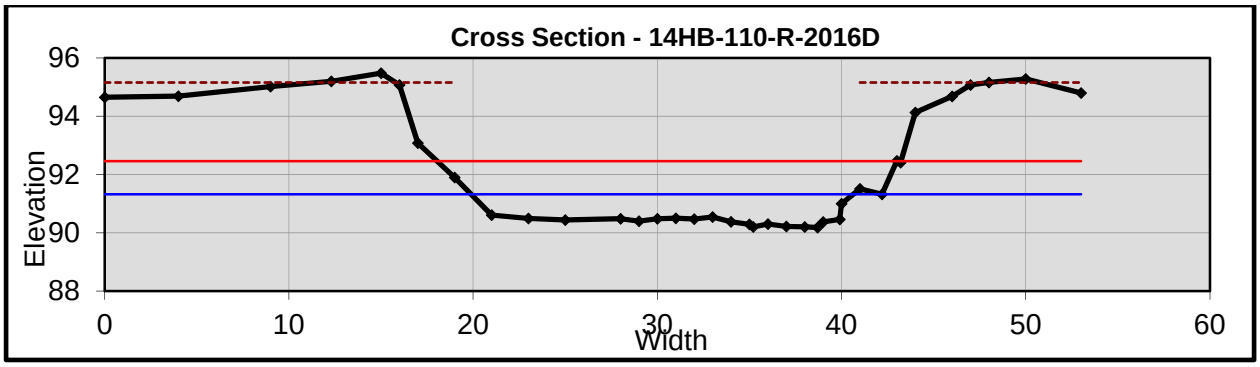
Flow Resistance		Sinuosity	Channel Type
0.037	Manning's roughness	1.2	**C3/5**



Size (mm)	
D16	0.062
D35	0.18
D50	0.64
D65	36
D84	74
D95	110

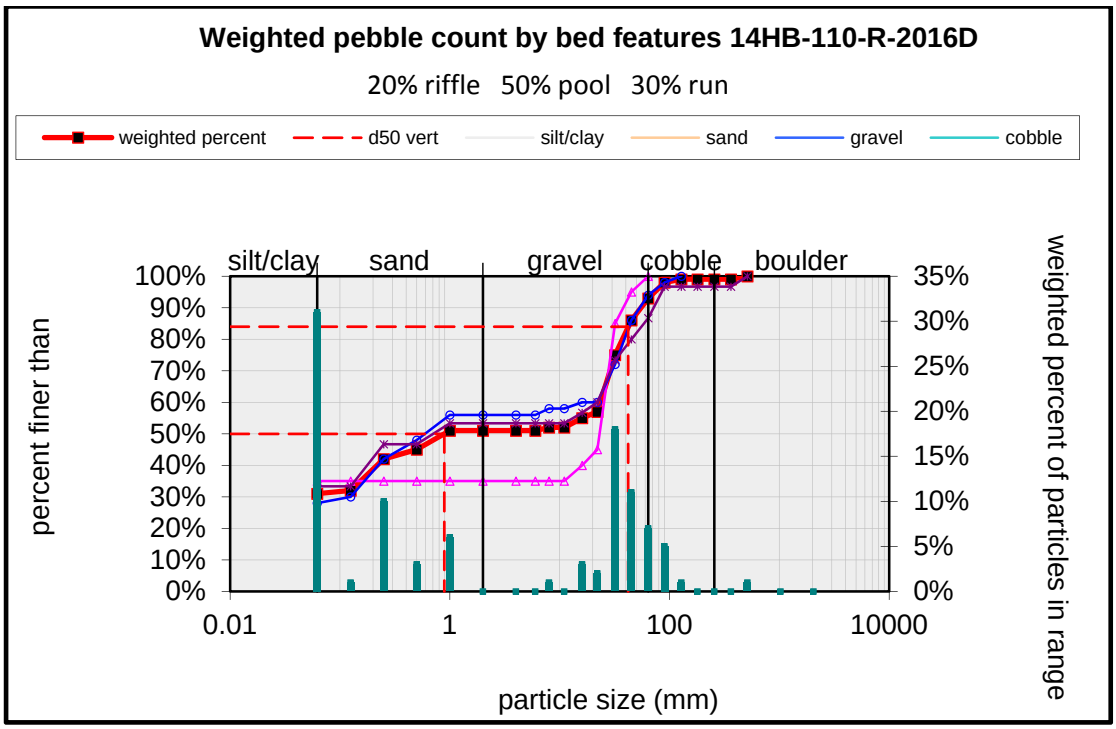
Size Distribution	
mean	2.1
dispersion	63.0
skewness	0.30

Type			
silt/clay	25%		
sand	37%	hardpan	1%
gravel	17%		
cobble	21%		
boulder	0%		

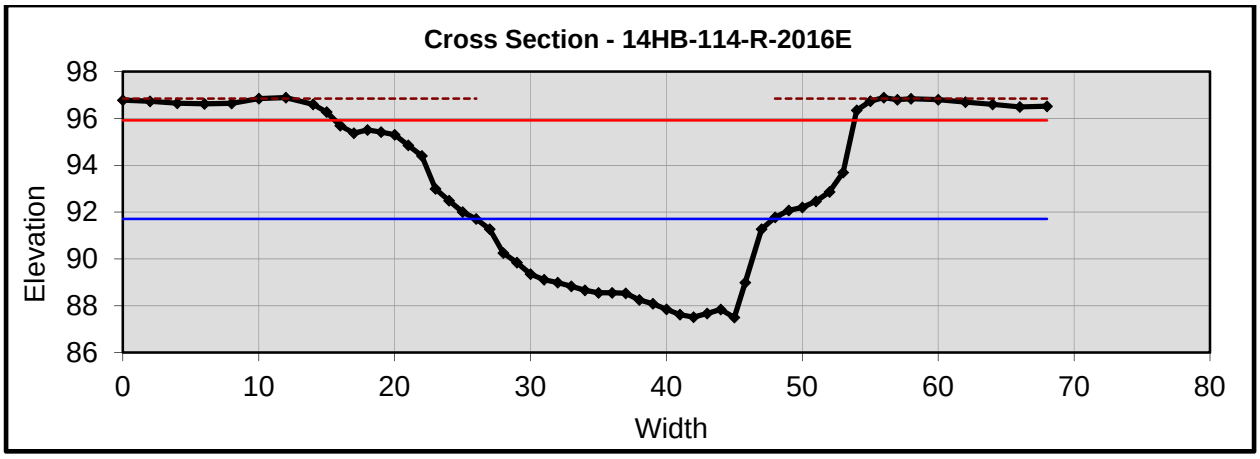


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
17.6	x-section area (ft.sq.)	25.1	W flood prone area (ft)	3.3	velocity (ft/s)
20.7	width (ft)	1.2	entrenchment ratio	58.2	discharge rate (cfs)
0.9	mean depth (ft)	5.0	low bank height (ft)	0.64	Froude number
1.1	max depth (ft)	4.4	low bank height ratio		
21.6	wetted parimeter (ft)				
0.8	hyd radi (ft)				
24.4	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.033	Manning's roughness	1.1	**F4/5**

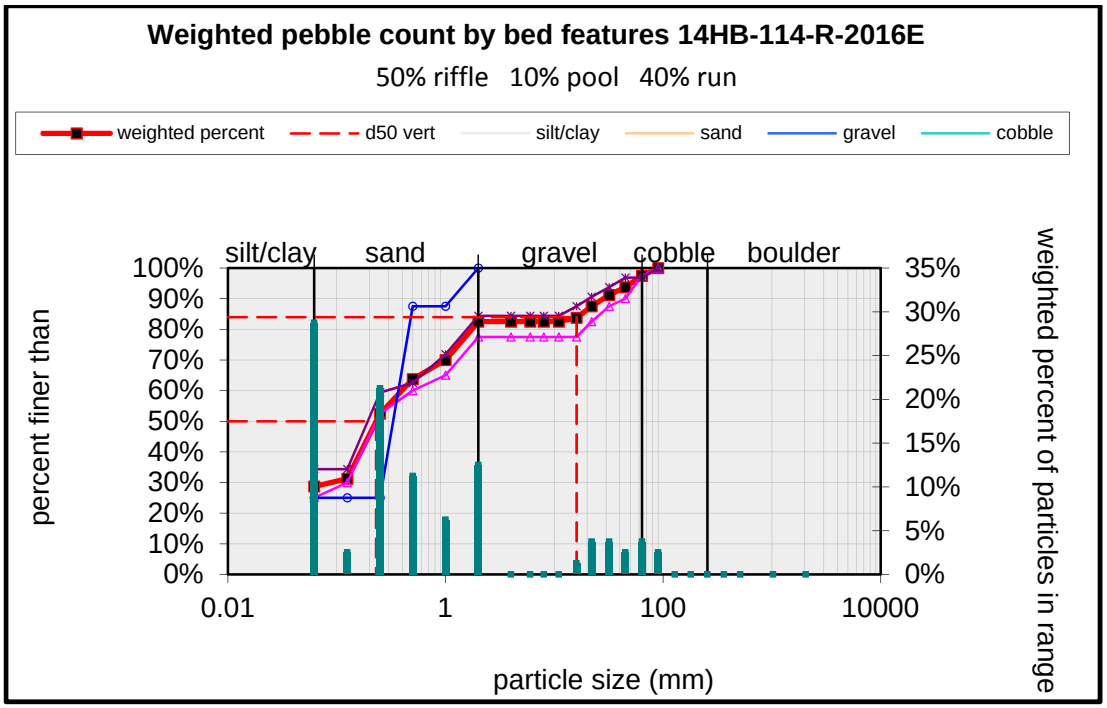


Size (mm)		Size Distribution		Type	
D16	0.062	mean	1.6	silt/clay	31%
D35	0.15	dispersion	30.8	sand	20%
D50	0.89	skewness	0.15	gravel	42%
D65	26			cobble	6%
D84	42			boulder	1%
D95	73				

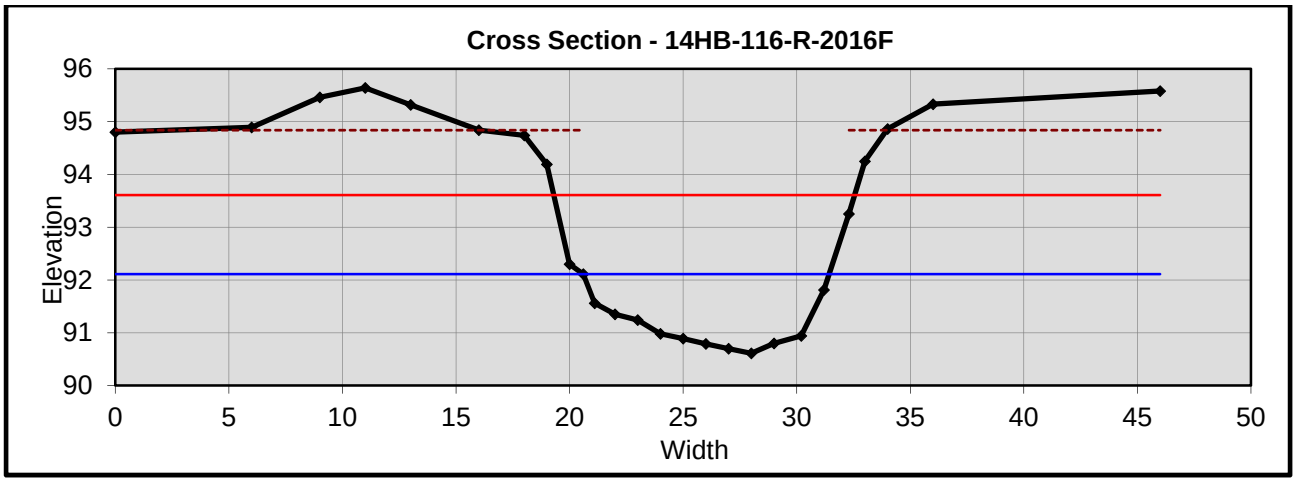


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
61.0	x-section area (ft.sq.)	37.8	W flood prone area (ft)	6.9	velocity (ft/s)
21.9	width (ft)	1.7	entrenchment ratio	421.5	discharge rate (cfs)
2.8	mean depth (ft)	9.3	low bank height (ft)	0.78	Froude number
4.2	max depth (ft)	2.2	low bank height ratio		
25.2	wetted parimeter (ft)				
2.4	hyd radi (ft)				
7.8	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.024	Manning's roughness	1.2	**B5c**

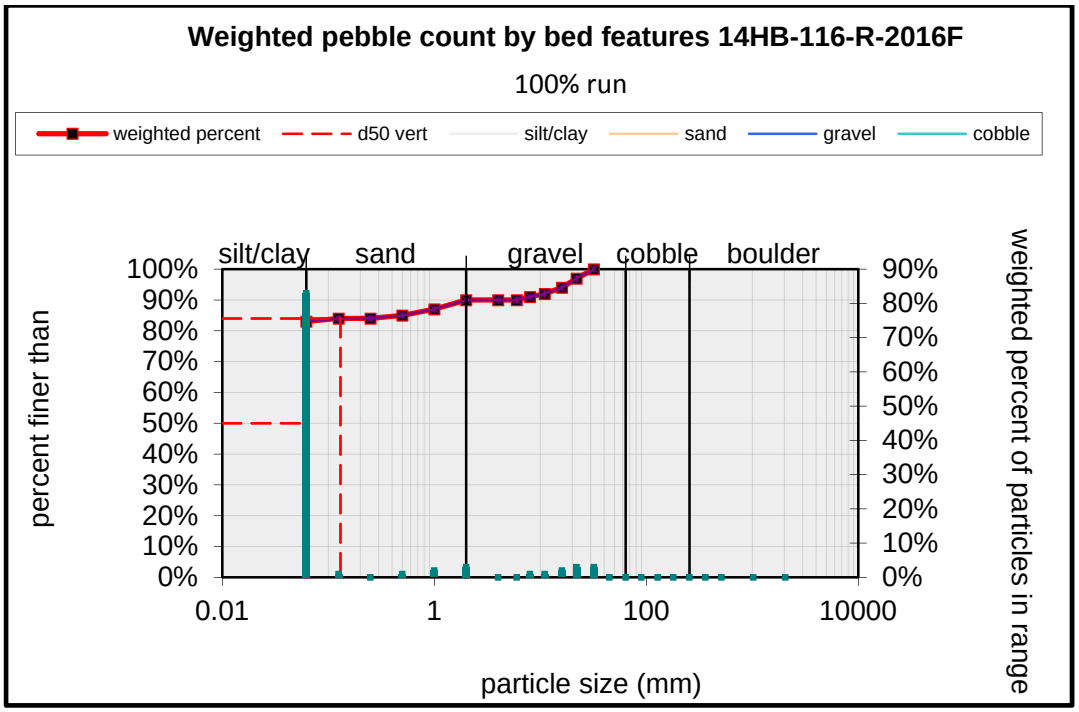


Size (mm)		Size Distribution		Type			
D16	0.062	mean	1.0	silt/clay	26%		
D35	0.14	dispersion	36.6	sand	48%	hardpan	11%
D50	0.23	skewness	0.41	gravel	13%		
D65	0.57			cobble	2%		
D84	16			boulder	0%		
D95	51						

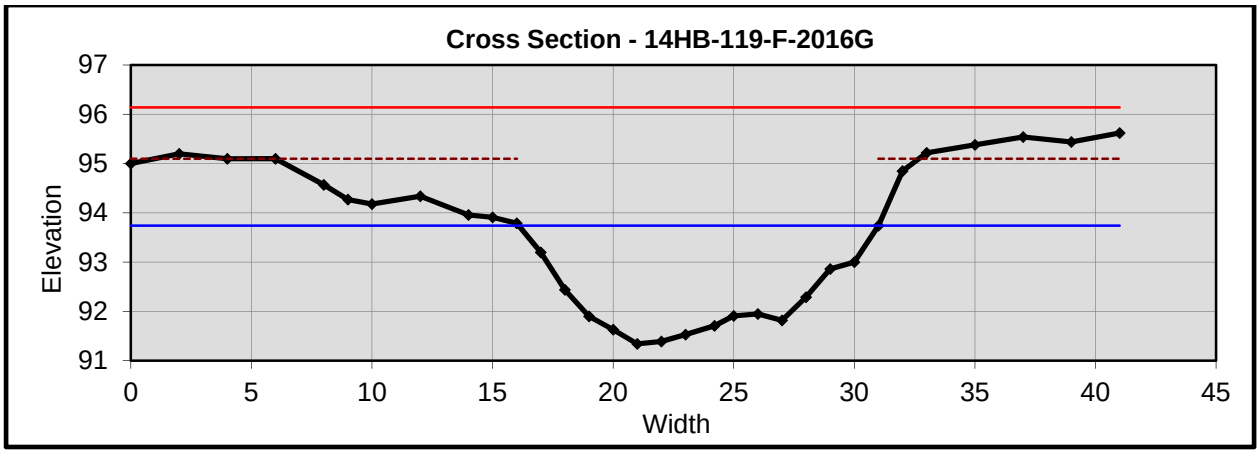


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
11.5	x-section area (ft.sq.)	14.9	W flood prone area (ft)	6.8	velocity (ft/s)
10.8	width (ft)	1.4	entrenchment ratio	78.4	discharge rate (cfs)
1.1	mean depth (ft)	4.2	low bank height (ft)	1.21	Froude number
1.5	max depth (ft)	2.8	low bank height ratio		
11.7	wetted parimeter (ft)				
1.0	hyd radi (ft)				
10.2	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.012	Manning's roughness	1.5	**G6c**



Size (mm)		Size Distribution		Type	
D16	0.062	mean	0.1	silt/clay	83%
D35	0.062	dispersion	1.5	sand	7%
D50	0.062	skewness	0.28	gravel	10%
D65	0.062			cobble	0%
D84	0.13			boulder	0%
D95	18				



Bankfull Dimensions	
23.4	x-section area (ft.sq.)
14.9	width (ft)
1.6	mean depth (ft)
2.4	max depth (ft)
16.1	wetted parimeter (ft)
1.5	hyd radi (ft)
9.5	width-depth ratio

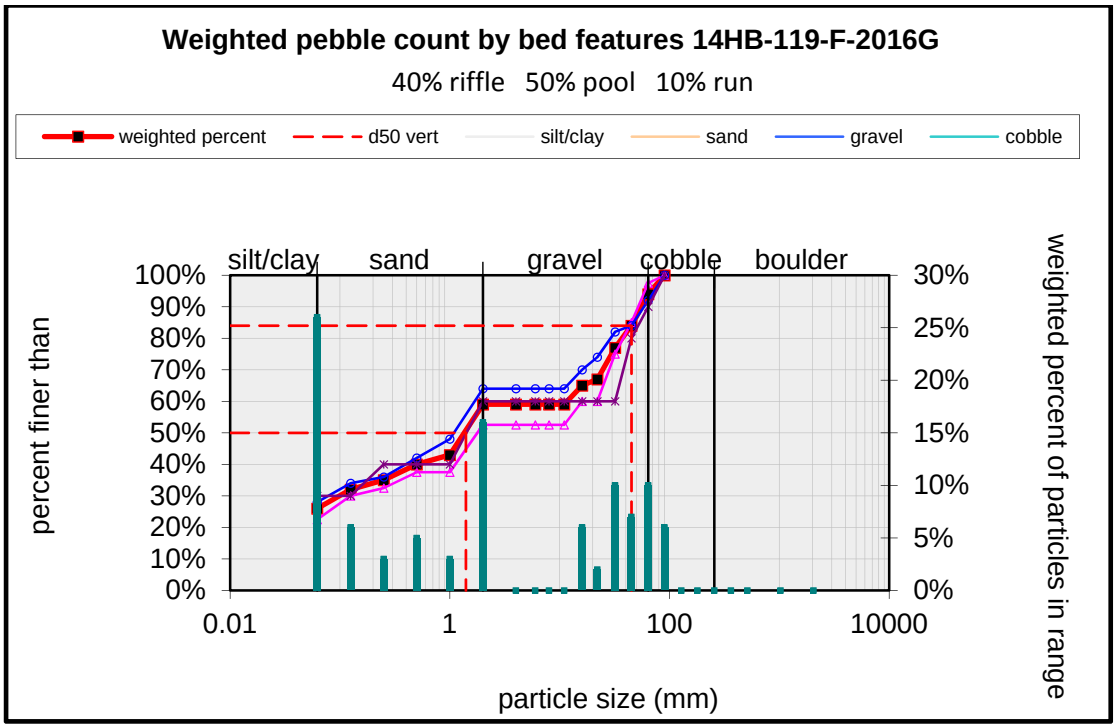
Flood Dimensions	
114.0	W flood prone area (ft)
7.6	entrenchment ratio
3.8	low bank height (ft)
1.6	low bank height ratio

Bankfull Flow	
5.8	velocity (ft/s)
136.5	discharge rate (cfs)
0.85	Froude number

Flow Resistance	
0.031	Manning's roughness

Sinuosity
1.2

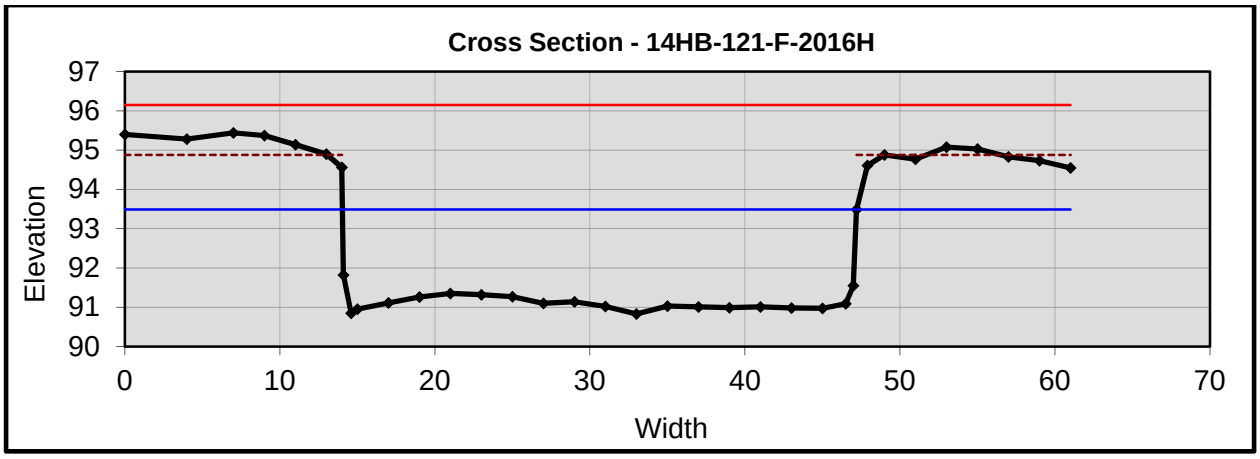
Channel Type
E4/5



Size (mm)	
D16	0.062
D35	0.25
D50	1.4
D65	16
D84	45
D95	68

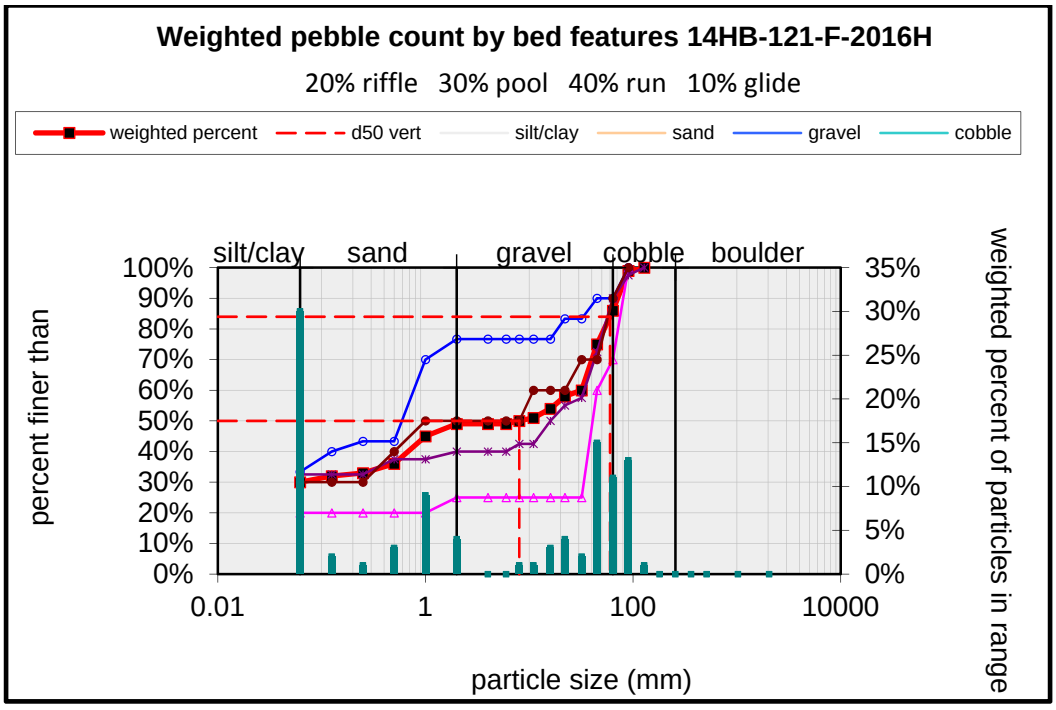
Size Distribution	
mean	1.7
dispersion	27.4
skewness	0.05

Type	
silt/clay	26%
sand	33%
gravel	35%
cobble	6%
boulder	0%

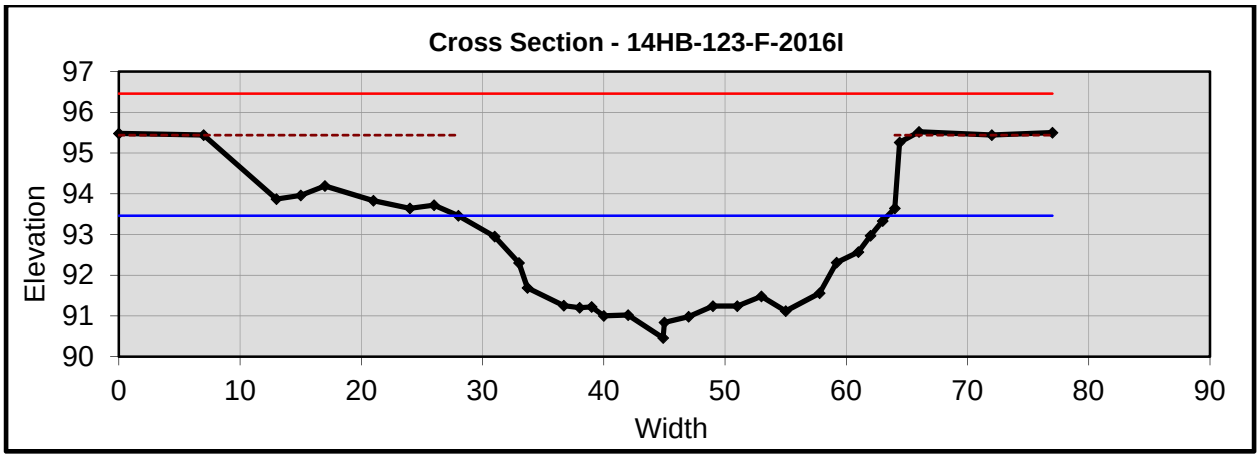


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
79.1	x-section area (ft.sq.)	160.0	W flood prone area (ft)	5.4	velocity (ft/s)
33.2	width (ft)	4.8	entrenchment ratio	427.2	discharge rate (cfs)
2.4	mean depth (ft)	4.1	low bank height (ft)	0.65	Froude number
2.7	max depth (ft)	1.5	low bank height ratio		
37.4	wetted parimeter (ft)				
2.1	hyd radi (ft)				
13.9	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.033	Manning's roughness	1.1	**C4/5**

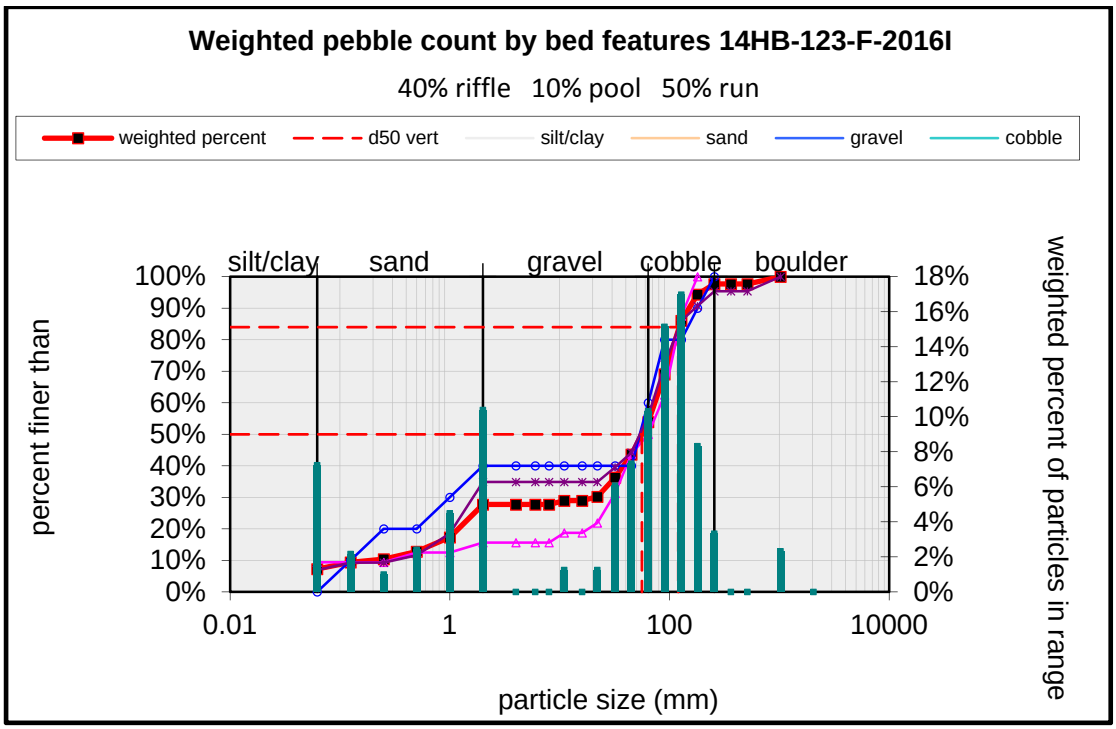


Size (mm)		Size Distribution		Type	
D16	0.062	mean	1.9	silt/clay	30%
D35	0.4	dispersion	68.3	sand	19%
D50	8	skewness	-0.36	gravel	37%
D65	36			cobble	14%
D84	60			boulder	0%
D95	81				



Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
63.7	x-section area (ft.sq.)	165.0	W flood prone area (ft)	6.8	velocity (ft/s)
35.4	width (ft)	4.7	entrenchment ratio	435.8	discharge rate (cfs)
1.8	mean depth (ft)	5.0	low bank height (ft)	0.91	Froude number
3.0	max depth (ft)	1.7	low bank height ratio		
36.7	wetted parimeter (ft)				
1.7	hyd radi (ft)				
19.7	width-depth ratio				

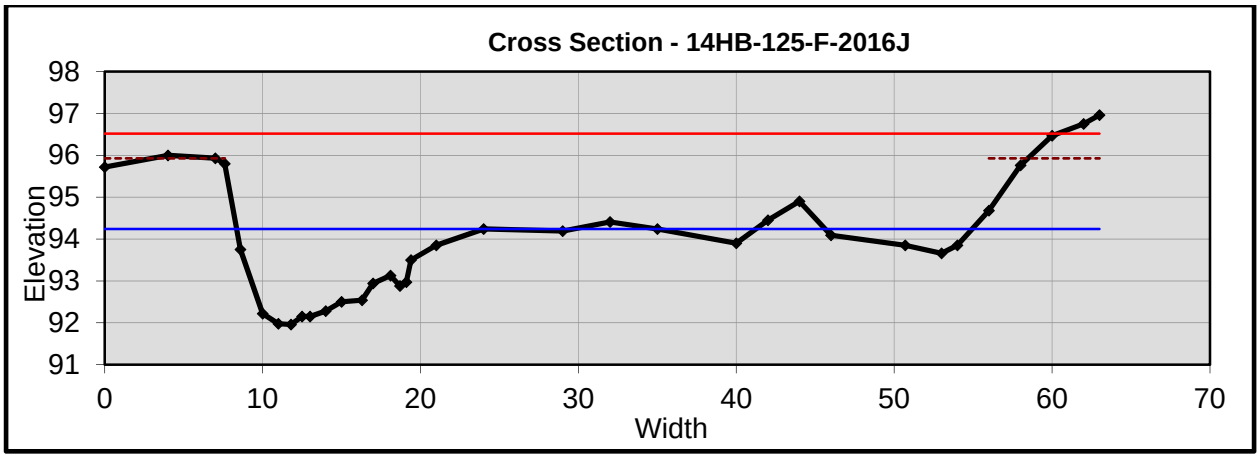
Flow Resistance		Sinuosity	Channel Type
0.041	Manning's roughness	1.2	**C3**



Size (mm)	
D16	0.82
D35	30
D50	56
D65	82
D84	120
D95	190

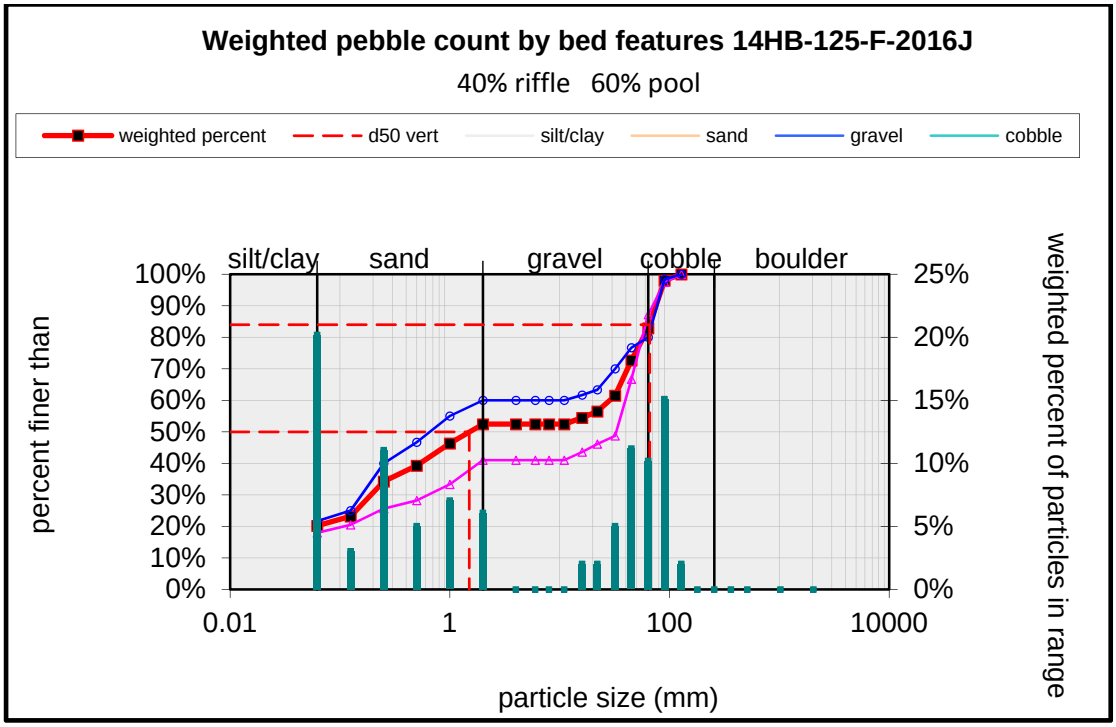
Size Distribution	
mean	9.9
dispersion	35.2
skewness	-0.51

Type			
silt/clay	7%	bedrock	7%
sand	19%		
gravel	24%		
cobble	41%		
boulder	2%		

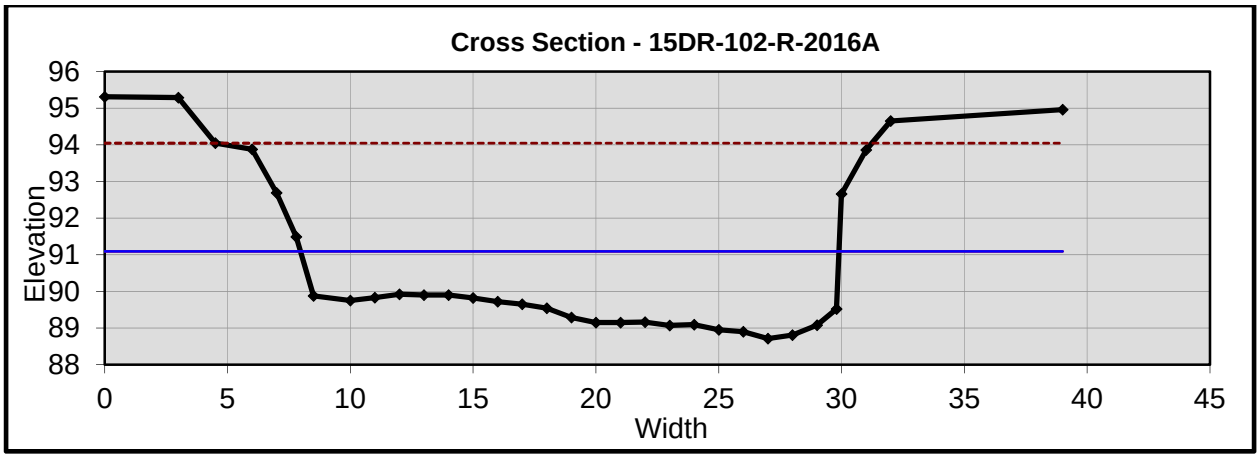


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
24.2	x-section area (ft.sq.)	213.0	W flood prone area (ft)	1.8	velocity (ft/s)
36.9	width (ft)	5.8	entrenchment ratio	43.8	discharge rate (cfs)
0.7	mean depth (ft)	4.0	low bank height (ft)	0.40	Froude number
2.3	max depth (ft)	1.7	low bank height ratio		
38.7	wetted parimeter (ft)				
0.6	hyd radi (ft)				
56.2	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.037	Manning's roughness	1.1	**C4/5**

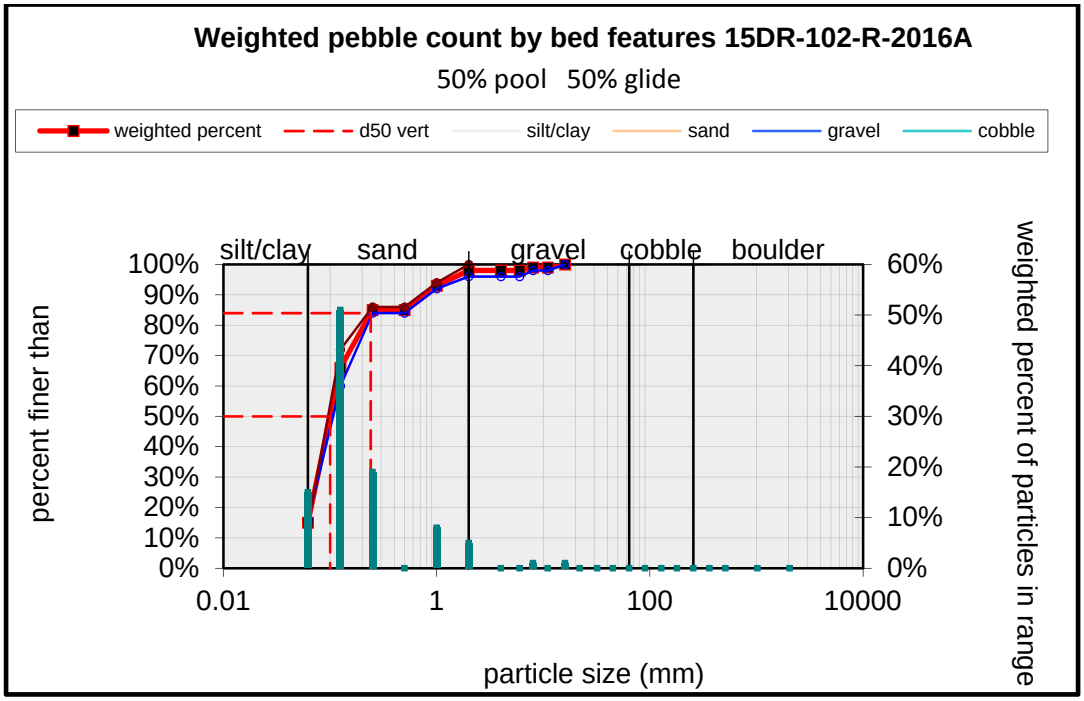


Size (mm)		Size Distribution		Type			
D16	0.062	mean	2.0	silt/clay	20%		
D35	0.28	dispersion	34.1	sand	32%	hardpan	1%
D50	1.5	skewness	0.07	gravel	30%		
D65	36			cobble	17%		
D84	66			boulder	0%		
D95	84						



Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
36.5	x-section area (ft.sq.)	21.9	W flood prone area (ft)	2.7	velocity (ft/s)
21.9	width (ft)	1.0	entrenchment ratio	98.3	discharge rate (cfs)
1.7	mean depth (ft)	5.3	low bank height (ft)	0.39	Froude number
2.4	max depth (ft)	2.2	low bank height ratio		
24.4	wetted parimeter (ft)				
1.5	hyd radi (ft)				
13.2	width-depth ratio				

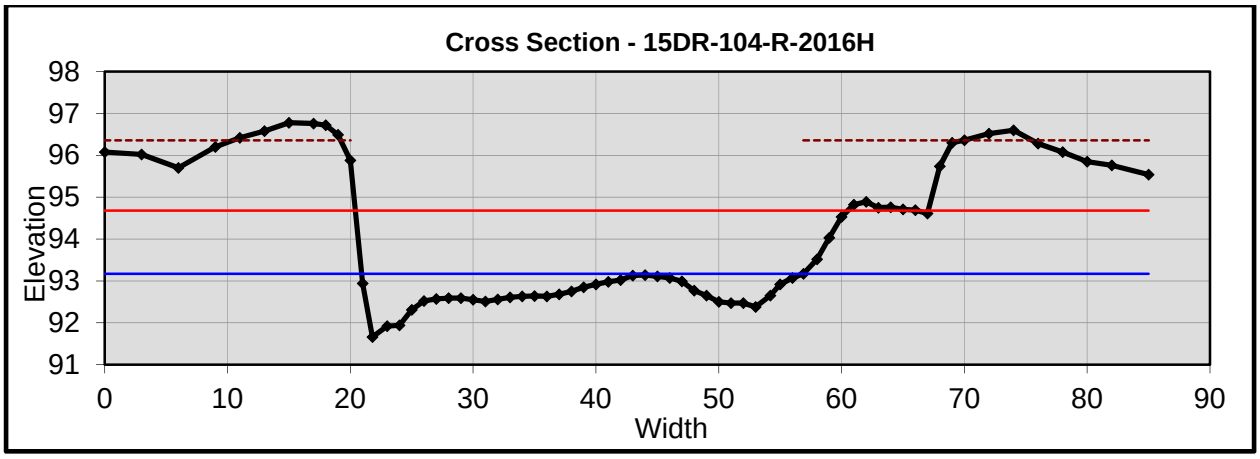
Flow Resistance		Sinuosity	Channel Type
0.013	Manning's roughness	1.1	**F5**



Size (mm)	
D16	0.063
D35	0.082
D50	0.1
D65	0.12
D84	0.24
D95	1.3

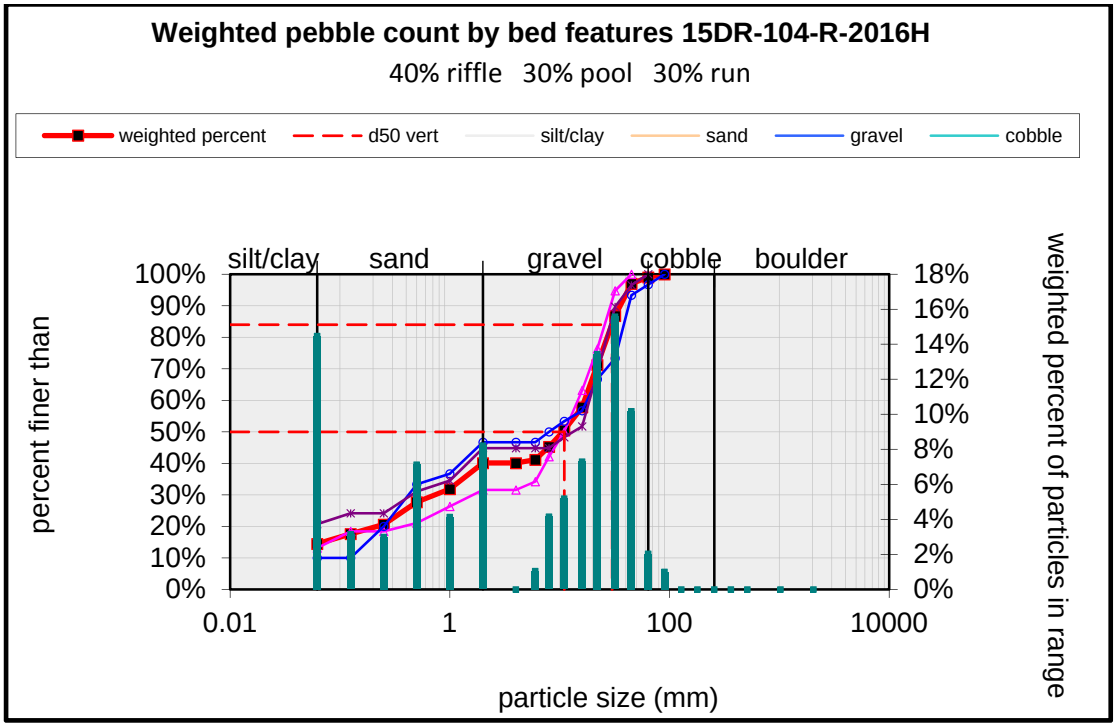
Size Distribution	
mean	0.1
dispersion	2.0
skewness	0.12

Type	
silt/clay	15%
sand	83%
gravel	2%
cobble	0%
boulder	0%

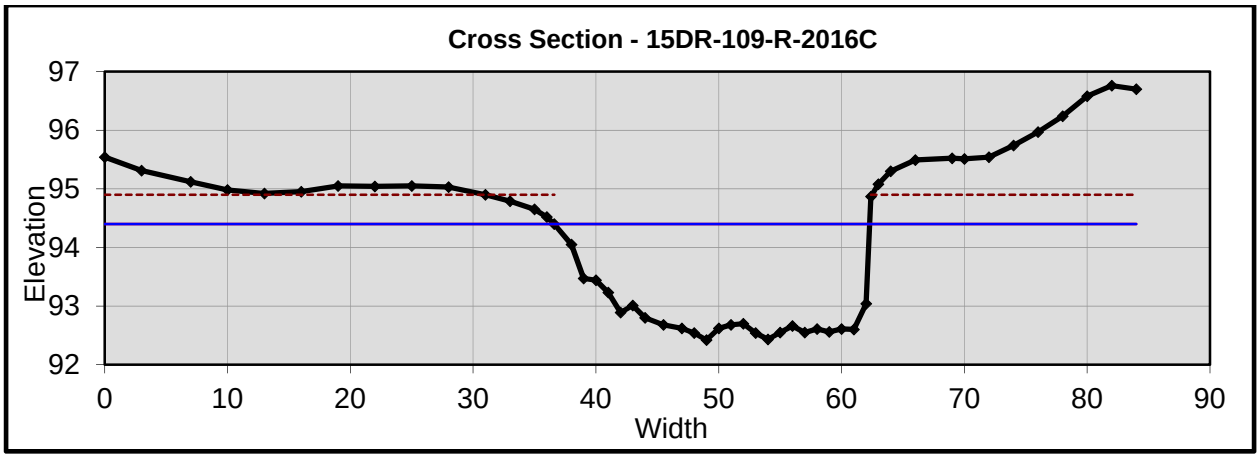


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
18.5	x-section area (ft.sq.)	41.0	W flood prone area (ft)	2.0	velocity (ft/s)
36.0	width (ft)	1.1	entrenchment ratio	36.0	discharge rate (cfs)
0.5	mean depth (ft)	4.7	low bank height (ft)	0.49	Froude number
1.5	max depth (ft)	3.1	low bank height ratio		
37.1	wetted parimeter (ft)				
0.5	hyd radi (ft)				
70.1	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.030	Manning's roughness	1.1	**F4/5**

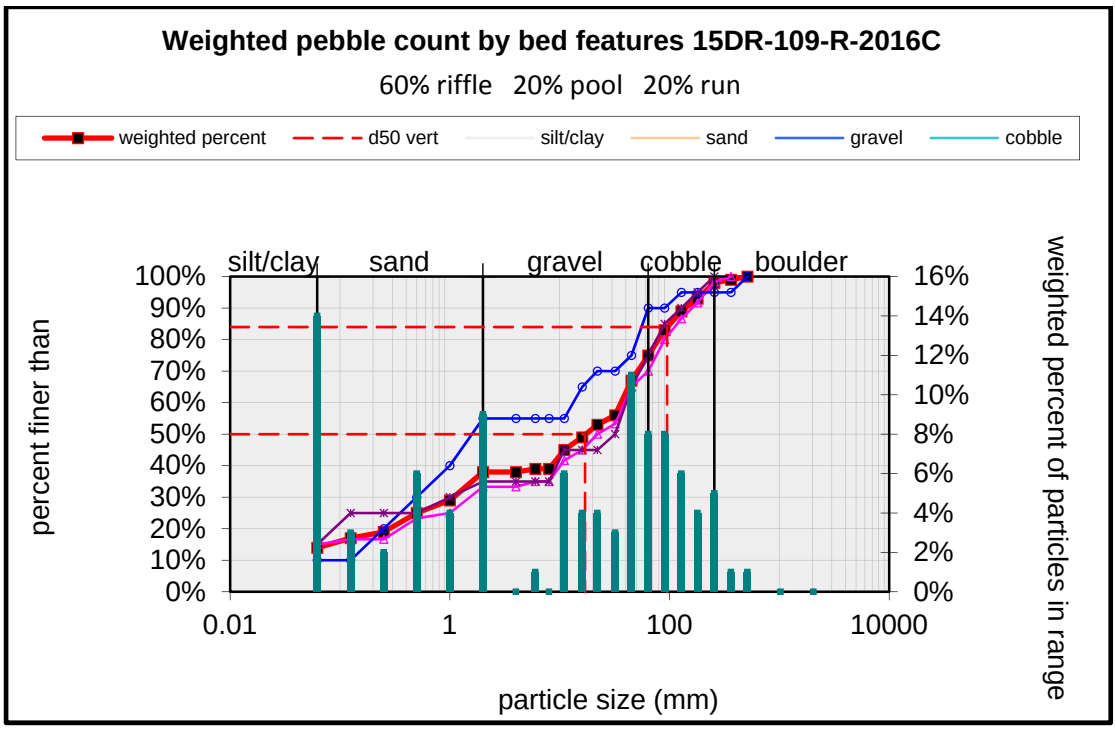


Size (mm)		Size Distribution		Type			
D16	0.087	mean	1.6	silt/clay	14%		
D35	1.3	dispersion	64.6	sand	25%	hardpan	2%
D50	11	skewness	-0.52	gravel	58%		
D65	19			cobble	1%		
D84	30			boulder	0%		
D95	42						



Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
39.6	x-section area (ft.sq.)	123.0	W flood prone area (ft)	5.4	velocity (ft/s)
25.7	width (ft)	4.8	entrenchment ratio	215.1	discharge rate (cfs)
1.5	mean depth (ft)	2.5	low bank height (ft)	0.79	Froude number
2.0	max depth (ft)	1.3	low bank height ratio		
27.3	wetted parimeter (ft)				
1.5	hyd radi (ft)				
16.7	width-depth ratio				

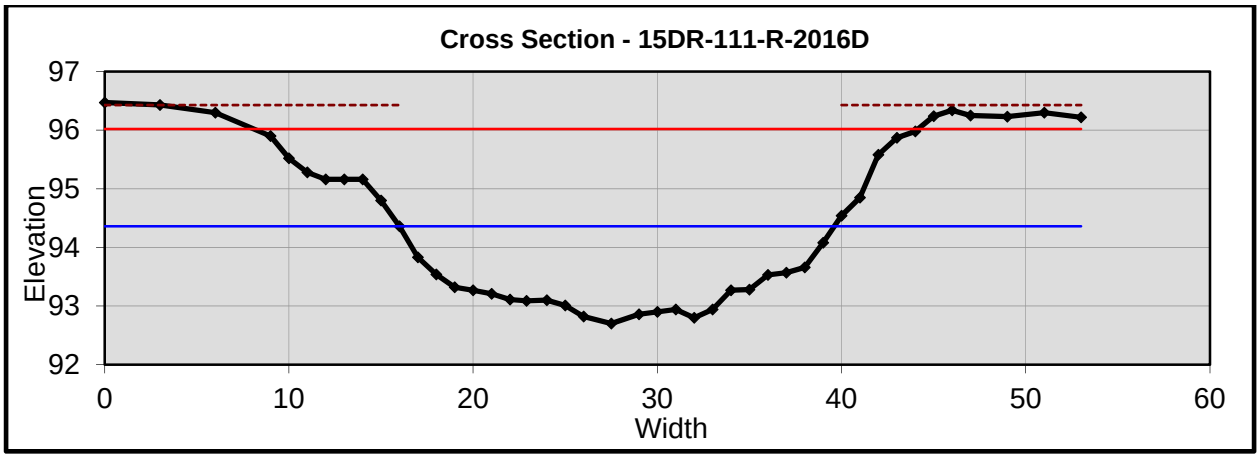
Flow Resistance		Sinuosity	Channel Type
0.040	Manning's roughness	1.1	**C4/5**



Size (mm)	
D16	0.099
D35	1.6
D50	17
D65	42
D84	95
D95	210

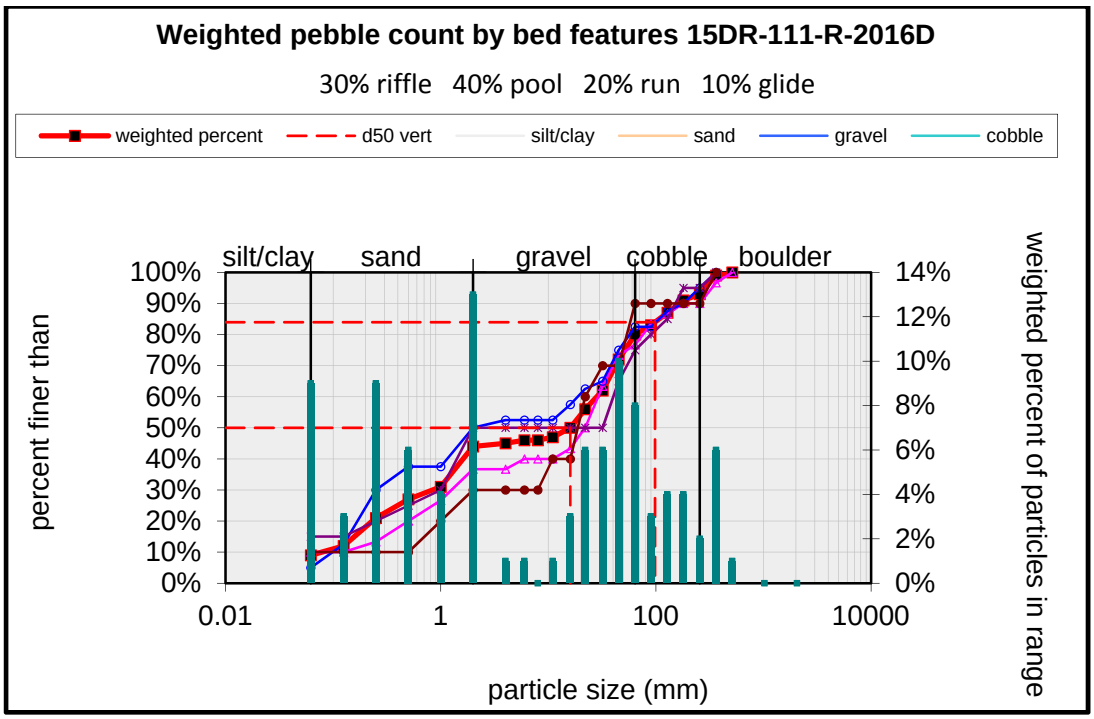
Size Distribution	
mean	3.1
dispersion	88.7
skewness	-0.43

Type	
silt/clay	14%
sand	24%
gravel	37%
cobble	23%
boulder	2%



Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
26.6	x-section area (ft.sq.)	36.1	W flood prone area (ft)	4.1	velocity (ft/s)
23.6	width (ft)	1.5	entrenchment ratio	109.3	discharge rate (cfs)
1.1	mean depth (ft)	3.7	low bank height (ft)	0.69	Froude number
1.7	max depth (ft)	2.2	low bank height ratio		
24.1	wetted parimeter (ft)				
1.1	hyd radi (ft)				
20.9	width-depth ratio				

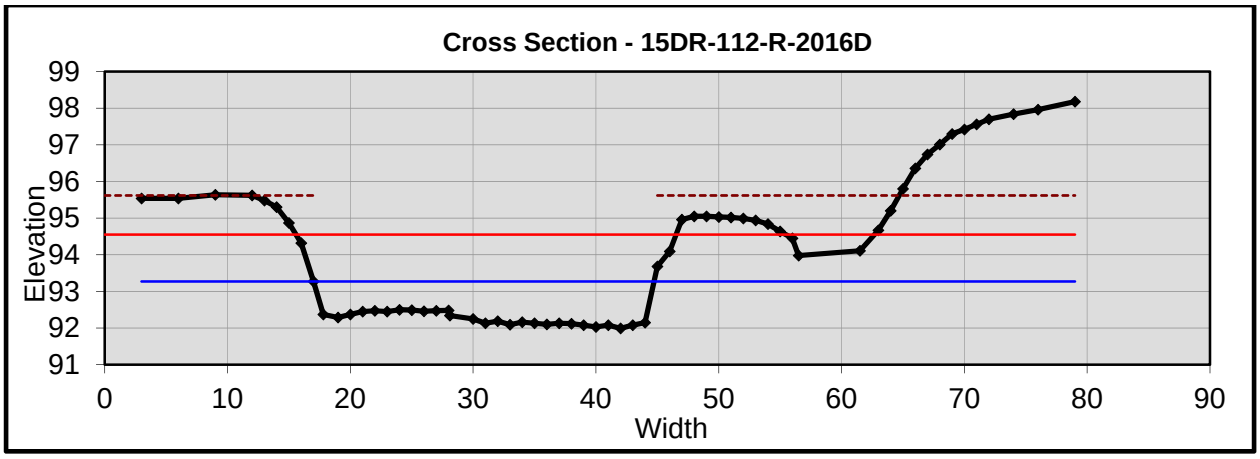
Flow Resistance		Sinuosity	Channel Type
0.042	Manning's roughness	1.1	**F4/5**



Size (mm)	
D16	0.17
D35	1.2
D50	16
D65	35
D84	98
D95	290

Size Distribution	
mean	4.1
dispersion	50.1
skewness	-0.36

Type	
silt/clay	9%
sand	35%
gravel	36%
cobble	13%
boulder	7%



Bankfull Dimensions	
27.5	x-section area (ft.sq.)
27.7	width (ft)
1.0	mean depth (ft)
1.3	max depth (ft)
28.9	wetted parimeter (ft)
1.0	hyd radi (ft)
28.0	width-depth ratio

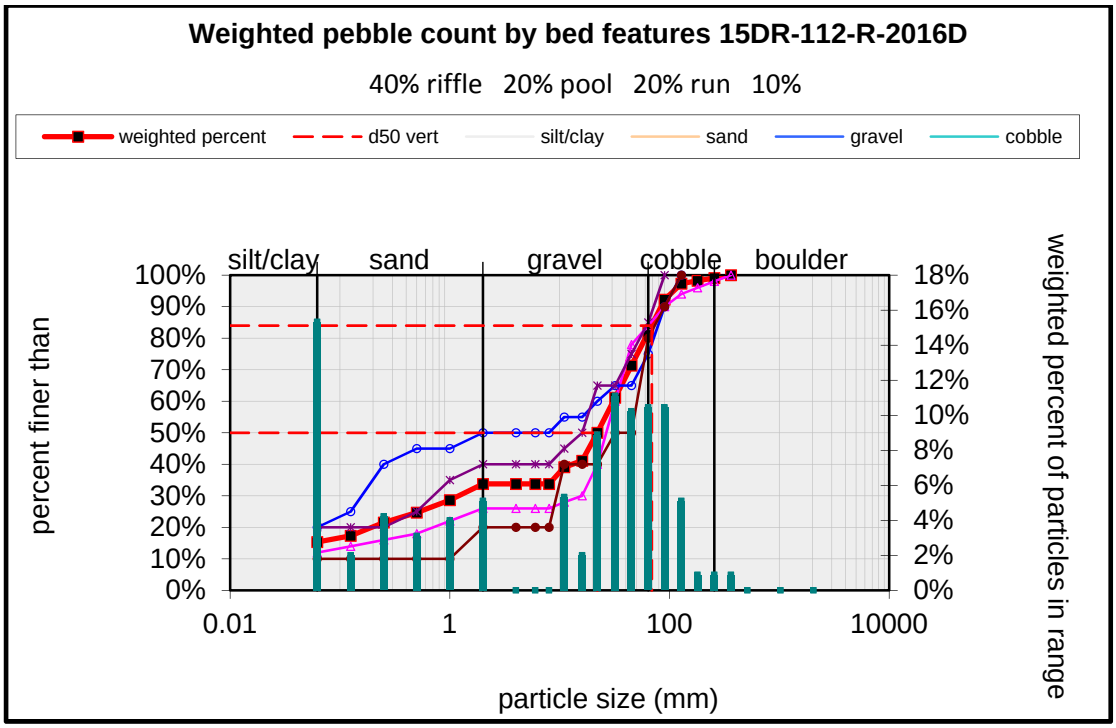
Flood Dimensions	
38.2	W flood prone area (ft)
1.4	entrenchment ratio
3.6	low bank height (ft)
2.8	low bank height ratio

Bankfull Flow	
2.8	velocity (ft/s)
75.7	discharge rate (cfs)
0.50	Froude number

Flow Resistance	
0.039	Manning's roughness

Sinuosity
1.2

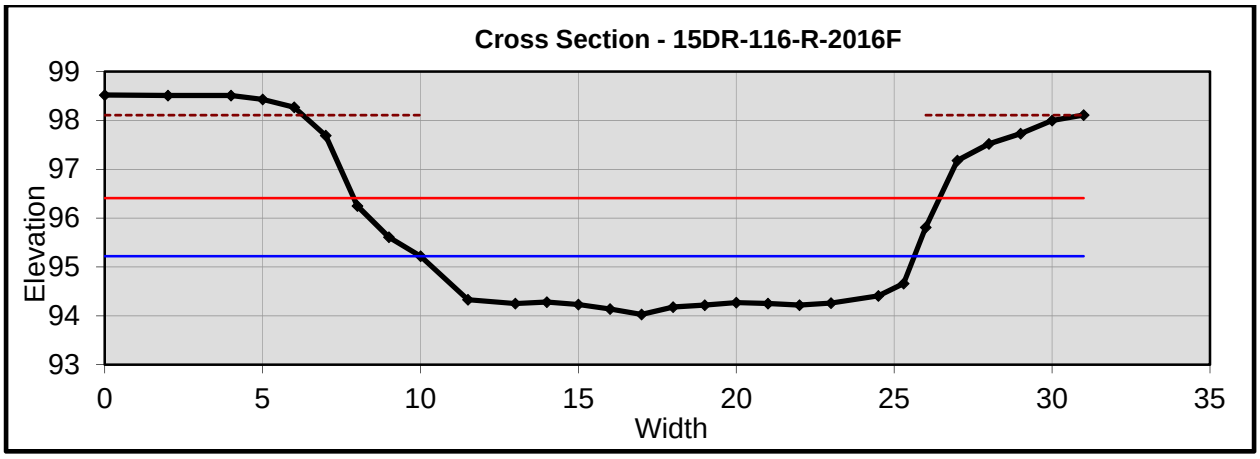
Channel Type
F4/5



Size (mm)	
D16	0.078
D35	8.6
D50	22
D65	36
D84	69
D95	110

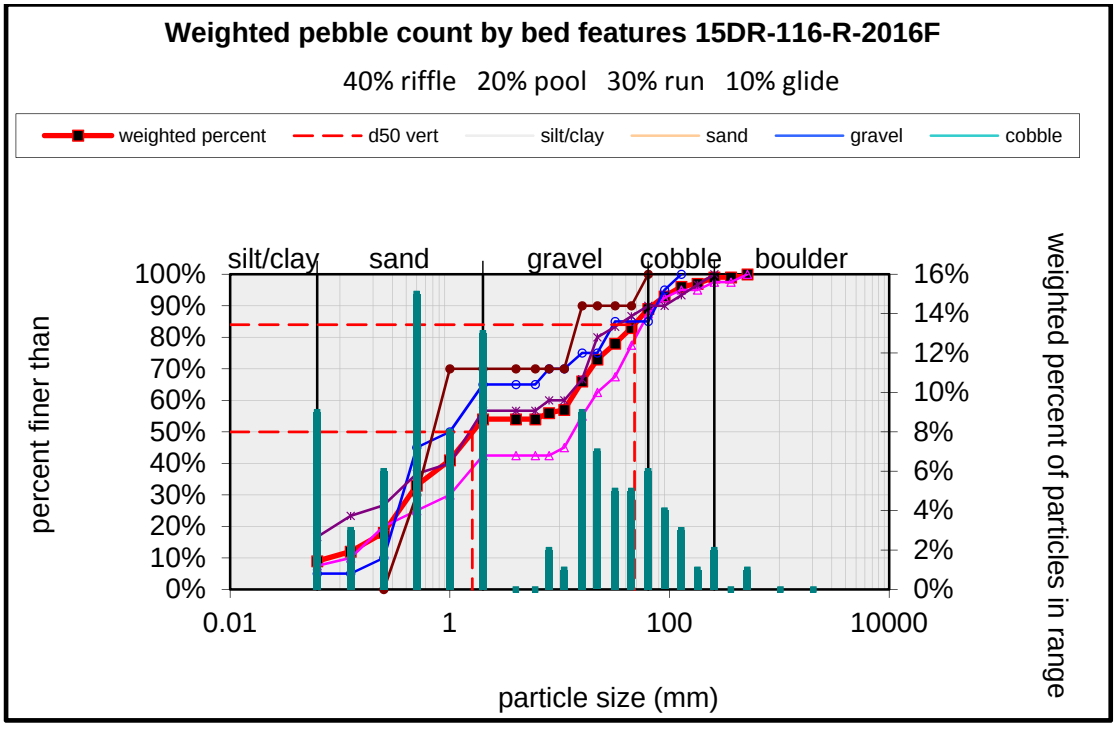
Size Distribution	
mean	2.3
dispersion	142.6
skewness	-0.57

Type	
silt/clay	15%
sand	18%
gravel	48%
cobble	17%
boulder	1%

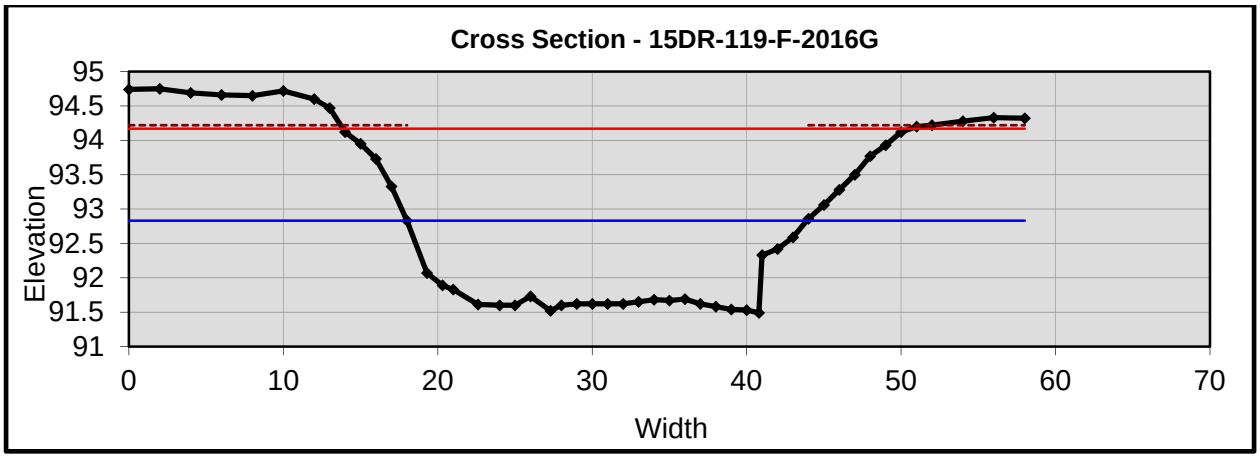


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
14.2	x-section area (ft.sq.)	18.5	W flood prone area (ft)	4.1	velocity (ft/s)
15.6	width (ft)	1.2	entrenchment ratio	58.1	discharge rate (cfs)
0.9	mean depth (ft)	4.1	low bank height (ft)	0.78	Froude number
1.2	max depth (ft)	3.4	low bank height ratio		
16.3	wetted parimeter (ft)				
0.9	hyd radi (ft)				
17.3	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.035	Manning's roughness	1.1	**F4/5**

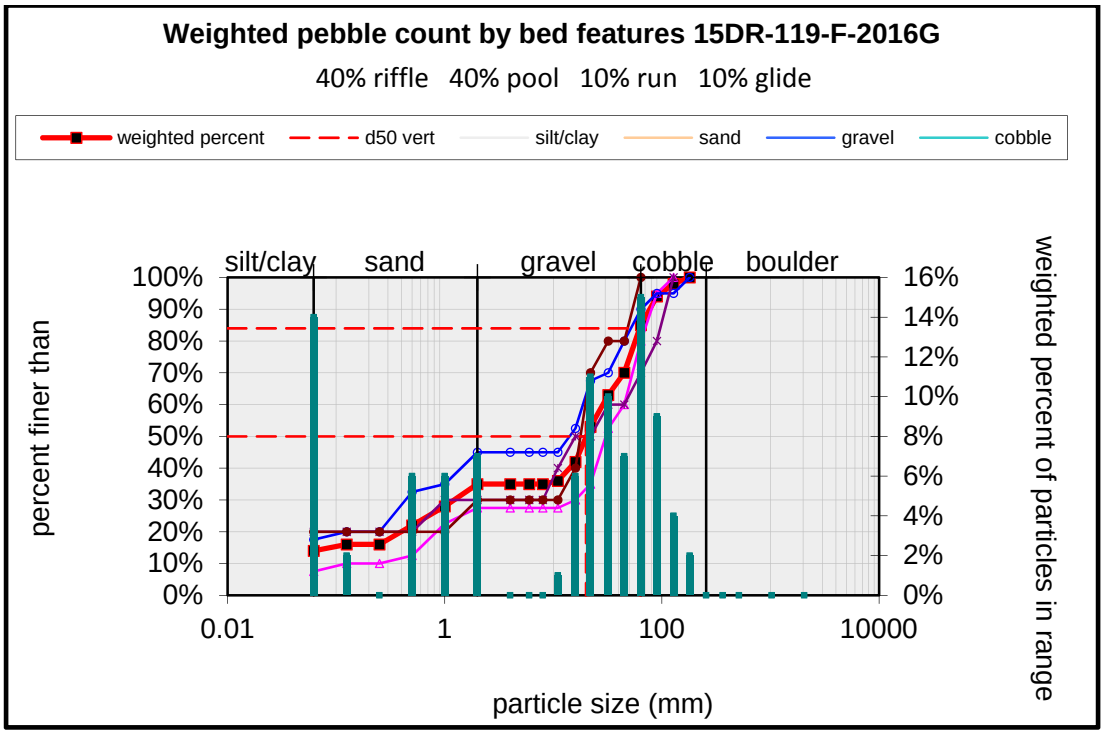


Size (mm)		Size Distribution		Type	
D16	0.2	mean	3.1	silt/clay	9%
D35	0.59	dispersion	19.0	sand	45%
D50	1.6	skewness	0.19	gravel	35%
D65	15			cobble	10%
D84	48			boulder	1%
D95	110				

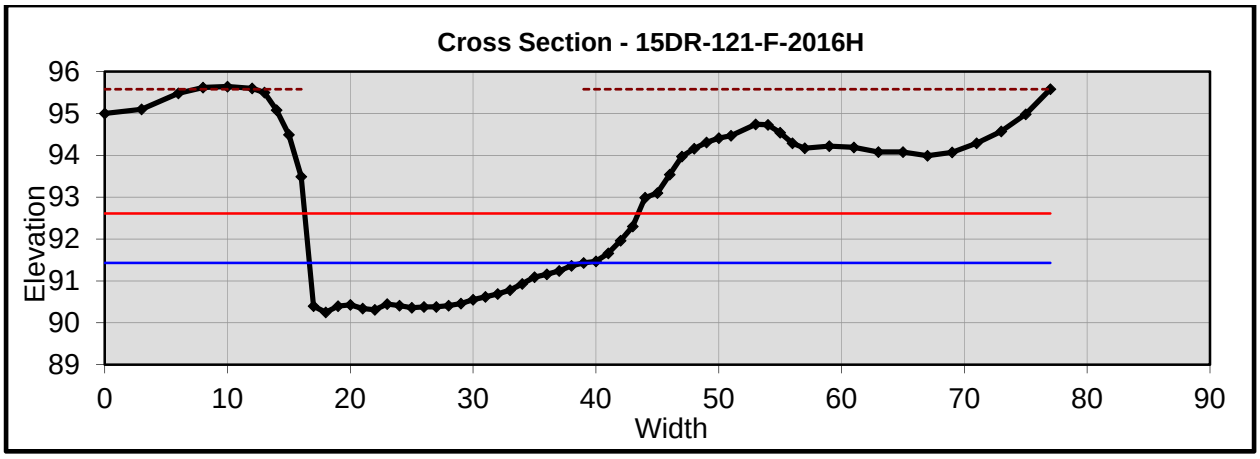


Bankfull Dimensions		Flood Dimensions		Bankfull Flow	
27.0	x-section area (ft.sq.)	36.8	W flood prone area (ft)	3.0	velocity (ft/s)
25.9	width (ft)	1.4	entrenchment ratio	81.7	discharge rate (cfs)
1.0	mean depth (ft)	2.7	low bank height (ft)	0.53	Froude number
1.3	max depth (ft)	2.0	low bank height ratio		
26.9	wetted parimeter (ft)				
1.0	hyd radi (ft)				
24.8	width-depth ratio				

Flow Resistance		Sinuosity	Channel Type
0.037	Manning's roughness	1.2	**F4/5**



Size (mm)		Size Distribution		Type	
D16	0.25	mean	4.0	silt/clay	14%
D35	8.5	dispersion	41.6	sand	21%
D50	20	skewness	-0.45	gravel	50%
D65	36			cobble	15%
D84	63			boulder	0%
D95	98				



Bankfull Dimensions	
17.7	x-section area (ft.sq.)
22.3	width (ft)
0.8	mean depth (ft)
1.2	max depth (ft)
23.2	wetted parimeter (ft)
0.8	hyd radi (ft)
28.2	width-depth ratio

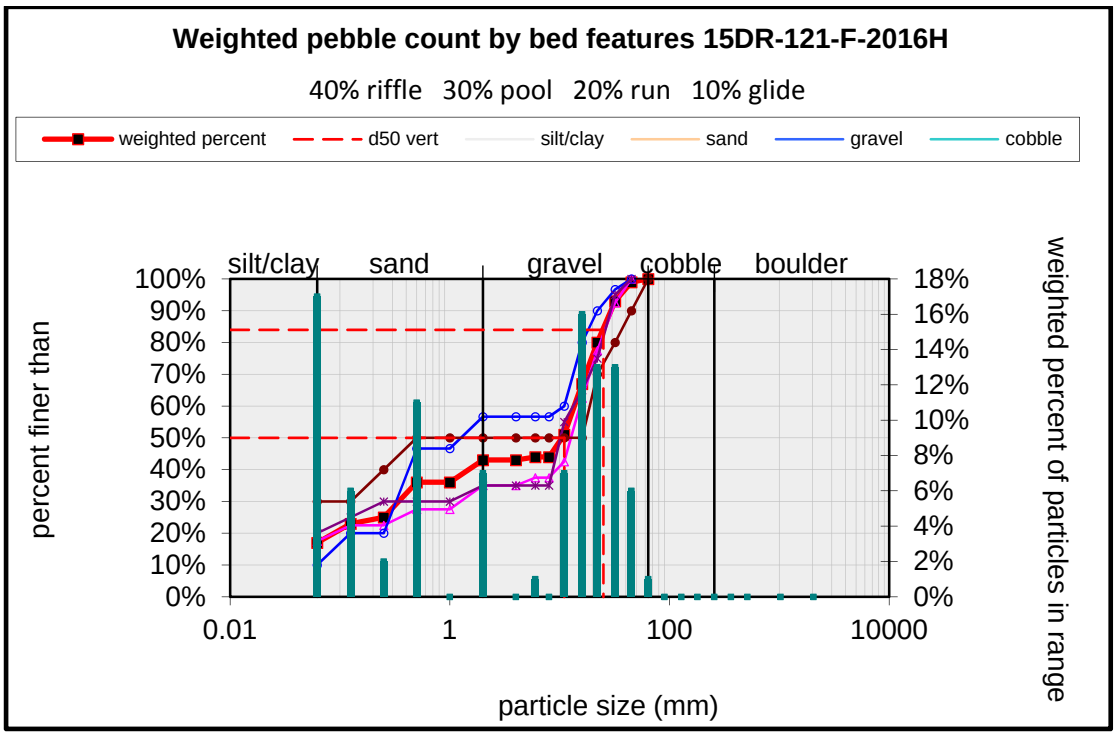
Flood Dimensions	
27.2	W flood prone area (ft)
1.2	entrenchment ratio
5.3	low bank height (ft)
4.5	low bank height ratio

Bankfull Flow	
2.8	velocity (ft/s)
48.9	discharge rate (cfs)
0.56	Froude number

Flow Resistance	
0.029	Manning's roughness

Sinuosity
1.2

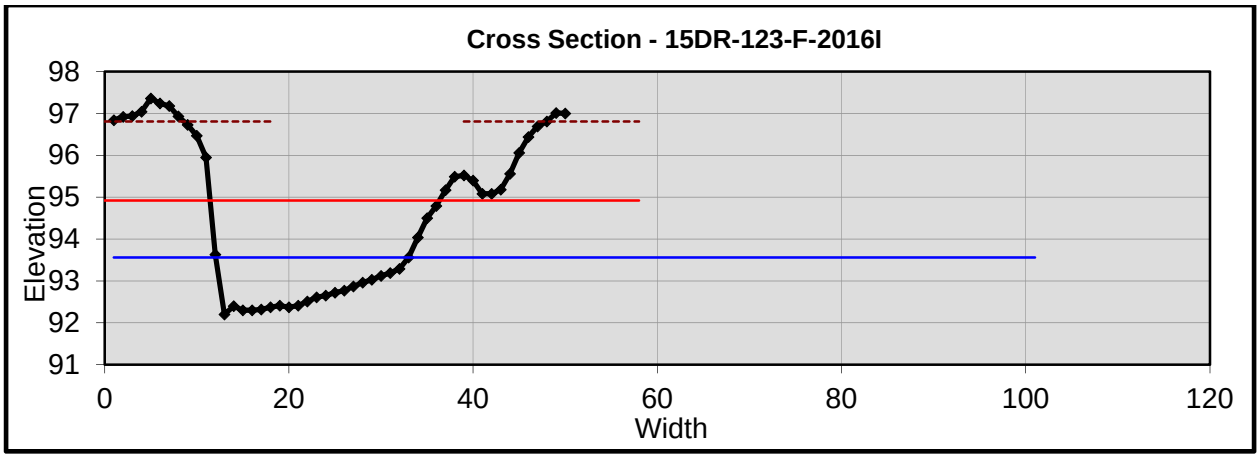
Channel Type
F4/5



Size (mm)	
D16	0.062
D35	0.47
D50	11
D65	15
D84	25
D95	36

Size Distribution	
mean	1.2
dispersion	89.8
skewness	-0.59

Type	
silt/clay	17%
sand	26%
gravel	57%
cobble	0%
boulder	0%



Bankfull Dimensions	
18.5	x-section area (ft.sq.)
21.0	width (ft)
0.9	mean depth (ft)
1.4	max depth (ft)
21.9	wetted parimeter (ft)
0.8	hyd radi (ft)
23.7	width-depth ratio

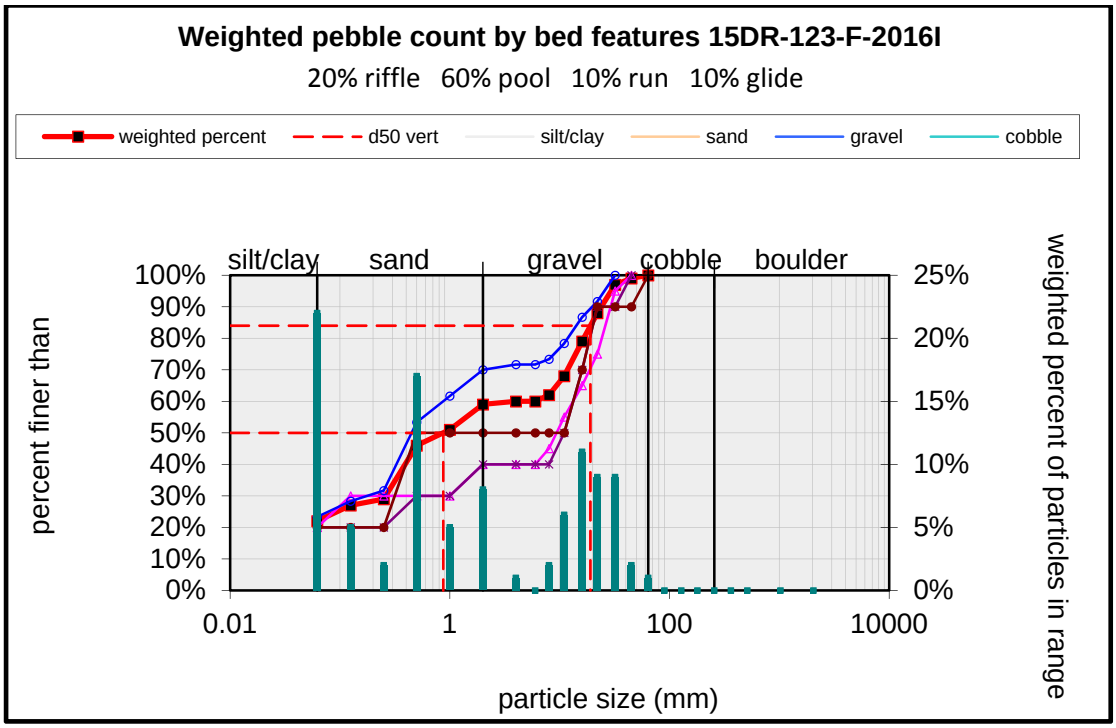
Flood Dimensions	
24.9	W flood prone area (ft)
1.2	entrenchment ratio
4.6	low bank height (ft)
3.4	low bank height ratio

Bankfull Flow	
3.1	velocity (ft/s)
56.7	discharge rate (cfs)
0.59	Froude number

Flow Resistance	
0.026	Manning's roughness

Sinuosity
1.1

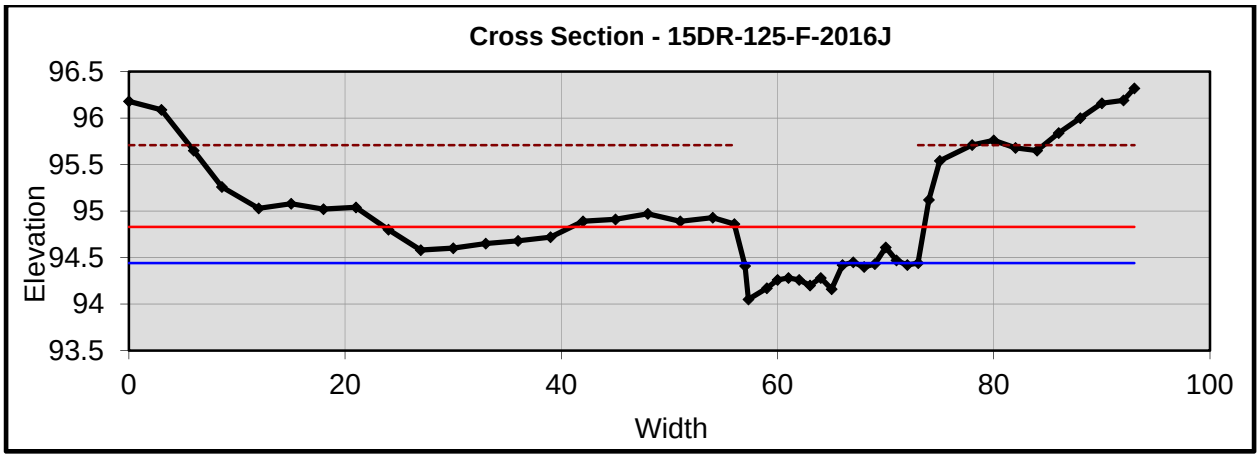
Channel Type
F4/5



Size (mm)	
D16	0.062
D35	0.32
D50	0.87
D65	9.4
D84	19
D95	29

Size Distribution	
mean	1.1
dispersion	17.9
skewness	0.06

Type	
silt/clay	22%
sand	37%
gravel	41%
cobble	0%
boulder	0%



Bankfull Dimensions	
2.0	x-section area (ft.sq.)
13.0	width (ft)
0.2	mean depth (ft)
0.4	max depth (ft)
13.2	wetted parimeter (ft)
0.2	hyd radi (ft)
83.0	width-depth ratio

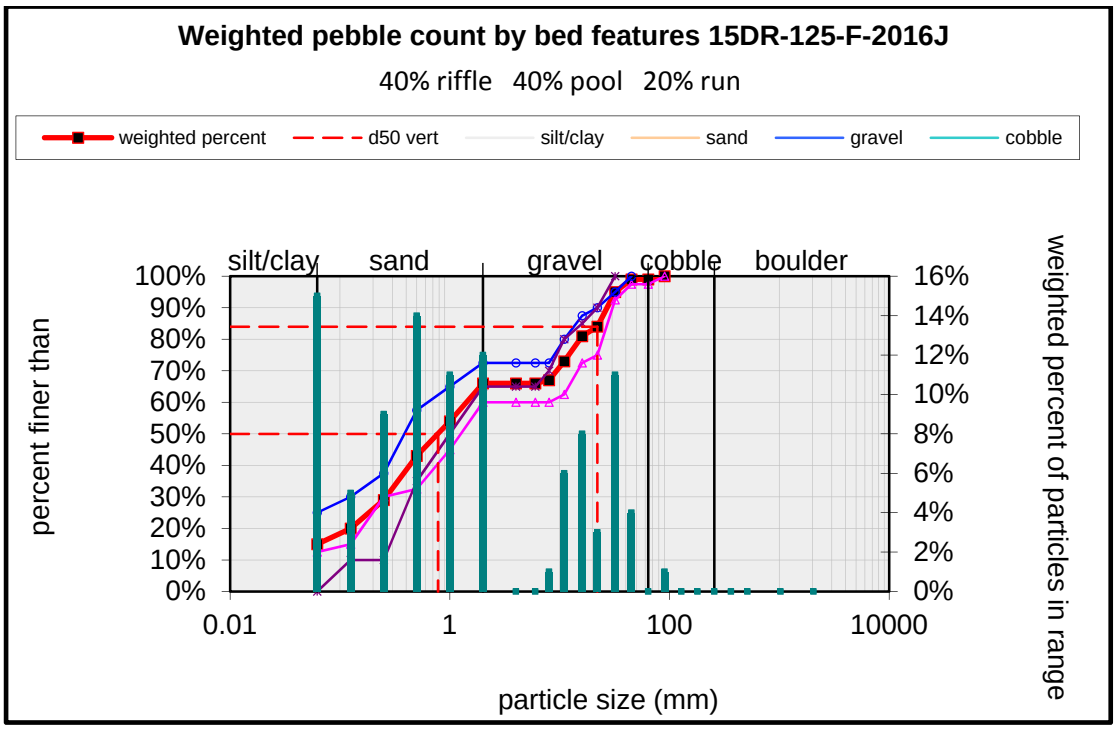
Flood Dimensions	
34.8	W flood prone area (ft)
2.7	entrenchment ratio
1.7	low bank height (ft)
4.3	low bank height ratio

Bankfull Flow	
1.0	velocity (ft/s)
2.0	discharge rate (cfs)
0.44	Froude number

Flow Resistance	
0.035	Manning's roughness

Sinuosity
1.2

Channel Type
C4/5



Size (mm)	
D16	0.071
D35	0.34
D50	0.78
D65	1.9
D84	22
D95	32

Size Distribution	
mean	1.2
dispersion	19.6
skewness	0.13

Type	
silt/clay	15%
sand	51%
gravel	33%
cobble	1%
boulder	0%

Appendix F: Quality Assurance/Quality Control

The biological monitoring program for the Rocky Gorge, Hammond Branch, and Dorsey Run subwatersheds includes chemical, physical, and biological assessments conducted throughout the selected PSUs. The sampling methods used are compatible with the Design of the Biological Monitoring and Assessment Program for Howard County Maryland (Tetra Tech, 2001) and the Quality Assurance Project Plan (QAPP) for Howard County Department of Public Works (Tetra Tech, 2001). A summary of the Quality Assurance/Quality Control (QA/QC) procedures and results are presented in this Appendix.

A quality assurance and quality control analysis was completed for the assessment work conducted in the Rocky Gorge, Hammond Branch, and Dorsey Run subwatersheds 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)
- Accuracy of data entry
    - number of errors/corrective actions
- Completeness
    - number of valid data points obtained as a proportion of those planned (QAPP, 2001).

Data that does not meet performance or acceptable criteria are re-evaluated to correct any problems or investigated further to determine the cause of any discrepancies.

Field Sampling

All field crew members collecting biological samples were recently trained in MBSS Spring Sampling protocols and certified in benthic macroinvertebrate sample collection procedures by MBSS. 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 including the duplicate sites, according to methods in the County QAPP. All *in situ* parameters were measured with a YSI Pro Plus series multiprobe, except turbidity which was measured using 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 both 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 collected at ten percent of the sites (one site for each PSU, three total for the 2016 sampling year). These QC samples were collected to determine the consistency and precision 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. Data collected from duplicate sites included water quality, benthic macroinvertebrate samples, and completion of the RBP habitat assessment. Photographs were also taken at duplicate sites.

Precision

Measures of precision calculated for the consistency of field sampling using intra-team site duplication were:

- Median relative percent difference (mRPD) and relative percent difference (RPD)
- Coefficient of variability (CV)
- 90% confidence interval (CI)

Acceptable measurement quality objectives (MQO) are listed in the table below. 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; Southerland et al., 2005). These new metrics were used to calculate the BIBI presented in this report.

Measurement Quality Objectives (QAPP, 2001)

Metric or Index	Precision	Accuracy	Completeness (%)
GPS		± 25m	100
Dissolved Oxygen	RPD ≤ 20%	± 0.2 mg/L	≥ 85
pH	RPD ≤ 20%	± 0.2 units	≥ 85
Temperature	RPD ≤ 20%	± 0.15 ˚C	≥ 85
Conductivity	RPD ≤ 20%	± 1% of value	≥ 85
RBP Physical Habitat Assessment	RPD ≤ 20%	NA	100
Macroinvertebrate taxa			100
Metric Scores	RPD ≤ 5%		
Bioassessment Scores	RPD ≤ 5%		
Sorting Efficiency	SE ≥ 90%		

GPS

All GPS points were collected with a Trimble ProXT GPS unit capable of accuracy of within 2 meters. Multiple readings (approximately 60) were recorded at the reach midpoint and averaged to obtain the location of the final point. Thus, the accuracy requirement of ± 25 meters was met. A GPS point was collected at all 30 sites, therefore the data meets the 100 percent MQO for completeness.

Water Quality

The following table shows the results of the water quality MQO analysis. The field equipment used, with correct maintenance and calibration, are capable of the required accuracy. Since the true accuracy of field measured water quality is not known with confidence, the measure of precision is used instead. Water quality data for all parameters were collected at all 30 sites, therefore the data meets the >85 percent MQO for completeness. One sample pair (09RG-102-R-2016A) had a water quality measurement that exceeded the MQO of ≤20% for turbidity. The calculated RPD for this sample pair was 64.15, above the stated MQO. However, the high RPD value is an artifact of comparing two low values. This automatically results in an inflated RPD value despite a difference of 1.02 NTU between the samples. All other water quality parameters were within the acceptable ranges for precision.

Measurement Quality Objectives Results – Water Quality. Bold records indicate values exceeding stated MQOs.

	Dissolved Oxygen (mg/l)	pH	Water Temperature (°C)	Turbidity (ntu)	Conductivity (µS/cm)
09RG-102-R-2016A	10.76	7.09	12.70	1.1	280.4
09RG-102-R-2016A QC	11.03	7.32	13.00	2.1	285.5
Absolute Difference	0.27	0.23	0.30	1.02	5.10
RPD	2.48	3.19	2.33	**64.15**	1.80
SD	0.19	0.16	0.21	0.72	3.61
14HB-123-F-2016I	12.26	7.58	8.20	3.0	429.7
14HB-123-F-2016I QC	10.10	7.57	16.70	3.3	436.8
Absolute Difference	2.16	0.01	8.50	0.28	7.10
RPD	19.32	0.13	68.27	8.89	1.64
SD	1.53	0.01	6.01	0.20	5.02
15DR-119-F-2016G	10.54	7.69	15.10	2.3	655.0
15DR-119-F-2016G-QC	10.75	7.95	15.50	2.3	679.0
Absolute Difference	0.21	0.26	0.40	0.00	24.00
RPD	1.97	3.32	2.61	0.00	3.60
SD	0.15	0.18	0.28	0.00	16.97
Median RPD	2.48	3.19	2.61	8.89	1.80

Habitat Assessment

The following table provides the result of the MQO analysis for the habitat assessment. The RPD was <10 percent for all QC sites, therefore, all data meets the MQO of ≤20 percent.

Measurement Quality Objectives Results – Habitat Assessment (RBP)

	RBP Total Score	RBP Percent Comparability	Narrative Rating
14HB-123-F-2016I	156	78	Supporting
14HB-123-F-2016I QC	153	77	Supporting
Absolute Difference	3.00	1.50	
RPD	1.94	1.94	
SD	2.12	1.06	
15DR-119-F-2016G	156	78	Supporting
15DR-119-F-2016G-QC	149	75	Partially Supporting
Absolute Difference	7.00	3.50	
RPD	4.59	4.59	
SD	4.95	2.47	
09RG-102R-2016A	127	64	Partially Supporting
09RG-102R-2016A QC	126	63	Partially Supporting
Absolute Difference	1.00	0.50	
RPD	0.79	0.79	
SD	0.71	0.35	
Median RPD	1.94	1.94	

Biological Assessment

The following three tables include the results of the QC analysis for the biological metrics and BIBI scores. A few metric scores fell outside the acceptable range for precision (shown in bold). In each case, the difference was only one scoring class (i.e, 1, 3, or 5), which resulted in a large RPD. In fact, even the smallest incremental difference in metric scores would result in an exceedance of the RPD MQO. Therefore, additional measures of precision were calculated among the combined QC data set to evaluate the significance of the differences in individual metric values and scores, as well as in the overall BIBI score.

Measurement Quality Objectives Results – Biological Sampling, Sample Pair RPD for Metric and IBI Scores

	BIBI	Total Taxa Score	EPT Taxa Score	Ephem Taxa Score	Percent Intolerant Urban Score	Percent Chironomidae Score	Percent Clinger Score
09RG-102-R-2016A	4.67	5	5	3	5	5	5
09RG-102-R-2016AQC	3.67	3	3	3	5	3	5
14HB-123-F-2016I	2.67	5	1	3	3	3	1
14HB-123-F-2016IQC	2.00	5	3	1	1	1	1
15DR-119-F-2016G	1.33	3	1	1	1	1	1
15DR-119-2016GQC	1.33	3	1	1	1	1	1
Median RPD	**24.0**	0.0	**50.0**	0.0	0.0	**50.0**	0.0

The BIBI is not scored on a continuous scale, but rather each metric is scored on an incremental scale (assigned a value of 1, 3 or 5), and these values are averaged to yield the final BIBI score. Since the piedmont BIBI score is an average of six metric scores, the BIBI scores shift by at least 0.3 or 0.4 with a difference in only metric (e.g., 2.0, 2.3, 2.7, 3.0). Additionally, an individual metric value may differ by only one taxa or one percent for a sample pair, but if it falls on either side of a scoring threshold (i.e, 1, 3, 5), the resulting difference in metric scores will differ by as much as 50 to 100% for RPD. For these reasons, the EPT Taxa score and Percent Chironomidae score mRPDs did not meet the MQOs.

Due to the overall BIBI score consisting of scaled incremental metrics, the RPD does not reflect the precision well. Additional measures of precision (CV, CI, and mRPD) for the combined sample pair results indicate far better precision than does RPD. None of the measures calculated deviated significantly from normal, acceptable levels of precision between duplicate sample pairs observed in similar studies (Hill et. al, 2005; Gallardo et. al, 2006).

All phases of the biological assessment were conducted for every site; therefore the 100 percent completeness MQO is met.

Measurement Quality Objectives Results – Biological Sampling, Combined Precision Measures for Metric Values

	Total Taxa	EPT Taxa	Ephem Taxa	Percent Intolerant Urban	Percent Chironomidae	Percent Clingers
09RG-102-R-2016A	25	12	3	68.0	18.4	89.3
09RG-102-R-2016AQC	22	7	2	59.8	29.5	77.7
14HB-123-F-2016I	27	4	2	17.4	55.0	21.1
14HB-123-F-2016IQC	29	5	1	8.5	67.8	22.9
15DR-119-F-2016G	21	3	0	4.3	76.7	14.7
15DR-119-2016GQC	20	2	0	5.2	68.1	15.5
CV	14.9	65.8	90.8	106.3	44.7	84.3
CI	5.9	5.9	2.0	47.4	38.5	55.6
mRPD	7.1	40.0	0.0	18.2	20.8	8.1

Measurement Quality Objectives Results – Biological Sampling, Combined Precision Measures for Metric and IBI Scores

	Total Taxa	EPT Taxa	Ephem Taxa	Percent Intolerant Urban	Percent Chironomidae	Percent Clingers	BIBI
09RG-102-R-2016A	5	5	3	5	5	5	4.67
09RG-102-R-2016AQC	3	3	3	5	3	5	3.67
14HB-123-F-2016I	5	1	3	3	3	1	2.67
14HB-123-F-2016IQC	5	3	1	1	1	1	2.00
15DR-119-F-2016G	3	1	1	1	1	1	1.33
15DR-119-2016GQC	3	1	1	1	1	1	1.33
CV	27.4	70.0	54.8	73.7	70.0	88.5	51.3
CI	1.8	2.7	1.8	3.2	2.7	3.4	2.2
mRPD	0.0	50.0	0.0	0.0	50.0	0.0	24.0

Laboratory Sorting and Subsampling

Only one highly qualified sorter was used to sort the 30 countywide samples. After 10 samples were sorted, the laboratory QC officer randomly selected one sample to resort to check the sorting efficiency of the technician. The target sorting efficiency rate for this project was 90%. The sorting technician saved the sample debris that was originally sorted for each sample and stored it in a separate container for QC purposes. The QC officer resorted the sample portion that was originally sorted and removed, counted, and added any organisms originally missed to the sample vials for identification.

Two samples were checked by the QC officer for this project, and both samples passed the QC with an error rate of 0.0% and 3.4%. Collectively the samples had an average sorting efficiency of 98.3%, which exceeds the sorting efficiency target of 90%.

Taxonomic Identification and Enumeration

Two samples (RG09-413-R-2016E and 15DR-121-F-2016H) were randomly selected for QC identification and enumeration by an independent lab. Original identification was completed by Aquatic Resources Center[1]. Re-identification of the randomly selected sample was done by Ellen Friedman of Maryland Department of Natural Resources. 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 or subphylum. 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. While MBSS does not specify MQOs for these measures, performance characteristics were compared to recommended standards from Stribling et al. (2003), whereby the PDE for each sample should be equal to or less than 5%, and the PTD should be equal to or less than 15%. Results for the taxonomic comparison and resulting values for PDE and PTD are found in Table 1 and Table 2 for samples RG09-413-R-2016E and 15DR-121-F-2016H, respectively.

Both PDE (0.00% and 0.47%) and PTD (6.60 and 1.89%) were well below the threshold values for acceptance of 5% and 15%, respectively, indicating good overall taxonomic agreement. Minor hierarchical differences for chironomids were observed between the labs. All other disagreements were minor.

[1] Address: 545 Cathy Jo Circle, Nashville, TN

Table 1. Taxonomic Identification and Enumeration Results for Sample RG09-413-R-2016E

Subphylum/Class	Order	Family	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Bivalvia	Veneroida	not identified	not identified	Veneroida	3	3	3
Insecta	Coleoptera	Dryopidae	Helichus	Helichus	1	1	1
	Diptera	Chironomidae			0	1	0
			Cricotopus/Orthocladius	Cricotopus/Orthocladius	18	18	18
			Cricotopus/Orthocladius	Cricotopus/Orthocladius	3	0	0
			Orthocladinae		0	5	0
			Diamesa	Diamesa	1	1	1
			Eukiefferiella	Eukiefferiella	1	1	1
			Hydrobaenus	Hydrobaenus	1	0	0
			Parametriocnemus	Parametriocnemus	1	0	0
			Paratanytarsus	Paratanytarsus	2	0	0
			Polypedilum	Polypedilum	3	3	3
		Empididae	Neoplasta	Neoplasta	2	2	2
	Ephemeroptera	Ephemerellidae	Ephemerella	Ephemerella	2	2	2
		Heptageniidae	not identified	Heptageniidae	3	3	3
	Trichoptera	Brachycentridae	Micrasema	Micrasema	1	1	1
		Hydropsychidae	Cheumatopsyche	Cheumatopsyche	27	27	27
			Hydropsyche	Hydropsyche	27	28	27
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	1	1	1
		Naididae	not identified	Naididae	9	9	9
				Total	106	106	99
				PDE			0.00
				PTD			6.60

Table 2. Taxonomic Identification and Enumeration Results for Sample 15DR-121-F-2016H

Subphylum/Class	Order	Family	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Insecta	Coleoptera	Elmidae	Stenelmis	Stenelmis	1	1	1
		Elmidae	Stenelmis	Stenelmis	1	1	1
	Diptera	Chironomidae	Polypedilum	Polypedilum	6	7	6
			Brillia	Brillia	1	1	1
			Chaetocladius	Chaetocladius	1	1	1
			Cricotopus/Orthocladius	Cricotopus/Orthocladius	59	59	59
				Eukiefferiella	0	1	0
			Parametriocnemus	Parametriocnemus	2	2	2
			Rheocricotopus	Rheocricotopus	1	1	1
			Thienemannimyia group	Thienemannimyia group	2	2	2
			Tvetenia	Tvetenia	1	1	1
			Tvetenia	Tvetenia	1	0	0
		Simuliidae	Simulium	Simulium	1	1	1
	Ephemeroptera	Baetidae	not identified	Baetidae	1	1	1
Oligochaeta	Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	1	1	1
	Haplotaxida	Naididae	not identified	Naididae	26	26	26
				Total	105	106	104
				PDE			0.47
				PTD			1.89