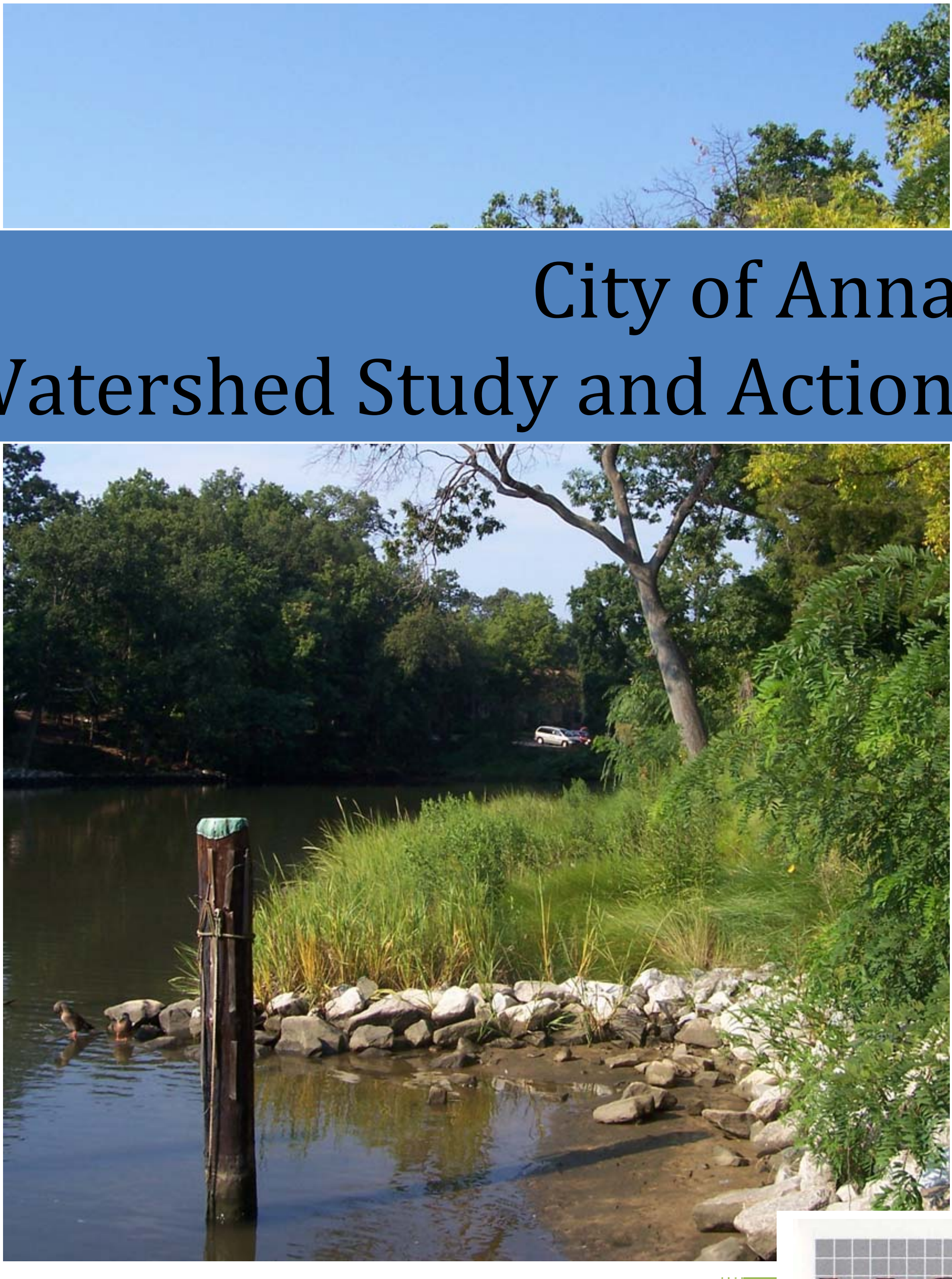
January 2009

City of Annapolis Watershed Study and Action Plan



Prepared for:

Mayor Ellen Moyer and Aldermen

City of Annapolis, Maryland

McCRONE ENGINEERS • SURVEYORS • PLANNERS

AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

City of Annapolis

Watershed Study and Action Plan

Final Report

January 2009

Prepared by

McCrone, Inc. - Engineers, Surveyors, and Planners &

AEGIS - Analytical and Environmental Geographic Information Systems

In Cooperation with

The City of Annapolis Department of Public Works and

The City of Annapolis Department of Information Technology

Prepared for

Mayor Ellen Moyer and

Aldermen - City of Annapolis, MD

Acknowledgements

We would like to thank Mayor Ellen Moyer, Annapolis City Council, Department of Public Works, Recreation & Parks, Finance Department - Information Technology, Planning & Zoning, Department of Neighborhood & Environmental Programs, Annapolis Harbormaster, Department of Economic Development, Weems Creek Conservancy, Chesapeake Ecology Center at the Adams Academy, Spa Creek Conservancy, Back Creek Conservancy, Friends of Back Creek Nature Park, Annapolis Conservancy Board, Annapolis Environmental Commission, Annapolis Port Wardens, Annapolis Maritime Advisory Board, Annapolis Recreation Advisory Board, Maryland Department of Transportation, Maryland Department of Natural Resources, Maryland Department of Environment, Anne Arundel County, The Center for Watershed Protection, The Ecologix Group, and all of the residents and volunteers of Annapolis who help save the Bay every day in their own way.

Data Disclosure

The geographic information system data layers and aerial imagery that were used throughout this study were provided and obtained by the following entities:

- City of Annapolis
- Anne Arundel County
- MD Department of Natural Resources
- MD State Highway Administration
- MD Department of Planning and Zoning
- National Agricultural Imagery Program

Additional descriptive and analytical layers were created and provided by Analytical and Environmental Geographic Information Systems and McCrone, Inc.

Statement of Purpose and Intent

Assisting the City with small watershed restoration action strategies for Weems Creek, College Creek, Spa Creek, and Back Creek is both an opportunity and a privilege for the project team. One goal for the City is to provide a plan that has pre-targeted the downstream funding with small, achievable packages of implementation. Watersheds are really improved one drop at a time.

It is important to note that this document is meant to be utilized as an Action Plan – not another watershed study. The waterways have been studied over and over again, resulting in an enormous amount of data and numbers reflecting the conditions of the waterways. The goal is this document is to provide a strategy and action plan that will address and improve sources of impairments to waterways, increase awareness, develop policy, and implement innovative and impactful projects. In addition to this document serving as a resource for watershed action planning, the digital geospatial data that has been refined, compiled, and analyzed will serve as the most important component of the project.

The total impervious cover calculations resulting from this study should yield a pathway to future TMDL compliance. Using GIS (geographic information systems) technology, the project team utilized the most current imaging available, and then mapped and quantified impervious surface across the City in each of the four watersheds. From this data, the project team derived the percentage of impervious cover, areas to be encouraged toward pervious surface, and existing open space, and made calculations based on Tributary Strategies factors for nutrient run-off from that impervious area. Specific and targeted stormwater management (SWM) and storm drain impairments can be bundled into grant-worthy packages. GIS mapping of impervious cover gives the City a high quality tool for managing urban impacts from hardscape in the City. Counting rooftops and classifying impervious surfaces lead to wiser decisions in land use and watershed capacity. Additionally, calculations and analysis of total tree canopy cover analysis by zoning district, land use, and watershed will allow the City to meet its urban tree canopy goals and create a pathway to programmatic changes in City codes and policies to meet future tree canopy cover goals.

The Annapolis watershed area is unique in that it is an urban watershed, and the impairments to that watershed are vastly different than those of other watersheds. Urban watersheds include (1) the 405 Bureau of Census Metropolitan Statistical Areas (MSA) considered either urban or urban fringe, and (2) water entering these MSAs (surface and ground waters entering the MSAs from upstream or up-gradient sources, source waters supplying the MSA population, and rain or snow events) (adapted from: US EPA, Risk

Management Research Plan for Wet Weather Flows, EPA/600/R-96/140, November 1996). A majority of the watersheds in the State of Maryland suffer from rural and agricultural, impairments. In the case of the Annapolis watershed, the Severn River Mainstem TMDL reports a high coliform impairment which could reasonably be extended to the four creeks of Annapolis. It is important to note that there are no septic systems in the City, so all wastewater that is not direct runoff goes to a wastewater treatment plant. Human activity and behavior in the watershed can influence this metric as well, and outreach and education goals must be set for this impairment.

The purpose of this document is to provide specific watershed strategy recommendations and conclusions to increase watershed awareness, reduce pollutants, and improve overall watershed health. Additionally, City-wide programmatic changes are suggested to the benefit of all four creeks. This document has the opportunity to serve as a model for future urban watershed action plans in Maryland and beyond. Most importantly, the geospatial data component will serve as the building blocks for sustainability of future watershed projects, studies, policy developments, and calculations. The implementation of this plan and utilization of the existing and enhanced geospatial datasets will spell success for restoration of the City's urban watershed.

Table of Contents

I. Introduction

This document is an action plan for the watersheds of Weems, Spa, College, and Back Creeks in the City of Annapolis. Although the City also includes the watersheds of Harness, Church, and Crab Creeks, as well as the South River, data for these areas is not included in this document.

The technical approach for this study was as follows:

Using best available GIS and Public Works data, distinct watershed mapping in GIS was completed depicting watershed boundaries, City of Annapolis and Anne Arundel County jurisdictions, identification of county, City of Annapolis, and federally owned lands, zoning and land use, and historical and recreational features from the existing recreation master plan. Specific watershed boundaries were compiled using boundaries provided by the City in previous watershed studies, and calculations were based on these compiled boundaries, which remain consistent throughout the document.

Impervious areas and lot coverage areas (as now defined by the legislature in HB1253/SB844) were computed for each watershed using protocol that was approved by the City of Annapolis prior to the start of the project. The impervious coverage mapping differentiates the types of impervious surfaces: rooftops, streets, parking surfaces, walkways, and the like. Best Available Technologies (BATs) and Best Management Practices (BMPs) for retrofits, and new water quality improvements are also suggested. The impervious data also assisted in computing reductions in nutrient and other impairments that are possible from implementing the suggested retrofits.

Tree canopy coverage was mapped for the entire combined watersheds, using data provided by the City, in addition to data resulting from the 2006 DNR SUFA study. This mapping was performed from the most recent available ortho-photography and topographic mapping (provided by the City). The mapping identified areas ideal for added urban tree canopy coverage to assist the Mayor and the City of Annapolis in achieving a target of 50% urban tree canopy by the year 2030, a goal which was set by the City as a result of the 2006 DNR SUFA study recommendations. This mapping may also be used to serve as the base mapping for possible future Tree City of Annapolis USA events.

To the combined mapping generated above, all known stormwater management (SWM) facilities and structures from best available Public Works records and from field walks by the project team are added. Unmanaged stormwater and methods for the addition of water quality BMPs or retrofits to existing inadequate management are recommended. The rain barrels and rain gardens are mapped and coded throughout the four watersheds based on data provided by the City. These practices are visually coded and tallied against the rooftops and other surfaces. Particular focus is applied to Back Creek in this mapping.

Using City of Annapolis data and the mapping generated above, recreational, habitat restoration, and improvement of historical sites opportunities was evaluated. The collected cultural and habitat features helped define pathways and the viability of the walking and biking cross-town trails.

A stream team for the field reconnaissance and identification of Back Creek existing drainage conditions was utilized. This was reconned against mapping provided above and is specific to the Back Creek hydrology. Sub-watershed drainage areas were defined and specific points of discharge are noted for future study and recommendations. Specific recommendations for reducing stormwater impacts are made for the Back Creek watershed. Additionally, BATs and BMPs for the treatment of the Back Creek drainage impacts are proposed. The process for filling the data gap at Back Creek has resulted in design recommendations and cost estimates for specific restoration project implementation.

An overall watershed strategy for restoration and enhancement of all four watersheds is discussed, and is a result of the coordinated efforts of the City, project team, and stakeholders. Specific projects and programmatic change recommendations are discussed for each of the sub-watersheds, as well as the City as a whole. The final plan includes a list of implementable and grant-worthy projects that can be implemented one at a time or in bundles, depending on funding. Recommendations for programmatic changes in codes are provided as useful tools for inclusion in Comprehensive Plan updates. The pulling together of all this existing and new work will help point the City of Annapolis towards compliance with HB1141 requirements for a new Water Resources Element.

II. Background

A. Existing Data Assessment

The following existing studies and information were given to the project team to evaluate for missing information and data gaps to be addressed in this study:

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Title	Date	Information
List of Rain Gardens, Bio-retentions & Water Quality Ponds in the City of Annapolis	12/1/2007	Lists and addresses of stormwater devices and which creek/river they outfall into
Lincoln Drive Rain Garden	1/21/2007	Timeline for installation and processes
City of Annapolis--Parks, Recreation and Open Space Master Plan (DRAFT)	11/5/2005	Redevelopment programs, trails, training and future strategy
An Environmental Action Strategy: Annapolis, MD	March 1974	Broad list of problems along with recommendations/solutions
Gems of the Severn	1988	Detailed analysis per sub-watersheds of Severn (i.e. locations, features, wetlands, plants)
A Report on Annapolis' present and potential Urban Tree Canopy	6/7/2006	Current percentages and recommendations
Final Report from the Task Force on Recreational Facilities, Services, and Programs	12/2/1998	Community Meeting Minutes, lists of recreational facilities and proposed ideas

Severn River Natural Areas of Highest Priority for Preservation	Feb. 1986	Detailed information for various sub-watersheds.
---	Dec. 2007	Various E-mail correspondence (8 pages)
Parks and Paths for People--Annapolis, MD	June 1987	Conservation of parks/trails along with potential future locations

Spa Creek Watershed

Spa Creek Headwaters Implementation Table	---	List of recommendations, timelines and estimated costs for recommendations
Spa Creek Tidal Sub-watershed Assessment Report	Dec. 2007	Detailed Outfall investigations along with locations & sample results, recommendations for improvements (tables, designs & pictures)
Spa Creek Headwaters Sub-watershed Restoration Management Plan	3/17/2006	Stream assessment, recommendations, locations of problem areas along with locations per maps

College Creek Watershed

College Creek Watershed Survey	4/10/1997	List of grants and letters from various agencies regarding aid for restoration
Draft---College Creek Watershed Assessment	2007	Results from several water quality samples, tasks for the Friends of College Creek from 2007, 2008 and beyond. Lists of items the FOCC want to have performed. List of comments/concerns from a community forum

Weems Creek Watershed

Weems Creek Watershed Improvement Plan	March 2003	Lists of recommendations and retrofits for areas for both the city and county
Weems and College Creeks Annual Water Quality Monitoring Report (Construction Phase, Year One)	July 2005	For Rowe Blvd. bridge replacement/rehabilitation. Lists and tables of water quality results. Maps of monitoring locations
Weems and College Creeks Annual Water Quality Monitoring Report (Construction Phase, Year Two)	Dec. 2006	For Rowe Blvd. bridge replacement/rehabilitation. Lists and tables of water quality results. Maps of monitoring locations
Weems and College Creeks Annual Water Quality Monitoring Report (Post-Construction Phase, Year Three)	Dec. 2007	For Rowe Blvd. bridge replacement/rehabilitation. Lists and tables of water quality results. Maps of monitoring locations
Recommendations for Weems Creek	12/16/1992	Report for lawsuit regarding recommendations for improvements

After reviewing the existing study data, it was apparent that not much study or work had been done for the Back Creek watershed. The other three sub-watersheds have had a significant amount of work done, to include specific water quality monitoring data, recommended restoration projects, and analyses of impairments and other issues. In order to complete an overall picture for the whole Annapolis watershed area, the project team, along with City staff and other stakeholders, participated in a boat tour of all four creeks. Pictures and video were taken throughout the trip, and notes for areas of concern were written. Part of the project team then went back out in the field to further evaluate specific issues in the Back Creek watershed that have not been previously assessed or studied.

B. Analysis of Gaps in Existing Data

Aside from the lack of field study for Back Creek, there is also a gap in the water quality data for this creek. Assessing the water quality for Back Creek is not part of the scope of this particular study. However, the mapping, analysis, and geospatial data that have been included in the study have helped paved a path for future water quality study implementation. Specifically, Chapter VII discusses current projects in all four sub-watershed areas that are being implemented by the City, as well as programmatic changes. The Chapter also provides a budget narrative for specific recommended future projects in addition to new programmatic changes that include a more detailed water quality analysis of Back Creek, as well as monitoring stormwater runoff impacts throughout the watershed.

The projects and programmatic changes that are discussed in Chapter VII provide a more in-depth description of projects and programmatic changes that have been suggested by the City, the project team, and the stakeholders in an effort to unify the work that has been done in all of the sub-watersheds. While it is important to focus on each sub-watershed, it is equally important to pay close attention to the watershed as a whole in order to develop and implement strategies that will help mitigate off urban-related impairments to the watershed.

C. Back Creek Analysis

The study data provided to the project team did not include much detail for Back Creek. A more detailed analysis of Back Creek is discussed in Chapter VIII of this study. To summarize, the project team completed field surveys and assessment of existing stormwater facilities, outfalls, and BMPs throughout the Back Creek watershed. Recommendations were then made for new BMPs and retrofits within Back Creek, and included cost estimates and disturbed land acreages. Data from this assessment was then used to offer additional programmatic change and outreach and education strategies. Please refer to Chapter VIII and Chapter IX for an in-depth analysis.

III. Urban Tree Canopy Analysis

A. Background and Previous Study Findings

In June 2006, the Maryland Department of Natural Resources (MD DNR) – Forest Service, in conjunction with the Unites States Department of Agriculture (USDA) Forest Service and the University of Vermont Spatial Analysis Lab, released a report on the City of Annapolis' present and potential urban tree canopy. The study utilized various GIS data, which included high-resolution remote sensing data from IKONOS satellite imagery that was interpreted for trees and other kinds of vegetation, as well as impervious surface coverage. This data was collected in 2004 as part of the SUFA (Strategic Urban Assessment Grant) project. Maryland Department of Planning parcel data was also used in the 2006 DNR study.

The study concluded that the City currently has a tree canopy total coverage of approximately 41%. This number reflects the percentage of tree canopy coverage for the entire land area set by the City's municipal boundary. Part of the intent of this study is to further analyze the tree canopy coverage in the City and determine the percentage of coverage within the watershed areas. Once that percentage is determined, recommendations are then made to increase as well as preserve existing tree canopy coverage in the watershed areas. Because the most urban and developed areas of the City are located within the watersheds, it is important to analyze and understand the actual tree canopy percentages located in the project study area. The project team has done an extensive analysis in GIS to determine the current existing tree canopy coverage within each sub-watershed, and we have broken down the total coverage based on land use. The results of this analysis are discussed in this chapter. A major component of this project is the deliverable of the geospatial data layers that have been refined and analyzed for this project.

B. Methodology

It is important to note that the 2006 DNR study raw data was not made available for the tree canopy analysis. DNR was contacted about acquiring the raw data, but the data was not available. Tree canopy data from the 2004 DNR SUFA was not utilized in the analysis, as the data is nearly five years old, and tree canopy coverage has changed. The project team made the decision to utilize the tree-line polygon and point data from the City, in addition to the full-leaf-on ortho imagery in order to more precisely calculate the tree canopy coverage for the project study area, consisting of the watersheds for Weems, Spa, College, and Back Creeks, within the City limits. The calculations do NOT reflect tree canopy percentages for the City as a whole, or for any of the other watershed areas in the City, only the project study area.

The project team was able to quality control (QC) the tree date provided by the City, while checking it against the ortho imagery. The QC process revealed many gaps in the data, where large areas of tree cover should have been originally compiled. The team was able to rectify all missing data during the QC process.

Methodology included extracting existing tree canopy cover data using GIS to pinpoint individual tree points and areas of tree canopy overlaid on aerial imagery. The base layer of individual trees and tree canopy, created in 2006 via photogrammetric (3D stereo imagery compilation) methodology, was updated using high- resolution, true color aerial imagery (2006) from the City of Annapolis, as well as 2007 National Agricultural Imagery Program (NAIP) true color aerial imagery with complete leaf-on to create a truly representative dataset of existing conditions. Individual tree points and canopy were modified and updated as needed for each sub-watershed using the latest available aerial imagery. To calculate area of tree canopy coverage for individual tree points, an average 15.5-ft buffer was applied to each point. An analysis of twenty-six tree species dominant in Anne Arundel County was used to determine the magnitude of the buffer, by taking the average of their ten/twenty-year spreads. Areas were then analyzed to assure that using an average buffer was efficient in capturing the true landscape. Both datasets were joined together to create an existing tree canopy layer. It is important to note that the City has the capability of determining future additions to the tree canopy coverage by modeling the canopies of new and future tree plantings by utilizing similar methodology.

Possible tree canopy cover was found using datasets created from previous analyses, including existing impervious area layers and existing tree canopy, as well as land use and individual owner parcel datasets delivered by the City of Annapolis. For each sub-watershed, total existing impervious area and existing tree canopy coverage were merged together to determine the total area unavailable for expanding tree canopy cover. The area not impacted by existing impervious and tree canopy were created into an open space layer. Open space was classified into one of thirteen land use categories to determine which areas to target for expanding tree canopy cover. This layer was joined with an individual owner database to determine how many parcels and how much acreage could be used for planning the expansion of tree cover. The resulting data is meant to assist future City planners in making decisions for prioritizing where to increase tree canopy cover.

C. Existing Conditions and Calculations by Sub-watershed/Results

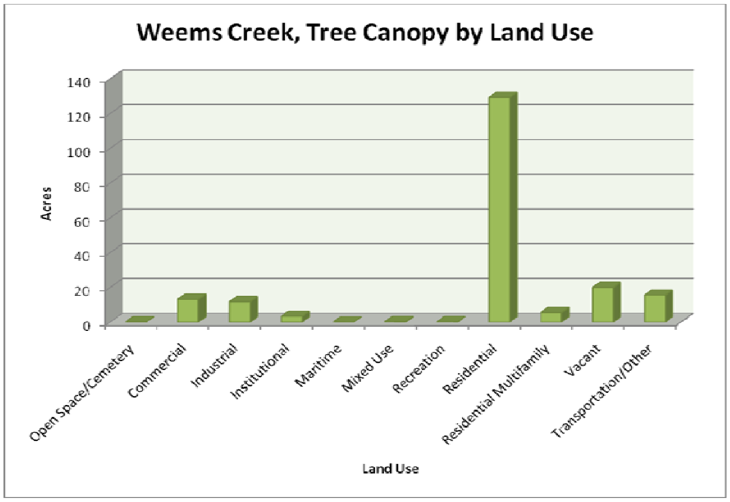
The project team utilized GIS technology and data from the City to calculate the existing tree canopy coverage for the City of Annapolis watershed study area, consisting of Weems, Spa, College, and Back Creeks. Total land acreage for the area inside of the Annapolis city limits, and within the watershed study area boundary, was calculated to be approximately 3,682.1 acres. The total area for the entire City of Annapolis boundary is approximately 4,542 acres, or roughly seven (7) square miles. The following chart displays a breakdown of the land acreages for the four sub-watersheds:

Watershed	Acres	Percentage of study area	Percentage of whole City
Weems	610.7	17%	13%
Spa	1,483.8	40%	33%
College	737.0	20%	16%
Back	855.7	23%	19%
Total	3,682.1	100%	81%

Specific results for each of the sub-watershed areas are discussed below.

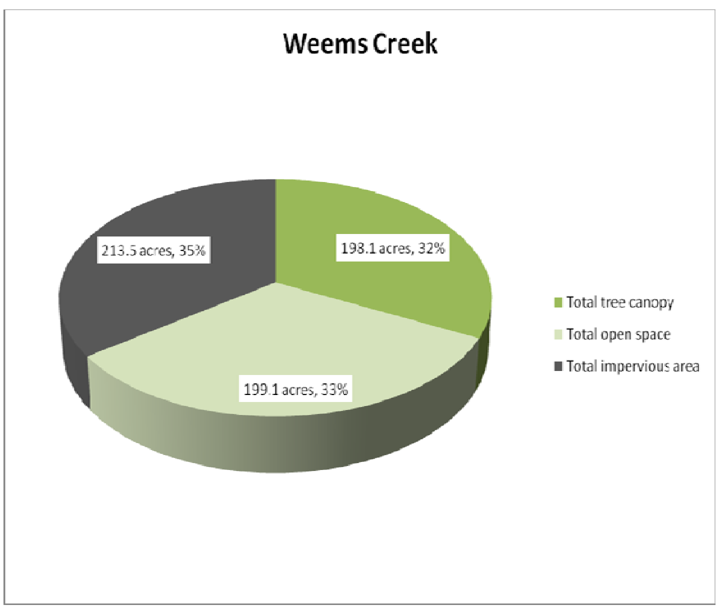
Weems Creek

Weems Creek is somewhat of a unique entity in the study, because only a portion of the total sub-watershed actually lies within the City limits. The northern portion of the sub-watershed area actually lies within Anne Arundel County, and a large portion of that area consists of the Annapolis Mall (Westfield Shopping Center) and other related commercial development. Although these areas have a great impact on the overall health and condition of the Weems Creek watershed, analysis of the county portion of the Weems Creek watershed is not included in this report, as the City has no jurisdiction in the county. For the purposes of this study, data was calculated for the Weems Creek watershed area within the city limits, which totals 610.7 acres, more or less. The following charts, graphs, and maps offer a graphical representation of the resulting data for Weems Creek:



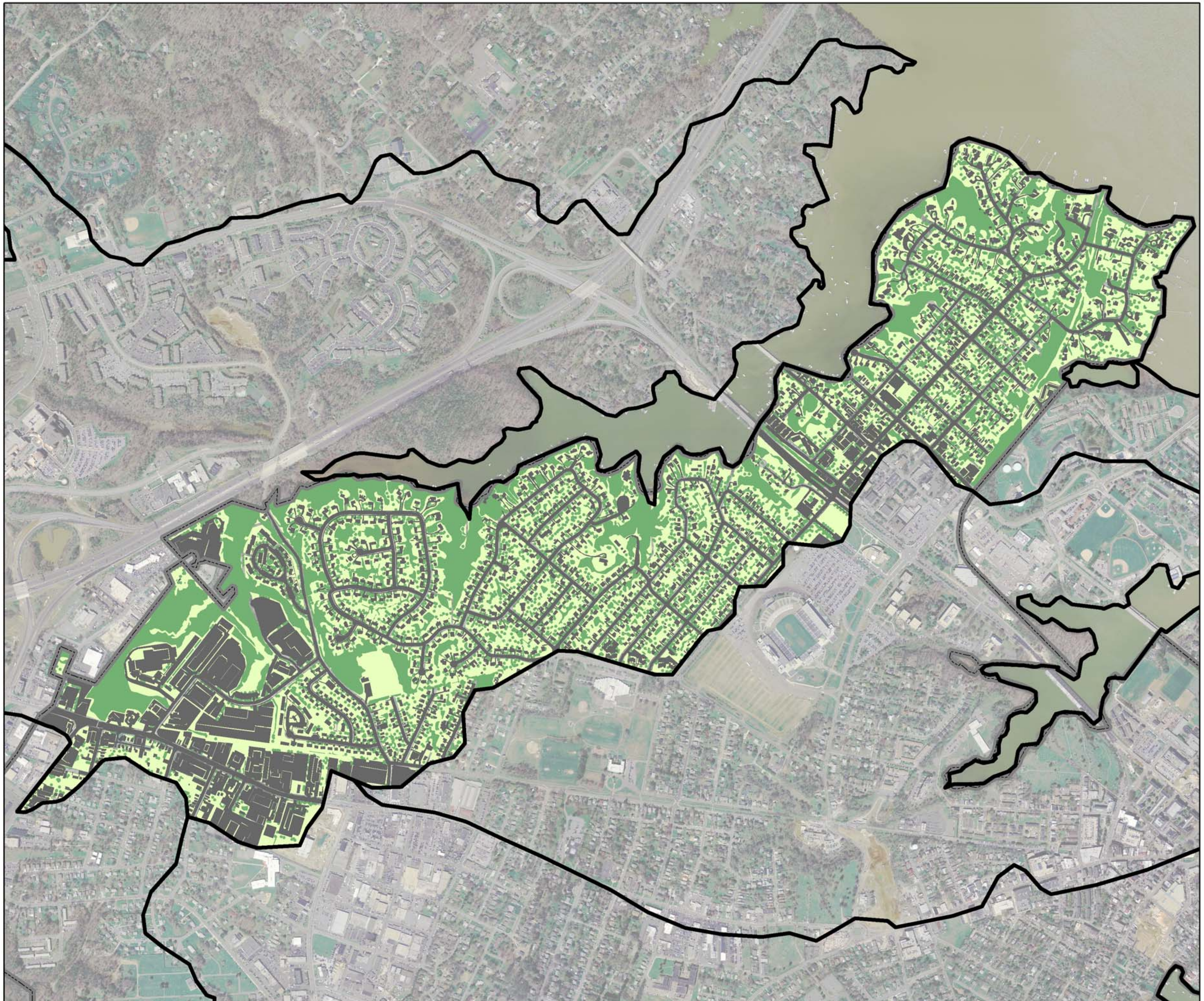
The above bar graph shows a breakdown in the existing tree canopy coverage (in acres) in the Weems Creek watershed per the 2005 designated land use categories. Residential and vacant uses were found to have the largest areas of tree canopy coverage.

The pie chart below depicts a breakdown of the total Weems Creek watershed acres into tree canopy, impervious, and open space/other areas. The data shows that 35% of the watershed area is covered by impervious surfaces, whereas 32% is covered in tree canopy, and the remaining 33% of land area is categorized as open space/other.



The chart below depicts the existing open space acreages per land use in Weems Creek. The resulting data is meant to assist the City in targeting certain land uses in each watershed to increase UTC (Urban Tree Canopy) by converting open space acreage to

Weems Creek



N S E W

Legend

- City of Annapolis
- Watershed Boundary
- Open Space
- Tree Canopy
- Impervious Surface

0 1,000 2,000 Feet

1 inch = 1,000 feet

Vicinity Map (not to scale)

AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

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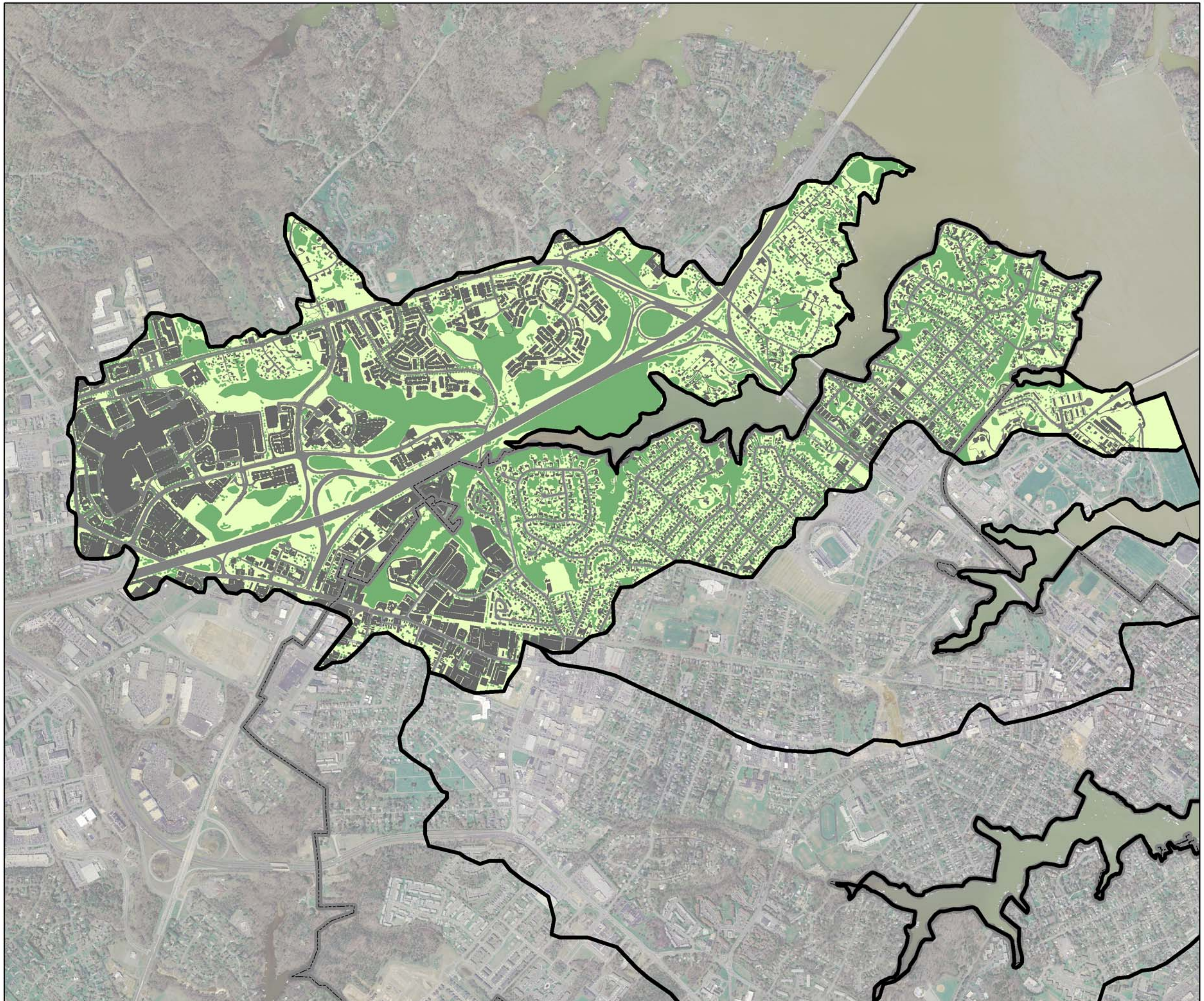
Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis



Weems Creek

N S E W

Legend

- City of Annapolis
- Watershed Boundary
- Open Space
- Tree Canopy
- Impervious Surface

0 1,500 3,000 Feet

1 inch = 1,500 feet

Vicinity Map (not to scale)

AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

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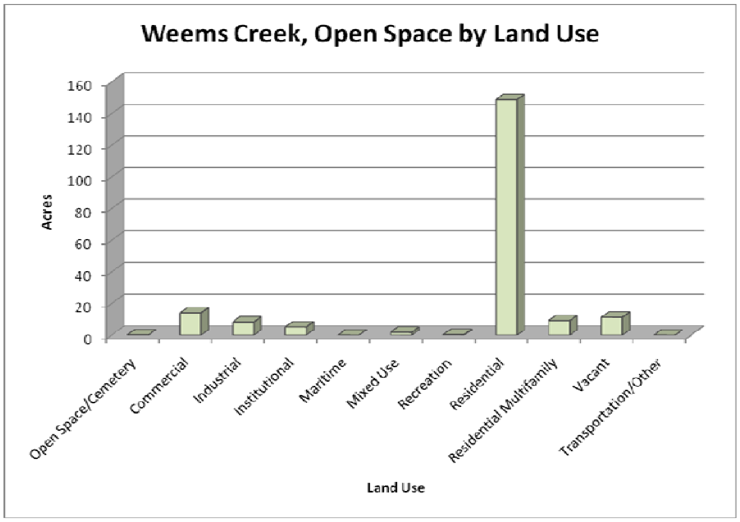
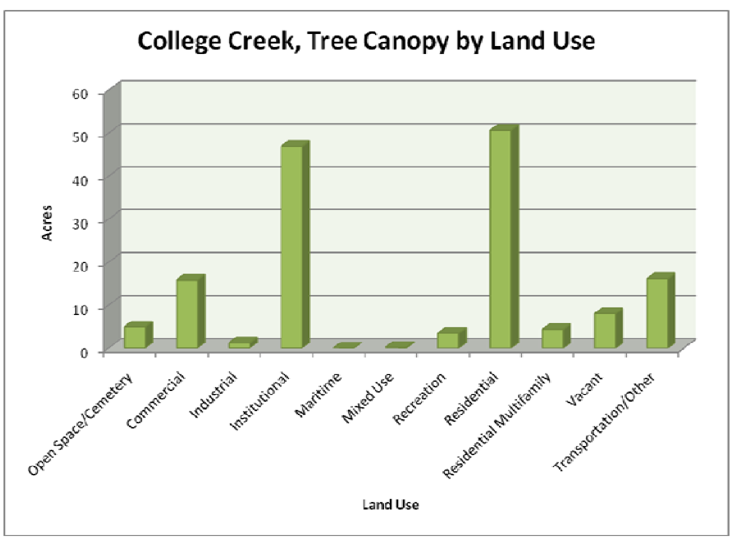
Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis

tree canopy coverage. The results for Weems Creek show that residential and commercial uses have the most areas of open space and should be considered priority target land uses.



College Creek

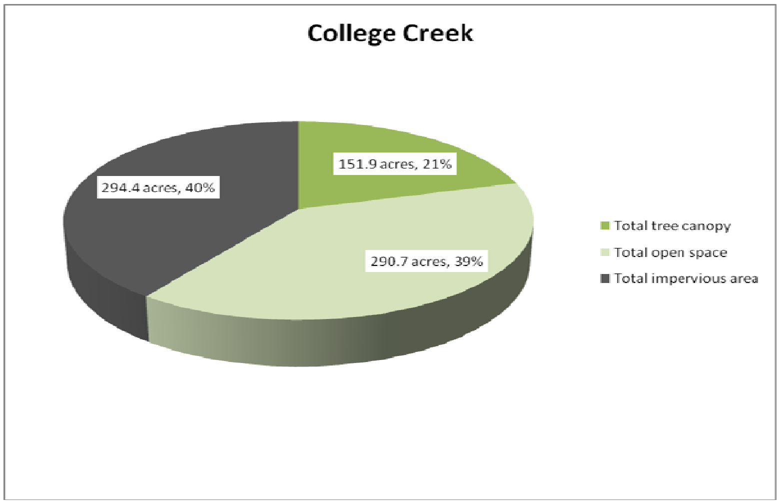
College Creek is the smallest of the four sub-watersheds and is nestled between Weems Creek and Spa Creek. The following charts, graphs, and maps offer a graphical representation of the resulting data for College Creek:



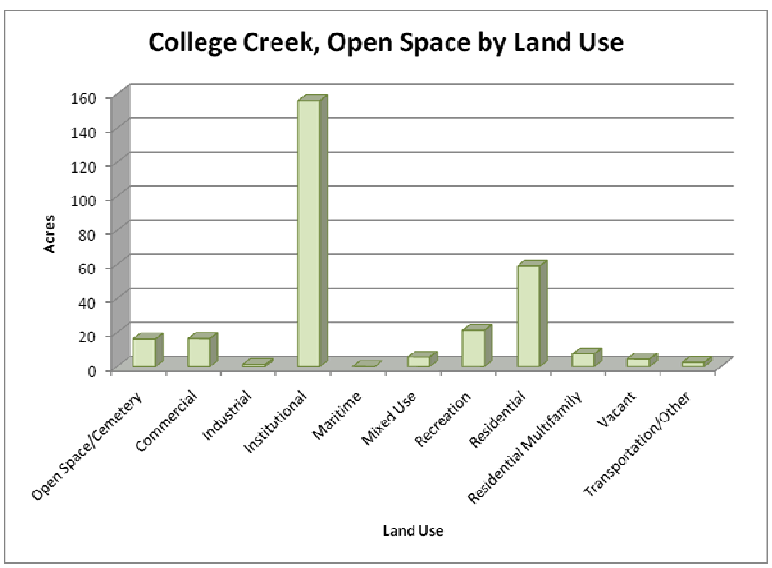
The above bar graph shows a break down in the existing tree canopy coverage (in acres) in the College Creek watershed per the 2005 designated land use categories.

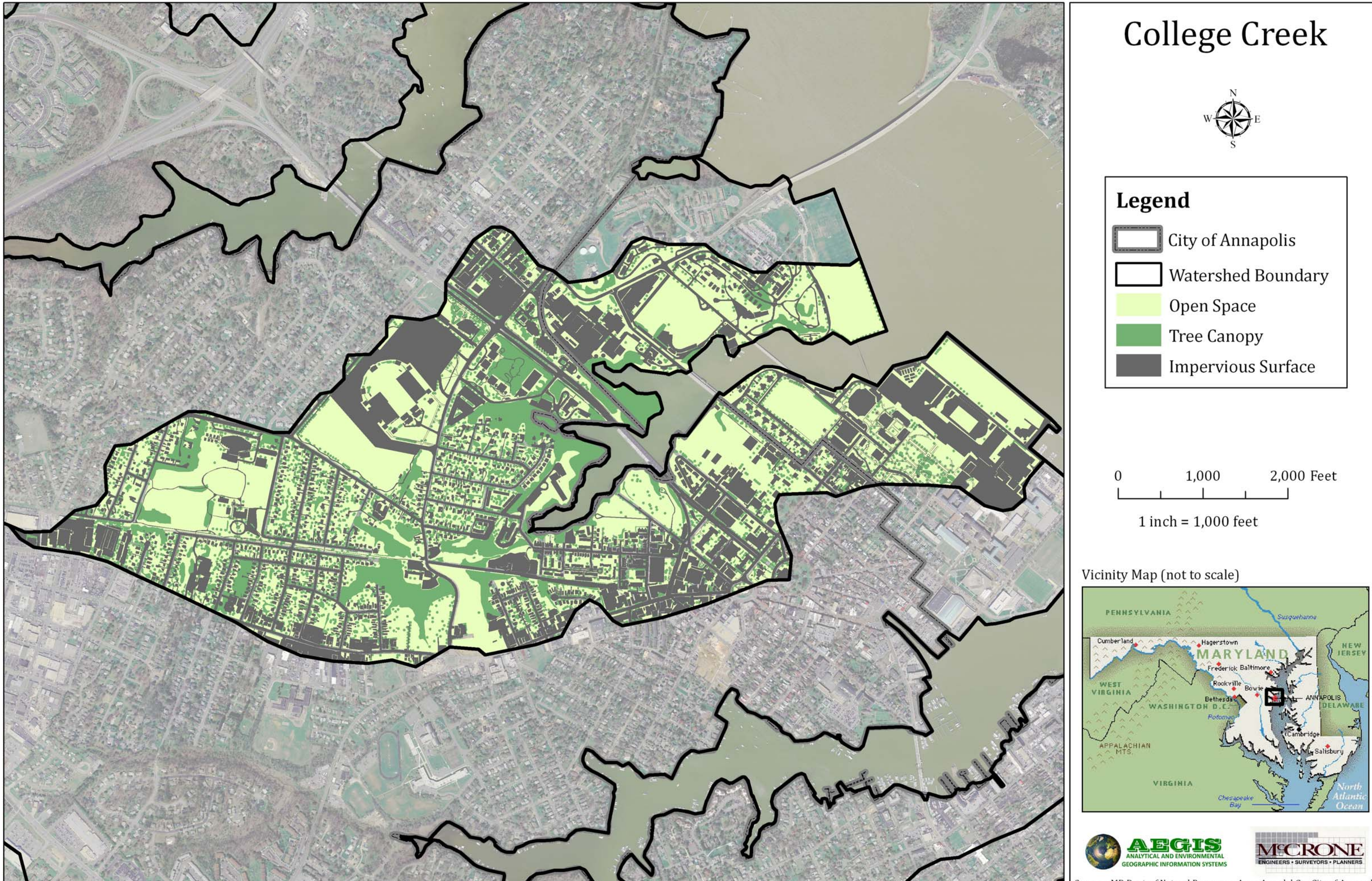
Residential and institutional uses were found to have the largest areas of tree canopy coverage.

The pie chart below depicts a breakdown of the total College Creek watershed acres into tree canopy, impervious, and open space/other areas. The data shows that 40% of the watershed area is covered by impervious surfaces, whereas 21% is covered in tree canopy, and the remaining 39% of land area is categorized as open space/other.



The chart below depicts the existing open space acreages per land use in College Creek. The resulting data is meant to assist the City in targeting certain land uses in each watershed to increase UTC by converting open space acreage to tree canopy coverage. The results for College Creek show that institutional and residental uses have the most areas of open space and should be considered priority target land uses.




College Creek
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Legend
City of Annapolis
Watershed Boundary
Open Space
Tree Canopy
Impervious Surface
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1 inch = 1,000 feet
Vicinity Map (not to scale)
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NEW JERSEY
Cumberland
Hagerstown
MARYLAND
Frederick
Baltimore
Rockville
Bowie
Bethesda
ANNAPOLIS
WEST VIRGINIA
WASHINGTON D.C.
DELAWARE
Cambridge
APPALACHIAN MTS.
Salisbury
VIRGINIA
Chesapeake Bay
North Atlantic Ocean
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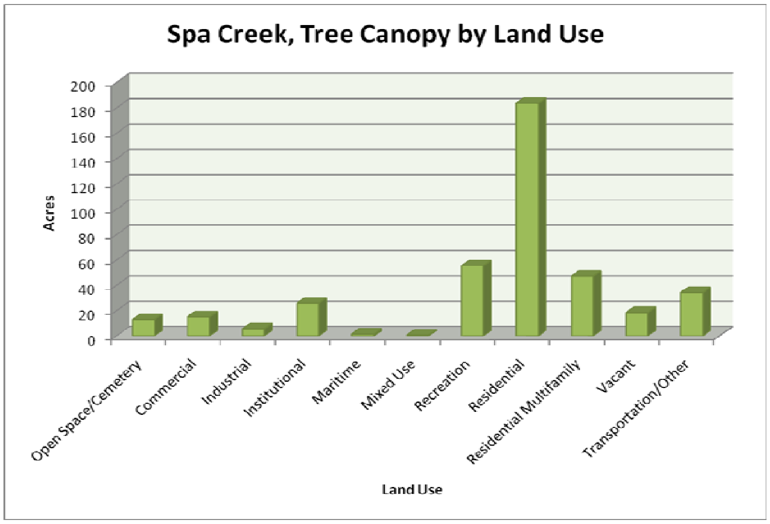
ENGINEERS • SURVEYORS • PLANNERS
Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis

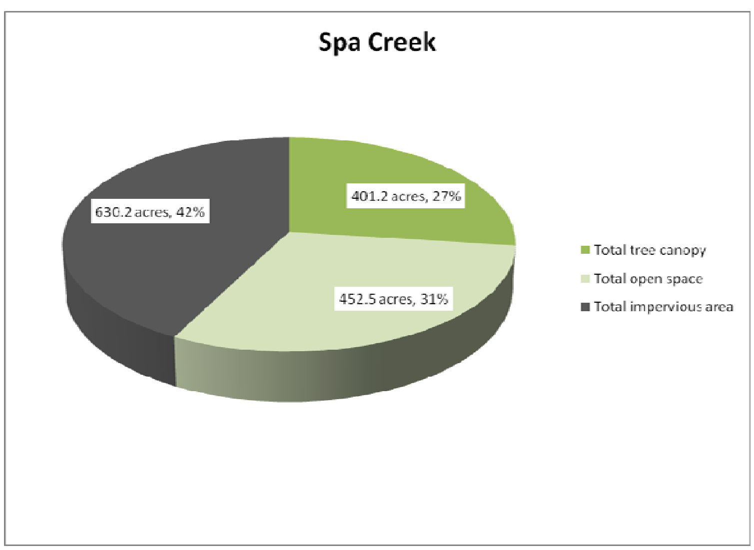
Spa Creek

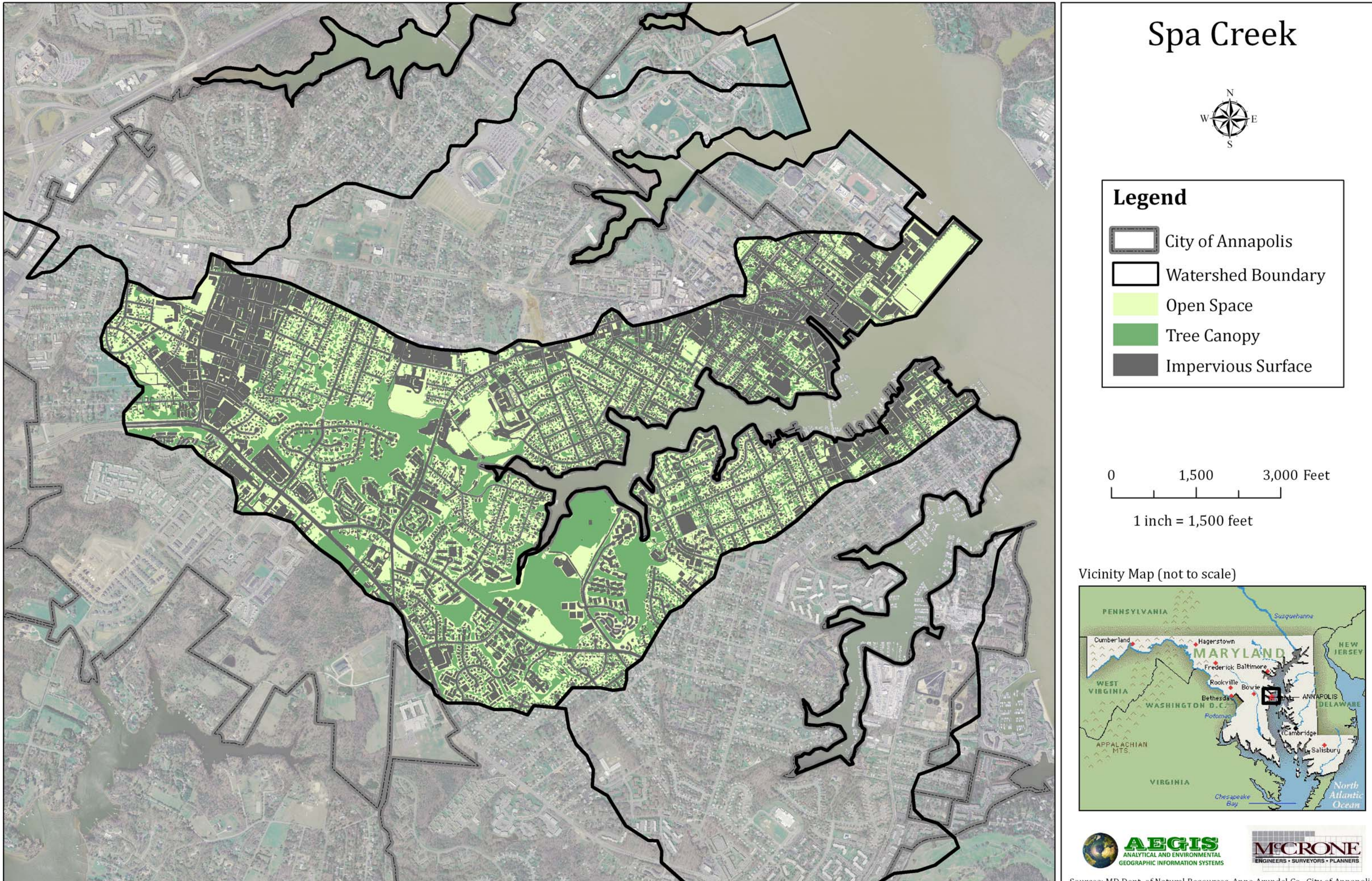
Spa Creek is located between College and Back Creeks and is the second largest sub-watershed in the study area. The following charts, graphs, and maps offer a graphical representation of the resulting data for Spa Creek:



The above bar graph shows a breakdown of the existing tree canopy coverage (in acres) in the Spa Creek watershed per the 2005 designated land use categories. Residential uses were found to have the largest areas of tree canopy coverage.

The pie chart below depicts a breakdown of the total Spa Creek watershed acres into tree canopy, impervious, and open space/other areas. The data shows that 42% of the watershed area is covered by impervious surfaces, whereas 27% is covered in tree canopy, and the remaining 31% of land area is categorized as open space/other.




Spa Creek
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Legend
City of Annapolis
Watershed Boundary
Open Space
Tree Canopy
Impervious Surface
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1,500
3,000 Feet
1 inch = 1,500 feet
Vicinity Map (not to scale)
PENNSYLVANIA
Susquehanna
Cumberland
Hagerstown
MARYLAND
NEW JERSEY
Frederick
Baltimore
WEST VIRGINIA
Rockville
Bowie
Bethesda
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WASHINGTON D.C.
DELAWARE
Potomac
Cambridge
APPALACHIAN MTS.
Salisbury
VIRGINIA
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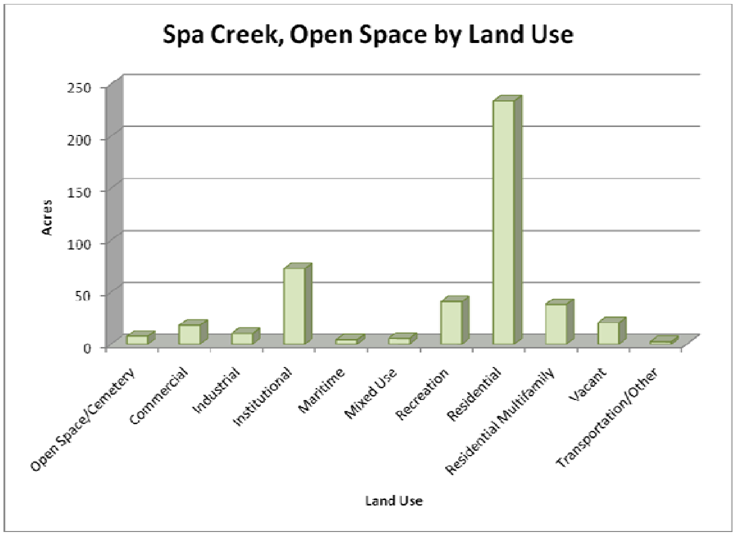
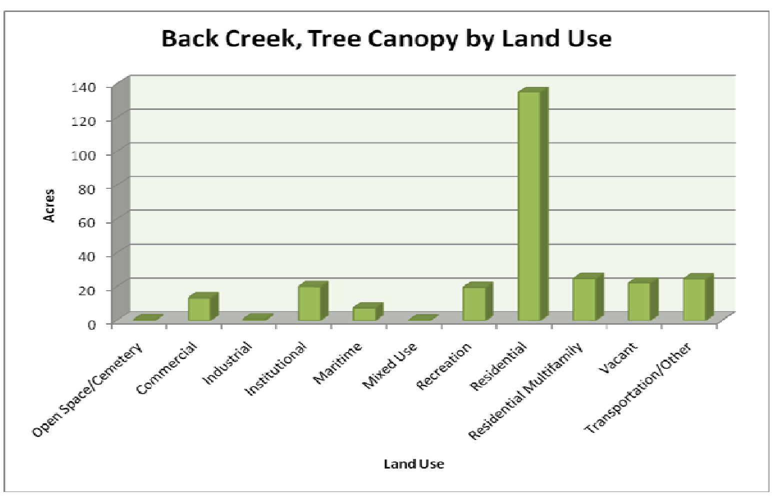
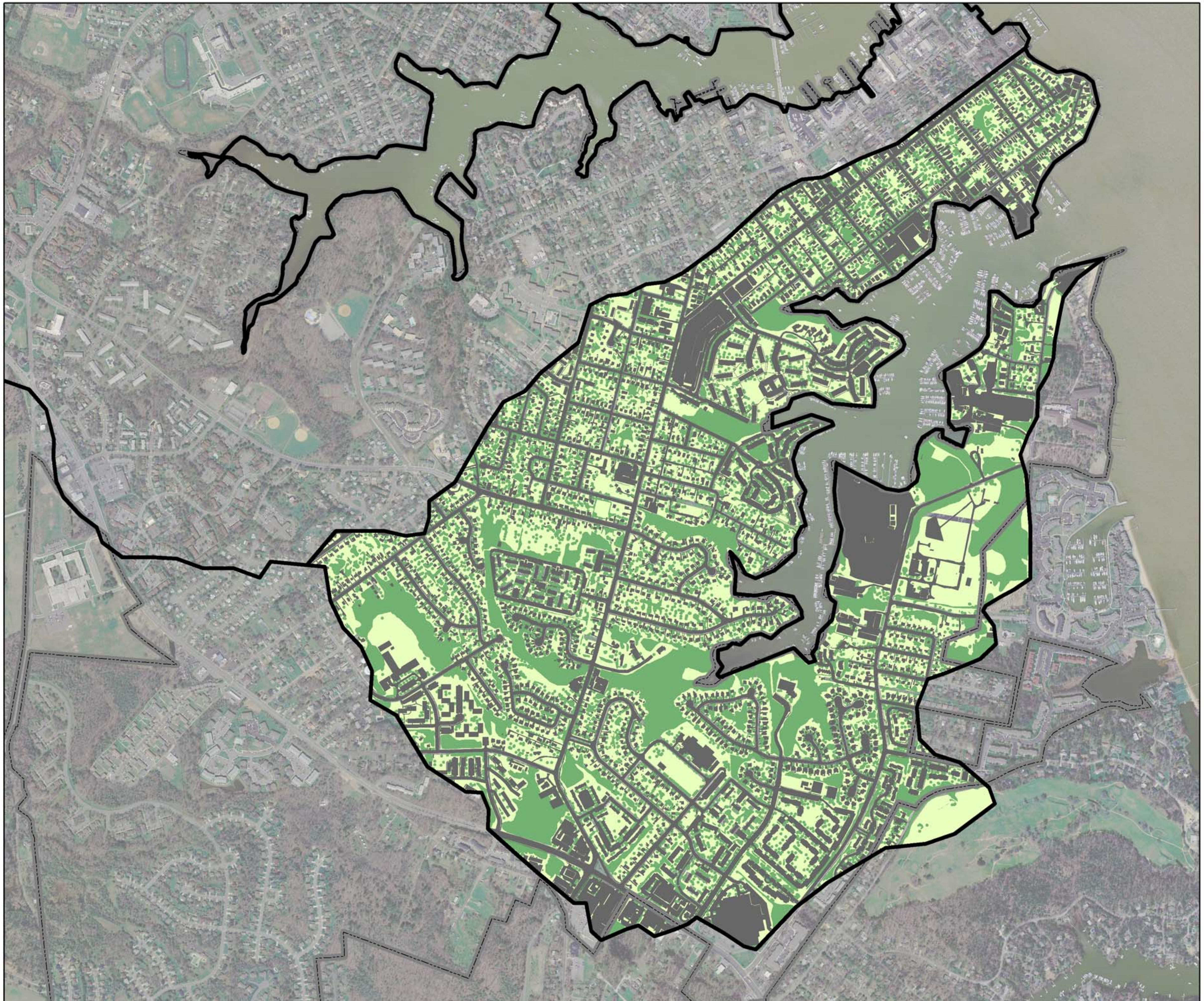
The chart below depicts the existing open space acreages per land use in Spa Creek. The resulting data is meant to assist the City in targeting certain land uses in each watershed to increase UTC by converting open space acreage to tree canopy coverage. The results for Spa Creek show that residential uses have the most areas of open space and should be considered priority target land uses.



Back Creek

Back Creek lies southeast of Spa Creek, and is the sub-watershed that has had the least amount of any previous study work completed. A more extensive analysis of Back Creek is included in this study in Chapter VIII. The following charts, graphs, and maps offer a graphical representation of the resulting data for Back Creek:





Back Creek

N
W E
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Legend

- City of Annapolis
- Watershed Boundary
- Open Space
- Tree Canopy
- Impervious Surface

0 1,000 2,000 Feet

1 inch = 1,000 feet

Vicinity Map (not to scale)

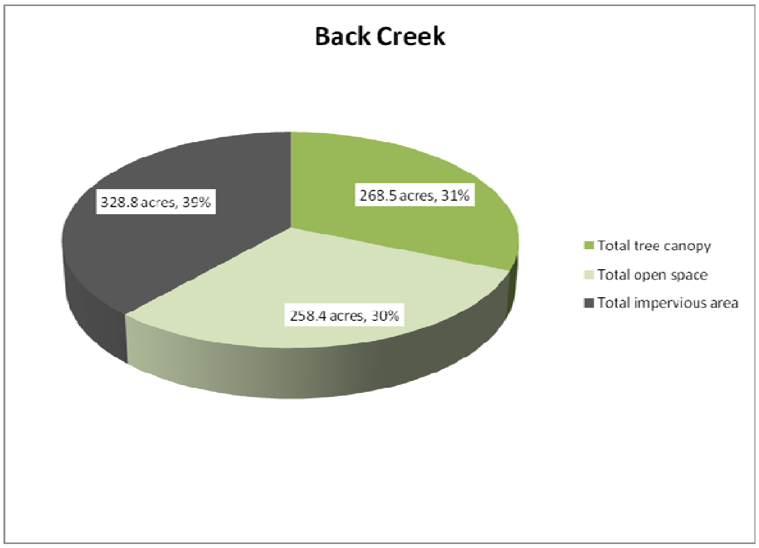
AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

McCRONE ENGINEERS • SURVEYORS • PLANNERS

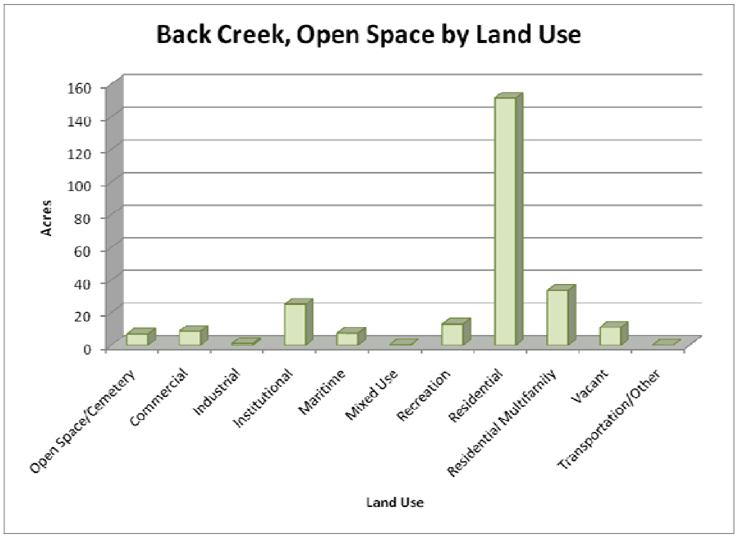
Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis

The above bar graph shows a breakdown in the existing tree canopy coverage (in acres) in the Back Creek watershed per the 2005 designated land use categories. Residential uses were found to have the largest areas of tree canopy coverage.

The pie chart below depicts a breakdown of the total Back Creek watershed acres into tree canopy, impervious, and open space/other areas. The data shows that 39% of the watershed area is covered by impervious surfaces, whereas 31% is covered in tree canopy, and the remaining 30% of land area is categorized as open space/other.

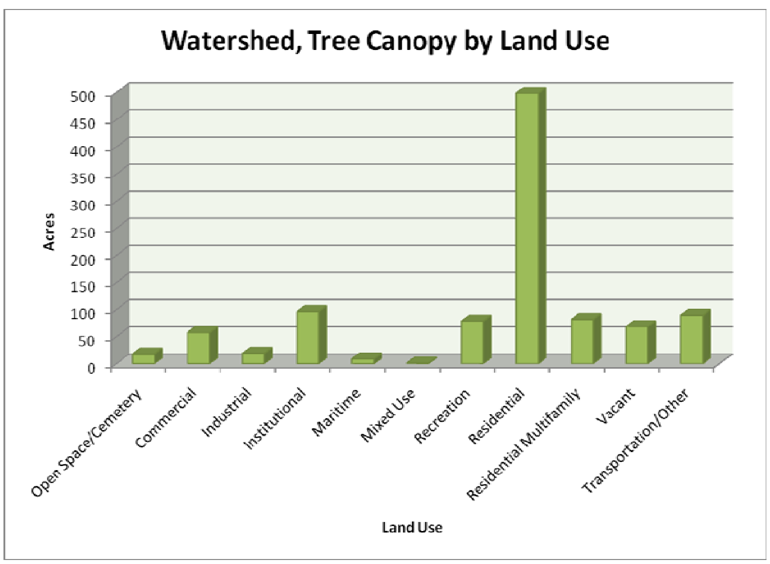


The chart below depicts the existing open space acreages per land use in Back Creek. The resulting data is meant to assist the City in targeting certain land uses in each watershed to increase UTC by converting open space acreage to tree canopy coverage. The results for Back Creek show that residential uses have the most areas of open space and should be considered priority target land uses.



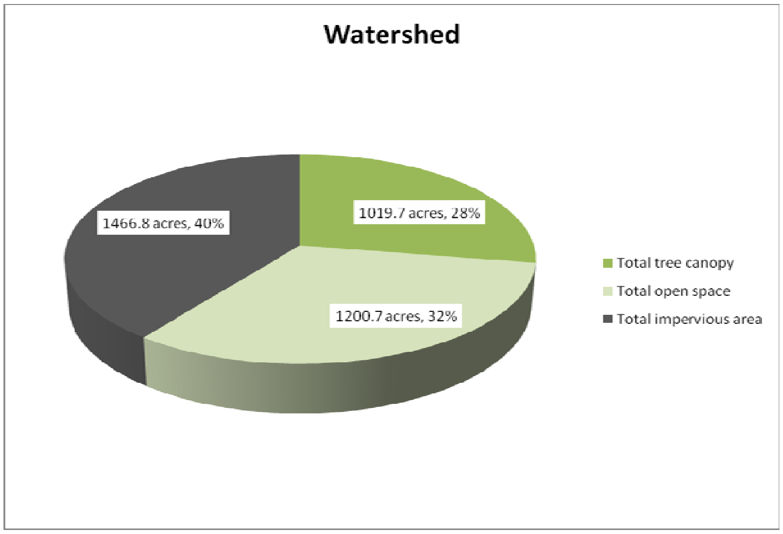
Total Watershed

We have included calculations and data for the total Annapolis watershed (all four sub-watersheds) in order to get an overall picture of the existing conditions throughout the watershed as a whole. The following charts, graphs, and maps offer a graphical representation of the resulting data for the total watershed area:

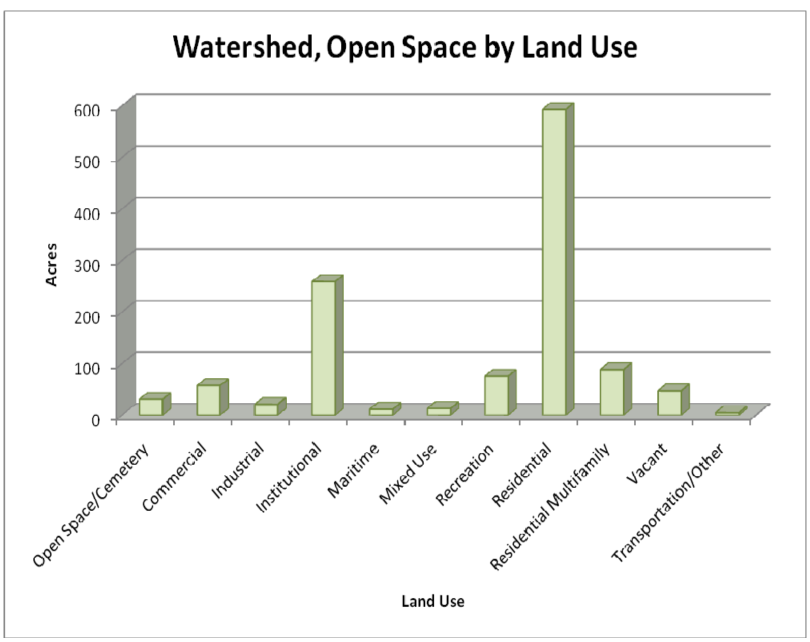


The above bar graph shows a breakdown in the existing tree canopy coverage (in acres) in the total watershed per the 2005 designated land use categories. Residential, institutional, vacant, and commercial uses were found to have the largest areas of tree canopy coverage.

The pie chart below depicts a breakdown of the total Annapolis watershed acres into tree canopy, impervious, and open space/other areas. The data shows that 40% of the total watershed area is covered by impervious surfaces, whereas 28% is covered in tree canopy, and the remaining 32% of land area is categorized as open space/other.

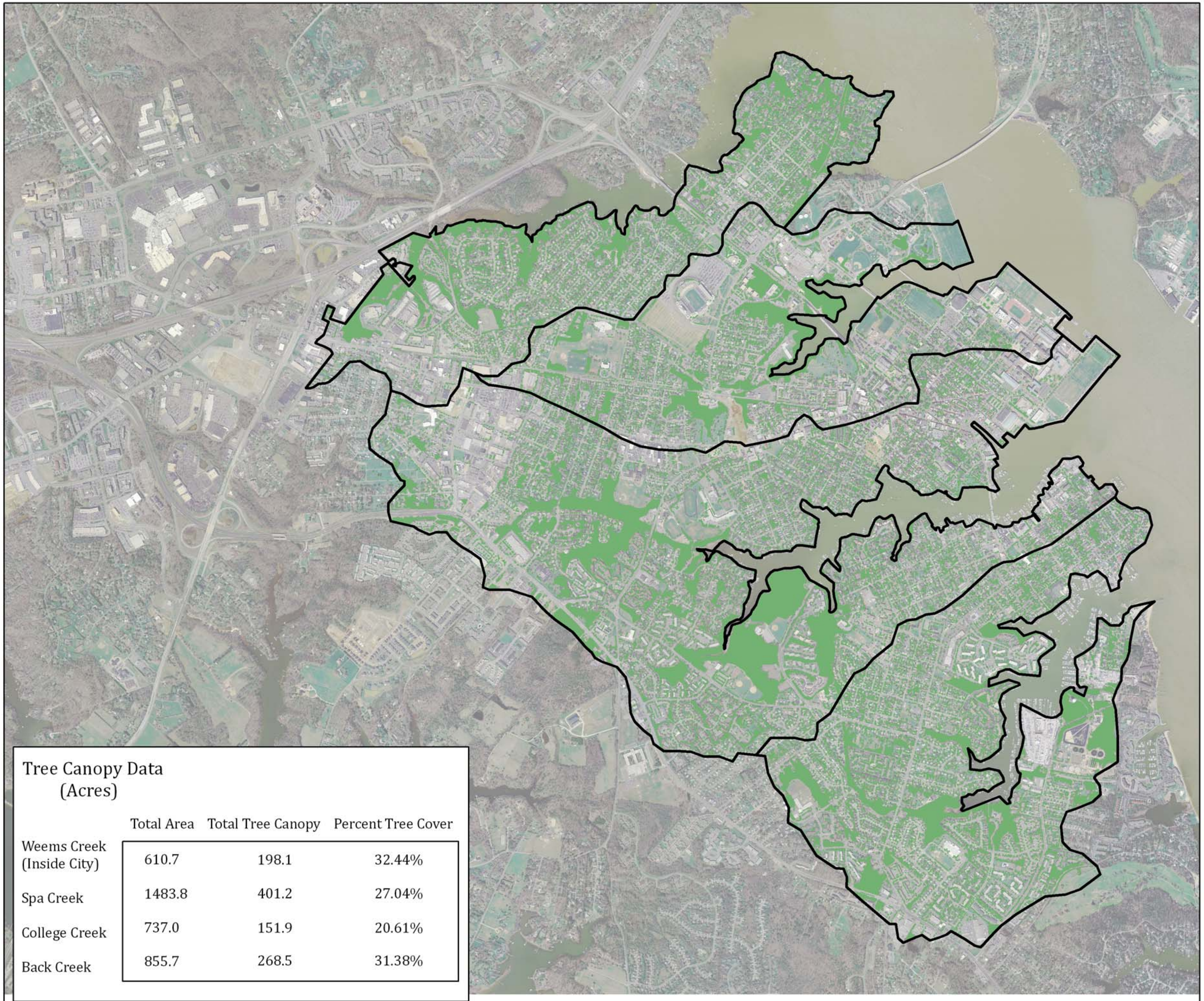


The chart below depicts the existing open space acreages per land use in the Annapolis watershed. The resulting data is meant to assist the City in targeting certain land uses in each watershed to increase UTC by converting open space acreage to tree canopy coverage. The results for the Annapolis watershed show that residential and institutional uses have the most areas of open space and should be considered priority target land uses.



Tree Canopy

Weems Creek
College Creek
Spa Creek
Back Creek



N
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Tree Canopy

Watershed Boundaries

0 2,000 4,000 Feet

1 inch = 2,000 feet

Vicinity Map (not to scale)

Tree Canopy Data
(Acres)

	Total Area	Total Tree Canopy	Percent Tree Cover
Weems Creek (Inside City)	610.7	198.1	32.44%
Spa Creek	1483.8	401.2	27.04%
College Creek	737.0	151.9	20.61%
Back Creek	855.7	268.5	31.38%

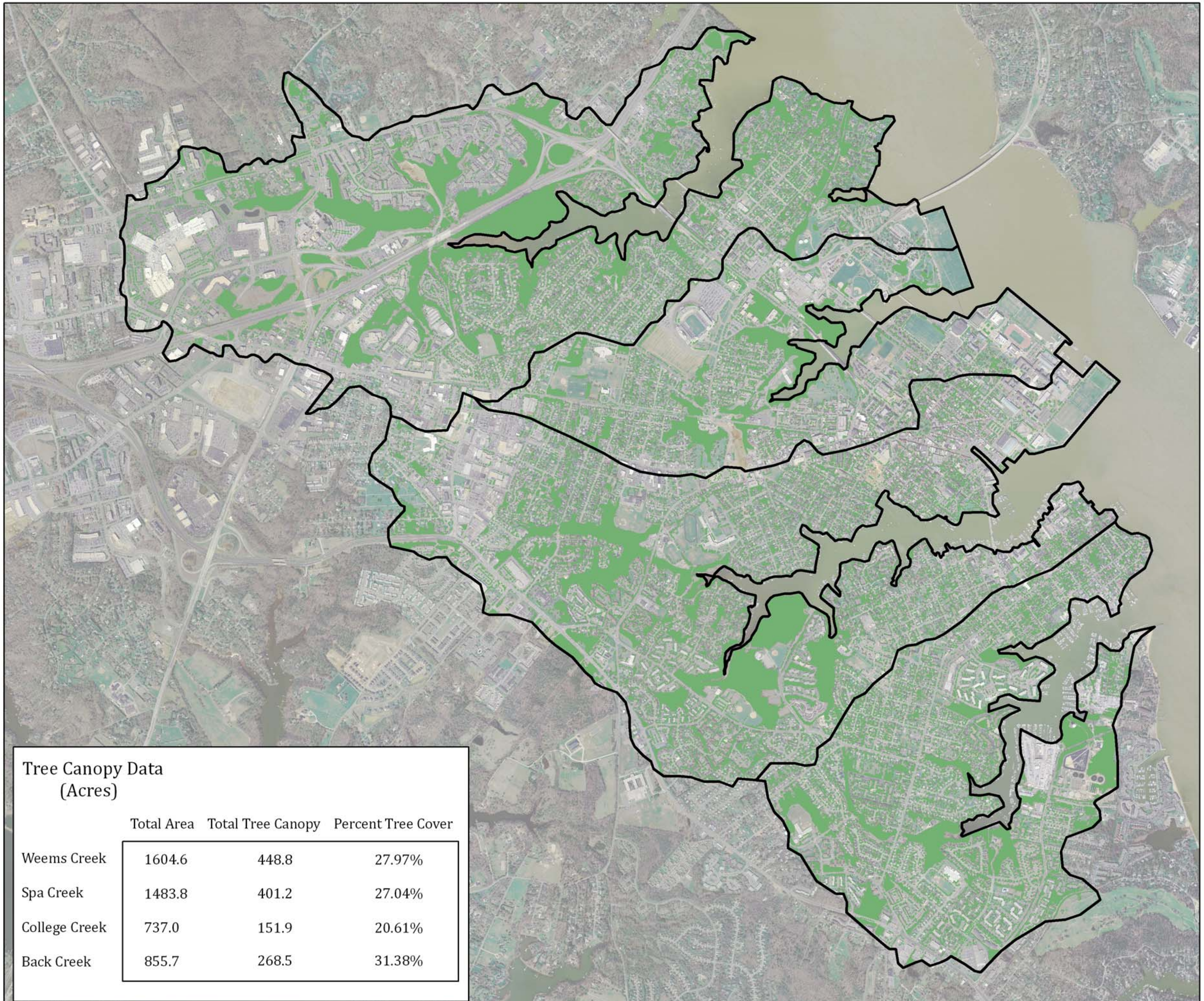
AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

McCRONE ENGINEERS • SURVEYORS • PLANNERS

Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis

Tree Canopy

Weems Creek
College Creek
Spa Creek
Back Creek



Tree Canopy Data
(Acres)

	Total Area	Total Tree Canopy	Percent Tree Cover
Weems Creek	1604.6	448.8	27.97%
Spa Creek	1483.8	401.2	27.04%
College Creek	737.0	151.9	20.61%
Back Creek	855.7	268.5	31.38%

N
W E
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Tree Canopy
Watershed Boundaries

0 2,000 4,000 Feet

1 inch equals 2,000 feet

Vicinity Map (not to scale)

AEGIS
ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

McCRONE
ENGINEERS • SURVEYORS • PLANNERS

Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis

D. Goals

Per the recommendations of MD DNR and the Urban Tree Canopy (UTC) study from 2006, the City of Annapolis has set a goal of attaining 50% city-wide UTC by the year 2036. This percentage was recommended based on adding 25% of the maximum possible additional UTC for the entire City area, which would be 25% of approximately 1,581 acres, or 395.25 acres, according to the MD DNR study. The 2006 study found the existing UTC to be approximately 1,737 acres, or 41%. Ultimately the goal of the City at this point in time is to increase the existing citywide UTC by 9% within a 22 year period.

The data results in Section C of this chapter call attention to the actual existing conditions within the project study area. Compared to the citywide existing UTC of 41%, the existing UTC within the project study area boundary for the city is approximately 28%. This is a 13% difference from the existing UTC of the entire city limits. Additionally, the project study area consisting of the four creeks makes up approximately 81% of the entire city. Hence, in order to increase the overall City UTC to 50% in the next 20 plus years, a significant increase in the watershed UTC will be necessary in order to counter new development and deforestation inside and outside of the project study area.

E. Recommendations and Action Strategies

The City should continue to monitor the progress of the realization of the 50% UTC goal by following the recommendations offered in the DNR 2006 report. Increasing the overall project study area's UTC will be a vital component in reaching this goal, and will be a win-win for the City, as increasing the tree canopy coverage in the watershed areas will help vastly improve watershed health and restoration. We recommend that the City strive for a project study area UTC of 50%. This means the City will need to nearly double the existing UTC in the project study area, by increasing the existing UTC by 22%, from 28% to 50%. This goal may sound aggressive, but because the study area makes up 81% of the entire city, it is necessary in order to reach the citywide goal.

Additionally, we would like to offer the following recommendations and action strategies for increasing UTC within the watershed and citywide:

1. Focus on preservation of existing tree stands inside and outside of the study area. The City should implement a tree canopy awareness program and consider developing policy and code to require new tree plantings as well as existing stand preservation for new development throughout the city.

Education and outreach is an important component of increasing awareness. The City has already made great strides by offering trees for planting. The difficulty lies in ensuring that trees which are distributed are actually getting planted.

2. Identify opportunities for new tree plantings to include public lands, parks, streetscapes, parking lots, etc. Create public awareness and recruit volunteers to assist in UTC initiatives throughout the watershed as well as the city. Some opportunities include:

    a. Partner with the U.S. Naval Academy to increase tree plantings at both the Navy-Marine Corps Stadium and on the campus.

    b. Work with city schools to plant trees on school property. Tree planting can be included as a class project, or school-wide annual event.

    c. Require increased tree plantings in open space areas of public housing properties.

3. The City should consider offering tree planting incentives for homeowners, condos, businesses, etc. in conjunction with public awareness activities and programs. Subdivisions and HOAs already have open space areas that could be planted with new tree cover. Additionally, public housing areas should be considered prime locations for new tree plantings. Incentives might include:

    a. Small property tax credits to be determined by the City can be given to residents for each tree planted on private property.

    b. Vouchers for free parking that residents can use for guests and visitors, or for time beyond what the City already allots to city residents for parking garages and street spaces.

    c. Recognition for tree planting efforts. This might include an annual or semiannual publication regarding tree canopy awareness which names individuals, businesses, and groups for their efforts in increasing UTC.

    d. For streetscape tree plantings, offer the opportunity to "donate" a tree to be planted along city streets. Individuals or groups can contribute a small sum to the City to have a tree planted and have a small name plate which recognizes their efforts.

4. The City should remove or require removal of vacant and unused impervious surfaces (parking, building foundations, etc.) throughout the watershed, as well

as the city. The first step in the process in identifying opportunities for removing/replacing unused or underutilized impervious areas that are considered public lands and properties owned by the City. Secondly, the City should begin to implement Green Alleys and remove existing impervious surfaces in alleyways. Green Alleys are discussed in greater detail in Chapter VIII of this document.

5. The City should work to increase riparian buffers around creeks and major streams in conjunction with living shoreline initiatives already taking place. During the boat tour of the four creeks, there were many areas where tree cover was either non-existent or scarce, at best. Additionally, our tree canopy mapping and analysis depicted an aerial view of existing tree cover around each of the creeks, and the mapping clearly shows that an increase in riparian buffers around creeks and major streams should be considered wherever possible. Many of the initiatives already discussed would be a good start for increasing riparian buffers and tree canopy around streams and creeks.

IV. Impervious Surface Analysis

A. Background and Previous Study Findings

Maryland Department of Natural Resources (DNR) received a Strategic Urban Forest Assessment (SUFA) grant in June 2004, which was used to fund a study to interpret satellite images of the city to determine impervious surface. The study determined that the city's total land area included 42% impervious surfaces (this percentage did not include sidewalks and roads). Impervious surfaces included parking, rooftops, and the like. Additionally, in June 2006, Maryland's DNR – Forest Service division, in conjunction with the Unites States Department of Agriculture (USDA) Forest Service and the University of Vermont Spatial Analysis Lab, released a report on the City of Annapolis' present and potential urban tree canopy. The study utilized various GIS data, which included high-resolution remote sensing data from IKONOS satellite imagery that was interpreted for trees and other kinds of vegetation, as well as impervious surface coverage. Maryland Department of Planning parcel data was also used in the DNR 2006 study. The study showed that the existing tree canopy coverage in Annapolis is approximately 41%.

Part of the intent of this watershed report and action plan is to further analyze the impervious surface coverage in the city and determine the percentage of coverage within the project study area. Once that percentage is determined, recommendations are then made in order to decrease or improve existing impervious surface areas as well as develop programs and BMPs to reduce the impact of the existing impervious surface coverage to the overall condition of the watershed areas. Because the most urban and developed areas of the city are located within the watersheds, it is important to analyze and understand the actual impervious surface percentage. The project team has done an extensive analysis in GIS to determine the current existing impervious surface coverage within each sub-watershed, and we have broken down the total coverage based on land use. The results of this analysis are discussed in this Chapter.

B. Methodology

The project team completed analysis and mapping of impervious areas, and impervious surface coverage was calculated for each sub-watershed using a direct, hands-on approach, allowing for more detail on a spatial level. A geographic information system (GIS), along with a visual interpretation of large scale, ortho-rectified aerial photography, and existing planimetric line data from the City of Annapolis were used to identify areas of impervious surfaces. The existing planimetric datasets included structural and transportation features, such as buildings, concrete pads, sports courts, decks, pools, sidewalks, driveways, parking lots, paved roads, and other non-pervious roads. Existing impervious line data was updated and modified using high resolution aerial imagery from the City of Annapolis (2006). Line data was adjusted to prevent overlapping or gaps in the dataset. Once all data was analyzed for quality control/quality assurance, line data was converted to polygon data. Impervious area was then calculated for each individual dataset, each sub-watershed, and the entire Annapolis project study area as a whole.

Impervious surfaces were categorized into several different classifications by the project team. This methodology allows the City to have a better understanding of what types of impervious surfaces need to be addressed and what programs and initiatives are needed to address those surface types.

C. Existing Conditions and Calculations by Sub-watershed

The project team utilized GIS technology and data from the City to calculate the existing impervious surface coverage for the City of Annapolis watershed study area, consisting of Weems, Spa, College, and Back Creeks. Total land acreage for the area inside of the Annapolis city limits, and within the watershed study area boundary, was calculated to be approximately 3,682.1 acres. The total area for the entire City of Annapolis boundary is 4,542 acres, more or less, or roughly seven (7) square miles. The following chart displays a breakdown of the land acreages for the four sub-watersheds:

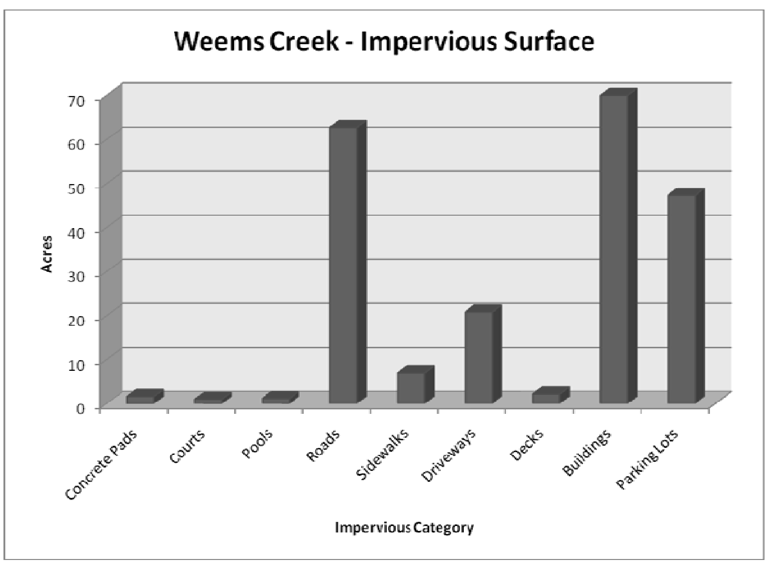
Watershed	Acres	Percentage of study area	Percentage of whole City
Weems	610.7	17%	13%
Spa	1,483.8	40%	33%
College	737.0	20%	16%
Back	855.7	23%	19%
Total	3,682.1	100%	81%

Analysis determined that the roads, parking lots, driveways, and buildings accounted for the largest percentages of impervious surfaces throughout the watershed. Specific results for each of the sub-watershed areas and the whole Annapolis watershed are discussed below.

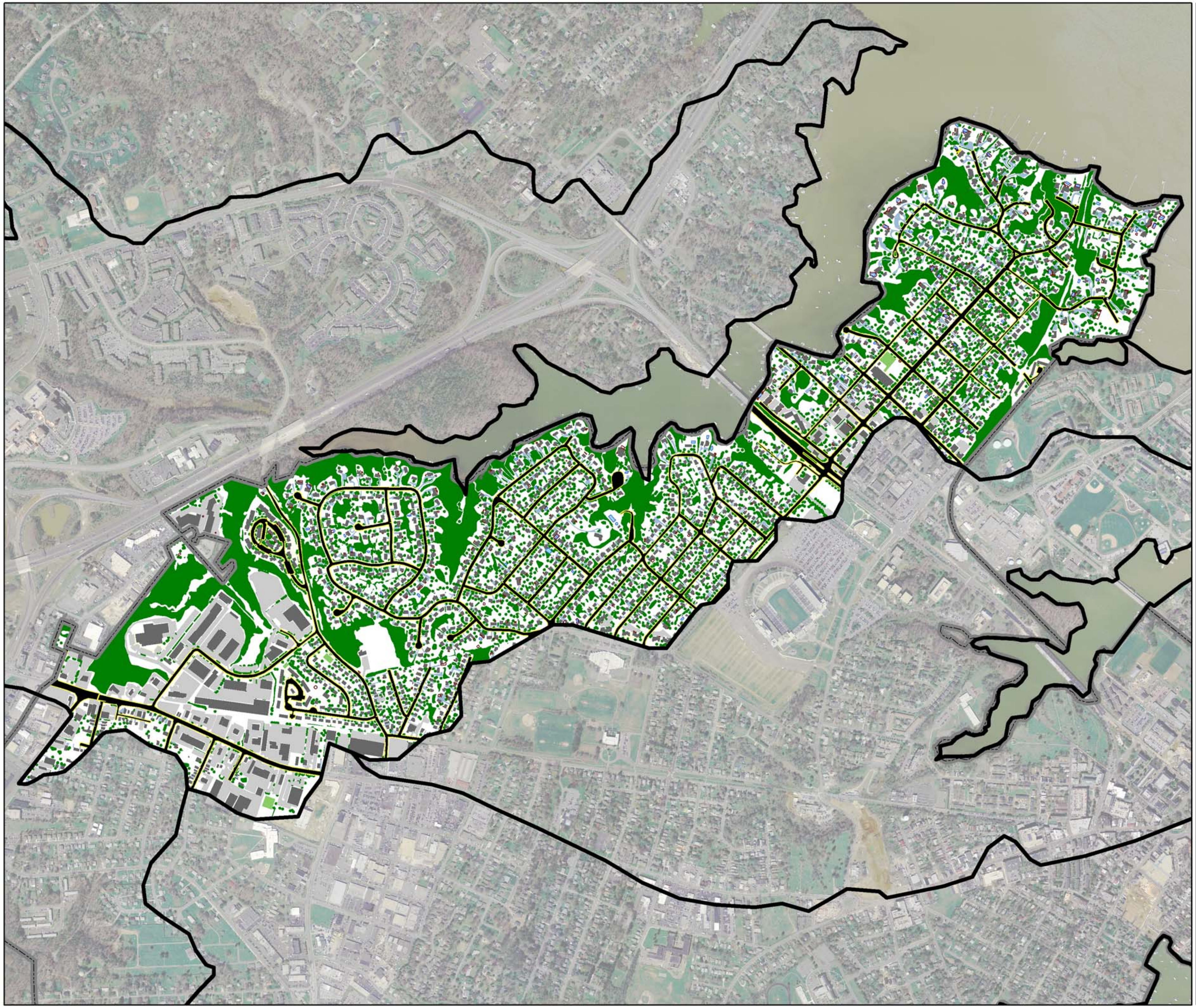
Weems Creek

Weems Creek is somewhat of a unique entity in the study because only a portion of the total sub-watershed actually lies within the City limits. The northern portion of the watershed area actually lies within Anne Arundel County, and a large portion of that area consists of the Annapolis Mall (Westfield Shopping Center) and other related commercial development. Although these areas have a great impact on the overall health and condition of the Weems Creek watershed, analysis of the county portion of the Weems Creek watershed is not included in this report, as the City has no jurisdiction in the county. For the purposes of this study, data was calculated for the Weems Creek watershed area within the city limits, which totals 610.7 +/- acres. The following charts, graphs, and maps offer a graphical representation of the resulting data for Weems Creek:

The following charts, graphs, and maps offer a graphical representation of the resulting data for Weems Creek:



The above bar graph shows a breakdown in the existing impervious coverage (in acres) in the Weems Creek watershed per impervious categories designated by the project team. Roads and buildings were found to be the largest areas of impervious surface coverage.



City of Annapolis Watershed Assessment

Weems Creek

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W E
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Legend

- City of Annapolis
- Watershed Boundary
- Tree Cover
- Buildings
- Roads
- Sidewalks
- Parking Lots
- Driveways
- Decks
- Concrete Pad
- Courts
- Pools

0 1,000 2,000 Feet

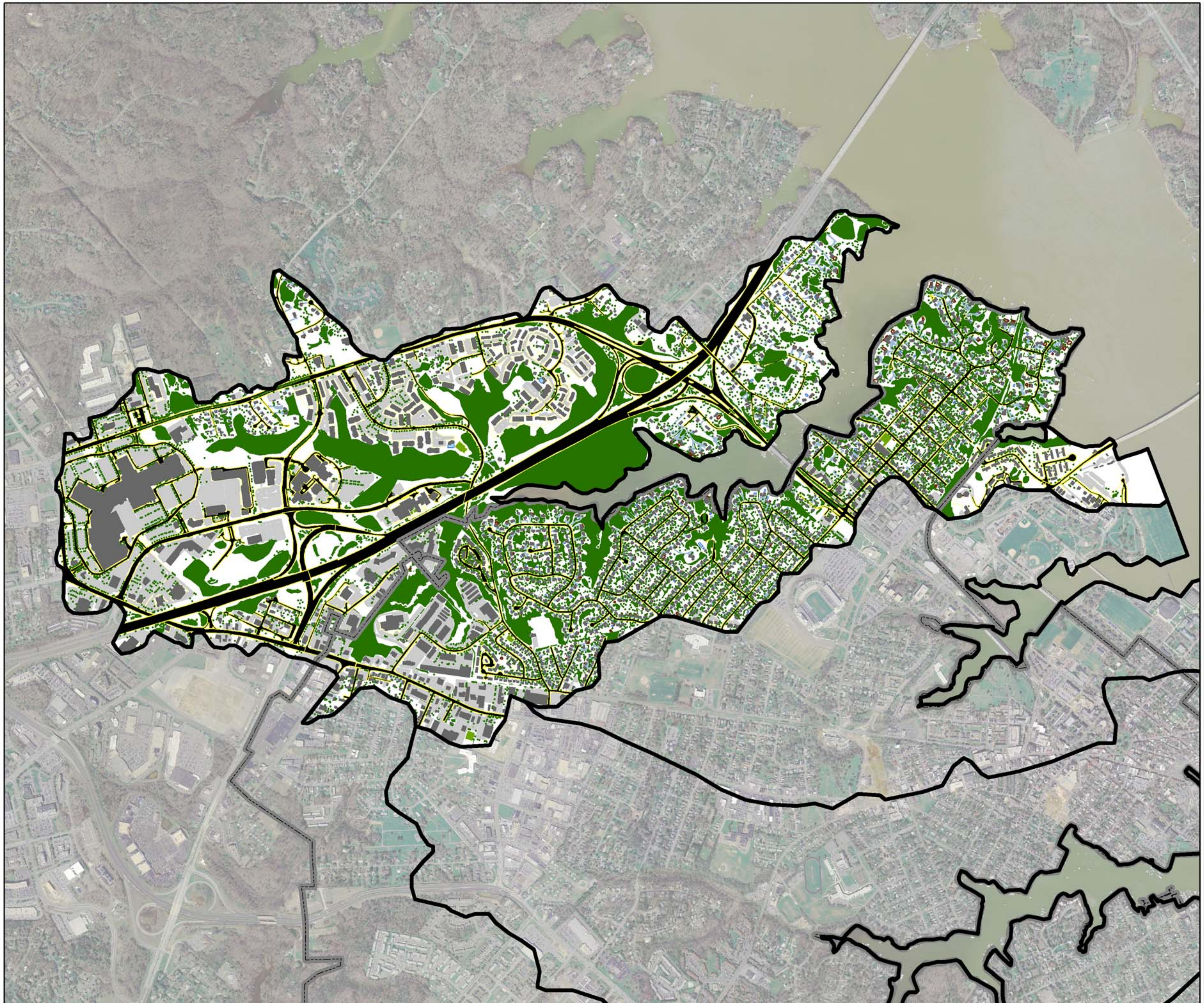
1 inch = 1,000 feet

Vicinity Map (not to scale)

AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

McCRONE ENGINEERS • SURVEYORS • PLANNERS

Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis



City of Annapolis Watershed Assessment

Weems Creek

N
W E
S

Legend

- City of Annapolis
- Watershed Boundary
- Tree Cover
- Buildings
- Roads
- Sidewalks
- Parking Lots
- Driveways
- Decks
- Concrete Pad
- Courts
- Pools

0 1,000 2,000 3,000 Feet

1 inch = 1,500 feet

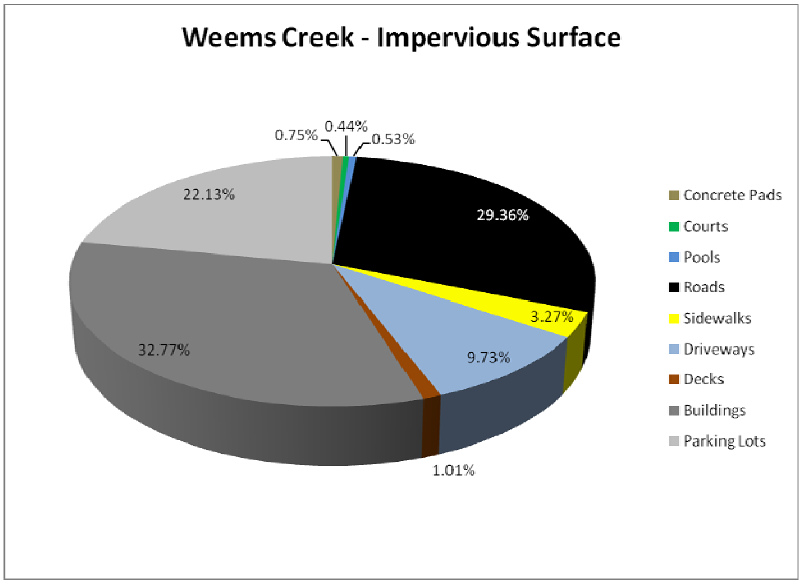
Vicinity Map (not to scale)

AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

McCRONE ENGINEERS • SURVEYORS • PLANNERS

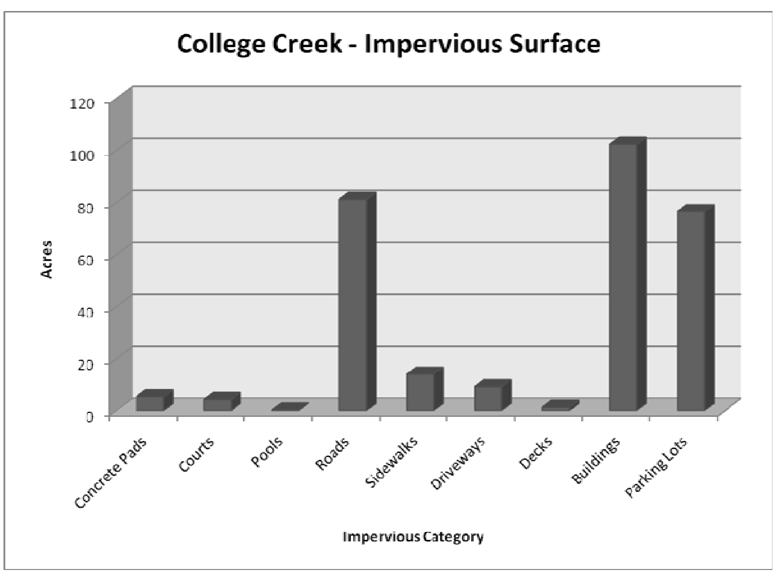
Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis

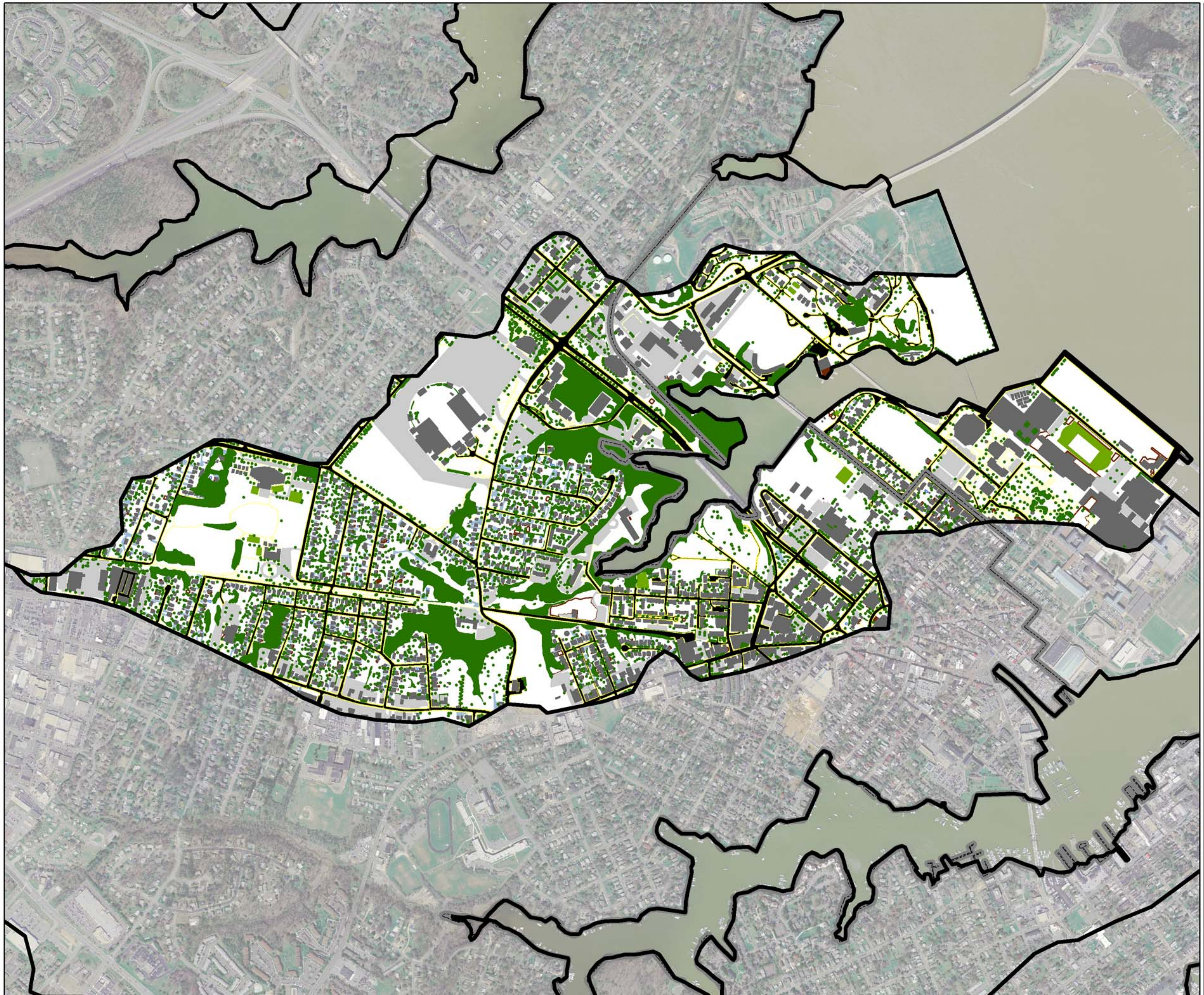
The pie chart below depicts a breakdown of the total Weems Creek impervious surfaces into the nine different impervious categories by percentage. The data shows that roads account for 29.4% of the total impervious surface in the Weems Creek sub-watershed, parking lots are 22.1%, buildings are 32.8%, and driveways are 9.7%.



College Creek

College Creek is the second smallest of the four sub-watersheds and is nestled between Weems Creek and Spa Creek. The following charts, graphs, and maps offer a graphical representation of the resulting data for College Creek:





City of Annapolis Watershed Assessment

College Creek

N
W E
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Legend

- City of Annapolis
- Watershed Boundary
- Tree Cover
- Buildings
- Roads
- Sidewalks
- Parking Lots
- Driveways
- Decks
- Concrete Pad
- Courts
- Pools

0 1,000 2,000 Feet

1 inch = 1,000 feet

Vicinity Map (not to scale)

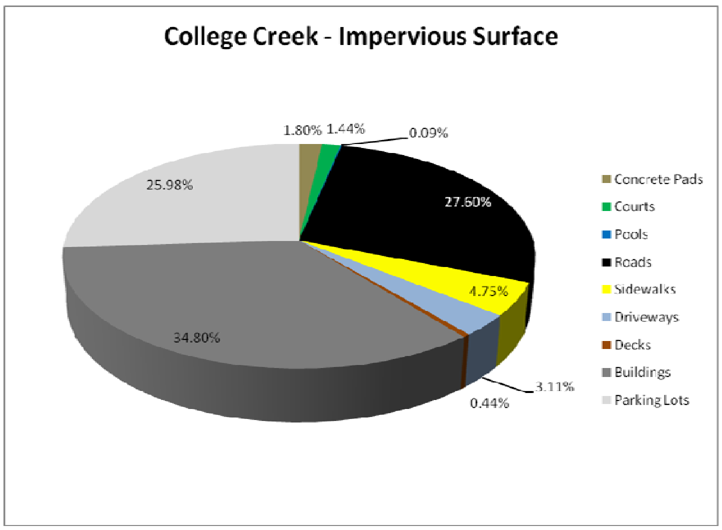
AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

McCRONE ENGINEERS • SURVEYORS • PLANNERS

Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis

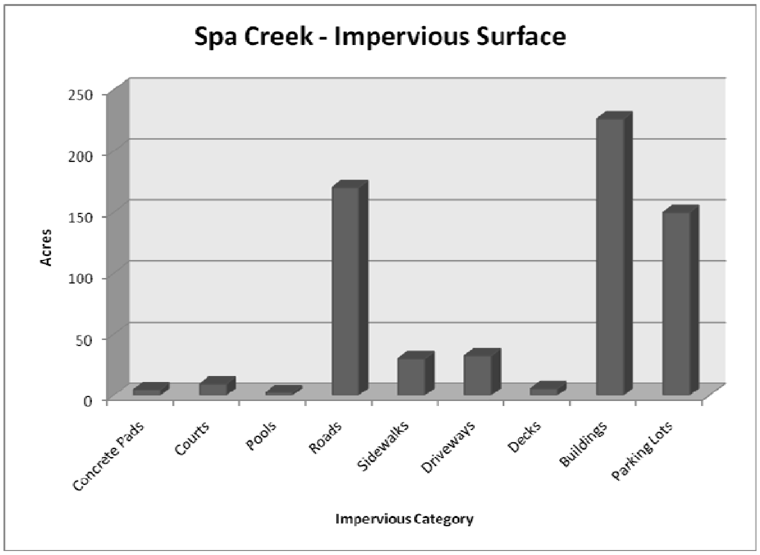
The above bar graph shows a breakdown in the existing impervious coverage (in acres) in the College Creek watershed per impervious categories designated by the project team. Buildings and roads were found to be the largest areas of impervious surface coverage.

The pie chart below depicts a breakdown of the total College Creek impervious surfaces into the nine different impervious categories by percentage. The data shows that roads account for 27.6% of the total impervious surface in the College Creek sub-watershed, parking lots are 25.9%, buildings are 34.8%, and driveways are 3.1%.



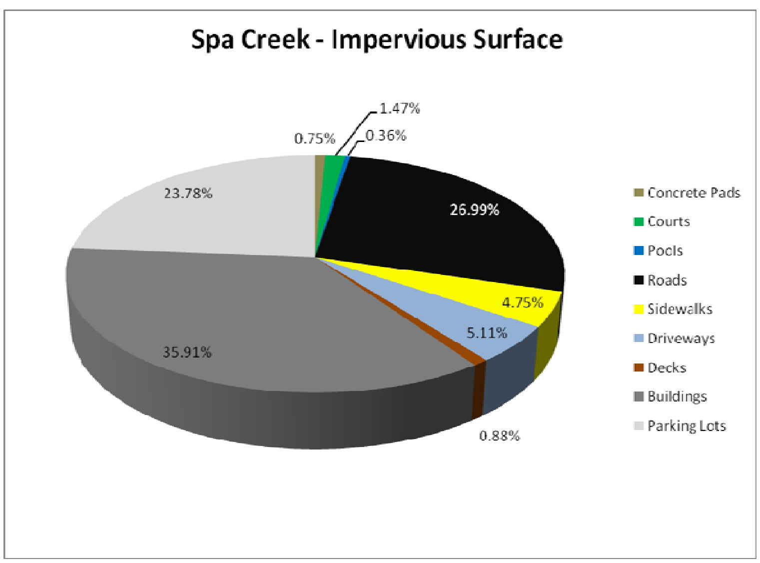
Spa Creek

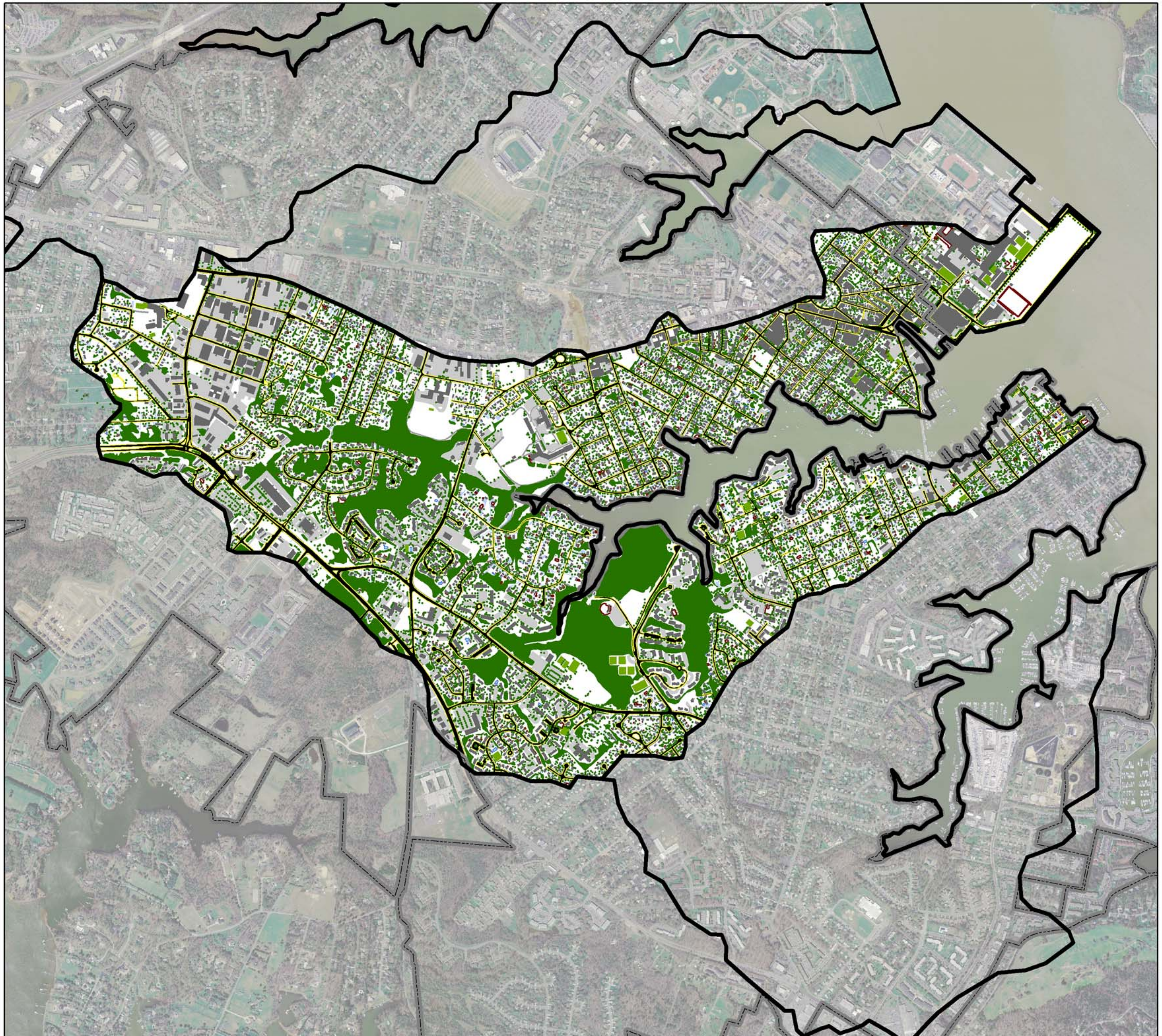
Spa Creek is located between College and Back Creeks and is the largest sub-watershed in the study area. The following charts, graphs, and maps offer a graphical representation of the resulting data for Spa Creek:



The above bar graph shows a breakdown in the existing impervious coverage (in acres) in the Spa Creek watershed per impervious categories designated by the project team. Buildings and roads were found to be the largest areas of impervious surface coverage.

The pie chart below depicts a breakdown of the total Spa Creek impervious surfaces into the nine different impervious categories by percentage. The data shows that roads account for 26.9% of the total impervious surface in the Spa Creeksub-watershed, parking lots are 23.8%, buildings are 35.9%, and driveways are 5.1%.





City of Annapolis Watershed Assessment

Spa Creek

N
W E
S

Legend

- City of Annapolis
- Watershed Boundary
- Tree Cover
- Buildings
- Roads
- Sidewalks
- Parking Lots
- Driveways
- Decks
- Concrete Pad
- Courts
- Pools

0 1,500 3,000 Feet

1 inch = 1,500 feet

Vicinity Map (not to scale)

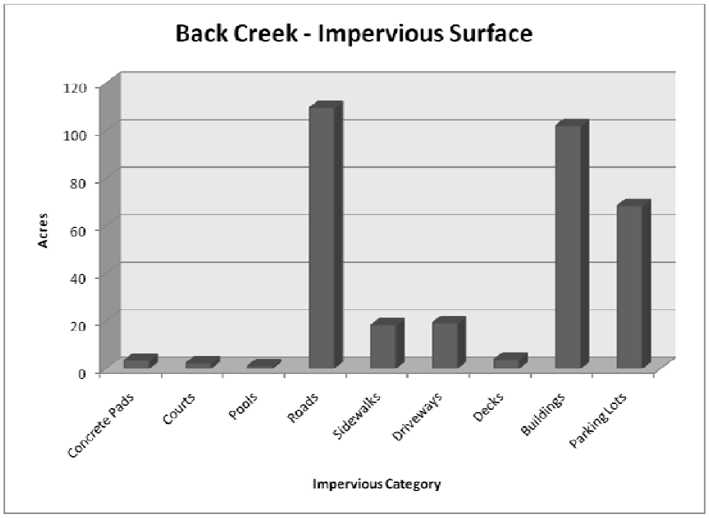
AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

McCRONE ENGINEERS • SURVEYORS • PLANNERS

Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis

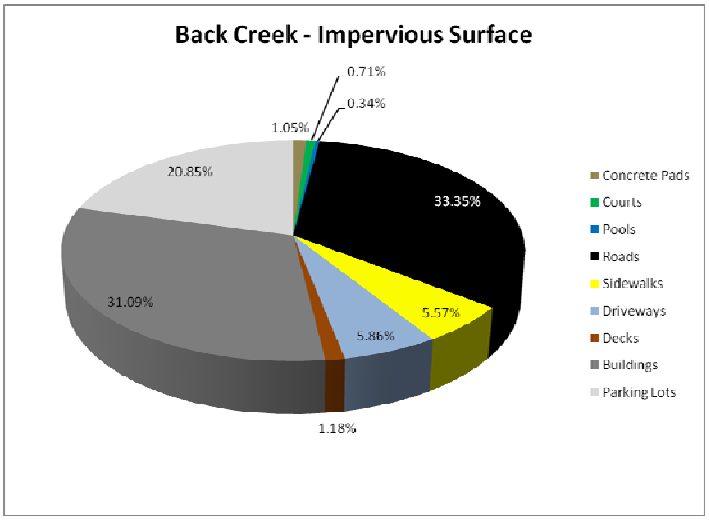
Back Creek

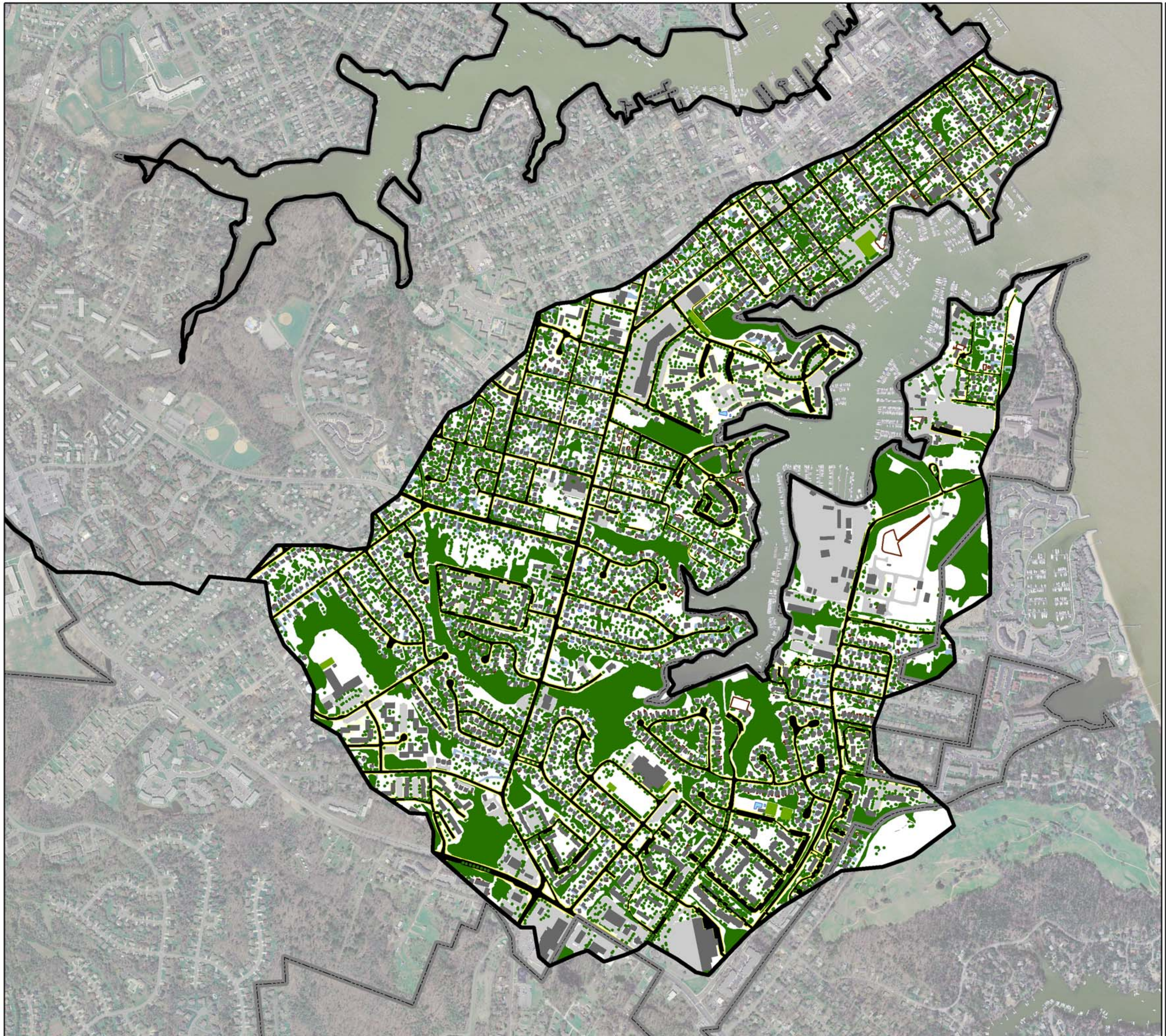
Back Creek lies southeast of Spa Creek, and is the sub-watershed that has had the least amount of any previous study work completed. A more extensive analysis of Back Creek is included in this study in Chapter VIII. The following charts, graphs, and maps offer a graphical representation of the resulting data for Back Creek:



The above bar graph shows a breakdown in the existing impervious coverage (in acres) in the Back Creek watershed per impervious categories designated by the project team. Roads and buildings were found to be the largest areas of impervious surface coverage.

The pie chart below depicts a breakdown of the total Back Creek impervious surfaces into the nine different impervious categories by percentage. The data shows that roads account for 33.3% of the total impervious surface in the Back Creek sub-watershed, parking lots are 20.8%, buildings are 31.1%, and driveways are 5.9%.





City of Annapolis Watershed Assessment

Back Creek

N
W E
S

Legend

- City of Annapolis
- Watershed Boundary
- Tree Cover
- Buildings
- Roads
- Sidewalks
- Parking Lots
- Driveways
- Decks
- Concrete Pad
- Courts
- Pools

0 1,000 2,000 Feet

1 inch = 1,000 feet

Vicinity Map (not to scale)

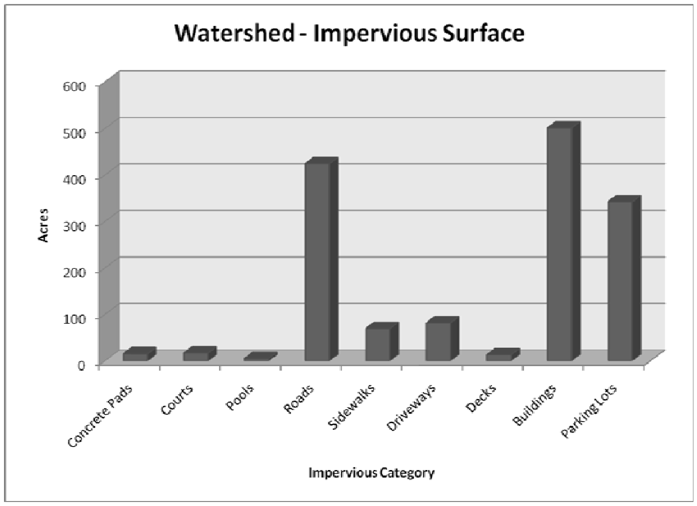
AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

McCRONE ENGINEERS • SURVEYORS • PLANNERS

Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis

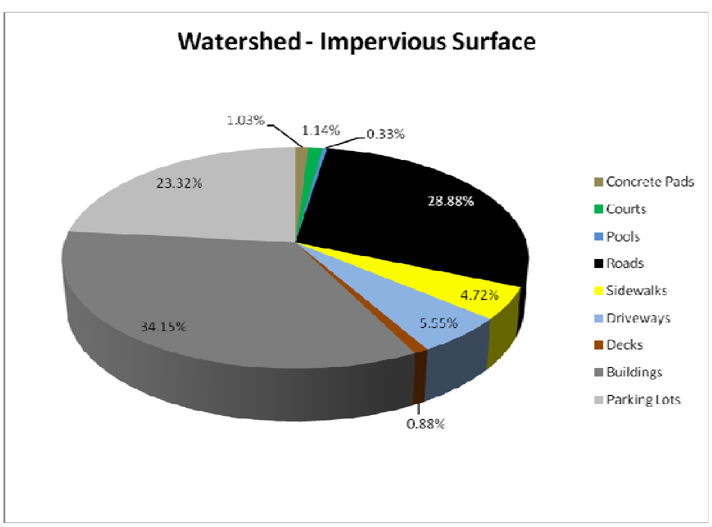
Total Watershed

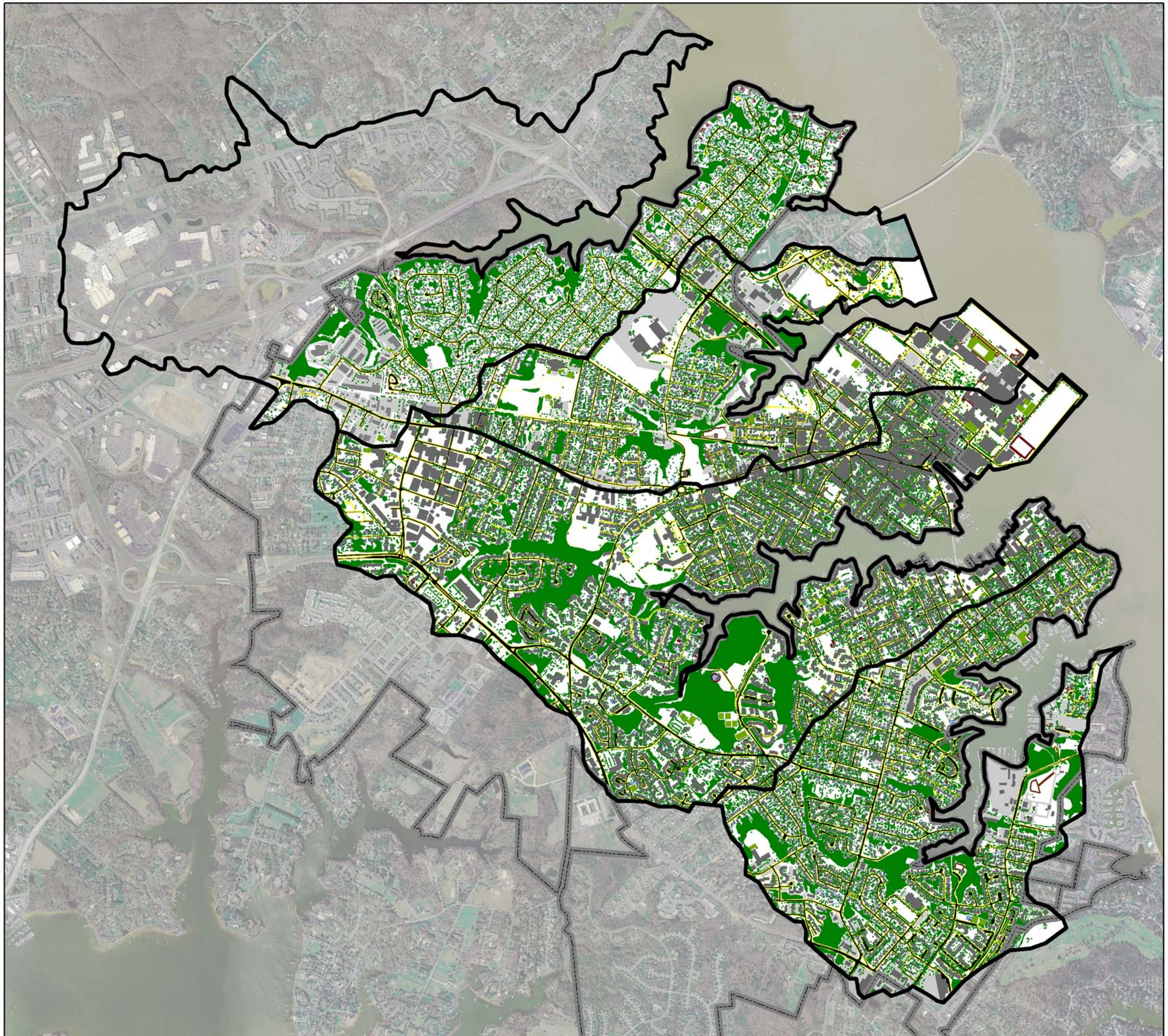
We have included calculations and data for the total Annapolis watershed (all four sub-watersheds) in order to get an overall picture of the exiting conditions throughout the watershed as a whole. The following charts, graphs, and maps offer a graphical representation of the resulting data for the total watershed area:



The above bar graph shows a breakdown in the existing impervious coverage (in acres) in the Annapolis watershed per impervious categories designated by the project team. Buildings and roads were found to be the largest areas of impervious surface coverage.

The pie chart below depicts a breakdown of the total Annapolis watershed impervious surfaces into the nine different impervious categories by percentage. The data shows that roads account for 28.9% of the total impervious surface in the Annapolis Watershed, parking lots are 23.3%, buildings are 34.2%, and driveways are 5.6%.





City of Annapolis Watershed Assessment

Weems, College, Spa, and Back Creeks

N
W E
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Legend

- City of Annapolis
- Watershed Boundary
- Tree Cover
- Buildings
- Roads
- Sidewalks
- Parking Lots
- Driveways
- Decks
- Concrete Pad
- Courts
- Pools

0 2,000 4,000 Feet

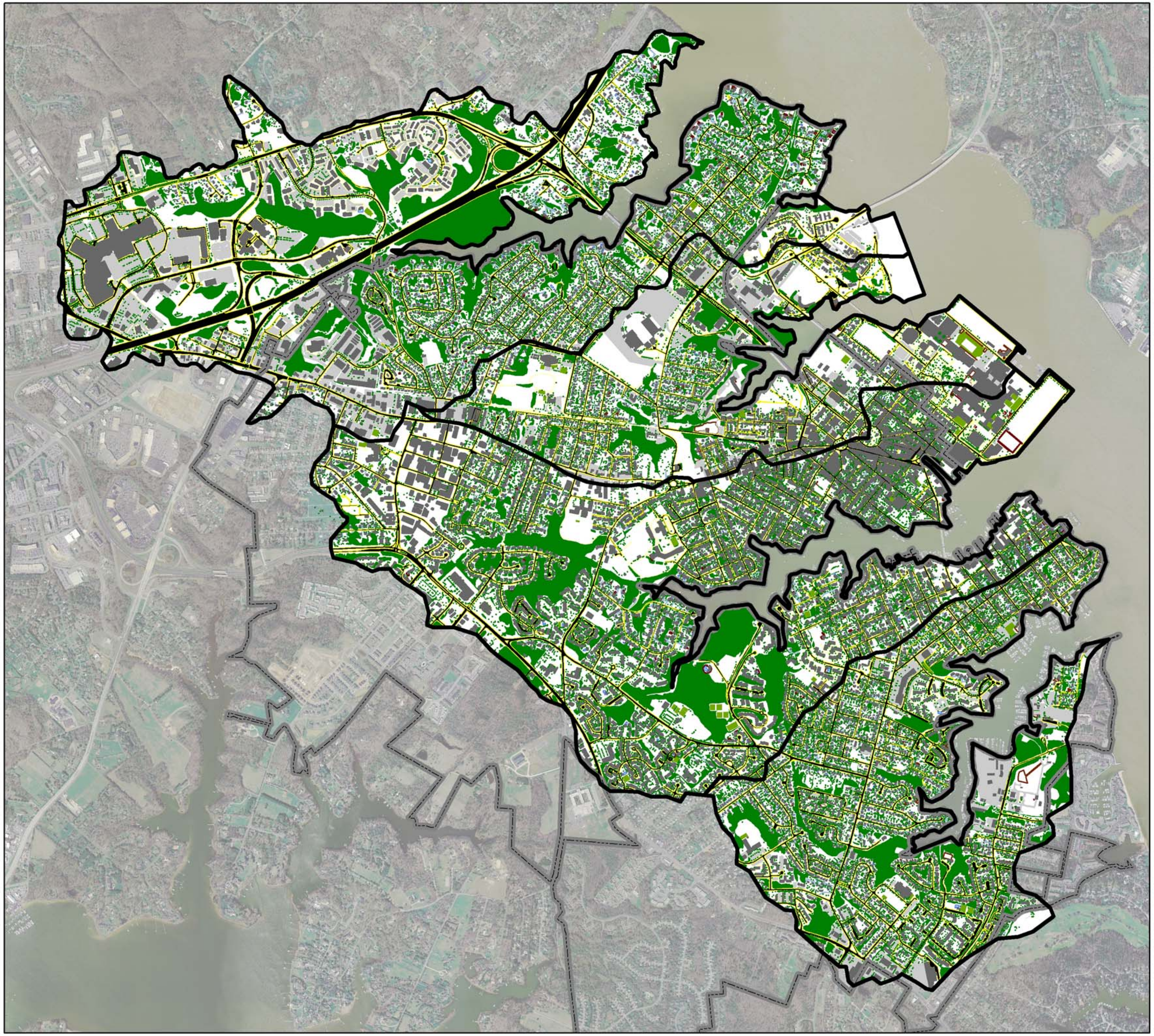
1 inch = 2,000 feet

Vicinity Map (not to scale)

AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

McCRONE ENGINEERS • SURVEYORS • PLANNERS

Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis



City of Annapolis Watershed Assessment

Weems, College, Spa, and Back Creeks

N
W E
S

Legend

- City of Annapolis
- Watershed Boundary
- Tree Cover
- Buildings
- Roads
- Sidewalks
- Parking Lots
- Driveways
- Decks
- Concrete Pad
- Courts
- Pools

0 2,000 4,000 Feet

1 inch = 2,000 feet

Vicinity Map (not to scale)

AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

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Sources: MD Dept. of Natural Resources, Anne Arundel Co., City of Annapolis

D. Goals

The data results in Section C of this chapter call attention to the actual existing conditions within the project study area. Obviously, it is the goal of the City to minimize the addition of impervious surfaces throughout the city as whole, and in the study area. It would be difficult to decrease the existing percentages by any significant amount, but by locating vacant and unused areas of impervious surfaces and converting those areas to pervious surfaces, in addition to encouraging and modeling watershed-friendly programs such as rain gardens, rain barrels, tree planting, etc., the City can reduce the impact of the existing impervious surfaces on the watershed's overall health and condition.

Increasing tree canopy coverage (discussed in Chapter III) will help reduce direct runoff from impervious surfaces. It will also having a cooling effect on impervious surfaces, reducing the temperature of the runoff that is flowing directly into storm drains and outfalls which empty directly into streams and creeks.

Additionally, innovative Best Management Practices (BMPs), combined with increased tree canopy, and a reduction of impervious surfaces, will provide alternatives to traditional stormwater management ponds which store runoff at higher temperatures, resulting in increased pollutants and bacteria that will later go into streams and creeks.

E. Recommendations and Action Strategies

We would like to offer the following recommendations and action strategies for reducing the impact of impervious surfaces to the creeks and watershed areas within the watershed boundary as well as citywide:

1. Target residents and encourage them to plant a tree, install a rain barrel, or put in a rain garden or green roof to reduce the impact of runoff from building rooftop impervious surfaces. Because this is an urban watershed, and building rooftops account for such a large percentage of the impervious surfaces throughout the watershed, it is important that residents are aware of the little things they can do to help improve watershed health.

2. Establish an impervious cover threshold in the zoning code specific to the watershed for future development, and incorporate tree canopy guidelines, as well as BMPs for stormwater runoff (suggested BMPs are discussed later in the study).

3. Minimize impervious cover in new development through techniques such as reducing the width of roads, smaller cul-de-sacs, narrower sidewalks, smaller parking areas, etc., where possible.

4. Encourage alternatives to impervious concrete and pavement, such as porous/pervious concrete and porous/pervious pavers, and implement incentive programs for new development as well as redevelopment for using alternative materials in place of impervious concrete and pavement. Additionally, encourage minimal paving of driveways and private walkways (details discussed in Chapter VIII).

5. Identify vacant and unused impervious areas which are public and remove those areas, replacing them with model rain gardens, porous pavement alternatives, and/or trees. Establish pollution reduction strategies, such as rain barrels, roof gardens, rain gardens, and bio-retention cells on public properties, such as schools, parks, etc. Implement a community outreach program in conjunction with these BMPs, and encourage city residents and business owners to follow the example of the City.

6. Possibly require the conversion of impervious surfaces on lots that have been vacant for several years to pervious surfaces. Require tree plantings or some other watershed-friendly BMPs. Opportunities for impervious surface removal/reductions include underutilized shopping centers throughout the city, concrete pads and sidewalks on public lands and parks that can be replaced with other surfaces, and impervious surfaces in alleys which can be replaced with gravel, grass, or porous concrete and pavers.

7. Increase tree plantings around the few existing stormwater management ponds throughout the city (see Chapter V). The increased tree cover will help cool the temperature of the ponds, helping to reduce pollutants and bacteria.

V. Water Quality and Quantity Control Structure Assessment

A. Background

Part of the scope of this study is to identify and provide the City with a digital inventory of existing water quality and quantity control structures throughout the watershed. Currently water and sewer operations within the city are owned and maintained by the City. According to Department of Public Works (DPW), pipes and pumps are all owned by the City, but the wastewater treatment facility is owned by both the City and County, although operated only by the County. All stormwater infrastructure is owned and maintained by the City, with the exception of infrastructure within County or State rights of way or that have been designated as private infrastructure through the development process. The project team was provided a digital scan of a water and sewer map of the city by the Department of Public Works, which included existing inlets, catch basins, pipes, and drains. DPW also provided a digital scan of the control structure and stormwater facility inventory, including easements and rights-of-way. This digital scan consisted of a street map of the city with existing structures and easements highlighted and notated by hand.

B. Methodology

The GIS team for this project was able to geo-reference the provided scans in our GIS software and, combined with spatial utility data provided by the City, created new digital layers from the digital scanned maps. GIS-compatible shapefiles were created and then imported into a geodatabase, later to be delivered to the City's GIS staff at the Office of Information Management.

Once these layers were created, they were then populated with available attribute data. Most of the attribute data came directly from the scans themselves, and much of that data was hand-written on the original paper maps housed at DPW. After data creation and attribution, new maps were created utilizing the newly developed data layers.

C. Existing Conditions

After an assessment of the existing data, as well as field survey analysis, the project team found that there are very few control structures within the watershed. The most common method for managing stormwater runoff throughout the city's watershed area consists of catch basins, pipes, and direct outfalls into each of the creeks. The project team's boat tour of each of the creeks revealed many direct pipe outfalls at street ends.

There are a few stormwater management ponds that have been installed with the development of subdivisions in parts of the watershed, and they are depicted on the existing control structure mapping included in this Chapter.

The following are some samples of outfalls and existing conditions observed via the boat tour and field survey.

Weems Creek

Field observation of Weems Creek during the boat tour showed several different types of outfalls and shoreline management practices. Figure 5-1 shows some attempted shoreline stabilization by use of what looks like sand bags and wood. Measures like this will help provide solutions for stabilizing shorelines by utilizing methods that are both effective and will contribute to improving water quality.

Figure 5-1

Figure 5-2 shows a direct underground pipe outfall into Weems Creek from a private residence. Figure 5-3 shows an above-ground pipe outfall directly into the creek from a private residence.

Figure 5-2

Figure 5-3

Because many of the city's streets run into waterways, there are many instances throughout the creeks where asphalt stops directly at the shoreline, and runoff flows directly from pavement into the water. Figure 5-4 is an example of a street-end ramp on Weems Creek where runoff would flow directly into the creek.

Figure 5-4

Spa Creek

There are also many streets that end at the Spa Creek shoreline. Figure 5-5 is an example of a street end that is currently outfalling into the creek through a concrete jersey wall. The City has converted many street ends into street end parks, rain gardens, and public water access ways, and will need to continue to convert street ends throughout the City to improve overall watershed health.

Figure 5-5

Figure 5-6 shows another example of pipe openings in a bulkhead at a street end, in particular, Revell Street. Runoff that does not flow into catch basins is flowing directly from the pavement into Spa Creek.

Figure 5-6

Figure 5-7 is yet another example of a street end, where runoff is able to flow directly from the pavement into the creek. In this particular example, there is a dumpster on the street, so any pollutants leaking from that dumpster are being washed directly into the creek. Figure 5-7 is also a good example of a public access point for small boats.

Figure 5-7

Figure 5-8 is another example of a street end, but instead of runoff outfalling directly into the creek, a stone trench has been installed, along with a vegetated shoreline.

Figure 5-8

College Creek

College Creek was not easily accessible during the boat tour, so the project team used kayaks to do a field analysis of the creek and its outfalls. Figure 5-9 is an example of a concrete pipe outfall into the creek.

Figure 5-9

Figure 5-10 is another example of a concrete pipe outfall into College Creek, but also shows where someone has dumped an old television into the water. By the look of the photo, the television has been in the water for some time.

Figure 5-10

Figure 5-11 is a good example of an eroding shoreline in need of stabilization. From the examples provided, it is obvious that each of the creeks has a variety of types of outfalls and shoreline problems.

Figure 5-11

Back Creek

Back Creek is home to a majority of the docked boats and marinas in the city, and also has a variety of outfalls and shoreline issues. Figure 5-12 is another example of a street end. In this particular example, the City has installed a small garden at the street end to reduce the impacts of direct runoff from the pavement.

Figure 5-12

Figure 5-13 is an excellent example of a living shoreline at a private residence. Living shorelines are preferred over bulkhead, stone, etc., but are not nearly as common throughout each of the creeks.

Figure 5-13

Figure 5-14 is another example of a pipe outfall from a street end. This particular outfall is located next to a marina, where there is the potential for toxic chemicals and pollutants to directly flow into and contaminate the creek.

Figure 5-14

D. Goals

Part of the intent of this study is to develop a working database of existing water quality and quantity control structures throughout the watershed that can be turned over to the City and continually maintained. Part of the deliverable for this study includes new digital maps, as well as GIS shapefiles and geodatabase layers of water quality and quantity control structures. The goal of the City should then be to maintain this new database on a regular basis, or as needed, as new structures are installed or retrofits and BMPs are implemented through various watershed projects.

E. Recommendations and Action Strategies

One recommendation to the City for maintaining and updating the water quality and quantity control structure database and maps is to train staff within the DPW in basic GIS concepts so that staff members are able to utilize the database and shapefile data, update information, and produce maps as needed. An alternative to this recommendation would be to request that the GIS team at the Office of Information Management be the keeper and maintainer of the data. All photographs and geospatial data relating to this project are part of the deliverable, so it is important that staff be able to work with the data and understand how to update it as needed.

Additionally, the project team has made recommendations in Chapters VII, VIII, and IX for addressing outfalls and retrofitting existing stormwater management throughout the creeks. It is important for the City to continue converting street ends when funds become available. The City should also work with local marinas and boat yards in getting them all green marina certified. Marinas and boat yards can also contribute to improving watershed health by adopting BMPs on their properties, such as rain gardens and other innovative practices (to be discussed in detail later in this document).

Finally, the City has already begun to implement many projects that address outfalls and reducing runoff into the creeks. It is vital that the City continue to implement projects by prioritizing them, budgeting annual funds, and applying for watershed project grants.

VI. Recreational, Historical, and Habitat Restoration Analysis

A. Existing Conditions

As previously mentioned, the City has taken many great strides to improve and restore the Annapolis watershed. Some of the implemented strategies have included projects for habitat restoration throughout the watershed, innovative recreation enhancement projects, among others. Specifically, some things the City has already done throughout the watershed include:

- Installing potential osprey nests throughout each of the four creeks.
- Planning, designing, and implementing street end parks, providing public access to waterways. Some of the street end parks include small floating docks and boat launches for kayaks, canoes, etc.
- Implementing model rain gardens at street ends that flow directly into the creeks. Some of these areas are considered street end parks, and others are strictly garden areas.
- Installing rain gardens and rain barrels at several publicly owned properties.
- Designing and building the Back Creek Nature Park, providing an educational and recreational area for students and citizens to learn about watershed health, impacts, and enhancement practices such as rain gardens and rain barrels.

There are several more programmatic and project specific strategies that the City has already and is currently implementing throughout the watershed area. These are discussed in detail in the next chapter (Chapter VII).

The City of Annapolis, particularly the downtown area, has historic significance, and is determined by the Maryland Historical Trust (MHT) to be within their designated historical area. Many of the historically significant buildings throughout the downtown area have been inventoried and are marked with signs and other information, and some of this data is available through a web search.

B. Goals

One of the intended goals of this study is to provide recommendations for specific opportunities for recreation, habitat restoration, and the improvement of historical site awareness for all four sub-watersheds. Recommendations are also to include a proposed walking and biking greenway trail between Weems Creek and Back Creek, creating a continuous pathway that connects each of the watersheds.

Recommendations should provide the City with tried and tested practices for enhancing watershed awareness, as well as new and innovative ideas for increasing awareness and participation in restoration efforts. The City should implement strategies that will create an enhanced public awareness, educate its citizens, and encourage hands-on support throughout the watershed. Part of that effort includes enhancing and preserving existing recreation, habitats, and historical sites as well as creating new ones. Recommendations for implementation are outlined in the next section.

C. Recommendations and Action Strategies

Public outreach and education should be the main focus in a restoration strategy that includes opportunities for recreation, habitat restoration, and historical sites. The significance of historical sites can be expanded beyond just buildings and monuments, and should include things such as street corners or intersections, historic trees and gardens, cemeteries, etc. Habitat restoration should be more than building an osprey nest, and should include practices such as current habitat preservation, creating new seepage wetland areas, and limiting new development in critical habitat areas. As for recreation, the City can already boast its many street end parks, educational parks, and other public recreational sites. However, in order to enhance public awareness of historical sites, habitat restoration, and recreation, the City should promote existing policies and procedures and implement new ones, including:

- Maintain spatial database of historically significant properties, structures, trees, etc. by utilizing data from the Historical Trust and related organizations. From the spatial database, the City should promote historical places for to residents and non-residents via the Historical Trust's brochures and website. Brochures can be updated to suggest several walking tours or routes of historical places throughout the city. These tours can be generic or themed.

- Community members and visitors should be able to visit the historical website (listed in the Online Resources at the end of this document) and have the opportunity to provide information from their own accounts if they wish.

- In the overall grand scheme, a website for the city that has an interactive mapping component that includes historic information, recreation, habitat restoration, land use information, tree canopy, impervious surfaces, and other watershed-related data resulting from this project is recommended. The public would have instant access to watershed information for the areas in which they live and work. Providing a more advanced technical method for sharing information about the watersheds is a key in keeping up with the ever-changing technological environment we are experiencing every day.

- Continue to convert street ends into parks, providing the public with access to the waterways they have grown to cherish. These parks provide scenic views of the creeks, and are an avenue for public outreach and education through signage and other information.

- For existing parks throughout the city, convert impervious walkways to alternate forms of porous and pervious pavement. This will help reduce the overall impervious surface in the city and provide a model for private landowners to follow. Add signage throughout parks to keep people aware of the effects they have on their watersheds.

- Consider dredging options in the creeks. Many of the complaints from concerned stakeholders and waterfront property owners are that the sediment in the creeks has built up to a point where water depth has decreased, making boating and water access increasingly difficult as time passes. Providing even a slighter deeper water access will increase land values and generate more property tax income for the city.

- Develop and distribute brochures and pamphlets to enhance community awareness about the importance of wetlands and habitat preservation and restoration. During the boat tour, the project team was fortunate enough to see some native species first hand in their habitats, but those existing habitats could be in danger if water quality is not improved and preservation is not made a priority.

- Create and implement a signage plan throughout each of the watersheds to make people aware of when they are entering or leaving a watershed, and are more in tune with the impact they could be having on that watershed by littering, leaving pet waste, etc. Signs should also be placed along designated trails and greenways. GIS technology could be used to create a signage plan for each of the four creeks.

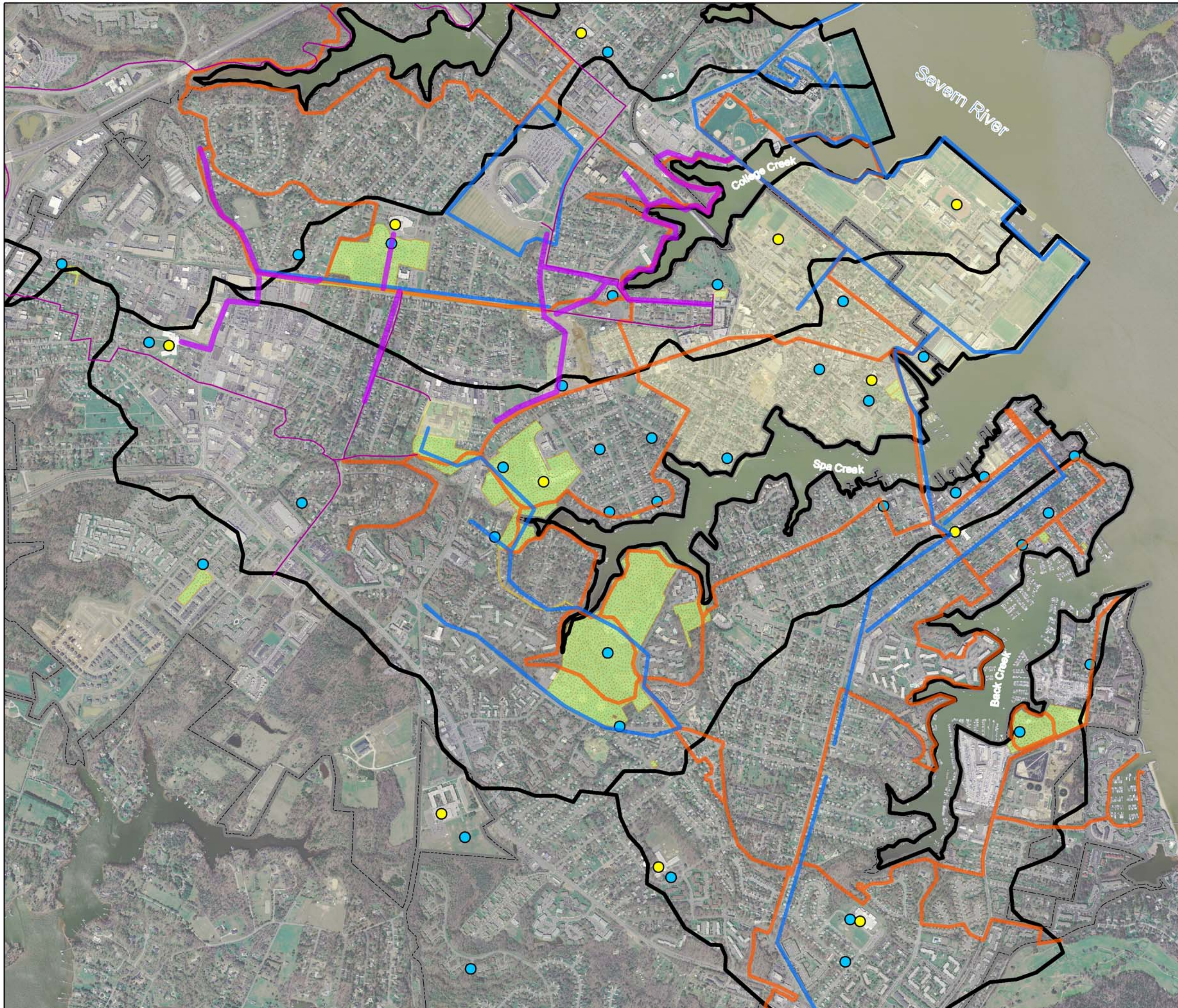
- Encourage the community and its visitors to explore and utilize existing (and proposed) trails and bike paths throughout the city. These trails and pathways will be valuable educational tools, and will provide people with a tour of the city, its watersheds, and many of the innovative and significant projects the City has been implementing. Again, signage is an important element of this recommendation.

- Work with the project team to secure future grants to continue restoration efforts. Host a workshop for stakeholders to learn about packing grant applications and developing innovative strategies for watershed restoration. It is clear that the future of the watershed will rely heavily on a combination of tried and true methods, as well as innovative and impactful projects and initiatives.

The following maps outline existing and proposed trail alignments for connecting the four watersheds, as well as a proposed bike path that has been developed in cooperation with City staff.

Existing and Proposed Trails

City of Annapolis



N
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Legend

- Parks
- Mini Park
- Pedestrian System
- Existing Trails
- Proposed Trails
- Schools
- Historical Area
- Watershed Boundary
- City of Annapolis

0 1,500 3,000 Feet

1 inch = 1,500 feet

AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

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Source: City of Annapolis, Maryland DNR, Anne Arundel County

Proposed Bike Trail

City of Annapolis

Legend

- Trail
- Public land
- Watershed Boundary
- City of Annapolis

0 2,000 4,000 Feet

1 inch = 2,000 feet

Vicinity Map (not to scale)

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AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

VII. Annapolis Watershed Enhancement Implementation Strategies and Recommendations

Introduction

This document is intended to be a unique urban strategy that can be used by other urban jurisdictions. The strategy bundles a multitude of projects of long-standing concern to our watershed stakeholders and the City. In our urban environment, airborne deposition of nitrogen and mercury are more of a threat to the Chesapeake Bay watershed environment than to the suburban and agricultural areas. Some key issues to note: (1) a dense urban tree canopy can help in the reduction of impairing elements and improve water quality; (2) land-based, marine-related activities, so dense and concentrated in our waters, can be better policed and regulated; (3) a strong outreach and education strategy for the thousands of residents and visitors that cruise into our creeks can greatly improve watershed behaviors; (4) sediment and erosion control planning requires new standards and enforcement to slow or eliminate sediment and its concomitant chemistry from our waterways; and (5) that urban concentrations of pet waste and wildlife living in the storm lines may contribute significantly to the fecal coliform impairment of the Severn River mainstem as defined in its Total Maximum Daily Load (TMDL).

The City should propose to adopt a series of associated programmatic changes, both in code and in policy, which will ensure the sustainability of each strategy and project included in the grant proposal. Moreover, the City needs to implement policies and programs. Adopting them is not enough. The City will have to examine its current available resources and formulate a strategy that will put them in a position to be able to enforce and implement programs and policies that they have adopted. The most important recommendation that can be made here is to provide a way of ensuring that programmatic changes are implemented and measured for success.

Scientific Feasibility

Consideration of the watershed's physical characteristics and proposed practices will demonstrate the effect of the project on water quality: By bundling four well studied watersheds together, the City presents an ideal acreage (3682.1 acres) for the validation of an urban watershed strategy with an array of specific projects small enough to be measurable for sediment capture, bacteria containment, and stormwater management controls. The City should anticipate approximately nine (9) months of construction and implementation time from the date of beginning of projects and to have demonstrable results within the first full year of the grant cycle. Each implementation project will have a set of design impairment reduction goals. Measurement of the success of each is based on Tributary Strategy Team's values applied to the scale of implementation achieved. Recommendations include a very broad range of individual best management practices, as well as innovative and challenging demonstration projects.

Implementation Readiness

Each sub-watershed comprising the project study area has a considerable study history and a standing watershed association or conservancy. GIS mapping and attribution is key for the implementation choreography, the reportage, and the delivery of final implementation achievements to BayStat for archiving, for closure of grant cycle work, and for future grants. The data is a work-in-progress, to be made more robust over time by the addition of practices and implementation with the goal of creating an entire city strategy of sustainable practices and programmatic enforcement. Using the mapping base described above, untreated existing conditions should be documented. Post-implementation mapping of completed projects would present a visual and precise record of the strategy and its achievements. Nutrient, bacterial, sedimentation, urban tree canopy, impervious surface reduction percentages, and water quality improvement calculations should be applied to the attribution of the mapping in a rolling record of work. Using baseline data from those many existing studies, we can move past the need to study the identified "hot spots" and move straight into the actual project implementation phases. Each watershed association or conservancy has had a hand in prioritizing projects and recommendations based on severity of impairment, likelihood of achieving reductions in the identified impairment, probable cost, and well-being of the waterway. A summary of the existing watershed studies and documents for the four creeks is found in Chapter II.

Implementation Ability

The City of Annapolis has in-house contracting protocols and staff ready and able to move projects forward to implementation. City department heads, working with the watershed manager and selected consultants, will develop programmatic code and policy changes tied to the specific goals of the grant. The City has a proven track record for accomplishing projects in a safe and timely manner. The City anticipates that there will be a significant volunteer component for each project, and that there will be in-kind contributions in the form of technical assistance, public outreach, and organizing volunteer labor. Most importantly, the multiple programmatic changes being proposed by the City guarantees the sustainability of the projects.

A. Projects Currently Underway

All projects discussed in this Chapter are focused in the small watersheds of Weems, Spa, College, and Back Creeks, and fall within the High Priority Lower Western Shore watershed (Scenic Severn River). The City already has a number of programs underway demonstrating environmental stewardship. These programs focus on: improving water quality, environmental education & public outreach, increasing urban tree canopy, and reducing impervious surfaces. They represent a recent or budgeted investment of over $20 million by the City. New projects, programmatic changes, and initiatives are recommended later in this Chapter.

The following projects are currently under way in the City of Annapolis:

- **Annapolis Watershed Study** –This Annapolis Watershed Study and Action Plan illustrates the strong commitment the City has to develop and implement a long-term Urban Tributary Strategy, utilizing nearly a decade's worth of previous studies, assessments, and action plans and filling in the gaps not addressed. The City anticipates that the watershed study will provide a watershed road map, much as a comprehensive plan does for land use, which can be used to determine future funding for projects highlighted in the Action Plan.

- **Back Creek Nature Park** – The City and the Maryland Department of Environment have committed resources for the creation of the Stormwater Educational Experience at Back Creek Nature Park, the City's Urban Living Classroom. In addition, resources have been provided by the City and various public/private partners for: living shorelines, living walls, the Eco Technology Walk, the Osprey Nature Center building/classroom restoration, and rain gardens. The City anticipates this funding can be used to enhance future funding options for the region's only Urban Living Classroom, a unique urban environment educational park in the heart of a built-out environment.

- **Sea Level Rise** – The City is hiring a consultant to assess impacts of Global Warming on Annapolis. The City was eight feet under water during Hurricane Isabel, and needs to develop short and long-term strategies for addressing this impending threat. The work of the consultant will position Annapolis to seek future funding for implementing the consultant's final recommendations. This project is consistent with the recommendation of the Governor's Climate Change Commission.

- **Annapolis Recreation Center** – The City is constructing a LEED Silver Certified building that will showcase the use of bioretention, cisterns, bioswales, detention ponds, and green roofs using building runoff to irrigate nearby ball fields, and utilizing pervious materials in the parking areas. The money spent on getting LEED certification for the new recreation center can be used to leverage grant money for other programs in Truxtun Park, where the new Recreation Center is located. Truxtun Park is the City's largest recreational facility and is located almost entirely in the Critical Area. The City will be focusing on addressing severe erosion problems along a large section of the Spa Creek shoreline.

- **Environmental Commission** - The Annapolis Environmental Commission (AEC) has commissioned a 12-point signage program demonstrating environmental BMPs at 12 sites (11 signs and one master) and complementing the City's Eco-Tour Program, called the Environmental Waypoints Program.

- **Navy-Marine Corps Stadium** – The City was part of a $2 million partnership to build rain gardens and plant hundreds of trees and bushes around the Navy-Marine Corps Stadium in order to handle all stormwater runoff from the property into Weems and College Creeks. Additionally, 11 acres of impervious surface were transformed to grass athletic fields. The City continues to maintain rain gardens, and replace diseased trees on the property.

- **Porter Drive Outfall** – The City committed resources for a stream valley restoration in an area that was highly eroded and pumping sediment directly into Weems Creek. Work included slope stabilization and native plantings along the slopes, along with continued maintenance responsibility. The City anticipates leveraging these initial expenditures on a Phase II stream restoration project in Porter Drive that will mimic the technique created by Underwood Associates in the Wilelinor stream valley.

- **GreenScape** – In its 17th year, the City budgets resources in order to support 60+ projects a year, involving a minimum of 900 volunteers throughout every ward of the city. The City supports GreenScape for tree planting projects throughout Annapolis, including a 500-tree giveaway to residents in the fall. This program helps achieve urban tree canopy goals with DNR of increasing tree cover from 41% to 50%.

- **Public Works Garage** – The City has initiated a wide range of projects targeted by the Spa Creek Conservancy and the Center for Watershed Protection at the DPW garage on Spa Road, including: materials storage, bulk pick-up protocol, installation of sand filters, installation of rain gardens. These combined projects will help to improve water quality along the adjacent non-tidal segment of Spa Creek.

- **Fourth Street-End Park** – The City removed impervious surface and installed a state-of-the-art rainwater filtration system and native landscaping adjacent to Spa Creek.

- **Burnside Street-End Park** – The City removed impervious surface and installed a rainwater filtration system and native landscaping adjacent to Spa Creek.

- **Reduce Impervious Surface Coverage throughout the City** – High-profile projects have already been designed and undertaken by the City, including: Gotts Court Garage at the Annapolis & Anne Arundel County Conference & Visitors Center, and the Annapolis City Dock.

- **Waterworks Park** – The City contributed resources to the Waterworks Park Master Plan and budgeted more resources toward refurbishing the historic public works building, converting it into an environmental classroom, and planting native landscaping in a non-tidal wetland area as part of a regional botanical garden.

- **Capital Programs FY '09** –Capital Programs for FY '09 include storm drain retrofits to reduce sediment loading into Back Creek at Windwhisper Lane, and street reconstruction to include porous pavement at storm drain inlets to provide infiltration at Barbud Lane.

- **Big Belly Solar-Powered Trash Compactor** – The City installed a trash compactor at the City Dock as part of a demonstration program which has proven to be a great success.

- **Rain Gardens** – The City, in partnership with local business, watershed associations, and private citizens, has installed more than 60 rain gardens and water quality ponds around Annapolis.

Clearly the City has been making great strides toward watershed health improvement by leveraging resources and implementing projects throughout all areas of the project study area. Continuing to build upon these initiatives is a key component in the future success of improving the quality of the four creeks, and the City as a whole.

B. Specific Project Recommendations

The project team, in conjunction with City staff and watershed stakeholder groups, compiled a list of recommended projects to be implemented as funds become available, as follows:

Back Creek

1. Back Creek Lagoon – As a partnership between Friends of Back Creek Nature Park, the Oyster Recovery Partnership, the Annapolis Maritime Museum, Bluewater, Baywoods, the Chesapeake Outdoor Group, and Alden Labs, the City intends to install Biohavens in the tidal lagoon at Back Creek Nature Park. As part of this project, the City will hire an independent water monitoring lab to conduct bathymetric surveys and substrate assessment; provide detailed design for Biohavens installation; obtain the necessary permits; conduct baseline water quality assessment; and procure, construct, and install Biohavens. The Biohavens will also be part of a partnership with the Oyster Recovery Partnership to initiate an oyster grow-out station for schools in the Annapolis area. Three oyster cages will hang from the Biohavens, with a connecting boardwalk that the City is currently working with the U.S. Fish & Wildlife Service to design and install. Water quality monitoring will be conducted after installation for a period of six months; results will be analyzed and an assessment report prepared. This is a major pilot program that could have positive water quality implications for all of the City's creeks. This project is referenced in "Floating Treatment Wetlands Study Plan for Pilot-Scale Demonstration Projects in Annapolis, MD," which was prepared by Alden Labs in 2008.

2. Davis Park Revitalization – The City will reduce the impervious surface throughout the park and create a meandering sidewalk. Currently, the park is covered in gravel that will be removed and replaced with sod and native landscaping similar to the innovative treatment employed at Fourth Street. The City has a design plan for this project from Hyde Concrete.

College Creek

3. College Creek Rain Barrels – Install 100 Rain Barrels on private and public property. The goal of this project is to help promote the concept of private individual stewardship and to reduce stormwater flows and improve water quality. This project will be the initiative of the Chesapeake Ecology Center and Calvary Methodist Church.

4. Install Smart Sponge at College Creek Storm Drains - The City proposes to install innovative, CO1414N (curb opening 14" x 14") Ultra Urban Filters designed for retrofitting existing storm drain infrastructure. The Smart Sponges will be strategically placed at 36 inlets located in the upper (southern) section of the College Creek watershed. The City, in partnership with McCrone and ABTech has selected a 60-inch storm pipe along Taylor Avenue (near DNR) and a 96" pipe at Glenwood Avenue (draining directly into College Creek). Water sampling would take place at the pipes.

Spa Creek

The recommendations were drawn from the Spa Creek Consolidated Master Restoration Plan, 7 May 2008, page 10, Table 5 – COA Consolidated Short-term Critical Project/Programs, Spa Creek Conservancy and the Spa Creek Headwaters Sub-watershed Restoration Plan, May 2006, Center for Watershed Protection.

5. Spa Creek Origin Stormwater Retrofit – This project is located at the end of gabion drainage area behind Forest Villa and Southwood communities. The goal of the project is to mitigate and restore the origins of Spa Creek by attempting to recreate a more creek-like configuration to eliminate the cause of extensive erosion and silting of the creek.

6. Southwood Stormwater Retrofit – This project is located in the Southwood Community and involves the installation of an erosion control BMP. Erosion from excessive stormwater flows is currently threatening sewer stack in-stream and a recently built retaining wall and rain garden (two long culverts convey the stream for 1/4 mile). Culvert may not be able to hold water capacity. This project will help control several damaging factors: heavy erosion and silting, pollution reduction from impervious surfaces and lawns.

Weems Creek

The City will to partner with the Weems Creek Conservancy and others to implement the following programs within the Weems Creek watershed:

7. West Street/Hudson Street Retrofit – This retrofit is for a new wet pond on the north side of West Street near Hudson Street, one of the City's largest industrial parks, to address uncontrolled stormwater runoff from approximately 13 acres of the West Street commercial corridor. It can be designed to perform both water quality and channel protection functions. The retrofit would also help to reduce erosive flows to a stream rehabilitation project adjacent to West Street near the Capital Newspaper building. This project is referenced in Table II - Retrofit Cost Information, in the "Weems Creek Watershed Improvement Plan," prepared by the Center for Watershed Protection for the Weems Creek Conservancy in 2003.

8. Tucker Street Retrofit – This retrofit concept is for Delaware sand filters to be retrofitted into the street at both inlets on Tucker Street which flow directly into

Weems Creek and one of the City's only public boat launches. The sand filters would filter road stormwater runoff from a portion of Tucker Street prior to entering tidal Weems Creek through a pipe at the end of the street. The sand filters would improve water quality before runoff is discharged into tidal waters. This project is referenced in Table II - Retrofit Cost Information, in the "Weems Creek Watershed Improvement Plan" prepared by the Center for watershed Protection for the Weems Creek Conservancy in 2003.

9. <u>Navy-Marine Corps Stadium</u> – This project entails Phase II of the tree planting by the City, NAAA and the Weems Creek Conservancy at the Navy-Marine Corps Stadium where a 1.2-mile bike/pedestrian trail and rain gardens circle the property.

City-wide Projects and Initiatives

10. <u>Continue Clean Air Initiatives</u> – Continue the Cloud 9 clean air program with fourth grade students in city schools – plant a tree, parents drive 10 miles less a week. The City is requesting education packages including teachers' guides and information for 500 fourth grade students. This will be a partnership with the Board of Education and Anne Arundel Community College**.**

11. <u>Rainscaping Education Stations</u> – Install functional and educational rainscaping stations throughout the city in pocket parks and elsewhere. Rainscaping stations are either an arbor/kiosk or an arbor/bench/kiosk with signage about rain gardens, rain barrels, permeable pavers, and green roofs. The top of the arbor contains a mini green roof; in front there are permeable pavers; there is signage on both sides; there is a rain barrel on one side, with rain water directed via a soaker hose to a rain garden (there may be some stations without rain gardens). As proposed by the Chesapeake Ecology Center, the City will install five RS x $4,000 each at the following location: Truxtun Park, Back Creek Nature Park, Chesapeake Children's Museum, Annapolis Maritime Museum, and the Bates Boys & Girls Club*.*

12. <u>Design a New Sediment and Erosion Control Manual</u> – Capacity-building financial support for consultants to draft ordinance would be required*.*

13. <u>Adopt and Administer a New Model Urban Tree Canopy Ordinance</u> – Key issues: any tree over four inches diameter at breast height (DBH) on site needs a tree permit (no construction, Section 14.12 of City Code) and for landscapes plans (construction, Section17.09 of City Code) any tree over four inches DBH outside of the Critical Area; or one inch DBH inside the Critical Area that are within the Limit of Disturbance need to be shown and mitigated for if removed. Capacity-building financial support for hiring new City staff within DNEP to administer the new permit requirements and monitor mitigation

Department of Neighborhoods & Environmental Programs needs an additional permanent, part-time staff person to monitor this program. The City will match part of the salary by providing resources, vehicle, and benefits. The City currently employs a full-time environmentalist to administer tree ordinances in the City. To expand the program by requiring permits to remove most trees in town will require another staffer to administer the program.

14. Doggie Waste Collection Bags & Brochures – The City has enough doggie waste containers throughout the parks; however, we could always use more bags. Currently, we are spending $171 per case of bags. The case has 6,000 bags. The City would then initiate a doggie waste collection outreach program to educate the public about the importance of picking up after their dog. The City would create a brochure and attach them to the containers about the importance of waste collection.

15. Install Ground Cover Around Street Trees – The ground cover will absorb rain water and reduce run-off into city streets. The pilot project will take place on West Street, from Church Circle to Westgate Circle, where the maintenance of street trees has become problematic.

16. Bilge Skimmers for Boaters – The City will purchase 500 skimmers to give to local boaters through our Recreation & Parks Department (superintendent at the Truxtun Park boat launch) and overseen by the Harbormaster's Office. Each boater would be required to show his or her boat registration and then they would be given a free skimmer. In order to show sustainability for the program, boaters would be required to turn in their old filter in order to qualify for a new one the following year during Phase II. Phase II would also expand the program into the private sector by having marinas provide the skimmers to each boater at cost as part of their yearly slip rental. This initiative would be combined with the City's program to encourage clean marinas.

17. Expand Rain Gardens in Schools – The City will partner with the U.S. Fish & Wildlife Service and Anne Arundel Community College environmental students to intern with a selected elementary school in Annapolis to design a Bayscapes garden, Rainscaping signs, and native landscaping. After the initial pilot project, the City would join our partners to expand the program to the remaining four schools.

18. Increase Tree Planting – Increase from 1,000 trees planted a year by the City, to 1,500 to compensate for the loss of canopy trees and to reach the 50% canopy goal**.**
In addition, a used 3/4-ton truck and a new, tow-behind water tank will have to be

purchased, and staffed with a part time intern to perform the watering during the summer months.

The City plants over 1,000 trees a year in public spaces and watering, especially during the recent dry summers, has become a serious maintenance issue. The City currently pays a local landscaping company thousands of dollars a year to water a small number of trees along only the main streets in Annapolis. Maintenance of street trees in an urban setting is expensive and requires special attention and funding.

19. Establish Storm Drain Sampling Program – Through the NPDES II program some limited sampling is taking place. Capacity building financial support for staff to implement program would be required in order to establish water quality monitoring stations at project locations, hire water samplers, and pay for the samples to be analyzed by an outside lab*.*

Implementation and Evaluation

The Annapolis City Council has adopted numerous legislative packages to protect the environment. A stormwater utility ordinance with strong run-off protection was passed. The City assumed erosion and sediment inspection authority from MDE. Environmental protection was further strengthened under Resolutions R-44-06 and R-38-06. Energy efficiencies were expanded under Ordinances O-56-07 (Green Buildings) and O-27-07 (reusable, recyclable, & compostable materials). Impervious surface reduction legislation is pending. Over the course of the last decade, the City and its many partners have spent millions of dollars producing watershed studies, assessments, and action plans. These studies have laid the groundwork for future projects in each watershed, illustrating the sustainability of the City's overall goals and objectives to restore the four urban watersheds which flow into the Scenic Severn River.

The project team concurs with the City and recognizes the efforts of the City and watershed stakeholder groups in recommending specific projects for each sub-watershed of the four creeks, as well as the City of Annapolis as a whole. Additional specific project and retrofit recommendations are included in Chapter VIII.

C. Programmatic Change Recommendations

Currently the City is implementing a host of programmatic changes. Administrative initiatives currently underway (and in the pipeline) that have been recommended by City staff to meet the City's environmental goals include**:**

1. Increase a wide range of Energy Efficiencies – This is an on-going part of City Ordinance O-27-07 passed by the Annapolis City Council in 2007. The City's

energy use and carbon footprint have been measured and innovations proposed under City Resolution R-38-06. At a press event on August 13, 2008, the City unveiled a pilot program in partnership with Maryland Energy Administration and Chamber of Commerce Foundation, and Commerce First Bank to increase homeowners' participation in increasing energy efficiencies. The City will also continue to expand its new "Sustainable Annapolis, Green Thriving Neighborhoods" Community Action Plan which can be found on the City's homepage.

2. Expand the Urban Tree Canopy – This is part of a commitment with DNR to increase urban tree canopy from 42% to 50% by the year 2036.

3. Establish a downspout disconnection program in selected neighborhoods. The issue is of concern in communities where downspouts and storm drains are combined with the waste water treatment plant (WWTP). Where they exist, the code requires a disconnect. There are instances in the historic district where narrow lot setbacks and side yards warrant drainage to the curb. Other instances exist in low lying areas such as Eastport.

4. Publish City of Annapolis NPDES II compliance documents. The US. Clean Water Act mandates a state permit program called the National Pollution Discharge Elimination System (NPDES). Annapolis started its NPDES Phase II program in 2002. The program is a combination of public education, stormwater discharge monitoring and infrastructure maintenance.

5. Initiate incentive program to encourage better equipment and materials storage at multiple locations. The Annapolis Department of Neighborhoods & Environmental Programs (DNEP) and other City Departments are developing a proposal for public facilities as a result of City Ordinance 0-27-07.

6. Initiate incentive program to encourage better maintenance of dumpsters and educate owners on stormwater impacts at multiple locations. The City's Environmental Program Coordinator is working with businesses to install big belly solar-powered trash compactors. Two restaurants at the City Dock now use these compactors.

7. Initiate incentive program for better vehicle and boat operations at various marinas. Accomplished through the Harbormaster, Port Wardens, the Maritime Advisory Board, and Pre-treatment program that the Department of Neighborhoods & Environmental Programs administers, the City will propose

regulatory changes that will require marinas to meet clean marina requirements as a condition for a permit.

8. Install storm drain medallions at targeted locations and publicize in media, water bills, etc. DNEP purchased 500 medallions that are being installed by the City's DPW.

9. Inventory and create electronic map of storm drain outfalls and create relational data base. Data is being provided as part of this study. This will be coordinated with the City's GIS Coordinator and IT Director.

10. Establish storm drain sampling program. Through the NPDES II program some limited sampling has occurred with volunteers and students. Funding support will be needed so that sampling can be done by a professional lab under contract to the City.

11. Educate City employees regarding proper vehicle maintenance and washing practices, stormwater impacts, proper disposal of fluids, and storage of materials. This will occur as a result of City Ordinance 0-27-07.

12. Expand the City's street sweeping program.

13. Continue reducing impervious surface coverage throughout the city. High-profile projects have already been undertaken: Gotts Court Garage at the Annapolis & Anne Arundel Conference & Visitors Bureau, and the Annapolis City Dock

14. Enhance Tree Ordinance to strengthen tree protection. Funding support will be needed to address the watering issues which are currently being handled by a private contractor at considerable expense to the City.

15. Secure financial support to design a ground-breaking Sediment and Erosion Control Manual.

16. Expand upon the Stormwater Utility Program – The City has passed a stormwater utility ordinance and has been inventorying & prioritizing water control structures throughout Annapolis. The City will apply this fee toward fixing damaged stormwater infrastructure.

17. Adopt a new model Urban Tree Canopy Ordinance – Key issues: the removal of any tree over four inches DBH on site needs a tree permit (construction, Section 14.12 of City Code); and for landscapes plans (construction, Section17.09 of City Code) any tree over four inches DBH outside of the Critical Area; or one inch

DBH inside the Critical Area that are within the Limit of Disturbance need to be shown and mitigated for if removed. Additional City staff within DNEP is required to administer the new permit requirements.

18. Expand the Urban Pet Waste Program – This will expand on the City's initial program of installing pet waste boxes in its major recreational facilities and some street-end parks.

19. Expand Environmental and Public Outreach Programs – Develop programs to better engage the public in Bay restoration efforts.

20. Expand Rain Gardens in Schools – The City will partner with the U.S. Fish & Wildlife Service and Anne Arundel Community College environmental students to intern with a selected elementary school in Annapolis to design a Bayscapes gardens, Rainscaping Signs and native landscaping.

The most important point to note is that the capacity building necessary for programmatic change and project implementation will be result of the political will of the City. Additionally, maintenance is a major factor to consider for project and programmatic change implementation. Innovative BMPs are recommended throughout this document, but the costs for administration and maintenance must always be considered. Also, the geospatial data delivered with this document will provide the City with the necessary database and analytical data to help manage projects and track the effectiveness of projects and programmatic changes. Additional recommendations are included in Chapters VIII and IX.

VIII. Back Creek Watershed Analysis

A. Field Survey, Existing Conditions, and Infrastructure Review

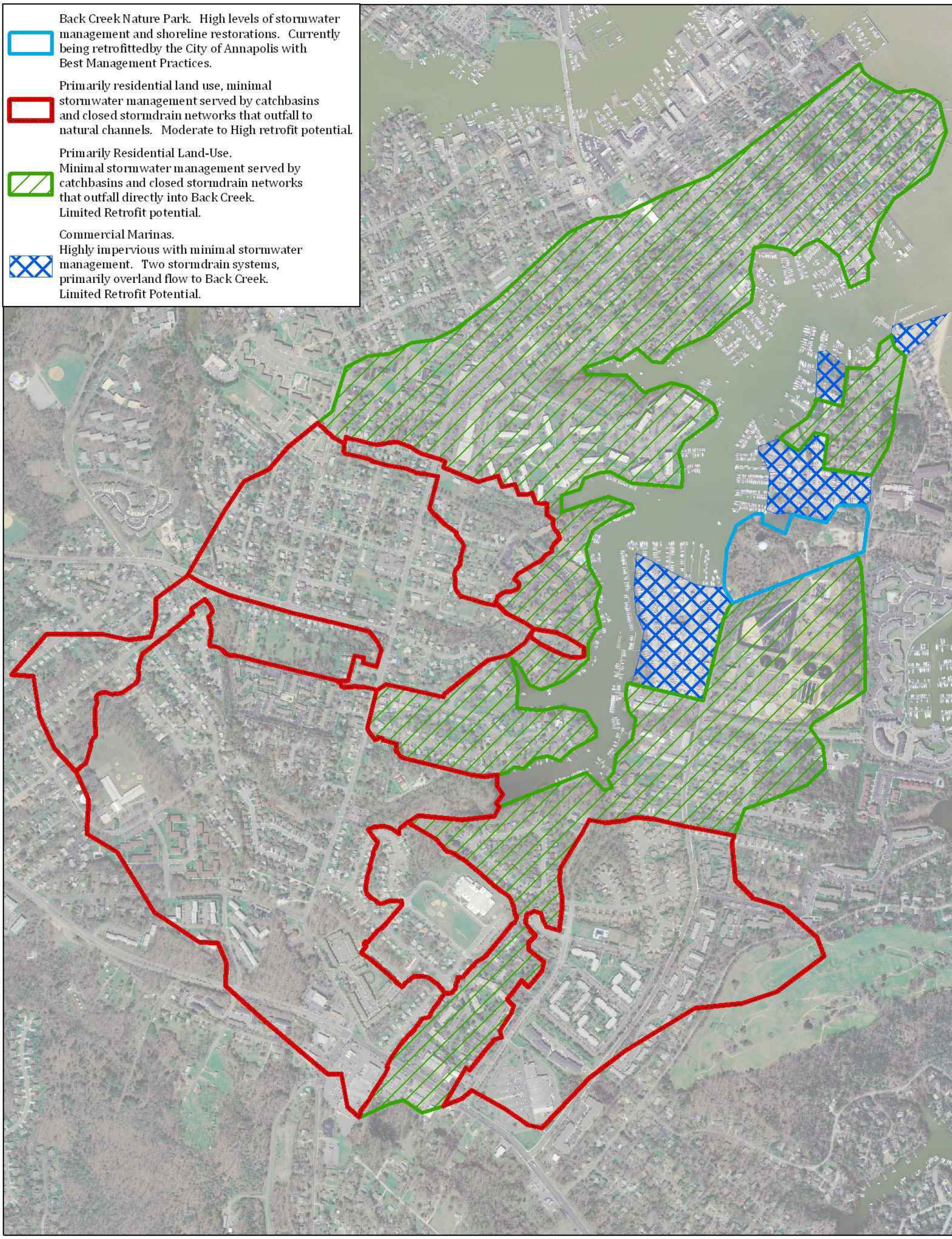
Introduction

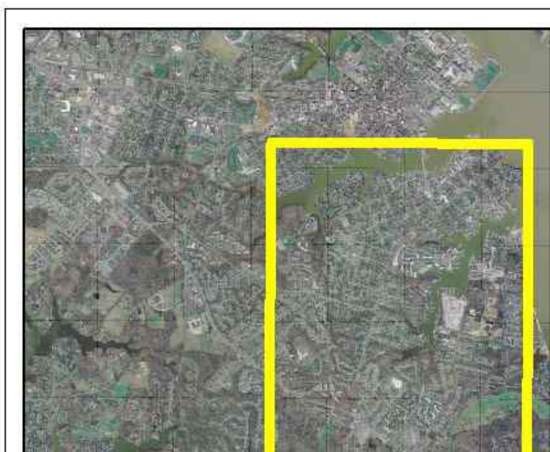
Back Creek is a major waterbody that exists almost entirely within the boundaries of the City of Annapolis. Back Creek begins near Georgetown East Elementary School, located off of Bay Ridge Avenue, and outfalls to the Severn River and subsequently into the Chesapeake Bay. The watershed consists of 855.7 acres and lies between the Spa Creek watershed to the west and Edgewood Road to the east. McCrone Inc. performed multiple site surveys throughout the Back Creek watershed area both on land and from the water.

Baseline Assessment

This watershed contains a multitude of land uses including residential, commercial, marina and recreation uses. In the Eastport area, residential homes make up the primary land use with most lots being approximately 1/8 acre. Farther south in the watershed along Bay Ridge Avenue, higher density residential development is present which consists of mainly apartment complexes comingled with the smaller residential lots. Also, greater commercial use is witnessed with small businesses and the Eastport Shopping Center. In the Tyler Heights area, most of the land use is small residential lots in the typical subdivision style with high density residential apartments. On the east side of Back Creek, more diverse land uses are present with small lot residential, apartment complexes, an elementary school, a large commercial shopping center, and several marinas.

Currently, the total impervious cover for the Back Creek drainage area is 328.8 acres (38.4%). Based upon the Center for Watershed Protection's Impervious Cover Model, Back Creek falls into the non-supporting waterbody category with a fair/poor stream quality (CWP, 1988). In addition, the tree canopy cover for the Back Creek watershed was calculated to be 31.4%.





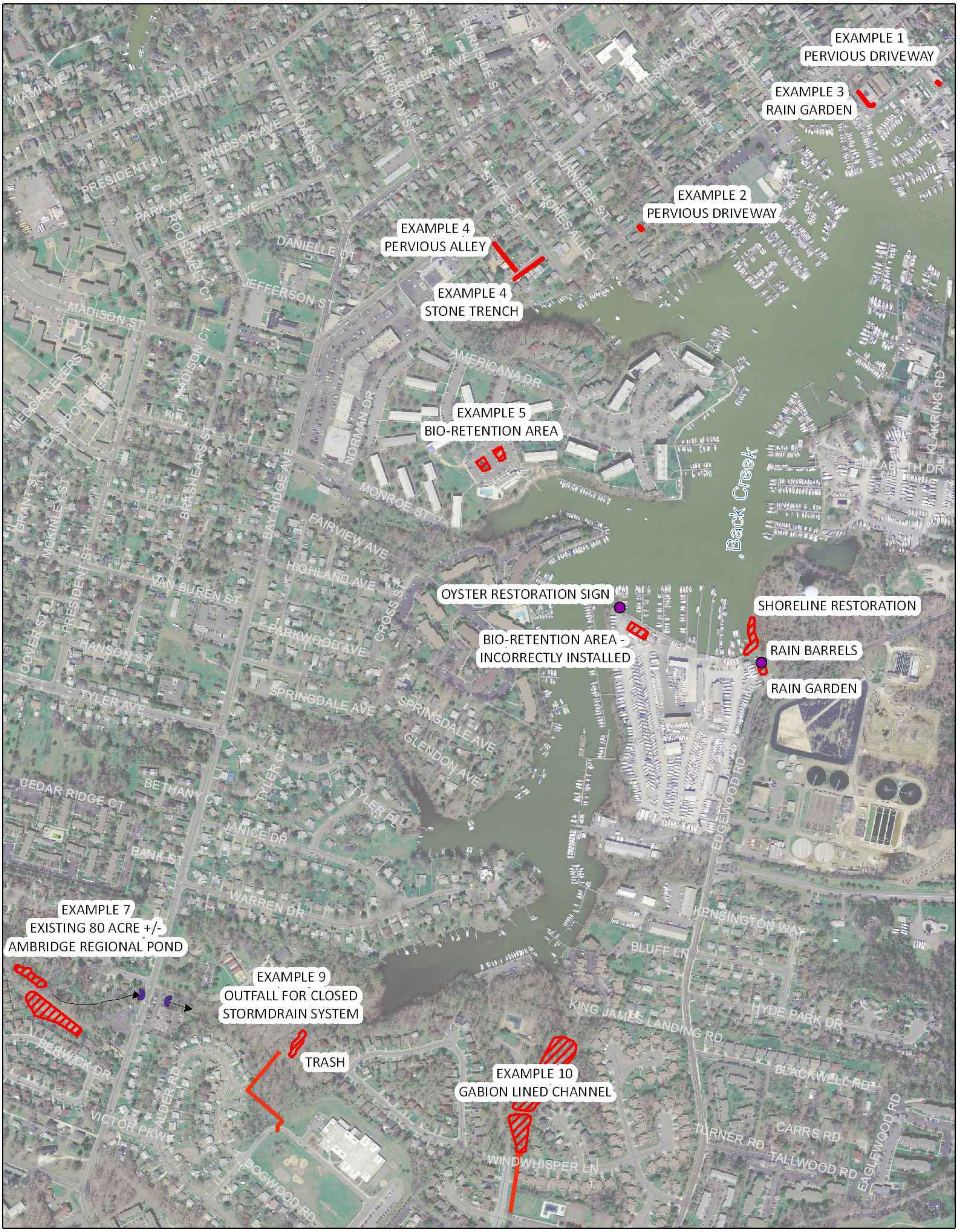
Back Creek Watershed
Existing Data Assessment

Exhibit 8-1-1

N W E S

1 inch equals 800 feet

Data Sources:
City of Annapolis
MD Dept. of Natural Resources
McCrone, Inc.



Back Creek Watershed
Existing Data Assessment

Exhibit 8-1-2

1 inch equals 500 feet

Data Sources:
City of Annapolis
MD Dept. of Natural Resources
McCrone, Inc.

Table 8-1 Back Creek Land Uses 2005	
Commercial	5.82%
Open Space/Cemetery	0.84%
Residential	43.86%
Residential Multi-family	10.40%
Recreational	4.03%
Transportation/Other	17.04%
Maritime	4.87%
Institutional	6.94%
Mixed Use	0.07%
Industrial	0.28%
Vacant	5.85%
Total:	100%

Back Creek mainly receives untreated and unmanaged storm runoff due to a lack of stormwater management best management practices (BMPs). This is due to most development having occurred before water quality management was enacted by the State of Maryland in 1986. In most areas, the runoff from storm events is captured by a network of inlets and flows via underground pipes to outfall into Back Creek. Since water quality has not been fully addressed for these events; trash, hydrocarbons, nutrients, sediment, bacteria and other contaminants are regularly conveyed directly into the creek. In general, urban pollution in this watershed is a result of non-point pollution sources. Common sources are the over-fertilizing of yards, unmanaged pet waste, leaks from automobiles and boats, and the sediment erosion from yards and tributary channels.

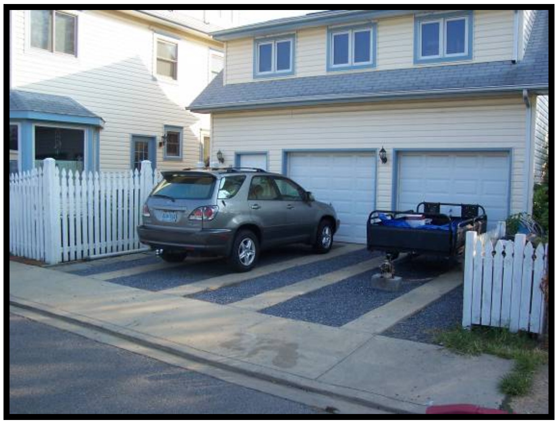
Most commonly, runoff outfalls directly into Back Creek via storm drains. The tributary channels that remain upstream in the watershed are generally in good condition. The majority of the commercial and multifamily waterfront properties in Back Creek use bulkhead for shoreline stabilization. During an inspection from the water of the shoreline, the majority of the bulkheads showed no visible structural failure or rot with no major sediment loss being observed. Residential properties utilize a mixture of bulkhead, riprap, and natural shorelines. The shoreline that has been maintained in a natural condition is generally in fair shape. However, eroding banks and tree loss were witnessed in some locations and are likely a result from wave action and the lack of adequate vegetative stabilization. Throughout the Back Creek watershed, minimal riparian buffers were observed with most development occurring right up to the shoreline. Adequate riparian buffers offer the ability to filter out sediment and nutrients from overland flow runoff, provide stabilization for the stream banks and providing habitats for aquatic species. The City has already undertaken these efforts at Back Creek Nature Park.

Figure 8-1: An example of sediment and tree loss on the west bank of Back Creek near Watergate Village.

The field survey of Back Creek began at the northwest corner of the drainage area (see Appendix X) also known as Eastport and ended at the Annapolis Sailing School on Bembe Beach. This report will discuss observations made in the same order that they were observed. Overall, there were very few stormwater management practices in place as most sites were conveyed directly to storm drains to outfall into Back Creek. There were; however, a large number of pet waste disposal stations located throughout the watershed at areas that seemed likely for the walking of a pet. We also witnessed several examples of impervious surface reduction, which will be detailed below.

EX-1 and EX-2 – Pervious Driveways:

Near the intersection of Second Street and Eastern Avenue, a pervious driveway for a residential home was observed. Concrete had been placed to absorb the vehicle's weight where the tires would otherwise compact the loose gravel and reduce infiltration rates. Also, near the intersection of Sixth Street and Chester Avenue, another pervious driveway was observed that utilized grass rather than gravel. On a small scale, the impervious area removed by these practices is low, but offer a great opportunity to disconnect impervious surfaces. However, with more than 86 acres of driveway located within the four watersheds, the impervious cover that could be removed by standardizing this practice is not trivial.

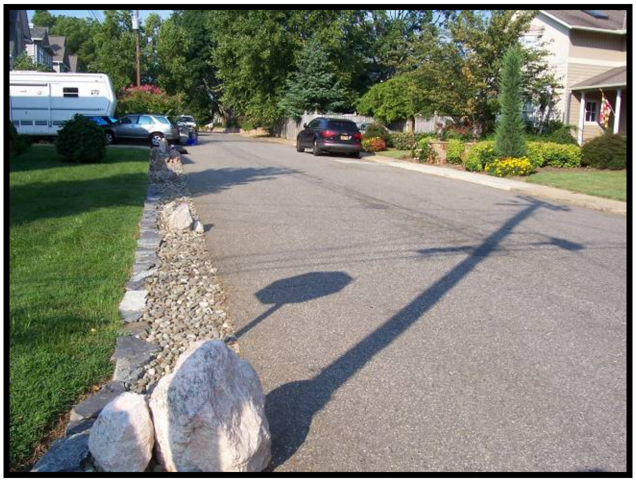
Figures 8-2 and 8-3: Figure 8-2 (left) is a pervious driveway near the intersection of Second St. and Eastern Ave. Figure 8-3 (right) is of a pervious driveway near Sixth St. and Chester Ave.

EX 3 – Rain Garden:

During a reconnaissance of the northwest side Back Creek watershed, an existing stormwater management structure was observed at the intersection of Third Street and Eastern Avenue that was not listed in the city stormwater records. This structure consisted of a rain garden that treated roof runoff from the Bunzh Maritime Trades Building, a commercial structure located on Third Street. The rain garden discharged via pipes into a closed storm drain system which ultimately discharges into Back Creek.

EX 4 – State Street and Chester Avenue Intersection:

Two types of water quality improvements were observed on Chester Avenue near the State Street intersection. The first consists of a stone trench placed adjacent to Chester Avenue to prevent vehicles from parking on the owner's property. Although unintentional, this trench is also able to serve a secondary purpose by capturing runoff from half of the crowned road and allowing for the water to infiltrate through the gravel bed. Also, large stones have been placed at intervals to eliminate vehicles from parking and driving on the owner's property. Again, this serves a secondary purpose of eliminating vehicles from parking and driving over the stone which leads to compaction and reduced infiltration rates. Located on the opposite side of the street from the infiltration shoulder, an alley was observed that had a pervious surface consisting of maintained sod. This allows for water quality treatment of adjacent area's runoff with the alley acting as a filter strip, plus reducing the amount of impervious area in the Back Creek watershed by having a pervious surface.



Figures 8-4 and 8-5: Figure 8-4 (left) shows the constructed stone trench with large boulders spaced randomly. Figure 8-5 (right) is of a pervious alley that very likely contained conventional pavement at some point in the past.

EX 5 – Watergate Village:

Watergate Village, located on Americana Drive, contains several well-executed bioretention facilities that treat runoff from the majority of the paved areas near the recreation building. This is an excellent approach to provide water quality management in a relatively high-density development because the landscaping features can do double duty as stormwater management devices.

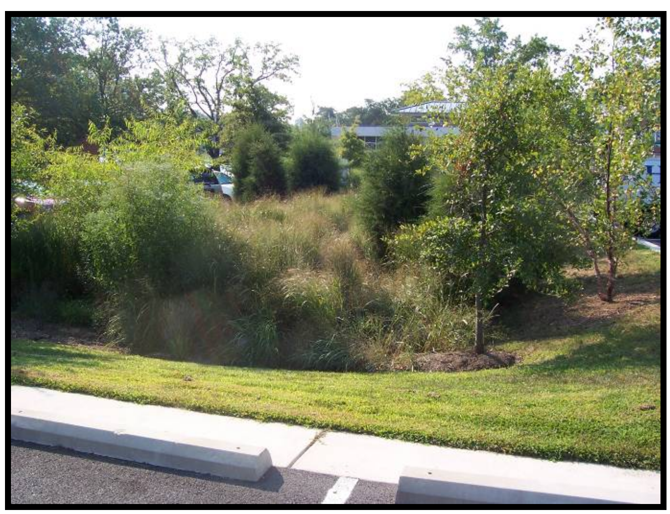


Figure 8-6: One of Watergate Village's Bioretentions

These bioretentions were situated to capture runoff from the adjacent drive aisles and parking areas along with potentially some of the drainage from surrounding buildings. They appeared to be in good working order and are being maintained.

Figures 8-7 and 8-8: Stormdrain Outfall at Watergate Village

The bioretentions along with presumably other surrounding drains outfall onto a riprap apron that empties into Back Creek (See Figures 8-7 and 8-8 above). Based on our observation, the riprap has avoided surface creep and appears to be providing a stable outfall to tidewater.

EX 6 – Existing Outfall at Intersection of Fairview Avenue and Cross Street:

Currently an outfall to Back Creek exists at the Fairview Avenue and Cross Street intersection. This outfall collects runoff from nearby residential homes, streets and subdivisions through inlets and closed storm drain systems. Negligible stormwater management and water quality treatment were observed in the subwatershed. The existing 42-inch pipe runs through a wooded parcel owned by St. Luke's Church and outfalls intro Back Creek.

Figure 8-9 (left) shows the wooded parcel owned by St. Luke's Church that has the storm drain pipe running through it and Figure 8-10 (right) shows one of the inlets adjacent to the parcel.

The outfall, as viewed from Back Creek (See Figure 8-11 below), shows sediment deposition at the discharge location. This is typical of the historic stream channels that flow into Back Creek; a condition at least partly caused by the lack of significant stormwater management facilities. Also, the surrounding banks have minimal riparian buffers. In places, trees were observed that had fallen into the Creek due to bank erosion.

Figure 8-11: View of the outfall from Back Creek

EX 7:

The next stormwater management site that was observed is located off Berwick Drive and serves the Ambridge subdivision. Currently, this regional pond is owned and maintained by the Ambridge Homeowners Association. According to the information provided by the City of Annapolis, this structure captures 80 acres of the watershed for treatment. During the site visit, it was observed that the structures were in fair working order, but had not been maintained recently. The outlet structures were not silted in and the outlet pipes were clear of any debris. Some sediment was noted in the bottom of the pond near the first pond riser. The pond was heavily vegetated and had woody vegetation growing on the inside embankment. NRCS Maryland Code No. 378, Pond Standards/Specifications states that trees and/or shrubs will not be allowed on any embankment. Regular maintenance and inspection should be performed as part of the required maintenance plan and it should be determined if sediment needs to be removed to return the pond to its original design capacity. Also, it should be noted that the gate that serves as the access point to the pond is in need of being repaired and was unlocked. Per NRCS Maryland Code No. 378, the fence surrounding the pond should be properly maintained since it functions as a safety device. With the facility bordering residential homes, annual inspection of the fence should be included in the annual maintenance of the pond.

Figures 8-12 and 8-13: The picture on the left shows the Ambridge Regional Pond with dense vegetation. The picture on the right shows one of the two outlet structures, free from debris.

The two outlet structures for the pond are in good condition and appear to be working properly. The risers were free from debris and had no visible silting. The trash racks were still secure and functioning properly. The outlet pipes were clear from silt and debris and in good condition. The concrete end-walls were also in good condition and had no structural failures evident. In contrast, both rock outfall pads were in need of reconstruction. The endwalls were discharging directly to bare soil and deteriorating filter fabric. It appears that the original riprap has been displaced approximately 20 feet downstream from its original location. New riprap outfall protection devices should be installed that incorporate larger size stones to prevent surface creep during large flow events.


Figures 8-14 and 8-15: The northern outfall (36" RCP). A picture facing the headwall (left) and a picture showing the riprap pile past the outfall (right).


Figures 8-16 and 8-17: The southern outfall (48" RCP). A picture facing the headwall (left) and a picture showing the exposed and frayed filter fabric (right) in the discharge channel.

EX 8:

The next location is a large wooded parcel that is owned by and adjacent to the Annapolis SPCA. This site is densely wooded and has considerable elevation relief. The contributing drainage area consists primarily of residential lots, roadways, and parking lots. Few upstream stormwater management devices were observed, and nearly all of the contributing drainage area is collected via inlets and piped to the wooded channel. The Ambridge Regional Pond (described above) is located within this overall subwatershed and treats a portion of the drainage area. The outfall channel is wooded until it empties into tidewater. The mouth of this channel on Back Creek has a shallow depth with established tidal wetland vegetation. Since a large contributing drainage area and a number of stormdrains discharge to this location, it has been designated as a proposed retrofit location. Please see Chapter VIII, Section B for further information.

Figure 8-18: View from Back Creek towards SPCA wooded channel

EX9:

To the south of the SPCA parcel is the Georgetown East Elementary School. The storm drains from the school and neighboring residential area are collected and discharge into the wooded area mentioned above. However, the pipe flowing from the school, once it enters the woods, is only partially set into the ground with approximately half of the 36-inch pipe being exposed. At the location the pipe is exposed, the pipe actually runs uphill for about twenty linear feet before turning back down slope. This storm pipe then flows under Alder Lane and then turns to discharge into the wooded tributary owned by SPCA.


Figures 8-19 and 8-20: The exposed pipe (left) flowing from Georgetown East Elementary School towards Evergreen Avenue. To the right is the outfall located approximately 100 ft. further downstream from the first picture that shows the erosion and lack of stone dissipation.

At the outfall, there is no stone riprap placed to absorb energy from the flows and reduce erosion. Also further downstream, a large pile of garbage that had washed down the storm drain inlets was visible. It should be noted that, to the right of the outfall in the picture to the right above, a utility pole has been placed next to the concrete pipe in the outfall area, and a tree has taken root in the flow channel. If no stormwater retrofit project is undertaken, we recommend this area be maintained and a new rock outlet protection device be installed.

EX10:

The next area of study was the commercial shopping plaza where the Giant Food store is located, plus the surrounding subdivisions. The site visit confirmed that the runoff from these areas is collected into a branching storm drain system that eventually outfalls next to a private marina located at the end of Georgetown Road. These storm drain systems accept a mixture of commercial development and residential land uses. No stormwater management for water quality or quantity was observed during the site visits. This storm drain system outfalls to an existing tributary channel via a 48-inch diameter concrete pipe. The receiving channel has been lined with gabions in that are good condition, along with gabion check dams to reduce discharging velocities.


Figures 8-21 and 8-22: The outfall located at the end of Georgetown lane with a picture of the gabion lined channel (left) and the discharging pipe on the right.

Marinas:

Since Annapolis has a proud maritime tradition, several marinas are present on the banks of Back Creek. For the most part, the marinas consist of a gravel lined storage yards with boats located on land for storage and repairs. Even though the storage yards are primarily covered with gravel, after years of running heavy equipment over top of it, we suspect the runoff characteristics are roughly the same as impervious pavement. Also, with boat repairs occurring in the storage yards, there is a potential for runoff to contain hydrocarbons, chemicals, heavy metals and particulates since few counter measures were observed. Some measures to treat runoff and provide water quality have been implemented at the marinas, but there is still room for improvement. Bert Jabin's Yacht Yard in Elktonia and Port Annapolis near Bembe Beach, both on Back Creek, have been certified as Maryland Clean Marinas. In order to achieve this distinction the marinas have to meet pollution prevention standards as set forth by Maryland Clean Marina Committee and the Department of Natural Resources. Bert Jabin's Yacht Yard located in Elktonia has a rain garden and an oyster restoration area, but it was noticed they appear to have a bioretention system that was installed incorrectly. All of the marinas would highly benefit from additional best management practices, such as perimeter sand filters to filter potential pollutants before discharging into the creek.

Figures 8-23 and 8-24: A rain garden (left) that treats a small drainage area located to the northeast of Bert Jabin's Yacht Yard. Figure 8-24 on the right shows the bioretentions installed incorrectly as raised mounds rather than being depressed.

EX11:

The Back Creek Nature Park located adjacent to Bert Jabin's Yacht Yard consists of a variety of stormwater devices to lend itself as a functional, educational device. A rain garden and rain barrels have been installed to treat the impervious area from the storage shed. On the coast, a shoreline rehabilitation project was witnessed that has transformed the shoreline back to an original condition.

B. Proposed BMP Retrofits

Introduction

The Back Creek watershed has not had the same level of study as the City's other watersheds. Therefore, a more comprehensive study was undertaken in this area to determine possible stormwater best management practice (BMP) retrofits that could be constructed as resources become available. While the following recommendations have been targeted to the Back Creek watershed, similar BMPs could be retrofit into any suitable area within the city as needs and resources allow.

The primary goal of stormwater retrofits in this watershed is to enhance water quality treatment in order to remove sediment, hydrocarbons, bacteria, nutrients and other pollutants that are found in urban runoff. Secondary benefits are realized in terms of enhanced groundwater recharge and reduced runoff rates, which helps protect downstream channels from erosion. Beyond that, BMPs may also provide enhanced habitat for plants and animals, and/or allow for recreational opportunities for humans. In addition, BMPs may be useful as a teaching tool for professionals working to clean up the bay, and for the public to learn the importance of environmental stewardship.

In preparing these recommendations, McCrone conducted an office assessment of the City's GIS data, property ownership information, and aerial photographs to begin to target areas that were under-managed in terms of stormwater management treatment, and where areas of undeveloped land exist. With this knowledge, a field survey was undertaken to confirm or eliminate locations that may be suitable for SWM retrofits, and to gain more specific knowledge of site constraints, hydraulics, and general suitability. With this information, we have prepared the following list of potential retrofit projects.

Exhibit 8-B-1 shows the watershed with the retrofit locations marked, along with their approximate drainage area. We have also provided a comparison chart for the six retrofits, as well as a detailed description of each.

1. Fairview Avenue – Seepage Wetland and Coastal Plain Outfall

This is a wooded area of roughly two acres located between Fairview Avenue and Monroe Street. Owned by St. Luke's Church, this area accepts some overland runoff from the church property, but the hydrology of this channel has been altered so significantly that the majority of stormwater has been piped to bypass the natural area and outfall into the marshy area just north of the Severn House Condominiums. By reconfiguring the adjacent storm drains, this area could be transformed into a seepage

Back Creek Watershed Stormwater Retrofits

Exhibit 8-B-1

N
W E
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1 inch equals 1,000 feet

Retrofit Key

A	Fairview Avenue
B	Springdale Avenue
C	Tyler Avenue
D	Bay Ridge Avenue
E	Georgetown East Elementary School
F	Georgetown Road

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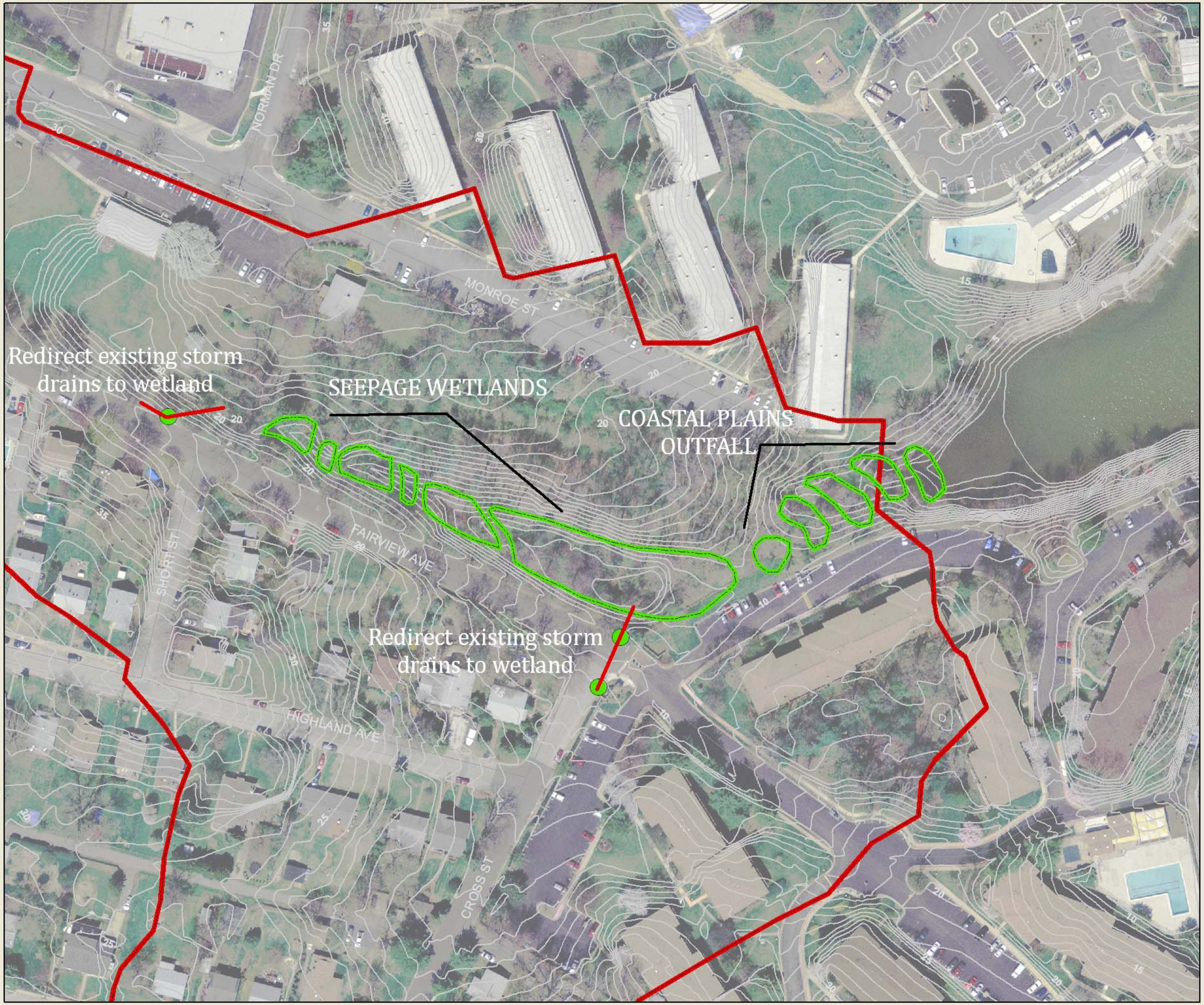
AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

Data Sources:
City of Annapolis
MD Dept. of Natural Resources
McCrone, Inc.



Back Creek Watershed Stormwater Retrofits

Fairview Avenue

Exhibit 8-B-2

1 inch equals 100 feet

AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

Data Sources:
City of Annapolis
MD Dept. of Natural Resources
McCrone, Inc.

McCRONE ENGINEERS • SURVEYORS • PLANNERS wetland with a coastal plain outfall that restores the hydrologic function of this watercourse.

The drainage area for this retrofit encompasses roughly 22 acres between Monroe Street, Parkwood Avenue, and Bay Ridge Avenue, a shown in Exhibit 8-B-2. There is a 24-inch storm drain in Fairview that flows from Bay Ridge towards the east, and this storm drain can easily be diverted into the upgradient end of the proposed retrofit. This portion of the drainage area will receive the maximum amount of treatment as it flows through the entire length of the wetland. The 42-inch storm drain that flows northeast from the intersection of Fairview and Cross Street can also be intercepted and directed into the downstream end of the proposed wetland.

Figure 8-25: Storm drain inlet in Fairview Avenue could be diverted into a new seepage wetland

Based on GIS ground cover data, the drainage area is roughly 38% impervious. To provide the required water quality volume required in the Maryland 2000 Stormwater Manual (2000 Manual), the proposed BMP will require a permanent pool of slightly over 32,000 cubic feet. Given the overall area available for restoration, this is probably near the upper range of what is feasible without significant earth-moving and tree removal, which we do not recommend. However, even if detailed engineering shows that it is not feasible to achieve the full water quality volume in this retrofit, we would suggest that any water quality treatment is better than none. Any deficiency can be compensated for by providing distributed water quality devices throughout the sub-drainage area such as rain gardens and rain barrels to make up the remainder.

One significant issue that would have to be addressed for this project to move forward is the fact that this land is privately held. In fact, when McCrone performed the field survey, it appeared that a wetland delineation had been performed recently in the wooded portion of the property. We suspect that the environmental constraints on the property pose a significant obstacle to private development, so the owner may be amenable to selling the property to the City outright, or selling an easement for the retrofit if the land has little value otherwise. Nevertheless, this is probably the first issue that should be investigated if a source of funding were found for this site. It should be noted that the proposed retrofits would not affect the improved portions of the property.

Overall, we give this location a **medium priority**. Relative to other projects in the Back Creek watershed, this would have a relatively high cost compared to the area treated. It is in an easily viewed location, which gives it considerable value as an educational tool. Conversely, the location it does not integrate with the proposed trail linkage discussed in Chapter VI.

2. Springdale Avenue – Street End Park Bioretention

This area is located at the end of Springdale Avenue, where the Parkwood Civic Association owns roughly 0.90 ac of waterfront property. There is a small dock, kayak/canoe storage racks with a launch area that is available for residents. Roughly thirty feet of gently sloping ground exists between the end of the road and the top of slope leading down to tidewater. This is enough room to create two bioretention areas to provide water quality treatment for the roadside ditches that run along both sides of the open section road.

Figures 8-26 and 8-27: End of Springdale Avenue looking towards the water

Back Creek Watershed Stormwater Retrofits

Springdale Avenue

Exhibit 8-B-3

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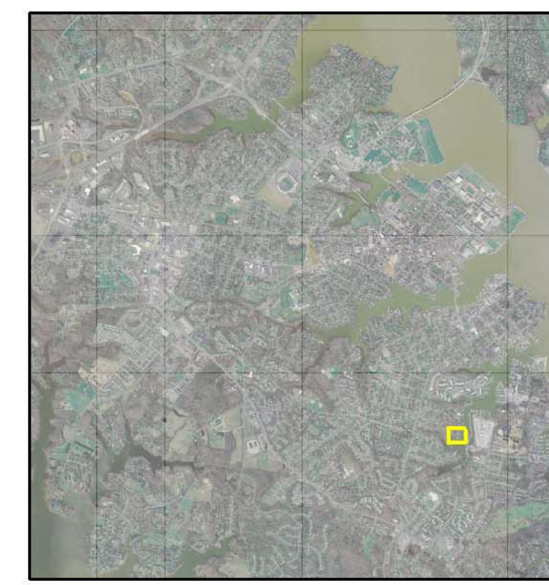
1 inch equals 50 feet



AEGIS
ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

Data Sources:
City of Annapolis
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Based on the water quality requirements of Springdale Avenue and the surrounding residences, these bioretentions would each need roughly 1,000 square feet of area, or 25 feet by 40 feet. These systems can be integrated with the existing street-end park, or even enhanced with additional facilities such as benches, picnic tables, grills, etc., to create a greater sense of place.

As shown in the pictures, the existing street runoff flows down a somewhat inadequate pair of swales that are stabilized with riprap. Despite the fact that the existing runoff does not have a well-executed outfall, there does not appear to be any significant erosion occurring. This may or may not continue to be the case over time. If improvements are contemplated at this location, special design consideration should be given to providing a stable outfall from the bioretention, possibly consisting of a drop structure, a coastal plain outfall, or some combination.

The existing shoreline appears to be relatively stable, with small riprap that has vegetation growing up through it. Given the steep slope above the tidewater, and the quick drop-off to the boat slips, it may be challenging to design a traditional living shoreline, when/if the existing stabilization fails. Adjusting the cross section of the shoreline to contain the low-slope tidal marsh would either involve cutting down the bank, as well as the existing trees, or placing fill in Back Creek and impacting the boat dockage. Neither impact is desirable, so we recommend that the existing shoreline stabilization be left in place until such a time as it is necessary to make repairs. At that time, advances to shoreline stabilization technology or changes in regulatory requirements may make a solution more apparent.

Overall, we give this location a **low priority**, unless the Parkwood Civic Association was able to provide significant monies or volunteer labor to the project. This site would not be particularly visible or beneficial except to a small population, and it may be more difficult to justify the use of public dollars, compared to other projects in the City. In addition, there is no gross deficiency that needs to be addressed, and the facility treats a relatively small area, which both decrease the sense of urgency for this site.

3. Tyler Avenue – Oversized Coastal Plains Outfall

Roughly 83 acres of the Back Creek watershed drains through a shallow gully located between Tyler Avenue and Park Lane, discharging into tidewater just south of Springdale Avenue. This encompasses an area from Jackson Street to Grant Street to Tyler Avenue. Stormwater from this region flows through the backyards of roughly 12 residential lots fronting Tyler Ave, east of Bayridge Avenue. While space is limited by both topography and private ownership, this concentrated flow is ideally suited for a coastal plains outfall (CPO).

Back Creek Watershed Stormwater Retrofits

Tyler Avenue

Exhibit 8-B-4

1 inch equals 100 feet

AEGIS ANALYTICAL AND ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEMS

Data Sources:
City of Annapolis
MD Dept. of Natural Resources
McCrone, Inc.

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Stabilizing this channel would not only minimize any further erosion along the stream channel, it would provide some water quality benefits, where there are currently few or none. The drainage area is primarily single-lot residential, with some small areas of multi-family and commercial, resulting in an imperviousness of 38%. The vast majority of stormwater would enter the CPO from Bay Ridge Avenue as piped flow, subsequently traveling as surface flow for 1,000 feet and dropping ten feet to reach tidewater.

Since the width of the gully varies, there should be opportunities to adapt the width of the CPO to take advantage of the topography, integrating wider drop structures that incorporate the features of a seepage wetland. This will maximize the opportunities for water quality treatment, especially in the section closest to tidewater where the width is as much as 100 feet. Here, the wetland would act as a low-flow filtering device, while large flows from intense storms would bypass around the wetland via the CPO.

Significant barriers to the implementation of this retrofit are the fact that the land is privately owned by multiple individuals, and the limited access. Building consensus among this number of homeowners to perform the work and impact their lots is likely to be challenging, if not insurmountable. In addition, there is minimal area available for access to the work area, equipment parking, materials staging, etc., making the project challenging from a logistical standpoint.

While we give this project a **low priority** due to these challenges, the fact that this is the only location to centrally treat this significant portion of the watershed makes it worth keeping on the table. In addition, this location would not be easily accessible as a teaching tool, and does not integrate with the proposed trail system. Still, this location could have a measurable benefit on water quality while working behind the scenes in residents' backyards.

4. Bay Ridge Road - Constructed Wetland

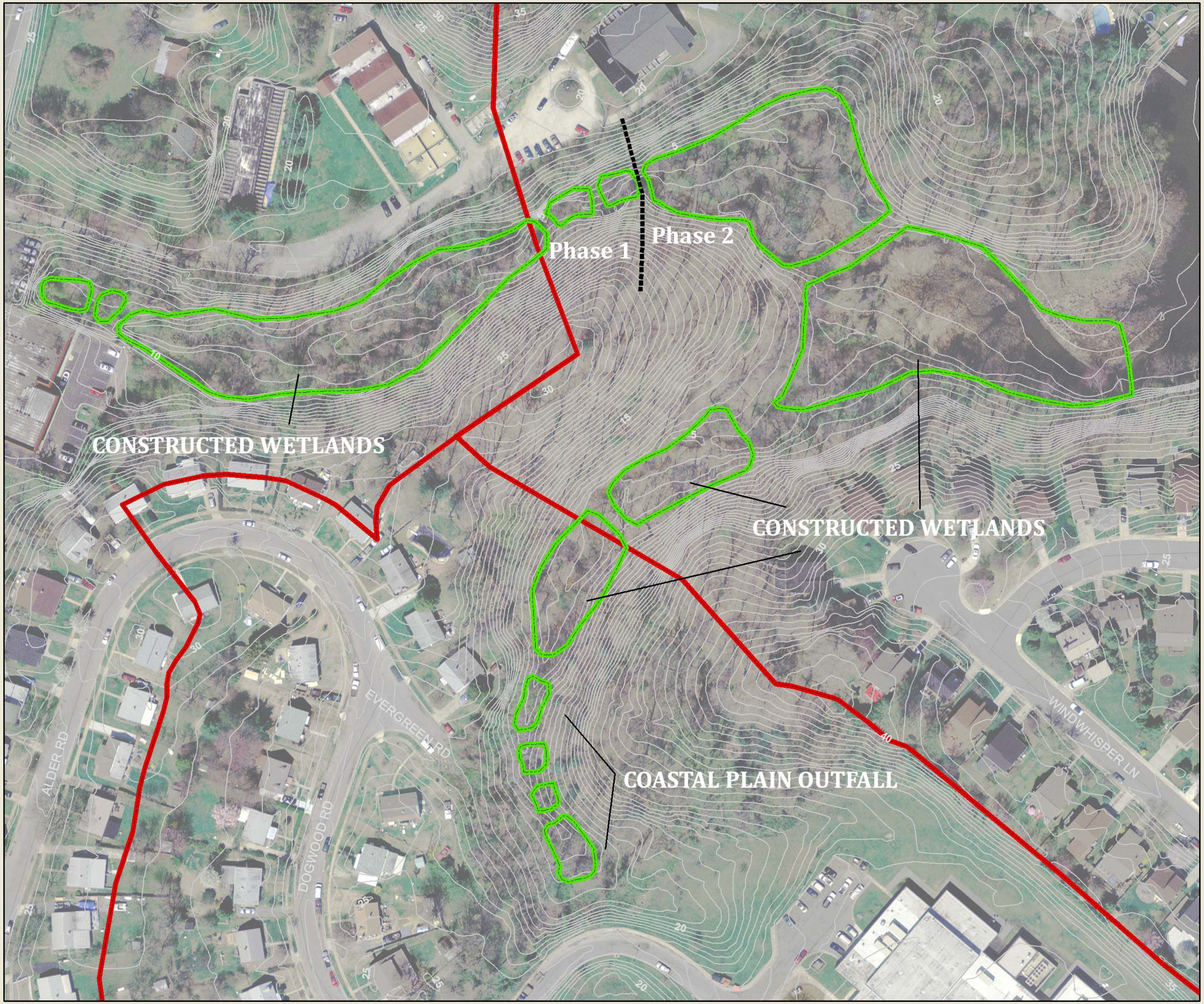
This watercourse is located east of Bay Ridge Road, and south of the entrance to the SPCA campus. The existing drainage channel is wooded, and appears to be relatively stable, despite the large flows that occur during intense storms. With a relatively flat floodplain, this location lends itself to a constructed wetland that can incorporate the topography and existing vegetation to provide water quality and a stable outfall for high-flow events.

Figure 8-28: Existing conditions downstream of Bay Ridge Ave, on SPCA property.

This is a particularly important location, because roughly 175 acres of runoff drains through this channel. Upstream land uses include single family residential, multi-family, and commercial, with significant areas of retail/commercial from Forest Drive included. The overall imperviousness is 38 percent, and this channel is fed almost exclusively by storm drains, with minimal overland flow. There is one significant existing stormwater device in this drainage area, consisting of the pond in the Watergate Village, which is described in Section A of this chapter.

Based on MDE's water quality requirements, 5.7 acre-feet of water quality volume are required for the entire drainage area. Providing a retrofit of this scale may not be realistic, so we have suggested breaking the improvements into two phases. The first phase could encompass a surficial area of roughly 0.8 acres, and approximately one quarter of the water quality volume and includes a coastal plain outfall to transition through a particularly steep area where the topography is at its narrowest. This CPO will provide a stable inflow to the Phase 2 improvements.

As the topography widens and flattens, it should be possible to design the Phase 2 improvements to provide the remaining water quality volume. The available surficial area is roughly 1.8 acres, which translates into an average depth of less than thirty inches. Utilizing shallow pools, and incorporating emergent wetland vegetation, the ponds will utilize natural processes to filter and cleanse the stormwater before discharging into Back Creek. A secondary advantage to this BMP will be that is provides additional habitat for fish, amphibians, mammals, birds, and beneficial insects.



Back Creek Watershed Stormwater Retrofits

Bay Ridge Road and Georgetown East Elementary School

Exhibit 8-B-5

1 inch equals 100 feet

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Data Sources:
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Regardless of the construction timing of this project, we recommend that the design be performed at one time to best balance the water quality and habitat benefits while minimizing tree removal, and grading. Special consideration will need to be given to providing a temporary bypass for the existing stormwater flow during construction to ensure that erosive velocities do not occur and cause excessive downstream sedimentation.

This location also has the advantage of integrating with the proposed trail system, which provides additional recreational and educational value. Since the ponds are large, maintenance by heavy equipment will be required at periodic intervals, and this access can be integrated with the public uses envisioned in this area.

We give this location **high priority** because of the large size of the drainage area and linkage with the trail with the accompanying recreational and educational value. Obviously, the largest obstacle to construction of this retrofit is cost, although it may be possible to reduce the scope of this improvement by constructing distributed BMPs, such as rain gardens, on upstream properties. Also important is the fact that this land is privately owned and would require cooperation from the SPCA to obtain an easement or to purchase the land.

5. Georgetown East Elementary School – Constructed Wetland

This location is northwest of the Georgetown East Elementary School on Basswood Road, in a wooded area. This watercourse, in fact, combines downstream with Phase 2 of the Bay Ridge Avenue Retrofit, which allows for additional polishing of stormwater before it is discharged into tidewater. We are proposing a similar type of constructed wetland as was described in the previous section.

This drainage area is considerably smaller than the previous one, at 29 acres. In addition to the school, the drainage area encompasses several single family lots along Dogwood Road and Victor Parkway. Since a larger portion of the drainage area is wooded, the overall imperviousness is 33 percent, which requires 0.83 acre feet of water quality volume. Consistent with other areas in the Back Creek watershed, there appears to be little in the way of existing water quality devices upstream of this location.

Several storm drain inlets are located on the school grounds and discharge via a closed storm drain into this area. However, our field investigation determined that the corrugated metal pipe outfall is actually sloped uphill in some locations, and we question whether this is functioning as intended. The pipe outfall has insufficient scour protection, and a telephone pole has been placed immediately adjacent to the pipe. This proposed retrofit could correct these deficiencies and restore a more natural outflow condition.

Figure 8-29: Outfall pipe sloped uphill.

Figure 8-30: Telephone pole at pipe discharge.

Working with the existing topography, the proposed retrofit could encompass up to 0.65 acres, which allows for a shallower system that contains a greater reliance on wetland vegetation for improved pollutant removal efficiency. Like the previous retrofit, we recommend that the final design incorporate a bypass mechanism to allow high-flow events to pass the water quality device to avoid re-suspending previously sequestered pollutants.

Located in close proximity to a school, and along the proposed trail route, this retrofit has the highest educational value of all the retrofits described. We give this a **high priority** for this reason, and because of its integration with the Bay Ridge Avenue retrofit.

Owned by the Anne Arundel County Board of Education (BOE), lack of city ownership is a challenge for this site as well. However, being a government agency, and recognizing the educational and environmental value to the community, it is hoped that the BOE may be amenable to the project. The price of this retrofit will also be significant, and will likely require grant funding or some other sizable source of cash.

6. Georgetown Road – Oversized Coastal Plain Outfall

This drainage area begins at the Giant Food store parking lot at Bay Ridge Avenue, encompassing several multi-family communities along Edgewood Road, and includes a portion of Annapolis Golf Club Links. The discharge is through a shallow gully near the intersection of Georgetown Road and Windwhisper Lane. There appears to be minimal upstream stormwater management, and concentrated storm drains discharge into this area via a 48-inch pipe at Windwhisper Lane and a 42-inch pipe at Yachtsman Way. Downstream of the pipes, the channel is stabilized by a gabion basket system that appears to have been constructed relatively recently and is in good condition. This traditional stabilization technique could be improved through an upgrade to an oversized coastal plains outfall which provides additional benefits beyond simple channel stabilization.

Figure 8-31: Gabion baskets located downstream from 48-inch culvert at Windwhisper Lane

This area totals 98 acres, and is roughly 41.7 percent impervious, requiring a water quality volume of 3.46 acres. It is unlikely that a project could be constructed in this area to provide the entire water quality in a coastal plains outfall, because of space and budgetary constraints. However, over-sizing the CPO to the extent possible will maximize the water quality treatment while providing all of the inherent benefits of that technology.

This land is privately owned by the Annapolis Roads Limited Partnership. Due to this, and the fact that the existing gabion baskets are in good working order, we give this site **low priority**. At such a time as this channel needs re-stabilization, it will make more sense to upgrade to the latest technology. In addition, this site does not lend itself to educational or recreational uses which reinforce the lack of urgency.

Back Creek Watershed Stormwater Retrofits

Georgetown Road

Exhibit 8-B-6

1 inch equals 100 feet

Data Sources:
City of Annapolis
MD Dept. of Natural Resources
McCrone, Inc.

C. Approximate Retrofit Costs

In the following Stormwater Retrofit Opportunities table, rough cost estimates are shown for the recommended retrofits on a per project basis. The estimated costs below were derived from the costs of similar projects constructed recently. Actual costs may be higher than the values listed below due to design costs not being included in the estimates. The total cost for all of the proposed stormwater retrofits is approximately $2.1 million.

It is important to keep in mind that no stormwater retrofit project can be judged by its first cost alone, because every BMP will also require ongoing operations and maintenance. This may range from changing a storm drain filter at regular intervals, to trimming woody vegetation from a stormwater wetland embankment, to replacing the soil media and vegetative plantings in a bioretention filter. These requirements should be developed during the design phase of every BMP that is proposed, so that the first cost and ongoing maintenance costs can be properly allocated budgeted for.

Table 8-2 - Stormwater Retrofit Opportunities									
Location	Proposed Project(s)	Disturbed Area (acres)	Drainage Area Received (acres)	Impervious Cover (%)	Nutrient Removal (%)				Cost
					TP	TN	Zn	TSS	
1 - Fairview	Seepage Wetlands	0.9	21.9	39.2%	65	50	65	80	$139,300
	Coastal Plains Outfall	0.3	21.9	39.2%	45	45	80	60	$135,000
2 - Springdale	Coastal Plains Outfall	0.03	1.5	43.3%	45	45	80	60	$10,900
	Bioretentions	0.04	1.5	43.3%	45	45	80	60	$38,100
3 - Tyler	Oversized Coastal Plains Outfall	2.1	82.5	38.1%	45	45	80	60	$920,000
4 - Bayridge-Georgetown East (Phase 1)	Constructed Wetlands	1.1	175.2	37.6%	65	50	65	80	$55,000
	Coastal Plains Outfall	0.23	175.2	37.6%	45	45	80	60	$101,000
4 - Bayridge-Georgetown East (Phase 2)	Constructed Wetlands	2.2	175.2	37.6%	65	50	65	80	$99,000
5 - Bayridge-Georgetown East	Constructed Wetlands	0.69	28.9	32.8%	65	50	65	80	$34,500
	Coastal Plains Outfall	0.38	28.9	32.8%	45	45	80	60	$122,500
6- Georgetown	Oversized Coastal Plains Outfall	1.2	97.7	41.7%	45	45	80	60	$525,000
Total									**$2,180,300**

IX. Programmatic Change Recommendations

The six centralized treatment devices described in Chapter XIII, Section B, plus other retrofit projects that have been identified in previously prepared watershed studies, have significant obstacles to implementation. The most notable examples are land acquisition and the cost associated with designing, constructing, and maintaining large stormwater systems. In contrast, the direction for stormwater management has been turning towards small-scale, distributed practices such as rain gardens, drywells, rain barrels, etc. In fact, the Maryland Department of the Environment (MDE) is currently revising the state's Stormwater Manual to provide additional design standards and details to implement these practices, collectively known as Environmental Site Design (ESD).

Since the majority of the city is already developed, there are many locations where the only option is to provide ESD practices on existing properties. In addition, implementing ESD upstream of a centralized stormwater wetland can reduce the required size of the wetland, since some fraction of the required water quality treatment has been provided upstream. This is an important tool in reducing the size, cost, and impact of these "end of pipe" treatment techniques.

Because Annapolis has, for the most part, been developed before stormwater management was required, ESD practices need to continue to be incentivized and/or mandated City-wide, to make any meaningful improvements to water quality. MDE's new Stormwater Manual will be an important tool in implementing these strategies during the review process for site plans and subdivisions. A homeowner or commercial property owner who is occupying an older property currently has no requirement to retrofit new stormwater practices unless they seek to get permits to renovate or expand. The City has been aggressive in its efforts to educate residents and property owners regarding the importance of stormwater management. Now it's time to actually make it happen on a more comprehensive scale, with the ultimate goal being that water quality is provided for 100% of the impervious area in the City.

A. Education and Outreach

The City has already taken important steps to educate inhabitants about environmental issues. The next step is to get this information in the hands of land owners at an appropriate time. For example, when a homeowner applies for a building permit, it is a perfect time to provide information, design guidelines, and a list of contractors who can install a rain garden or rain barrel, remove impervious surfaces, or to convert lawn to Bayscape plantings. If the lot is waterfront, also include information regarding living shorelines (see Section E below). If the lot has a dock, include information regarding oyster gardens. Providing this information at the time of construction makes it more likely the practice(s) will be implemented since the site is already disturbed, contractor mobilization is shared, and the cost may be able to be rolled into the larger financing. To make more rapid improvements, the city should consider passing legislation that requires these items so that people are compelled to plan for them at the earliest stages of design.

Example of a driveway with a reduced impervious surface.

B. Green Programs and Impervious Reduction Strategies

The City has already demonstrated its commitment to reducing impervious area and providing stormwater management for the properties and public streets under its jurisdiction. It is also important that programs for storm drain maintenance and street sweeping be continued and expanded as necessary.

Continuing along this vein, we have identified several programs that can be targeted for implementation or expansion:

a. GreenScape and Tree Planting

The City's current budget supports 60+ projects a year, involving a minimum of 900 volunteers throughout every ward of the City. The City supports GreenScape for tree planting projects throughout Annapolis, and also give away 500 trees to residents in the fall. These long-standing programs can be expanded to include more locations, more publicity, and more plant material.

If the City wishes to more aggressively target the urban tree canopy coverage of 50%, the two primary mechanisms would be requiring plantings via legislation at property owners' expense, or by making additional plant material available through programs such as GreenScape. If desired, the program could be expanded to include private property, both residential and commercial. Since private property that is not undergoing development or re-development is not required to meet any tree coverage standards, the City should incentivize additional tree plantings to the extent possible.

b. Closed Storm Drain Treatment

Closed storm drain treatment through filter technology is the only option in many locations in the city because there is no room for infill BMPs.

The City has proposed to install innovative products that retrofit existing stormwater structures. These products are designed specifically for urban environments, where hydrocarbons, pathogens, and trash are the primary pollutants. These proposed products will be strategically placed at 36 inlets located in the upper (southern) section of the College Creek Watershed. This technology, or similar storm drain retrofits, are the only treatment option available for many areas of the city where storm drains discharge directly to tidewater, such as through a street-end park. We recommend that this test installation be evaluated for its effectiveness and if it is found to be effective, that the program be expanded to the maximum extent practical. In addition, other technologies or products may be worthy of consideration now or in the future, as further advancements are made.

c. Green Alley Program

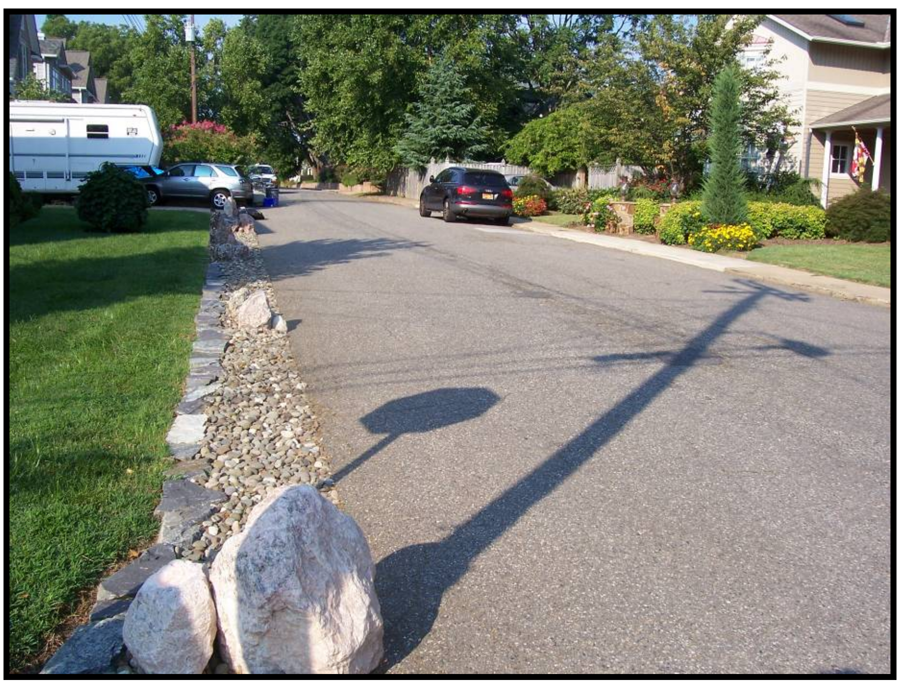
During our field investigations, we noted one location where an unpaved alley was located between two fenced yards.

Example of an unpaved alley.

Whether on purpose, or by accident, this serves as an example of how to re-think the materials used in the city's alleys based on the amount of traffic they see. Removing impervious surfaces will reduce the volume of runoff, restore infiltration, and provide water quality treatment. This approach could be implemented in many other locations in the city where traffic is minimal or has been eliminated. Where alleys are still used by vehicles on a regular basis, grass pavement technology could be implemented to allow vehicles to pass safely while addressing compaction issues and providing a permeable surface for infiltration to occur. In more urban alleys, the City should consider replacing conventional pavement with pervious asphalt or concrete paving systems. Porous pavement is a natural fit for these locations due to the low traffic volume, and slow speeds. The City of Chicago, IL already has a sucessful green alley program in place.

d. Remove Sidewalk and Install Infiltration Trench

Another innovative stormwater technique could be implemented either on open section roads, or where removal of a sidewalk is an option. As part of the mantra of removing impervious surfaces, some cities, are removing sidewalks on one side of streets where two exist and utilizing that space for stormwater management. Since a traditional open swale adjacent to the road is not an option in much of the city as it currently exists, a stone-filled water quality trench can be constructed within the narrow strip that is left, without posing a risk to cars. Of course, it is still desirable to prevent cars from driving on the stone, so some mechanism to deter cars such as curbing with intermittent curb cuts or large stones would be needed. The trench would capture road runoff and give it a chance to infiltrate before being conveyed downstream to the storm drain system. A picture of what this would look like is shown below.



Sidewalk replaced with stone infiltration trench

e. Shoreline Stabilization

During our tour of the waterfront, there were few areas of unstable bank that were sloughing off into the water and causing turbidity and siltation problems.

The City has led the charge toward living shorelines, and the Annotated Code of Maryland requires living shorelines except where it can be demonstrated that such measures are not feasible due to wave energy, water depth, steep slopes, excessive shade, etc.

The City's Board of Port Wardens reviews shoreline stabilization applications, and they have been, and should continue to be educated regarding the benefits and limitations of living shorelines. Property owners and contractors will need to adapt to these new requirements. The City could facilitate the learning process by hosting an informational meeting or meetings with MDE staff and design professionals familiar with living shorelines presenting. It is important that shoreline contractors are comfortable with the living shoreline technology and are trained on how to install them, so that they can help sell living shorelines to property owners. Recognizing the value of living shorelines, the Critical Area Commission and City Staff have been working together to facilitate their implementation or to collect fees in lieu of mitigation where they are infeasible.

A similar outreach can be made for property owners, to familiarize them with the new requirements and how living shorelines work. It would be prohibitively costly to replace an existing bulkhead or riprap slope before the end of its lifespan, so the transformation towards non-structural stabilization will take place over several decades. In the meantime, the City can facilitate in installation of new stabilization practices and any rehabilitations of failing traditional shorelines that may occur.

f. Street Sweeping and Storm Drain Inlet Cleaning

A significant reduction in pollutants can be achieved simply by vacuuming trash and plant matter out of storm drains and sweeping the streets on a regular basis. The City already has an aggressive street sweeping and inlet cleaning program in place. It is important that these programs not fall victim to the budgetary axe during challenging economic times. As the City's existing street sweepers age and need to be replaced, be aware that the newer technology utilizes dry sweeping combined with a vacuum system to remove smaller particulates. According to the Runoff Report, *A Clean Sweep Now Possible* (The Terrene Institute, Alexandria, VA. 6(4). July/August 1998), street sweeping can reduce nonpoint pollution by 35 to 80% and nutrients by 15 to 40%.

C. Stormwater Utility

Greenfield projects are already required to provide water quality treatment for 100% of the proposed impervious surfaces, and MDE is revising the state stormwater management manual to target ESD practices. This sets a high standard and helps ensure that new development discharge treated stormwater. Since the City has, for the most part, been built with no stormwater management facilities, the only meaningful improvements to water quality will be made by retrofitting the existing properties.

With respect to redevelopment projects, MDE's draft stormwater manual requires the following: Sites that are 40% impervious or less shall meet the standards for new construction; or for sites that are more than 40% impervious, provide water quality treatment for 50% of the existing impervious surface. (Water quality treatment may consist of impervious surface removal.) These requirements represent a higher standard than the City's current requirement that 50% of impervious surfaces be treated or removed for any redevelopment project.

While this may make incremental improvements, it is unlikely to result in a measurable improvement in water quality in the city because it only applies to existing sites that are seeking to expand. If the City is serious about improving water quality and the health of the Chesapeake Bay, they will need to increase the level of water quality treatment for all the properties that currently have no water quality treatment facilities.

A good analogy would be a landfill: current environmental standards require a lining and monitoring to ensure that the trash we dispose of does not contaminate groundwater. Modern landfills protect the environment, however historic landfills that were constructed half a century ago and abandoned have no such protection and generate plumes of contamination that continue to expand and contaminate groundwater. If we are to protect the environment, it is not enough to ensure that we do no additional damage; we must reverse historic damage to the extent we can.

In the case of stormwater management, this means dealing with older properties. Ideally, water quality treatment would be retrofit into all existing properties over time to achieve 100% treatment of all impervious surfaces. The new MDE regulations take us partway there, but not all the way. What is needed is an incentive to do more, and we feel the best way to accomplish this is through expansion of the City's stormwater utility program. Property owners are used to paying for clean potable water, and they are used to paying to have their wastewater conveyed to the treatment plant where it is cleansed and released. The next step is to create a mechanism for them to pay for the pollution generated by the impervious surfaces they own.

This is only fair. Owners of newly constructed properties have paid for the design and construction of stormwater management facilities, and they pay for ongoing maintenance and inspection. In contrast, existing properties have been polluting the Chesapeake Bay for years, decades or even centuries. The stormwater utility is not intended to clean up the pollution these sites have generated, only to stop more of it from entering the Chesapeake Bay. In addition, the utility is only intended to address water quality management, which is an order of magnitude less expensive than water quantity management. Water quantity management requires that the rate of stormwater discharge is held to pre-development levels. This typically requires large ponds, underground storage chambers, or other storage facilities. These require significant space on site, and are costly to implement. Both these factors make it unreasonable to provide quantity management for redevelopment projects as part of the stormwater utility program.

The City's current stormwater management utility (Section 12.10.180 of the Municipal Code) amounts to an annual fee of $35 for each residential water service and $180 per year for a business. This is a simple, easily calculated fee that raises important funds for public stormwater management improvement programs. This is a great start, but one significant limitation to the fee may be that it does little to encourage property owners to make improvements or add retrofit systems to their lots to address stormwater. It is suspect that the majority of people pay the fee and feel like they have done their part to clean up the Chesapeake Bay. While this may be true to some extent, we believe that this action by itself won't get the city to 100% treatment. It also creates considerable inequity in that owners of new properties that do address stormwater management are basically paying twice: once for the construction of the facility that serves their property, and again in a quarterly fee. It is recommended that the stormwater utility program be updated to better incentivize and facilitate construction of stormwater management practices, and that once in place, the property owner not be required to pay the quarterly fee. (Section 17.10.180.C. allows the Director of Neighborhood and Environmental Programs to accept construction of a stormwater management facility as payment of the utility fee.)

One way to incentivize is to increase the cost to more accurately reflect the actual cost of a stormwater retrofit. For example, if a homeowner were to spend $2,000 to remove their driveway and replace with wheel tracks, install rain barrels and a small rain garden, this equates to $158 per year amortized over 20 years at 5.0% interest. Commercial retrofits are probably significantly more costly because they include significantly more impervious area for each water tap.

This leads to the next source of inequity, which is that the current fee structure is based on the number of water taps, which has little bearing on impervious area. A 1,000 square-foot ice cream shop with on-street parking pays the same stormwater fee as a 2-acre self- storage facility with restrooms in the office. Since the self-storage site generates more pollution from its larger surface area, it should logically pay a higher fee than the ice cream shop. It would be more equitable to assign the fee based on impervious coverage. And it could even be possible to have a sliding fee that could account for a portion of the lot being treated and a portion untreated. This would allow for incremental retrofits over time, with the fee being reduced proportionally.

We recommend studying the likely cost of stormwater retrofits, as well as the possibility of implementing a sliding fee based on impervious coverage. However, a sliding fee would involve considerable extra expense in measuring impervious area, conducting onsite inspections and an appeals process if the property owner disputed the City's measurements. The results of the study can be used in refining the stormwater utility fee program. The ultimate goal of the utility should be to provide treatment for 100% of the impervious surfaces in the city.

The funds generated by the utility would be allocated towards the capital projects, such as those described in this document and in other watershed studies. These projects provide centralized stormwater management for upstream properties that are not treated. As more and more upstream properties are retrofit, the source of funds to the city is reduced, and the emphasis shifts from constructing new centralized BMPs to maintain the existing practices.

Ultimately, if every property in the City had onsite stormwater management, the collected fee could drop to zero. This would be a cause for celebration because it would signify that 100% stormwater management has been achieved.

As property owners decide to reduce or eliminate the fee by installing stormwater management, it will very likely spawn a cottage industry of professionals to design, install and maintain ESD practices, as well as facilitating the paperwork to adjust the city stormwater bill. Many examples of small scale ESD sites already exist around the city, with more planned, making it easy for people to choose practices that work with their site and tastes.

Similar utilities have been contemplated or implemented in several areas nationwide, including Anne Arundel County, Maryland; several areas in Florida; Wake County, North Carolina; Wichita, Kansas; Portland, Oregon; and Douglas County, Washington. Montgomery County, Maryland has developed a program for homeowners to apply for rebates towards the cost of rain gardens, rain barrels, green roofs, permeable pavement, tree canopy, or conservation landscaping. This program could serve as a model for distributing Annapolis' stormwater utility funds.

The term for stormwater utility has also been assigned the misnomer of "rain tax" in some areas. This belies the true intent of the program, which is to provide removal of harmful pollutants by coloring the concept as a government tax on a free resource that falls from the sky. It will be important to describe the utility in the proper terms if it is to gain public acceptance.

This concept will be an important one for the entire Chesapeake Bay watershed to embrace if we are going to really clean up the Bay. The current sentiment by environmental activists appears to be focused on penalizing new growth by instituting high (sometimes unrealistically high) environmental standards. While it is vital that new developments minimize their impact, it is important to recognize that development has occurred for centuries with little or no regard to the environment. We need to strive to clean up our past mistakes if we hope to realize a meaningful improvement in water quality.

"I think the environment should be put in the category of our national security. Defense of our natural resources is just as important as defense abroad. Otherwise, what is there to defend?" - Robert Redford.

X. Conclusions

The City of Annapolis watershed is unique in that it is a completely urban watershed with impairments much different than those of mostly rural watersheds. While rural watersheds do contain municipalities which contribute some impairments related to impervious surface and urban nonpoint sources, they most substantial impairments come from agriculture-related issues. The City has a very different set of issues to deal with when it comes to watershed health and restoration, issues relating to urban nonpoint sources, recreation, stormwater management and runoff, sediment, etc. The City of Annapolis is in a position to embrace new technologies and innovative best management practices to improve the overall health and conditions of its creeks and watersheds, and believes that it can serve as a model for other urban watershed restoration efforts in the future.

The City has already implemented, or is in the process of implementing, many programmatic changes and watershed restoration projects throughout the city, and has also already set higher standards and goals for increasing city-wide tree canopy and decreasing impervious surfaces. This report emphasizes the importance of continuing to implement the projects, programs, and goals the City has already put into place. Additionally, this report emphasizes the importance of and the need for capacity building and maintenance in order to achieve the City's goals and objectives for the watersheds. There must be political will, enthusiasm, and resources to not only implement projects and programmatic changes, but also to see that they are carried out, enforced, and completed, and that the results are measurable where possible in order to document their effect on the overall improvement of the sub-watersheds.

Perhaps the most important piece of this report is the digital, GIS/geospatial component. The project team received many different geospatial datasets from the City which provided a good base for the work done during this project. As a result of this project, the City now has the most accurate geospatial data layers representing the most accurate current tree canopy and impervious surface polygons for each of the sub-watersheds. All gaps in this data have been filled and quality controlled. Calculations have been made for each of the sub-watersheds in the study area for tree canopy and imperviousness. Impervious surfaces have been categorized and calculated as well. Categorizing the different types of impervious surfaces throughout the watershed area gives the City a way of accurately quantifying the different types of impervious surface and will help prioritize best management practices for each surface type. Additionally, geospatial data has been created from DPW paper maps, and can continue to be maintained digitally, rather than keeping paper records for water and sewer data. GIS data has also been compiled from the paper maps of previous watershed studies, recreation plans, and the like. The result is a more comprehensive geodatabase for the city that contains accurate and current information and can also be used for future scenario modeling.

Digital geospatial data created and enhanced as a result of this project can also be used for online web mapping, should the City or any of the watershed conservancy groups decide to implement an online watershed mapping application. This geospatial data also will enable the City to better manage its resources, make smarter queries for mailings, notifications, and public outreach, and can be contributed to the Governor's iMap initiative for a statewide online GIS mapping application.

The City of Annapolis and its residents all play a role in the health of the watershed. Immediate and meaningful implementation of projects and programmatic changes will lead to measurable environmental successes in watershed. The City and its stakeholder partners must continue to work together to ensure the success of programmatic code and policy changes, and must work cooperatively to implement meaningful projects and best management practices. Assuring sustainable outreach efforts is also key in making sure everyone has a hand in watershed restoration and understands the importance of collaborative implementation and maintenance efforts.

References

Admiral Heights Improvement Association, Chesapeake Bay Foundation, Severn River Commission, & Weems Creek Conservancy, 1992. *Recommendations for Weems Creek.* Prepared for Honorable William Donald Schaefer. Weems Creek Conservancy. Annapolis, MD.

Center for Watershed Protection, 2006. *Spa Creek Headwaters Subwatershed Restoration Management Plan.* Prepared for the Spa Creek Conservancy. Center for Watershed Protection. Ellicott City, MD.

Center for Watershed Protection, 2007. *Spa Creek Tidal Subwatershed Assessment Report.* Prepared for the Spa Creek Conservancy. Center for Watershed Protection. Ellicott City, MD.

Center for Watershed Protection & EcoLogix Group, Inc., 2003. *Weems Creek Watershed Improvement Plan.* Prepared for the Weems Creek Conservancy. Center for Watershed Protection. Ellicott City, MD.

Davison, A. Todd & Rucker, Colby B. - Severn River Commission, 1988. *Gems of the Severn.* Prepared for Anne Arundel County and the City of Annapolis. Severn River Commission. Annapolis, MD.

Galvin, Michael F., Grove, J. Morgan, and O'Neil-Dunne, Jarlath, 2006. *A Report on Annapolis' Present and Potential Urban Tree Canopy.* Prepared for the City of Annapolis. Maryland Department of Natural Resources. Annapolis, MD.

Gannett Fleming, Inc. & ESA, Inc., 2005. *Weems and College Creeks Annual Water Quality Monitoring Report (Construction Phase, Year 1).* Prepared for the Maryland State Highway Administration. Gannett Flemming. Baltimore, MD.

Gannett Fleming, Inc. & ESA, Inc., 2006. *Weems and College Creeks Annual Water Quality Monitoring Report(Construction Phase, Year 2).* Prepared for the Maryland State Highway Administration. Gannett Flemming. Baltimore, MD.

Gannett Fleming, Inc. & ESA, Inc., 2007. *Weems and College Creeks Final Water Quality Monitoring Report (Post-Construction Phase, Year 3).* Prepared for the Maryland State Highway Administration. Gannett Flemming. Baltimore, MD.

Institute for Community Research and Development, School of Government and Business Administration, The George Washington University, 1987. *Parks and Paths for People.* Prepared for the City of Annapolis. George Washington University, Washington, DC.

Murphy/Williams, 1974. *An Environmental Action Strategy: Annapolis, MD.*

Severn River Commission, 1986. *Severn River Natural Areas of Highest Priority for Preservation.* Prepared for Anne Arundel County and the City of Annapolis. Severn River Commission. Annapolis, MD.

Task Force on Recreational Facilities, Services, and Programs, 1998. *Final Report*. Prepared for the City of Annapolis. Annapolis, MD.

Glossary

319

A section of the federal Clean Water Act dealing with non-point sources of pollution. The number is often used alone as either a noun or an adjective to refer to some aspect of that section of the law, such as grants.

BATs

Best available technologies

BMPs

Best management practices

BOE

Board of Education (Anne Arundel County)

Conservation Easement

A legal document recorded in the local land records office that specifies conditions and/or restriction on the use of and title to a parcel of land. Conservation easements run with the title of the land and typically restrict development and protect natural attributes of the parcel. Easements may stay in effect for a specified period of time, or they may run into perpetuity.

CPO

Coastal plains outfall

DBH

Diameter at base height

DNEP

Department of Neighborhoods & Environmental Programs (City of Annapolis)

DNR

Department of Natural Resources (Maryland State)

DPW

Department of Public Works (City of Annapolis)

EPA

Environmental Protection Agency (United States)

ESD

Environmental Site Design

Geodatabase

A database designed to store, query, and manipulate geographic information and spatial data.

GIS

Geographical Information System, a computerized method of capturing, storing, analyzing, manipulating, and presenting geographical data.

HOA

Home Owner's Association

MDA

Maryland Department of Agriculture

MDE

Maryland Department of the Environment

MDP

Maryland Department of Planning

NAIP

National Agricultural Imagery Program

NPDES II

National Pollution Discharge Elimination System – Phase II

NPS

Non-Point Source, pollution that originates in the landscape that is not collected and discharged through an identifiable outlet.

QC

Quality control

Riparian Area

1. Land adjacent to a stream. 2. Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines. (National Research Council, *Riparian Areas: Functions and Strategies for Management.* Executive Summary page 3. 2002)

SAV

Submerged Aquatic Vegetation, important shallow-water sea grasses that serve as a source of food and shelter for many species of fin- and shell-fish.

SUFA

Strategic Urban Forest Assessment

SWM

Stormwater management

Synoptic Survey

A short-term sampling of water quality and analysis of those samples to measure selected water quality parameters. A synoptic survey as performed by DNR in support of watershed planning may be expanded to include additional types of assessment like benthic macro-invertebrate sampling or physical habitat assessment.

TMDL

Total Maximum Daily Load, a determination by MDE of the upper limit of one or more pollutants that can be added to a particular body of water beyond which water quality would be deemed impaired.

Tributary Teams

Geographically-focused groups, appointed by the Governor, oriented to each of the 10 major Chesapeake Bay tributary basins found in Maryland. The teams focus on policy, legislation, hands-on implementation of projects, and public education. Each basin has a plan, or Tributary Strategy.

USDA

United States Department of Agriculture

UTC

Urban tree canopy

Water Quality Standard

Surface water quality standards consist of two parts: (a) designated uses of each water body; and (b) water quality criteria necessary to support the designated uses. Designated uses of for all surface waters in Maryland (like shell fish harvesting or public water supply) are defined in regulation. Water quality criteria may be qualitative (like "no objectionable odors") or qualitative (toxic limitations or dissolved oxygen requirements).

Watershed

All the land that drains to an identified body of water or point on a stream.

WRAS

Watershed Restoration Action Strategy, a document outlining the condition of a designated watershed, identifying problems, and committing to solutions of prioritized problems.

Online Resources

McCrone, Inc.
http://www.mccrone-inc.com

AEGIS (Analytical and Environmental Geographic Information Systems)
http://www.thinkaegis.com

City of Annapolis
http://www.ci.annapolis.md.us/

City of Annapolis Department of Neighborhood & Environmental Programs
http://www.ci.annapolis.md.us/info.asp?page=1323

City of Annapolis Public Works Administration
http://www.ci.annapolis.md.us/info.asp?page=1366

Anne Arundel County
http://www.aacounty.org/

Anne Arundel Board of Education
http://www.aacps.org/

Maryland Department of Natural Resources
http://www.dnr.state.md.us/

Maryland Department of Agriculture
http://www.mda.state.md.us/

Maryland Department of the Environment
http://www.mde.state.md.us/

Maryland Department of Planning
http://www.mdp.state.md.us/

United States Department of Agriculture
http://www.usda.gov/wps/portal/usdahome

Environmental Protection Agency
http://www.epa.gov/

National Agriculture Imagery Program
http://165.221.201.14/NAIP.html

Weems Creek Conservancy
    http://weems-creek.org/

Spa Creek Conservancy
    http://www.spacreek.org/

Chesapeake Ecology Center (focus on College Creek)
    http://www.chesapeakeecologycenter.org/

Appendix 1

A report on Annapolis' present and potential Urban Tree Canopy

Prepared for:

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Summary

On January 12, 2005, the Maryland Department of Natural Resources (MD DNR) invited the City of Annapolis to participate in the Urban Tree Canopy (UTC) goal setting process in accordance with the Chesapeake Bay Program's Riparian Forest Buffer Directive No. 03-01. Mayor Ellen Moyer accepted the offer shortly thereafter.

During the following fall and winter city staff, MD DNR, and representatives from US Forest Service and the University of Vermont Spatial Analysis Lab developed analytical methods for the UTC analysis, and established timelines for UTC goal setting completion.

Researchers from the US Forest Service and the University of Vermont Spatial Analysis Lab coordinated with MD DNR and performed the agreed upon analyses. Using various GIS data, including high-resolution remote sensing data interpreted for trees and other vegetation and parcel information from the Maryland Department of Planning, the team was able to quantify existing UTC and possible UTC by geographical boundaries and parcel land use type. Possible UTC was classified into enhancement scenarios based on the 25th, 50th, and 75th percentiles. Results were compared with median UTC for Maryland communities as well as with existing and target UTC for various jurisdictions that have set UTC goals.

While it is easy to think of UTC enhancement in terms of planting trees, UTC enhancement requires a combination of tree protection, tree maintenance, and tree planting to be fully realized and efficiently implemented. The impacts of setting a UTC goal will likely include PROW and public Exempt Commercial lands. On private lands, a combination of education and outreach, landowner incentives, and refocusing of regulatory mechanisms (Critical Area Law, Forest Conservation Act, Landscape Ordinance, etc.) to specifically achieve the objectives of the UTC goal will likely be required. As trees and tree crowns take time to grow, UTC planning has a temporal as well as a quantitative element. Twenty to thirty years' time will be needed to achieve a significant increase in UTC.

The basic premise of UTC enhancement is water quality improvement related to the Chesapeake Bay. In a study of all (245) small watersheds in Montgomery County, MD, Goetz et al. (2003) found overall of tree cover of 44.6% to be associated with stream health ratings of "good", with increases in overall UTC associated with improvements in stream health ratings and decreases in overall UTC associated with declines in stream health ratings.

We recommend that Annapolis adopt a 50% UTC goal to be attained by 2036, with remote sensing assessment of progress in attaining the UTC goal at 10-year intervals. This goal corresponds to the 25th percentile enhancement scenario and slightly exceeds the target established by Goetz (2003). Such a goal would make Annapolis a leader in UTC among US cities.

We recommend that the US Forest Service Northeast Research Station, MD DNR Forest Service, and the Chesapeake Bay Program work with the City to:

1. Develop an implementation plan to realize the UTC goal;
2. Issue an updated report containing the newly annexed areas and reflecting the updated ward boundaries within six months of the availability of digital shapefiles for the new ward boundaries; and,
3. Provide ongoing technical assistance on implementation and monitoring UTC goal progress.

*To assist in use of this document, terms that may require explanation are introduced in the body in **bold italics** and defined in the Glossary section. At a hyperlink to a Figure or Table, click on the link and you will go to that Figure or Table.*

Assignment

The assignment as identified by the client (City of Annapolis) was to help Annapolis to be a pilot community for the Urban Tree Canopy program.

Background

The Chesapeake Bay Program's Riparian Forest Buffer Directive No. 03-01 (Chesapeake Executive Council) was signed in December 2003. This expanded riparian buffer directive "...recognizes that urban tree canopy cover offers stormwater control and water quality benefits for municipalities in the Chesapeake Bay watershed and can extend many riparian forest buffer functions to urban settings" and commits to, among others, the following goals:

- By 2010, work with at least 5 local jurisdictions and communities in each state to complete an assessment of urban forests, adopt a local goal to increase urban tree canopy cover and encourage measures to attain the established goals in order to enhance and extend forest buffer functions in urban areas; and,
- Encourage increases in the amount of tree canopy in all urban and suburban areas by promoting the adoption of tree canopy goals as a tool for communities in watershed planning.

On January 12, 2005, the Maryland Department of Natural Resources (MD DNR) sent a written invitation to Mayor Moyer. The letter invited Annapolis to be one of the five (5) communities referred to in the directive noted, and committed to provision of technical assistance in the event of acceptance.

On January 28, 2005, Mayor Moyer responded by letter, committing to participation.

On November 4, 2005, the initial goal-setting meeting was held at City Hall. Participants included Annapolis and MD DNR staff. The group reviewed data and methods, agreed upon certain analyses and set a date to review results and recommend a goal. The timeline called for:

1) An updating of data, methods, analyses, and subsequent report of results by spring 2006;
2) The development of a goal recommendation in early 2006, and
3) A report for the City to review in order to make an announcement on a UTC Goal.

On May 26, 2006, the final goal setting meeting was held at City Hall. Participants reviewed and discussed data and analyses noted in the remainder of this report.

Methods

Existing And Possible Canopy Cover

Existing UTC was extracted from the MD DNR ***Strategic Urban Forests Assessment*** (SUFA) land cover layer that was created from high-resolution leaf-on ***IKONOS*** satellite imagery in 2004 (Irani and Galvin 2003). Using a geographic information system (GIS) the SUFA layer was overlaid on a composite layer consisting of street and parcel boundaries. Parcel land use type was determined by linking the Parcel data with the MD Property View® dataset. PROW was used to describe non-parcel areas consisting of both roads and the adjacent land. Due to provision of the building and road layers, we were also able to calculate the amount of UTC overhanging improvements.

To estimate ***possible UTC***, building footprints and water features were added to the above composite layer containing UTC, streets, and parcels. Possible UTC was defined as any piece of land in the city not occupied by a building, existing UTC, a street, or water. Thus, those areas that are deemed possible largely consist of grass and non-road/non-building paved surfaces.

By combing the building footprint layer and the roads layer with the SUFA (UTC) layer, we were also able to calculate existing UTC overhang (UTC over improvements).

Scenarios

Possible UTC was classified into scenarios based on 25th, 50th, and 75th percentiles. Results were compared with median UTC for Maryland communities as well as with existing and target UTC for: Portland, OR (Poracsky and Lackner 2004); Vancouver, WA (Kaler and Ray 2005); Montgomery County, MD (Montgomery County 2000); Roanoke, VA (Urban Forestry Task Force and Roanoke Department of Recreation and Parks 2003); Fairfax County, VA (Funders' Network for Smart Growth and Livable Communities 2005), and, Baltimore, MD (Galvin et al. 2006a).

Results

Land use

Land use types in acres and as a percentage of the total City land area are summarized in Table 1.

Land cover

Land cover as a percentage of the total City land area is depicted in Figure 1.

Existing UTC

Existing UTC by land type in acres and as a percentage of the total City land area is summarized in Table 2. Currently, UTC covers 1,737 acres or 41% of the City. Most UTC occurs on Parcel lands (37%) in contrast to PROW (4%). The three land use types with the most existing UTC are Residential (23%), Exempt-Commercial (5%), and PROW (4%).

Possible UTC

Possible UTC by land type in acres and as a percentage of the total City land area is summarized in Table 3. The five land use types with the largest possibility for increasing canopy cover are Residential (15%), Exempt Commercial (8%), Commercial (7%), Apartments (3%), and Unknown (3%). Of these five land use types, Residential and Exempt-Commercial already have the highest levels of existing canopy cover.

Discussion

This analysis was performed based on data acquired prior to the recent annexation (March 2006) of three parcels. We have also been advised that, based on the noted annexations, ward boundaries will be redrawn in the near future and will differ from what is presented here.

The majority of land area in the City is parcel land (Figure 2). These lands contain the majority of existing UTC as well as the majority of possible UTC. The MD Property View®

dataset does not categorize land as public or private. Public lands are primarily found in the created PROW non-parcel class and in a percentage of the Exempt Commercial (EC) class. The EC class consists mostly of properties owned by the City, state and federal government, nonprofit or charitable organizations (museums, colleges), and private institutions (churches, hospitals). During the implementation phase, the public lands can be extracted from the EC class in order to identify public v. private lands, as they will likely require different approaches for UTC enhancement. The greatest opportunities for UTC enhancement exist on private Residential, Exempt Commercial, and Commercial lands, on public Exempt Commercial and possibly on PROW lands, followed by private Apartments and Unknown lands (Figure 3). Though opportunity exists on the remaining five (5) classes of land types, they each represent no more than 1% of the total possible UTC.

Existing UTC (1,737 acres) covers an area approximately the size of all Residential lands in the City (1,805 acres). The maximum possible UTC is 3,318 acres or 78% of City land area, a 91% increase. However, the probability and/or preferability of such an increase is unknown. As a public initiative on public lands only, modest canopy goal increases are achievable through PROW plantings alone. More significant increases would involve other land use types and owners as policy makers, planners, and managers considered the probability and preferability of different options.

While we may not think of trees in cities as a typical “forest,” these trees provide valued services to our daily lives. These benefits include: reducing the urban heat island effect, improving water quality, saving energy, lowering city temperatures, reducing air pollution, increasing neighborhood desirability and quality of life, enhancing property values, providing wildlife habitat, facilitating social and educational opportunities, and providing aesthetic benefits. Scientists now have the ability to qualify and quantify the benefits of UTC. An increase in UTC brings an associated increase in the UTC benefits listed above (Galvin et al. 2006b).

The basic premise of this UTC enhancement effort is water quality improvement related to the Chesapeake Bay. In a study of all (245) small watersheds in Montgomery County, MD, Goetz et al. (2003) found overall of tree cover of 44.6% to be associated with stream health ratings of “good”, with increases in overall UTC associated with improvements in stream health ratings and decreases in overall UTC associated with declines in stream health ratings. Realizing that the maximum “possible” UTC identified (78%) is not possible for practical purposes, we sought then to identify the maximum probable/preferable UTC in order to attain the desired water quality benefits established by Goetz (2003).

Three possible UTC scenarios were developed for Annapolis, representing low, medium, and high UTC enhancement:

1. Low: 50% UTC (Current UTC + 25% of possible UTC; Table 4)
2. Medium: 59% UTC (Current UTC + 50% of possible UTC; Table 5)
3. High: 68% UTC (Current UTC + 75% of possible UTC; Table 6).

A comparison of existing and potential UTC under scenarios 1, 2, and 3 to median UTC for Maryland communities and existing and planned UTC in four other jurisdictions that have set UTC goals is found in Figure 4.

As trees and tree crowns take time to grow, UTC planning has a temporal as well as a quantitative element. Twenty to thirty years’ time will be needed to achieve a significant increase in UTC.

While it is easy to think of UTC enhancement in terms of planting trees, it is critical that UTC enhancements include a combination of tree protection, tree maintenance, and tree planting in order to be fully realized and efficiently implemented. Luley and Bond (2002) offered the following conceptual analysis for increasing UTC: $\mathbf{C_T = C_B + C_N + C_G - C_M}$

Where:

$\mathbf{C_T}$ = total UTC in the modeling domain over time (realization of UTC goal);
$\mathbf{C_B}$ = the existing UTC;
$\mathbf{C_N}$ = UTC increase from new trees (planting);
$\mathbf{C_G}$ = the growth of existing UTC (protection and maintenance); and,
$\mathbf{C_M}$ = UTC mortality or loss due to natural and man-induced causes.

UTC enhancement can be most efficiently realized by maximizing protection and maintenance in combination with new plantings. A 1999 study by the US Forest Service Northeastern Research Station found that over 65% of the trees in Baltimore were less than 15.2 cm (approximately 6") ***d.b.h***., and approximately 75% were less than or equal to 22.9 cm (approximately 9") d.b.h. If these trees are managed so that their anticipated mature crown projections are realized, significant UTC enhancement will occur in concert with planting efforts.

The impacts of setting a UTC goal will likely include focusing or reallocating public agency resources (funds, staff, etc.) to enhance UTC on Urparian and public Exempt Commercial lands. On private lands, a combination of education and outreach, landowner incentives, and refocusing of regulatory mechanisms (Critical Area Law, Forest Conservation Act, Landscape Ordinance, etc.) to specifically achieve the objectives of the UTC goal will likely be required.

Recommendations

We recommend that Annapolis adopt a 50% UTC goal to be attained by 2036, with remote sensing assessment of progress in attaining the UTC goal at 10-year intervals. This goal corresponds to the 25th percentile enhancement scenario and slightly exceeds the target established by Goetz (2003).

We recommend that the US Forest Service Northeast Research Station, MD DNR Forest Service, and the Chesapeake Bay Program work with the City to:

1. Develop an implementation plan to realize the UTC goal;
2. Issue an updated report containing the newly annexed areas and the new wards within six months of the availability of digital shapefiles for the new ward boundaries; and,
3. Provide ongoing technical assistance on implementation and monitoring UTC goal progress.

Glossary

d.b.h.: Diameter at breast height (1.4m or 54 in. above the ground). A standard measure of tree size in forestry and arboriculture.

Exempt Commercial: A land use type recognized by MD Property View®. It is locally defined and includes lands that are zoned commercial and exempt from property taxes. These include federal, state, county, and municipal lands, and certain private tax-exempt lands normally associated with non-profit entities.

Existing UTC: Any piece of land in the city that was covered by tree canopy at the time of satellite data acquisition.

IKONOS: A commercial satellite that collects high-resolution imagery panchromatic (black and white) imagery at a resolution of 1-meter and multispectral (natural color and near infrared [NIR]) imagery at a resolution of 4-meters. Space Imaging, Inc. distributes IKONOS imagery under the product name CARTERRA.

Possible UTC: Any piece of land in the city that is not occupied by a building, existing UTC, a street, or water. Those areas that are deemed possible primarily include grass and non-road/non-building paved surfaces

PROW: Land that falls within the public road right-of-way, derived by identifying all non-parcel lands. This land use type is not recognized by MD Property View®.

Strategic Urban Forests Assessment: A process to extract UTC information from high-resolution remote sensing imagery. A vegetation mask is created from the NIR-to-red, (Band4:Band3) ratio image. A texture image of the resulting ratio image is produced to separate UTC vegetation from non-UTC vegetation pixels (separate trees from other vegetation). The resulting image provides for quantification of existing UTC and non-UTC vegetation.

Urban Tree Canopy: Urban tree canopy (UTC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above.

Urparian: Urparian describes the vegetated areas around roads and sidewalks. The term comes from combining urban and riparian to form a single word. In less urbanized systems, the corridor around streams (the riparian zone) is extremely important for water quality. This area of vegetation captures and processes pollutants before they can make it into surface waters. In urban areas, however, riparian zones are often less effective at removing pollutants. One reason is that urban streams tend to be deeply incised, causing the riparian zone to be disconnected from the stream below. Secondly, the streams in many urban areas have been functionally replaced with storm sewers. In this context, the soil and vegetation around roads and sidewalks is the new riparian zone. By increasing tree canopy in the urparian zone, we can return some of the environmental benefits of riparian areas to urban systems.

Figures

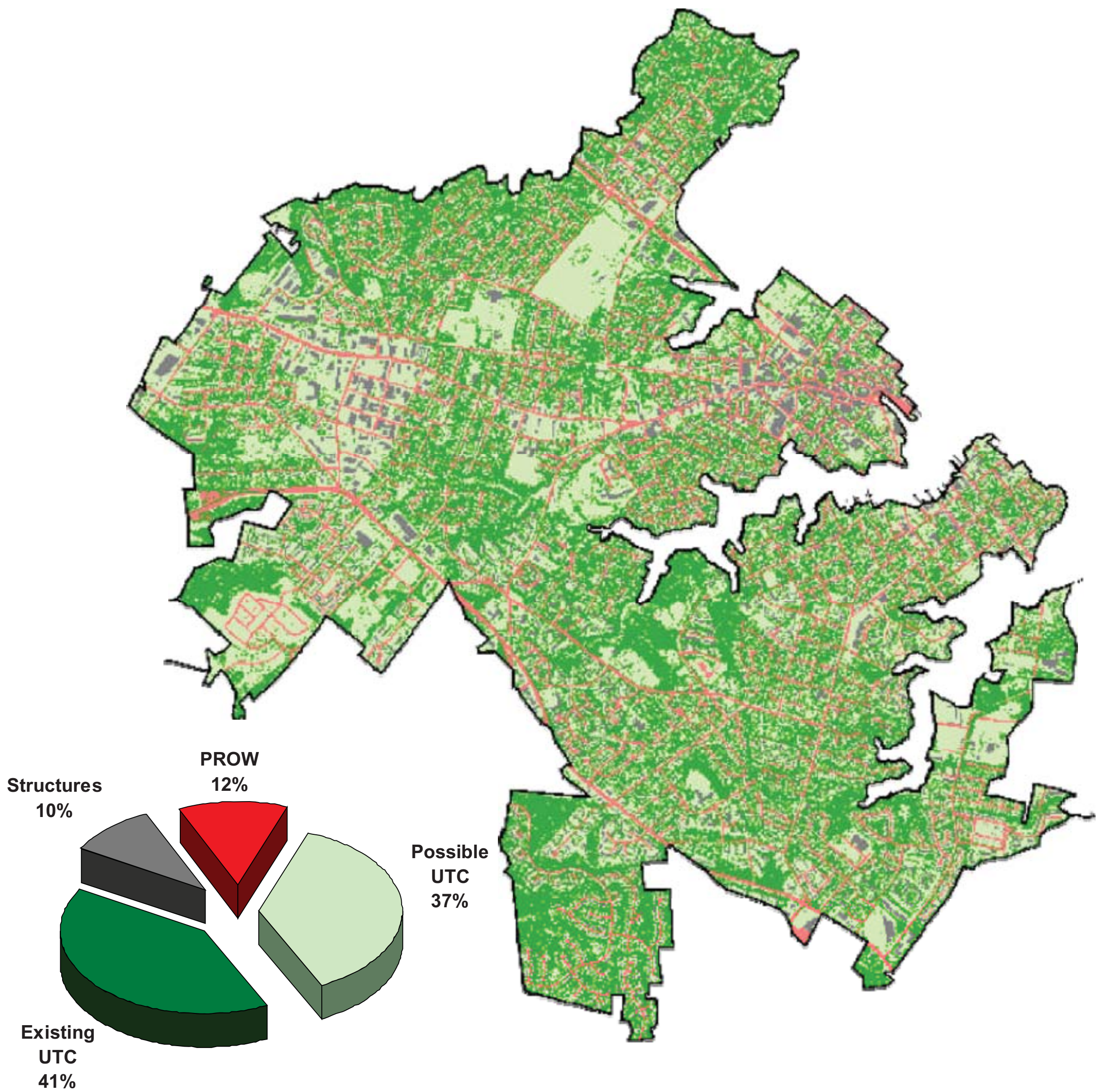


Figure 1 – Current condition from a UTC perspective

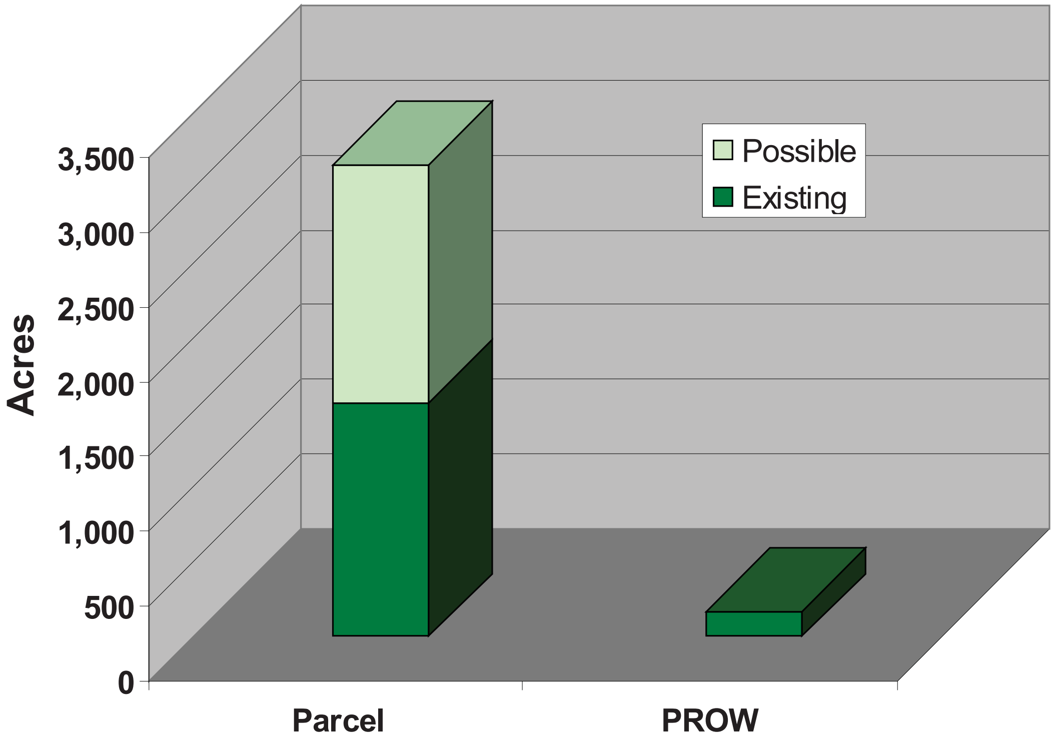


Figure 2 - Existing and possible UTC on parcel lands and PROW

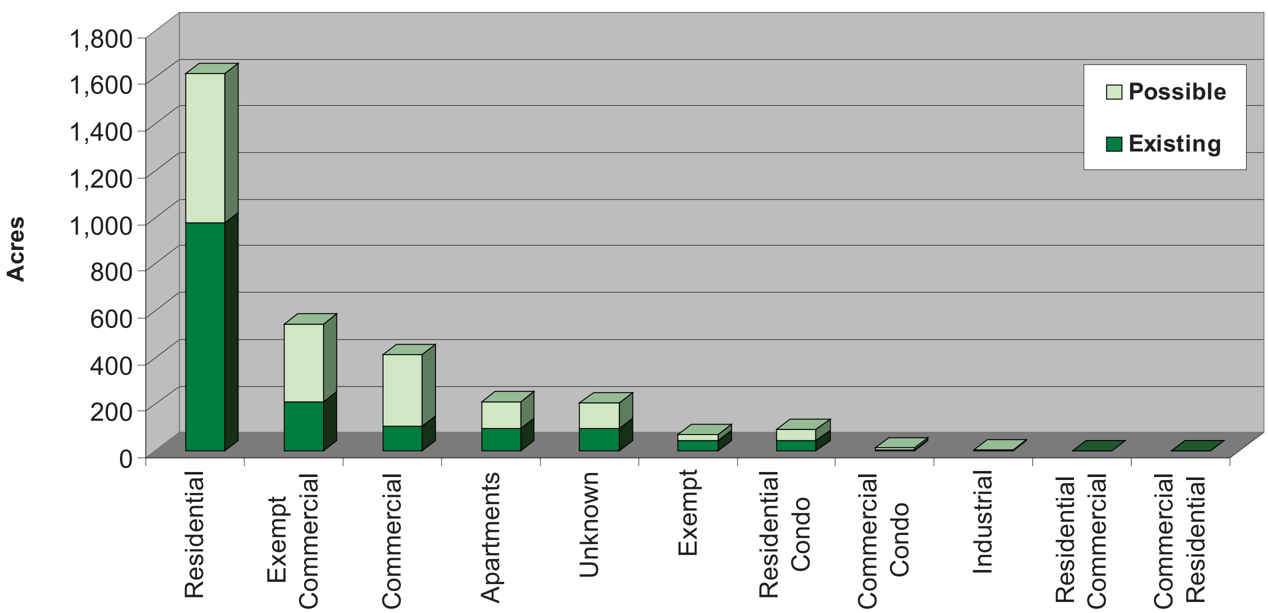


Figure 3 – Existing and possible UTC on parcel lands by land use type

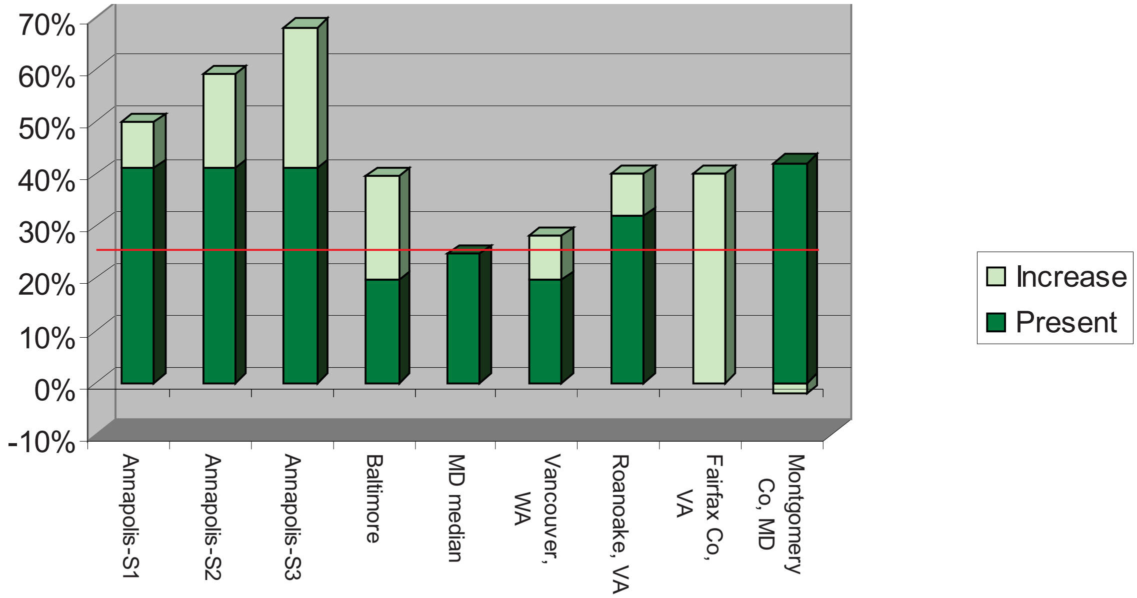
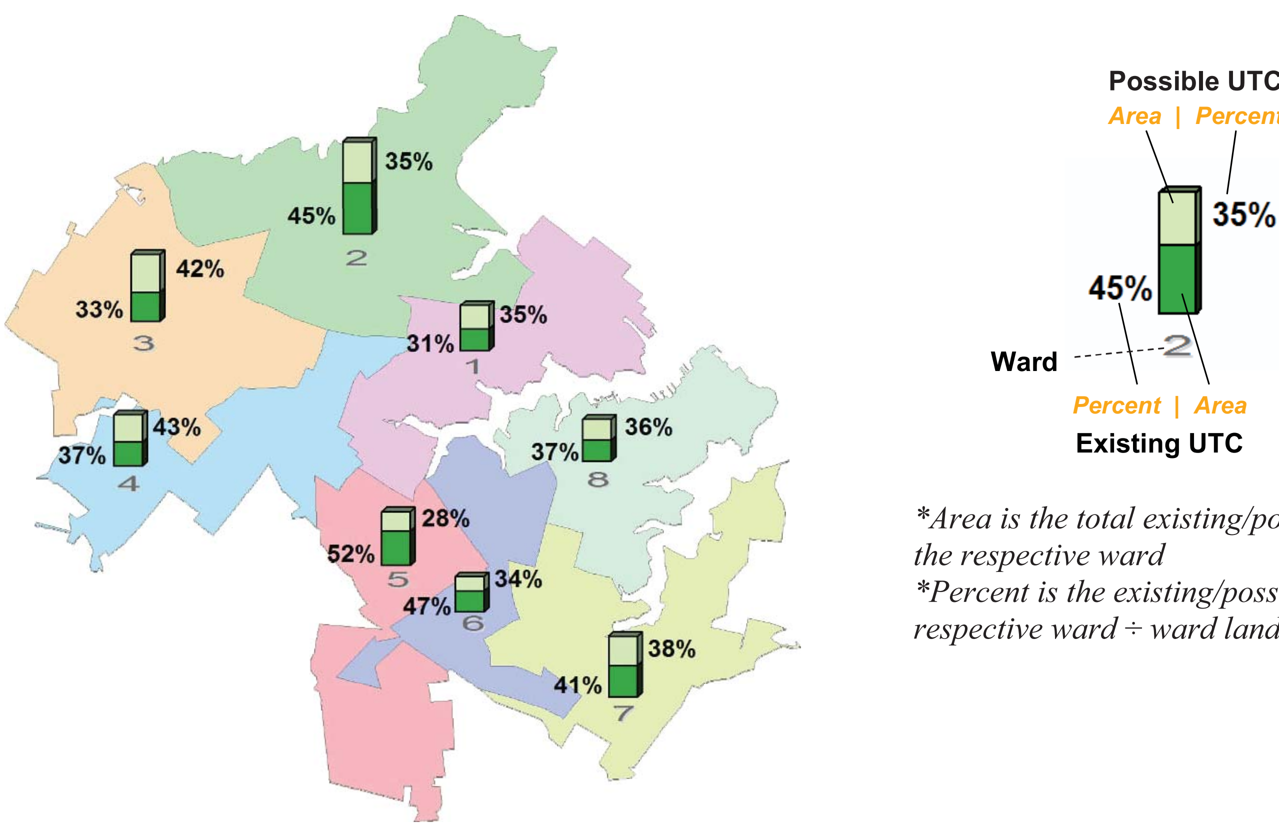


Figure 4 - Comparison of existing and possible UTC among scenarios and jurisdictions



**Area is the total existing/possible for the respective ward*
**Percent is the existing/possible for the respective ward ÷ ward land area*

Figure 5 - Existing and possible UTC by Ward

Tables

Land Area		
Land Type	**Acres**	**Percent of Total Area**
City	4274	
PROW	694	16%
Parcel	3580	84%
Parcel Breakout by Land Use Code		
Unknown	221	5%
Commercial	510	12%
Commercial Condo	13	0%
Commercial Residential	0	0%
Exempt	71	2%
Exempt Commercial	607	14%
Industrial	6	0%
Apartments	239	6%
Residential	1805	42%
Residential Condo	109	3%

Table 1- Land types in acres and as a percentage of the total City area

Existing UTC		
Land Type	**Acres**	**Percent of Total Area**
City	1737	41%
PROW	171	4%
Parcel	1566	37%
Parcel Breakout by Land Use Code		
Unknown	94	2%
Commercial	103	2%
Commercial Condo	3	0%
Commercial Residential	0	0%
Exempt	44	1%
Exempt Commercial	209	5%
Industrial	2	0%
Apartments	96	2%
Residential	974	23%
Residential Condo	41	1%

Table 2 - Existing UTC by land type in acres and as a percentage of the total City land area

Possible UTC		
Land Type	**Acres**	**Percent of Total Area**
City	Unknown	0%
Urparian	Unknown	0%
Parcel	1588	37%
Parcel Breakout by Land Use Code		
Unknown	110	3%
Commercial	305	7%
Commercial Condo	8	0%
Commercial Residential	0	0%
Exempt	26	1%
Exempt Commercial	331	8%
Industrial	3	0%
Apartments	112	3%
Residential	641	15%
Residential Condo	51	1%

Table 3 - Possible UTC by land type in acres and as a percentage of total City land area

	Existing UTC		Possible UTC		Existing + Possible		S1: Realize 25% of possible		
Category	**Acres UTC**	**% Total Land area**	**Acres UTC**	**% Total Land area**	**Acres UTC**	**% Total Land area**	**Acres UTC**	**% Total Land area**	**% UTC Increase**
City	1,737	41%	1,581	37%	3,318	78%	2,132	50%	23%
PROW	171	4%	0	0%	171	4%	171	4%	0%
Parcel	1,566	37%	1,588	37%	3,153	74%	1,962	46%	25%
Unknown	94	2%	110	3%	204	5%	122	3%	29%
C	103	2%	305	7%	409	10%	180	4%	74%
CC	3	0%	8	0%	10	0%	4	0%	76%
CR	0	0%	0	0%	0	0%	0	0%	0%
E	44	1%	26	1%	70	2%	50	1%	15%
EC	209	5%	331	8%	540	13%	292	7%	40%
I	2	0%	3	0%	4	0%	2	0%	46%
M	96	2%	112	3%	209	5%	124	3%	29%
R	974	23%	641	15%	1,615	38%	1,134	27%	16%
RC	0	0%	0	0%	0	0%	0	0%	0%
U	41	1%	51	1%	92	2%	53	1%	32%

Table 4 - Scenario 1: Realization of 25% of possible UTC

	Existing UTC		Possible UTC		Existing + Possible		S2: Realize 50% of possible		
Category	Acres UTC	% Total Land area	Acres UTC	% Total Land area	Acres UTC	% Total Land area	Acres UTC	% Total Land area	% UTC Increase
City	1,737	41%	1,581	37%	3,318	78%	2,528	59%	46%
PROW	171	4%	0	0%	171	4%	171	4%	0%
Parcel	1,566	37%	1,588	37%	3,153	74%	2,359	55%	51%
Unknown	94	2%	110	3%	204	5%	149	3%	58%
C	103	2%	305	7%	409	10%	256	6%	148%
CC	3	0%	8	0%	10	0%	6	0%	151%
CR	0	0%	0	0%	0	0%	0	0%	0%
E	44	1%	26	1%	70	2%	57	1%	30%
EC	209	5%	331	8%	540	13%	375	9%	79%
I	2	0%	3	0%	4	0%	3	0%	91%
M	96	2%	112	3%	209	5%	152	4%	58%
R	974	23%	641	15%	1,615	38%	1,295	30%	33%
RC	0	0%	0	0%	0	0%	0	0%	0%
U	41	1%	51	1%	92	2%	66	2%	63%

Table 5 - Scenario 2: realization of 50% of possible UTC

	Existing UTC		Possible UTC		Existing + Possible		S3: Realize 75% of possible		
Category	Acres UTC	% Total Land area	Acres UTC	% Total Land area	Acres UTC	% Total Land area	Acres UTC	% Total Land area	% UTC Increase
City	1,737	41%	1,581	37%	3,318	78%	2,923	68%	68%
PROW	171	4%	0	0%	171	4%	171	4%	0%
Parcel	1,566	37%	1,588	37%	3,153	74%	2,756	64%	76%
Unknown	94	2%	110	3%	204	5%	177	4%	88%
C	103	2%	305	7%	409	10%	332	8%	222%
CC	3	0%	8	0%	10	0%	8	0%	227%
CR	0	0%	0	0%	0	0%	0	0%	0%
E	44	1%	26	1%	70	2%	63	1%	44%
EC	209	5%	331	8%	540	13%	457	11%	119%
I	2	0%	3	0%	4	0%	4	0%	137%
M	96	2%	112	3%	209	5%	181	4%	87%
R	974	23%	641	15%	1,615	38%	1,455	34%	49%
RC	0	0%	0	0%	0	0%	0	0%	0%
U	41	1%	51	1%	92	2%	79	2%	95%

Table 6 - Scenario 3: realization of 75% of possible UTC

References

Chesapeake Executive Council. 2003. Expanded Riparian Forest Buffer Goals, Directive 03-01. http://www.chesapeakebay.net/info/pressreleases/ec2003/RFB_Report_EC_Meeting.pdf (accessed 1/12/06).

Funders' Network for Smart Growth and Livable Communities. Livable Communities @ Work. Vol. 2, No.1.. Coral Gables, FL. 12 pp.

Galvin, M. F., J. M. Grove and O'Neil-Dunne. 2006a. A report on Baltimore city's present and potential urban tree canopy, Maryland Department of Natural Resources, Forest Service: 17.

Galvin, M. F., J. M. Grove and O'Neil-Dunne. 2006b. Urban Tree Canopy factsheet. Maryland Department of Natural Resources, Forest Service.

Goetz, S.J., R.K. Wright, A.J. Smith, E. Zineckerb and E. Schaubb. 2003. IKONOS imagery for resource management: Tree cover, impervious surfaces, and riparian buffer analyses in the mid-Atlantic region. Remote Sensing of Environment 88 (2003) 195–208.

Irani, F.W. and M.F. Galvin. 2003. *Strategic Urban Forests Assessment: Baltimore, Maryland*. In *Proceedings from the American Society of Photogrammetry and Remote Sensing 2003 Annual Conference, "Technology: Converging at the Top of the World"*.

Kaler, D. and C. Ray. 2005. City Of Vancouver Canopy Report: GIS Analysis Using 2002 LIDAR Data. Vancouver-Clark Parks & Recreation. http://www.cityofvancouver.us/parks-recreation/parks_trails/urban_forestry/docs/canopyreport.pdf (accessed 1/12/06).

Luley, C.J. and J. Bond. 2002. A Report to North East State Foresters Association: A Plan to Integrate Management of Urban Trees into Air Quality Planning. Davey Resource Group. Naples, NY. 70 pp

Montgomery County. 2000. Forest Preservation Strategy - A Strategy To Increase The Quantity Of Forest Canopy, Improve The Quality Of Forests And Trees, And Protect And Restore Forest Ecosystems Throughout The County: A Task Force Report Requested By The County Executive. Montgomery County Forest Preservation Task Force. http://www.montgomerycountymd.gov/content/dep/IFCT/documents/strategy.pdf (accessed 1/12/06).

Poracsky, J. and M. Lackner. 2004. Urban Forest Canopy Cover In Portland, Oregon, 1972-2002: Final Report. Cartographic Center, Geography Department, Portland State University. Portland, OR. 42 pp.

Urban Forestry Task Force and Roanoke Department of Recreation and Parks. 2003. Roanoke Virginia Urban Forestry Plan: An Element of the Vision Plan (2001-2020) http://www.roanokeva.gov/85256A8D0062AF37/CurrentBaseLink/09DB22A1D86CBD0F85257090006AC331/$File/Urban%20Forestry%20Plan.pdf (accessed 1/12/06).

US Forest Service Northeastern Research Station. 1999. UFORE in action: Baltimore, MD. http://www.ufore.org/action/02-00.html (accessed 1/13/06).

Appendix 2

'Connecting the dots'

Crews begin survey of Annapolis creeks

City representatives Steve Carr and Frank Biba look for problems along Spa Creek during a tour of the four creeks in Annapolis yesterday. The city has hired a private firm to help in creating a plan for improving all four creeks.

By Colleen Dugan — The Capital

WED June 11, 2008

By PAMELA WOOD
Staff Writer

Under the blistering sun yesterday, a team of Annapolis government employees and outside contractors floated in two boats up and down each of the city's four creeks.

They were looking for the things that can't be seen from land or from maps: failing shorelines, silted-in coves, bad stormwater controls.

The information will be a key piece in a puzzle as the city develops a master plan for fixing up each of the four creeks: Back, College, Spa and Weems.

"Water quality has been measured a million times. We know all that stuff. What we want to do is unify all the information the city has," said Michael Whitehill, a vice president of McCrone, the private firm the city is paying $80,000 to conduct most of the work on the plan.

Yesterday, McCrone's crew teamed up with city employees and the mayor for an on-the-water survey.

(See SURVEY, Page A9)

By Colleen Dugan — The Capital

Bill Brooks of the McCrone engineering firm makes notes on a map during a survey of the four creeks in Annapolis yesterday. McCrone was hired by city officials to create a plan for improving the creeks. Two boats from the Annapolis Harbormaster's Office took McCrone and city employees on a floating tour of the creeks yesterday.

6·11·08

SURVEY

(Continued from Page A1)

As employees from the Harbormaster's Office piloted two boats through city waters, McCrone employees documented their finds on paper, in pictures and on video. The city employees were able to point out areas that have had projects completed and areas that need work.

There was talk of wildlife — fish, ospreys, herons and at least one turtle — and the varied uses of the waterfront, which range from undeveloped stretches to large homes to busy marinas. Each use presents a different challenge. For example, marinas might have problems with fuel spills or pollution from stripping paint off boats. Homeowners, on the other hand, might be using too much fertilizer on their lawns, which harms the creeks.

"We've got a little bit of everything in each of these creeks ... it's a real mixed bag here," Mr. Whitehill said.

As the survey continued up and down the creeks, Annapolis Mayor Ellen O. Moyer said the city has worked hard to improve the environment, as have the various nonprofit groups devoted to the creeks.

But, she said: "It became obvious we really needed a coordinated plan."

The money for the survey was put into the city budget last year, she said.

The final plan will identify problems and list possible solutions. Some solutions might need to be taxpayer-funded government projects. Others might be projects the nonprofit groups or individual homeowners could take on — for example, installing more rain gardens and rain barrels in a neighborhood, or raising filter-feeding oysters in the water.

Mr. Whitehill said his team will take their on-site documentary work and combine it with all the various plans and studies, as well as water quality data and city government records.

"We're going to prioritize the projects so we're not pouring sand down a rathole," Mr. Whitehill said. "We're going to see if we can connect the dots in all the studies that have been done ... This will allow us to put all the pieces together."

They're also hoping to hear from people who live, work and play in and around the creeks. There will be public meetings later this summer, but Mr. Whitehill said he'd like to hear from people even before then.

And this citywide creek study is about more than reducing pollution and improving creek health. It's also about improving access to the water. There's talk of more trails leading to the water and improvements to the city's many waterfront, street-end parks.

The entire plan should be complete by November.

To share ideas for the study of the creeks, contact Shannon Rose at annapoliswater@yahoo.com or call the Mayor's Office at 410-263-7997.

pwood@capitalgazette.com