

George Washington Regional Commission (GWRC)

# Coastal Technical Assistance Program: Final Report - FY 2010





# **GWRC Coastal Technical Assistance Program**

**NA10NOS4190205-Task 47**

**FY 2010**

**FINAL REPORT**

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The views expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Department of Commerce, NOAA, or any of its sub-agencies.

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# Product #1: Report on Local Government Coordination and Training Program

## ATTACHMENT 1.1

### Training & Coordination Meeting Schedule & Outcomes Summary

#### A. Coordination Meetings:

**Regional Planning Directors:** 10/13/10, 3/2/11.

Topics Discussed:

On 10/13/10, the Planning Directors discussed the following topics:

- a) Local Consideration of Transfer of Development Rights
- b) Local Reaction to TMDL Allocations – regional coordinated comment?
- c) Local Progress on UDA adoption
- d) Local Comprehensive Plan Updates/Adoption
- e) Local 2011 Redistricting Plans...GWRC/UMW sponsoring regional seminar

On 3/2/11, the Planning Directors discussed the following topics:

- a) Green Infrastructure Plan Development and Involvement of Local Planning Commissions
- b) Local Planning Concerns - CZM Technical Assistance / Training Needs
- c) Advance planning of FY 11-12 CZM technical assistance projects
- d) Distribution of CZM “Introduction to Climate Science” Training CD

Outcomes:

- a) Early support from Planning Directors on the idea of regional coordination of local responses to WIP-2 planning processes helped engage local staff in further committee coordination efforts later in the year.
- b) GWRC staff organized regional redistricting seminar with vendors and technical experts to help local governments decide how to approach the development of new magisterial district boundaries.

Average Attendance: 4 local planning directors

#### B. Product #2: Support to GWRC’s Green Government Commission Sub-Committees: See Attachment 2.2

#### C. Children and Nature Network Initiative

**Children & Nature Network Committee:** 10/21/10, 10/25/10, 11/22/10, 1/12/11, 1/21/11, 1/28/11, 2/4/11, 3/18/11.

Topics Discussed: As a committee continuing work begun in the previous fiscal year, the CANN Committee explored community funding grant opportunities to find funding support to print the publication “Passport Guide to the Central Rappahannock”

Outcomes:

- a) UMW student volunteers re-designed the graphic layout of the “Passport” to be more attractive to youthful audience.
- b) On-going regional coordination of environmental education network, working closely with Friends of the Rappahannock.

Average Attendance: 5 (FOR & GWRC staff, UMW students and local environmental educators)

#### D. WIP-2/TMDL Planning Support

**WIP-2/TMDL Planning Committee:** 7/28/11, 8/11/11, 8/18/11, 9/15/11.

**GWRC Stormwater Planning Group Meetings  
& WIP-TMDL Training Webinars**

## #1: July 28, 2011 Agenda

### Attendance (6):

- David Nunnally, Caroline County
- Kathy Harrigan, consultant
- Kevin W Utt, City of Fredericksburg
- Richard Street, Spotsylvania Co (not present in person, participated in webinar)
- Steve Hubble, Stafford County
- Kevin Byrnes, GWRC Staff
- Laura Wagner, GWRC Intern
- Ryan Flaherty, GWRC Intern
- Betsy Hudson, GWRC Intern

### **Webinar: Surviving Your Local WIP: A Practical Guide to Nutrient Accounting for the Chesapeake Bay TMDL**

(Tom Schueler, CSN)

Localities will need to prepare watershed implementation plans in 2011 and 2012 to conform to the forthcoming Bay-wide nutrient TMDL. Designed to guide local governments through this uncharted process, this webcast begins with a simple process to analyze urban land use and stormwater BMP data and calculate the baseline nutrient load. The webcast also outlines a wide range of cost-effective practices that can be used to incrementally reduce your local nutrient load – and maximize larger benefits to your community. The webcast will profile the [Chesapeake Stormwater Network](#)'s Technical Bulletin No. 9, "Nutrient Accounting Methods to Document Local Stormwater Nutrient Reductions in the Chesapeake Bay Watershed."

### **Meeting Minutes:**

The agenda for the webinar was split up into four parts. Part 1 covered what we already know/don't know about nutrients in stormwater. Part 2 was a short primer on bay-wide TMDL and WIP plans. Part 3 was a discussion of processes for estimating the local baseline load. This is a five step process:

- Do your exclusions (deduct state and federal roads, state and federal lands, incorporated lands, rural zoning, parklands, and industrial stormwater permits);
- Break your MS4 into major watershed units;
- Convert your most recent land use data into land cover units;
- Merge your BMP inventory into your watershed GISystem;
- Select your local loading model.

Part 4 was a discussion of low cost strategies a region can undertake to reduce their local nutrient load before considering stormwater retrofits. The prompter presented this in nine steps:

- Take credit for fertilizer reductions on urban turf;
- Take nutrient reduction credits for more stringent stormwater requirements at redevelopment projects;
- Become an early adopter of stormwater regulations;
- Take credit for community reforestation;
- Take credit for current and future stream restoration projects;
- Re-tool your stormwater maintenance program;
- Take the mass credit for intensive street sweeping;
- Investigate septic hookups and upgrades;
- Take credit for eliminating illicit discharges.

### **Questions on the Webinar's 9 Steps (Kathy Harrigan)**

1. Regarding the baseline date for the WIP process does that refer to the construction of the BMP, its operation, or does it refer to something else entirely?
2. Will there be credit for MS4 program elements that are already in place or just the additional amount of reduction achieved by an increased program?
  - a. BMP Maintenance
  - b. Street sweeping
  - c. Illicit discharge elements
  - d. Also will it apply to reduction of sanitary sewer collection system improvements that reduce I/I and SSO issues.
3. How far out can you project projects (e.g. redevelopment, reforestation, retrofits)? Through 2025? In 2 clumps base to 2017? 5-year chunks?

4. How speculative can you be/or what does speculation need to be linked to (e.g. redevelopment to local economic projections, reforestation programs as implemented now or extrapolated out)?
5. Qualification of BMPs—local effort/state effort (e.g. street sweeping load reduction estimates)

The next webinar will be held 8/18/2011 and will discuss stormwater retrofits.

**Discussion after webinar:**

1. For the next meeting Steve Hubble would like to do an MS4 overview for the members of the committee. Kevin Utt will also bring his report to present as well. Steve discussed how the idea of excluding areas (as presented in webinar) has already been successful in NVRC region. Stafford has already successfully merge BMP data with GIS. This will be discussed more at the next meeting. Next week Stafford will begin working on their first watershed management plan with a focus on nutrient reduction. This will act as a blueprint for all plans going forward.
2. Kevin Byrnes suggested that the GWRC will run the CityGreen tool to ascertain data to be used in a proposal to the Coastal Zone Management. He also asked of Steve and Kevin Utt to include any actions/programs focused on nutrient removal in the proposal to the CZM. Kevin Byrnes also brought up the topic of bringing the University of Mary Washington to the table more through the Brownfields grant, internship/research opportunities for students, and through contact with Meta Braymer (V.P. of Economic Development and Regional Engagement).
3. David Nunnally inquired and discussed what he should be doing going forward. He discussed the possibility of having to separate his county into sub-watersheds. He was interested in why we shouldn't just report total discharge versus what we are actually removing.
4. The discussion then moved to missing stakeholders and if we should bring the Department of Conservation and Recreation to the table. The next meeting will be on August 18<sup>th</sup> and the present members decided to start the meeting at 11:00am to allow time for Steve and Kevin to present.

**#2: August 11, 2011 Agenda: 11:00am**

**Attendance (10):**

Steve Hubble, Stafford Co	Kevin Utt, City of Fredericksburg
Kathy Harrigan, Private Citizen & Consultant	
David Nunnally, Caroline Co	Kevin Byrnes, GWRC staff
Eldon James, RRBC Exec. Director	Laura Wagner, GWRC intern
Ryan Flaherty, GWRC intern	Lynette Humphries, GWRC intern
Betsy Hudson, GWRC Intern	

• **Overview of Stafford MS-4 program – Steve Hubble**

**Webinar: August 11: Noon to 1:30**

***LID Changes Everything: The New Stormwater Maintenance Paradigm***

Ted Scott, Stormwater Maintenance, LLC & Tom Schueler, CSN

Concerns about maintaining LID practices were a recurring theme among stormwater managers and professionals alike. The comprehensive webcast will address how LID maintenance problems can be reduced through improved design, construction protection, installation methods, and final inspection and project acceptance procedures. In addition, the webcast will feature tips on how to modify local stormwater maintenance programs to meet the future maintenance challenges associated with an increased number of distributed LID practice. The webcast will include a guest speaker, Ted Scott, who operates a private stormwater maintenance company that manages hundreds of stormwater facilities across the Chesapeake Bay. The webcast will also go over a newly released CSN Technical Bulletin on LID maintenance to assist designers and local stormwater managers on this important topic.

**Discussion of Webinar & City LID Program & MS-4 (Kevin Utt was called out of the meeting by City)**

**Adjourn: 2:00 pm**

**#3: August 18, 2011 Agenda: 11:45 start**

Attendance (4):

Steve Hubble, Stafford Co	David Nunnally, Caroline Co
Kevin Utt, City of Fredericksburg	Ryan Flaherty, GWRC intern

Webinar: Noon to 1:30

***Stormwater Retrofits to Maximize Nutrient Reduction***

Tom Schueler, CSN and Guest Speaker (Presentation attached)

Stormwater retrofitting will be a major strategy for many localities to achieve nutrient reductions to meet more stringent MS4 stormwater permits and TMDLs. This webcast will focus on how to maximize nutrient reduction through a wide range of urban stormwater retrofits. The webcast will feature a recommended process to find, evaluate, design and construct stormwater retrofits across an urban watershed. In addition, simple techniques and accounting methods will be provided to document local stormwater nutrient reductions as part of watershed implementation plans (WIPs). The methods are also designed to find the most cost-effective combination of retrofit practices that enhances community values and environmental amenities.

#### **Discussion of Next Steps**

Adjourn: 2:00 pm

#### ***Meeting Notes:*** 8/18/2011

##### **Before Webinar:**

1. Dave discussed his thoughts on the WIP process and his dealings with the DCR. He argued that we were too reliant on DCR to anticipate issues. It is inherently a conflict of interests for DCR. [We're] Reliant on DCR for our cost analysis which gets reported to the General Assembly. These are not reflective of real world numbers. In essence DCR is less knowledgeable than the locality.
2. There was also a short discussion on the new DCR division of Stormwater Management.

##### **After Webinar:**

1. We need to bring in ideas that are outside the box.
2. We should use PDC as the output/reporter of information.
3. Need to bring more people to the table.
4. Dave, Kevin Utt, and Steve discussed their upcoming presentation to Eldon, RE: RRBC Sept mtg.

#### **#4: Sept. 15, 2011 Agenda**

##### **Attendance:**

Steve Hubble, Stafford Co

Kevin Utt, City of Fredericksburg

David Nunnally, Caroline Co

Kevin Byrnes, GWRC staff

Eldon James, GWRC Interim Executive Director

Laura Wagner, GWRC intern

***Webinar: September 15:*** Noon to 1:30

##### ***Increasing the Delivery of Residential Stewardship Practices in Urban Watersheds***

Tom Schueler, CSN and Guest Speaker (Presentation attached)

Local stormwater managers will need to play a greater role in enhancing public involvement, expanding stormwater education and delivering residential stewardship practices. This webcast will focus on how local governments and watershed groups can engage the public to improve the quality of runoff from their homes and yards. The webcasts will feature the lessons learned in implementing programs to build rain gardens, disconnect roof leaders, install rain barrels and plant trees to restore the Bay. Learn about the tricks for reaching out to the public and providing meaningful incentives to motivate homeowners to keep stormwater on their property. Case studies will be featured from several local demonstration projects across the Bay watershed.

##### **Committee Discussion:**

##### **After Webinar:**

- a. Dave Nunnally commented that this presentation was not very professional or insightful.
- b. Committee discussed presentation at RRBC meeting on Sept 14<sup>th</sup> regarding local perspectives about stormwater management programs.

Adjourn: 2:00 pm

##### **Committee Outcomes:**

- a) MS4 permittees agreed to share BMP database template with rural localities not yet urbanized enough to come under the MS4 program
- b) Staff agreement to support taking a regional approach to the response to WIP-2 process.
- c) Participation of local staff in regionally-hosted webinar to share reactions to professional development webinars on stormwater management practices.

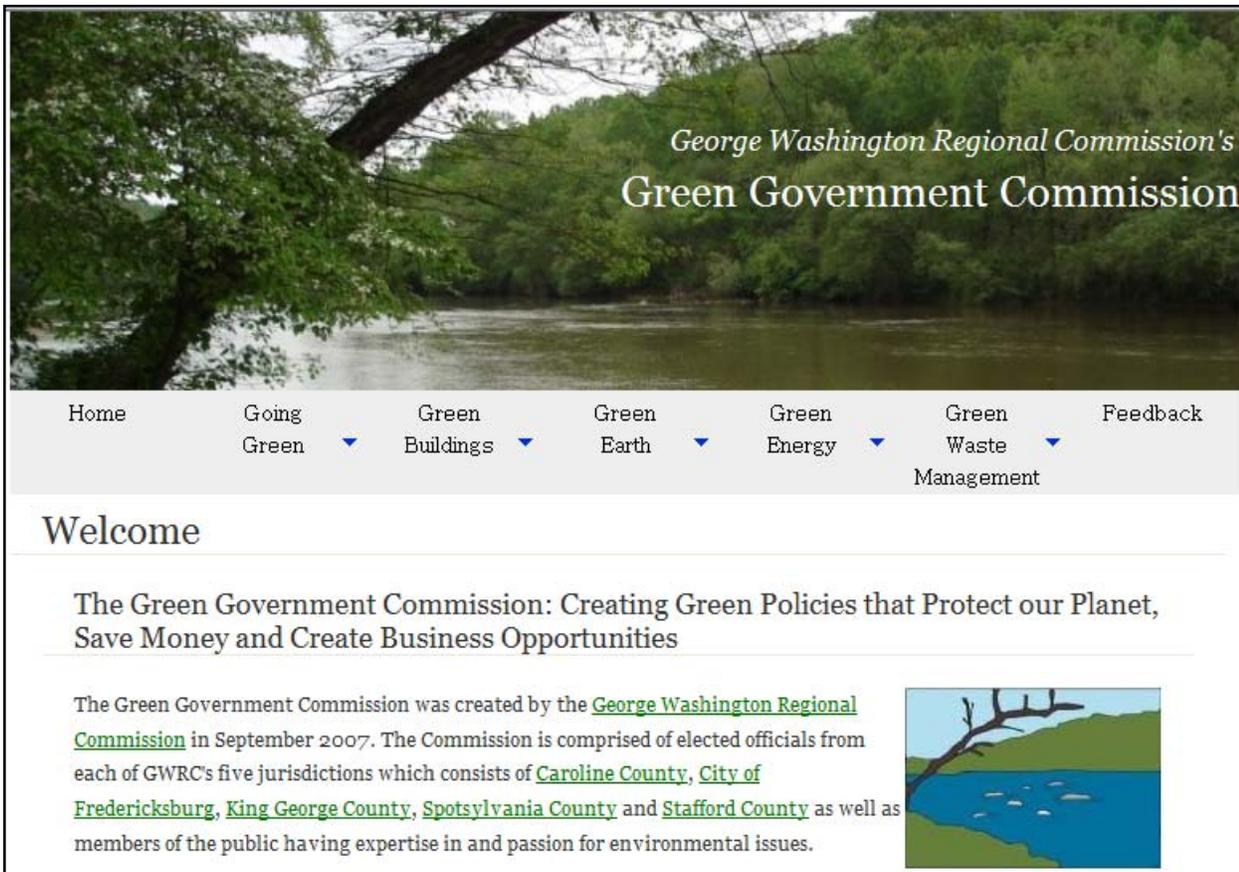
**Other Training Sessions:**

1. **GW-HELP Contractor Training:** 1/26/11 (Introduction), 2/28/11-3/4/11 (BPI Auditor Training), 8/19/11 (Program Orientation); 9/9/11 (Compass Energy Software webinar)
2. **GW-HELP Intern Orientation:** 3/21/11 (Preparation for Home Show)

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Attachment 2.1

Screen-Shot of [www.GWGreenGovt.org](http://www.GWGreenGovt.org) website:



## Report on GGC Sub-Committee Meetings & Outcomes

**Green Government Commission (GGC) Green Earth Sub-Committee:** (10/8/10, 11/4/10, 11/17/10, 12/2/10, 1/6/11, 1/31/11, 2/3/11, 4/7/11, 5/12/11, 7/12/11, 8/14/11)

**Average Meeting Attendance:** 5-7 local govt. staff and non-profit group representatives

### Summary of Committee Activities:

1. Committee agreed to support GWRC staff effort to complete regional Green Infrastructure Plan under CZM Task 12.03
2. Committee participation and input helped define and focus the Green Infrastructure Plan message to relate the Plan to on-going land planning development, conservation and environmental management efforts of local government in a manner that would be seen as supportive of and complimentary to local activities and land development policy.
3. Committee assisted in the critique of Powerpoint presentation (attached) which was taken to local government planning commissions to introduce the Green Infrastructure Plan concept and elicit questions and concerns of local planning commissions to be addressed in the final Plan.

### Outcomes:

1. Green Infrastructure Plan overview presentation was delivered to Spotsylvania, King George County and City of Fredericksburg Planning Commissions, Spotsylvania Co Committee of 500 public meeting. Scheduling difficulties with Stafford and Carline Co precluded giving presentation to these Planning Commissions.
2. Green Infrastructure Plan was adopted by Resolution 12-07 by the George Washington Regional Commission, Oct 17, 2011.

**Green Waste Management Sub-Committee:** (10/20/10, 11/17/10, 1/19/11, 2/16/11, 3/9/11, 5/19/11)

**Average Meeting Attendance:** 8-9 local government staff, interested local recycling and waste management businesses, local military base environmental staff, sustainability program staff from University of Mary Washington

### Summary of Committee Activities:

Topics Discussed: Committee meetings explored:

1. Organizing community observation of America Recycles Day and Earth Day celebration with exhibits and information about recycling opportunities throughout the Region.
2. Creating, under GWRC website, a central collection of recycling program information to broaden community awareness of similarities and differences between community-based recycling programs.
3. Working with sustainability curriculum faculty at University of Mary Washington in the development of a dedicated internship program to support recycling in Fredericksburg City public school system and outlying rural county school systems
4. Working with Spotsylvania Co public school system to provide trained recycling advocates to promote better commercial recycling program compliance at Spotsylvania Towne Center.
5. Design of a regional Internet survey to collect more comprehensive business recycling information at lower cost.

### Outcomes:

1. Committee supported City's Earth Day celebration with exhibits and community recycling information.
2. Committee chair resigned due to work conflicts, leading to suspension of Committee meeting activities in May due to limited GWRC staff and intern availability to pursue Committee project ideas.
3. Successful 2010 America Recycles Day event, in cooperation with local chapter of Sierra Club and City of Fredericksburg Clean & Green Commission. (see: <http://www.fredericksburg.com/News/FLS/2011/112011/11052011/663092>)
4. Completed on-line business recycling survey design (see: [http://www.kwiksurveys.com/preview-survey.php?survey\\_ID=IOKEJF\\_ec5be6a2](http://www.kwiksurveys.com/preview-survey.php?survey_ID=IOKEJF_ec5be6a2)) to support 2012 local recycling report to Commonwealth of Virginia.

**Green Building (GW-HELP) Sub-Committee:** (10/5/10, 10/6/10, 10/20/10, 11/3/10, 11/17/10, 12/1/10, 1/5/11, 2/2/11, 2/16/11, 3/2/11, 3/9/11, 3/23/11, 3/30/11, 4/20/11, 5/4/11, 6/8/11, 6/22/11, 7/12/11, 7/27/11, 8/31/11, 9/7/11, 9/14/11)

**Average Meeting Attendance:** 6-7, including representatives of participating local governments, consultant staff

**Summary of Committee Activities:**

Committee worked with GWRC staff in the design and implementation of regional pilot Home Performance with Energy Star (HPwES) program, under ARRA-funded \$1 million energy-efficiency and conservation block grant awarded to GWRC by the Virginia Department of Mines, Minerals and Energy. Committee and GWRC staff collaborated in the development and issuance of Request for Proposals for:

- a) Marketing Plan Development Consulting and Implementation Services,
- b) HPwES Quality Assurance and Quality Control Consulting Services,
- c) Loan Loss Reserve Management and Banking Services, and
- d) Energy Audit Software and Data Management Services.

In May 2011, GWRC submitted HPwES program sponsor application to the US EPA Energy Star program. Program named "GW Home Energy Loss Prevention (HELP)" program. Committee continued to confer with GWRC staff on program design and implementation strategies.

**Outcomes:**

1. GWRC sponsored Building Performance Institute Building Analyst training class offered through Germanna Community College, providing classroom and field training to 7 local contractors, 1 local housing non-profit staff member and 3 local government building officials. 100% of class passed BPI-written exam, and several passed the BPI-proctored field exam. As a result, GWRC was able to enroll 5 contracting firms in the GW-HELP program to provide home energy audit and energy-efficiency retrofit improvements.
2. Created program website ([www.gwhelp.org](http://www.gwhelp.org)) to provide HELP program information to the local market.
3. Development of program incentives schedule to attract homeowner applications.
4. GWRC application as HPwES program sponsor approved by EPA HPwES program.
5. Developed comprehensive marketing plan to explain the program and generate public awareness of and interest in pursuing home energy audits and energy-saving retrofits.
6. Developed program design document to catalog program procedures so that student interns can assist by processing homeowner applications, maintain tracking systems, etc.
7. Consultant RFP and EPA HPwES sponsor application used as a template by Richmond Regional Energy Efficiency Alliance, saving considerable time and effort to fast-track the start-up of another regional energy efficiency program.
8. Approx. 18 program applications, 9 completed home energy audits and 1 home energy retrofit by Sept 30, 2011.
9. Developed HELP loan loss reserve program and conceptual agreement with Union First Market Bank; however, GWRC Board rejected the proposed program.

**Product #3:  
City of Fredericksburg's Functional Land Use Classification Project**

**ATTACHMENT 3.1**

**City of Fredericksburg Functional Land Use Classification Project:**

**University of Mary Washington Project Report**

**(See Final Report in following 15 pages)**

UNIVERSITY OF MARY WASHINGTON  
DEPARTMENT OF GEOGRAPHY

# Application of the APA Land Based Classification Standards, Function Dimension to the City of Fredericksburg, Virginia

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## Final Report

**Jacqueline Gallagher and Stephen P. Hanna, with  
Ryan Flaherty, Elizabeth Hudson, John Mulrey,  
Michelle Woody, and Austin Broderick**

**6/14/2011**

This report is submitted to the George Washington Regional Commission in accordance with the “Subcontract between the George Washington Regional Commission and the University of Mary Washington,” entered into on December 16, 2010.

## **Introduction and Purpose**

The following report details the methodology used to apply the American Planning Association (APA) Land Based Classification Standards, Function Dimension (LBCS-F) to all parcels within the City of Fredericksburg, Virginia. This work was carried out by students and faculty in the Geography Department of the University of Mary Washington under contract with the George Washington Regional Commission (GWRC). The goal was to use the same classification standards used by Stafford County so that the GWRC will, at a later date, have landuse information for all parcels within their region. This report summarizes the results of the classification as well. In addition to this report, the Geography Department agreed to deliver a shapefile containing the classified parcels and metadata for this shapefile to both the GWRC and to the City of Fredericksburg.

## **Personnel and Division of Tasks:**

The work described in this report was completed by the following:

Principle Investigator: Dr. Jacqueline Gallagher, Associate Professor

Dr. Gallagher supervised the student research assistants and was the primary author of the final report. Supervision included developing the classification methodology with the students, answering questions about the classification, and checking the accuracy of the work. In addition, Dr. Gallagher liaised with the GWRC and the personnel at the City of Fredericksburg's GIS office.

Research Associate: Dr. Stephen Hanna, Professor

Dr. Hanna provided students with background information on classification and image interpretation. He assisted Dr. Gallagher in checking the accuracy of the work and in writing the final report.

Student Research Assistants: Ryan Flaherty, Elizabeth Hudson, John Mulrey, Michelle Woody, Austin Broderick.

The five student research assistants contributed to the development of the methodology and classified the overwhelming majority of the 8178 parcels within the City. As described below, this included using remote data to assign an APA LBCS-F code to each parcel, field-checking parcels where remote data did not lead to a certain classification, and field checking a spatially stratified, random sample consisting of 10 percent of all parcels to test the accuracy of the remotely classified parcels.

## Methodology:

### Data Sources:

At the beginning of the contract period, the City of Fredericksburg provided the UMW Geography Department with the data necessary to complete the project. This data included:

- A GIS layer containing all current parcels in the City of Fredericksburg (shapefile format)
- A GIS Layer containing all current structures in the City of Fredericksburg (shapefile format)
- All 2009 3-inch and 6-inch resolution imagery of the City provided by the Commonwealth of Virginia to local governments (Mr.SID format)

All data were loaded onto a single computer in the Geography Department's Projects room. The original Tax Parcels file was modified, removing fields that were unnecessary to this project and adding fields that allowed classification. The new shapefile was called Parcels APA\_F. It contains the field GPIN, which the city will use to join it to their existing data. In addition, it contains new fields as follows:

- **APA\_F:** classification of economic function per the American Planning Association's Land Based Classification Standards, which can be found here:  
<http://www.planning.org/lbcs/standards/>
- **APA\_F\_1:** used where APA\_F is 9950, mixed use: this will be the ground floor use
- **APA\_F\_2:** used where APA\_F is 9950, mixed use: this will be the secondary use (often, but not always, upstairs or downstairs; can be adjacent but clearly not primary)
- **APA\_F\_3:** used where APA\_F is 9950, mixed use: this will be a tertiary use
- **A\_A\_F\_4:** used where APA\_F is 9950, mixed use: this will be a fourth use
- **APA\_S\_Res:** parcels classified as residential (1100) in APA\_F, and parcels that include parking, are also classified by the structural dimension.
- **Class\_by:** initials of person making initial classification; this was originally used to indicate that a parcel had been classified.
- **Uncertain:** Yes may be recorded, to note that APA\_F was difficult to determine or carries some uncertainty, based on the current attribute and image data, and after a field check. Originally this was used to indicate that a field check was necessary.
- **Sampled:** 'DID' indicates that a parcel was selected for a field check as part of a sample; 10% of all parcels was field checked to test the accuracy of the classification.
- **Fld\_Chk\_by:** initials of person making the field check
- **Changed:** 'Yes' indicates that the classification code was altered after a field check; if not, this column was left blank.
- **Date** of final classification. Format: month/date/year hour:minute:second AM or PM (1/19/2011 10:52:38 AM). Column remained blank until project finalized on June 15, 2011.

- **Notes:** this may contain a more specific function code, or information about why a classification code was used, or about the parcel in general

All classification work was done on this one shapefile (Parcels APA\_F), on one computer; this eliminated potential problems with different versions of the shapefile being used, or work needing to be done twice. This shapefile was backed up on a regular basis.

UMW will provide metadata defining all codes and terms used in each of the fields described above. This metadata will be delivered to the GWRC and the City with the final report on or before June 15.

#### Modifications of APA Land Based Classification Standards, Function Dimension

Classification was by the American Planning Association's Land Based Classification Standards, Function Dimension, which uses the following basic breakdown:

- 1000: Residence or accommodation functions
- 2000: General sales or services
- 3000: Manufacturing and wholesale trade
- 4000: Transportation, communication, information, and utilities
- 5000: Arts, entertainment, and recreation
- 6000: Education, public admin., health care, and other inst.
- 7000: Construction-related businesses
- 8000: Mining and extraction establishments
- 9000: Agriculture, forestry, fishing and hunting

Within these are more specific codes indicating more specific economic functions, down to a fourth level (e.g. 2111, car dealer). Based on guidance from GWRC and the City we classified to the THIRD level where possible (e.g. 2110, Automobile sales or service establishment) but to second or even first level where information was lacking or a variety of uses within the first classification level) in a single parcel made it impossible to classify with a single specific code (e.g. 2100, Retail sales or services; 2000, General sales or services). If a very specific (fourth level) number was known for a parcel, it was placed in the Notes field.

A new classification number was created, after consultation with GWRC. 9950 denotes mixed use across the first level of classification – e.g. on a single parcel BOTH residential and sales functions were found, so the parcel was coded 9950 with a code in APA\_F\_1 for the ground floor or major use, and in APA\_F\_2 for the secondary use. The mixed use code was not used for mixed sales or mixed manufacturing – instead, a higher level of function was used so as to indicate the economic function of that parcel. Although this was not done in Stafford County, there is discussion of the need for such a code (Jeer, 1997) and it makes sense that in the older parts of Fredericksburg where traders and shopkeepers traditionally

lived above or adjacent to their places of business there is still mixed use. In addition, modern development sometimes favors mixed use (e.g. EPA, 2010).

While function was being classified, residential parcels were also given a structural code in the APA\_S field; a distinction was made for detached or attached housing, townhouses, and multifamily apartments. Per instructions from the City, no attempt was made to count the number of units in apartment buildings. The basis for attached housing was often the tax parcel information: duplexes or apartments were often noted. Sometimes two walkways were noted on the air photo; sometimes two mailboxes were noted in the field check.

After consultation with GWRC, a new APA\_S code was devised, for residential parcels *without* a dwelling but with a garage or shed or swimming pool and adjoining a parcel *with* a dwelling, where both parcels had the same owner. The parcel without the dwelling was given an APA\_F code of Private Household (1100) and an APA\_S of 1160 to indicate a Residential Outbuilding.

Parking areas were also given a structural code, so as to distinguish between open lots, covered lots, multistory or underground lots. There is no economic function code for parking, so where a parcel consisted entirely of parking it was given an APA\_F code denoting the purpose of the parking (commonly an adjoining parcel containing a store or church) and an APA\_S code denoting the type of parking. If a parcel was not obviously attached to a particular function (e.g. downtown lots or structure) an APA\_F of 4000 (the first level number for transportation) was given, with an APA\_S denoting the type of parking.

The code 9910, Not Applicable to this Dimension, was used for parcels which did not have an economic function and would not be developed. Examples include floodplain easements along rivers and parcels that were roadways or alleys.

Parcels within utilities easements could have been classified as Not Applicable to this Dimension but do technically have a function, so were given the code 4300 for Utilities. A problem here is that some parcels noted as having utility easements are also being used for other purposes (in residential gardens or lots owned by businesses). If clear, this latter function was given priority.

The code 9990, To Be Determined, was used for undeveloped land that could potentially be developed for any use. For some parcels, we know the currently intended use (e.g. Amelia Square on William St, the Slavery Museum and Kalahari Water Park in Celebrate Virginia) but since construction hasn't started we classified them To Be Determined in the event that funding does not materialize.

### Description of Method

The first area to be classified was one surrounding the UMW campus, including College Heights, parts of the route 1 corridor and parts of William Street. All steps were completed in this area so as to gain familiarity with the method in an area known to and easily accessible by the students.

Subsequently, all steps were completed in the rest of the city.

First, parcels were classified using the following information

- Tax parcel information (zoning information, ownership, remarks, anything pertinent)
- 2009 3-inch air photos
- Fredericksburg GIS, <http://gis.fredericksburgva.gov/parcelViewer/>
- Google maps, Bing maps, including street views
- Google address or business search (since such data are entered by the individual, it is not always in the correct geographic location, so use of mapped data was not always correct)
- Yellow Pages, <http://www.yellowpages.com/>

When a classification could not be made using ‘remote’ information, ‘Yes’ was recorded in the Uncertain field, and sometimes a Note was added stating the uncertainty. Uncertain parcels were discussed among the students and/or with the professors, and were generally field checked – meaning that a visit was made to the parcel to see what its economic function really was. While field checking, other parcels in the same vicinity were often examined as well. We did not venture onto private property in order to conduct a field check.

Just over 10% of all parcels were sampled and checked in the field to be certain that this classification was accurate. This was done by placing census blocks from the year 2000 onto the map layer, counting how many parcels existed in each census tract, and randomly selecting 10% of those parcels. A random number generator was used (Haahr, 1998). The census blocks are smaller in areas where parcels are small and high-density, so the sampling rate was higher in those areas (e.g. downtown), which helped to test accuracy. Parcels to be sampled were labeled ‘DO’ in the Sampled field; this was changed to ‘DID’ once sampling was completed. If sampling resulted in a change to the original classification, ‘YES’ was recorded in the Changed field; this allowed us to keep track of how many parcels were not originally classified correctly, and thus of the accuracy of the original classification. Sometimes parcels that were marked Uncertain (thus to be field checked) were the same ones marked to be sampled.

### Detailed Notes

Parcels that were zoned residential and in residential areas that are still being developed (e.g. Idlewild) were given APA\_F codes of Private Household (1100) even if no structure had yet been built. It was

decided that the function would not be anything other than residential in such areas, so to use a To Be Determined code would be misleading. However, the APA\_S field was left at 0 if no house yet existed.

In areas zoned other than residential (e.g. CT, commercial-transitional) vacant parcels surrounded by residential parcels were given the To Be Determined code (9990); although a house might be the most likely use of the empty parcel, any structure could potentially be built based on city zoning (e.g. Lafayette Blvd. near Cobblestone and Spotswood).

Vacant parcels determined to be 'land locked' or surrounded by other parcels with no access to a road were particularly difficult to classify; examination of ownership of surrounding parcels and zoning allowed classification.

Some areas of the city were particularly difficult to classify by economic function because parcels could not easily be delimited on the ground, because uses could not easily be discerned. These included:

- Industrial Park off Summit Road and Belman Road, where buildings appeared to be empty or did not display any business name despite activity. Where possible the type of building was used to provide a logical classification (e.g. warehouse or manufacturing) – but future use could be different
- Transitional areas along Lafayette Boulevard, Route 1, Route 2, Route 3
- Newly developing areas in Celebrate Virginia

Finally, supervising faculty examined the classified map, to check for completion, for accuracy in areas known to be difficult, for consistency in use of code numbers, and for the remaining Uncertain parcels. For some parcels, we have left a 'Yes' in the Uncertain field with a note to indicate the difficulty.

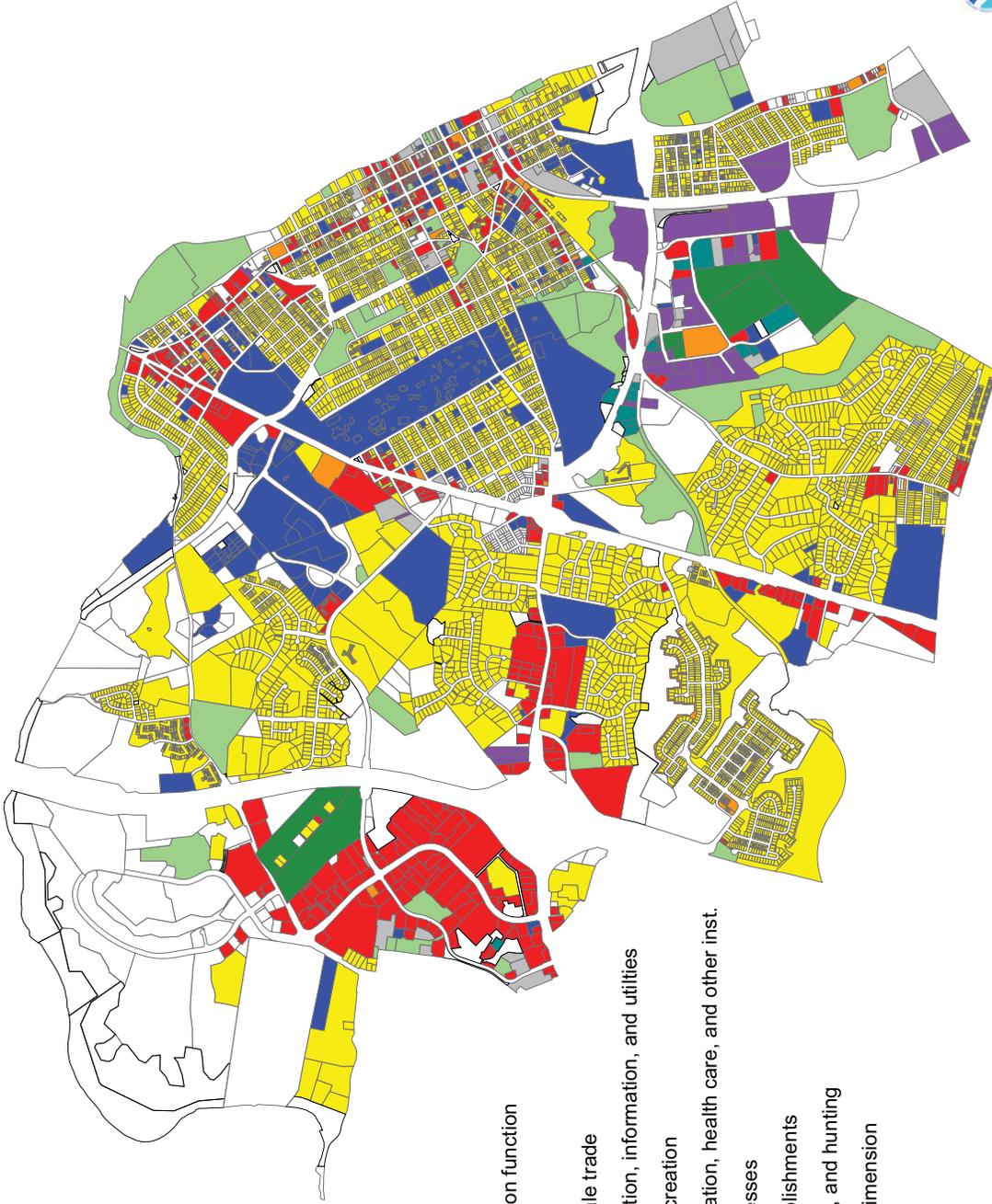
Metadata has not yet been completely added for the shapefile. Metadata will be complete by or before the deadline for the final report (June 15, 2011)

## **Results**

Application of the LBCS-F was applied successfully to all parcels within the City of Fredericksburg. Of the 8,178 parcels classified according to economic function:

- 79% are classified as residence or accommodation (includes hotels and empty lots zoned residential with street access);
- 7.7% are classified as general sales or services;
- 0.6% are classified as manufacturing and wholesale trade;
- 1.2% are classified as transportation, communication, information, and utilities (includes functions ranging from mixed-use parking, to newspaper publication, to movie theaters);

# Fredericksburg Tax Parcels by American Planning Association's LBCS Function



## Economic Functions:

- Residence or accommodation function
- General sales or service
- Manufacturing and wholesale trade
- Transportation, communication, information, and utilities
- Arts, entertainment, and recreation
- Education, public administration, health care, and other inst.
- Construction-related businesses
- Mining and extraction establishments
- Agriculture, forestry, fishing, and hunting
- Not applicable to function dimension
- Mixed-use
- To be determined

1:28,000

Sources: Tax Parcels provided by City of Fredericksburg  
 Layer data from APA's Land Based Classification Standards  
 Data compiled by students at University of Mary Washington  
 Map provided by Dr. Stephen Hama, UMW



Virginia Coastal Zone  
MANAGEMENT PROGRAM

This project was funded, in part, by the Virginia Coastal Zone Management Program at the Virginia Department of Environmental Quality through Grant # NA10NOS419, of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended.

- 1.1% are classified as arts, entertainment, and recreation (includes all parks, the fairgrounds, museums, and art studios);
- 3.7% are classified as education, public administration, health care, and other institutions (includes university, government buildings, physician's and dentist's offices);
- 0.3% are classified as construction-related businesses;
- 0% are classified as mining and extraction establishments;
- 0.1% are classified as agriculture, forestry, fishing, and hunting;
- 1.6% are classified as mixed use (see methodology section);
- 3.9% are classified as to be determined (see methodology section);
- 0.7% are classified as not applicable in function dimension (see methodology section).

Employing the sampling method described above, 827 parcels were field-checked to assess the accuracy of these results. The LBCS-F codes assigned to 45 of these parcels (approximately 5% of the sample) were changed as a result of the field check. In addition, despite field checks and research by both students and faculty, the classification of 50 parcels remain uncertain and are marked as such in the attribute table.

While the percent of sampled parcels changed and the number of parcels with uncertain LBCS-F codes were very low, Dr. Gallagher and Dr. Hanna did a detailed final check of the students' work to find and correct any remaining errors during the first two weeks of May. As a result, we are confident that we have reduced errors to less than 5% of all parcels.

## **Citations**

EPA, 2010. Smart Growth Illustrated. <http://www.epa.gov/smartgrowth/case/mizner.htm> Accessed May 12, 2011.

Jeer, S. 1997. Treatment of Accessory Uses in Land-Based Classification Standards. <http://www.planning.org/lbcs/background/> Accessed May 12, 2011.

Haahr, M. 1998. *RANDOM.ORG*. School of Computer Science and Statistics. [www.random.org](http://www.random.org).

## Detail of Expenditures:

### Original Project Budget:

Estimated Mileage costs incurred by students*	
350 miles @ \$0.50 per mile**	\$175.00
Estimated Faculty supervision and reporting costs*	
Dr. Gallagher: 45 hours @ \$38.00 per hour	\$1,710.00
Dr. Hanna: 10 hours @ \$44.00 per hour	\$440.00
F&A (indirect costs)	\$232.50
<b>Total:</b>	<b>\$2557.50</b>

\*GWRC will only be charged for the costs actually incurred.

\*\*Reimbursement for students is \$0.50 per mile  
([http://www.umw.edu/ap/travel/personal\\_vehicle\\_mileage.php](http://www.umw.edu/ap/travel/personal_vehicle_mileage.php))

### Actual Expenditures (see Appendix A)

Mileage costs documented by students	\$64.00
128 miles @ \$0.50 per mile	
Faculty supervision and report costs	
Dr. Gallagher: 45 hours @ 38.00	\$1,710.00
Dr. Hanna: 10 hours @ \$44.00	\$440.00
F&A (indirect costs)	
10% of incurred costs	\$221.40
<b>Total Incurred Costs:</b>	<b>\$2,435.40</b>
<u>Payment received from GWRC (Feb. 14, 2011)</u>	<u>-\$500.00</u>
Total Due when project is accepted as complete	\$1,935.40





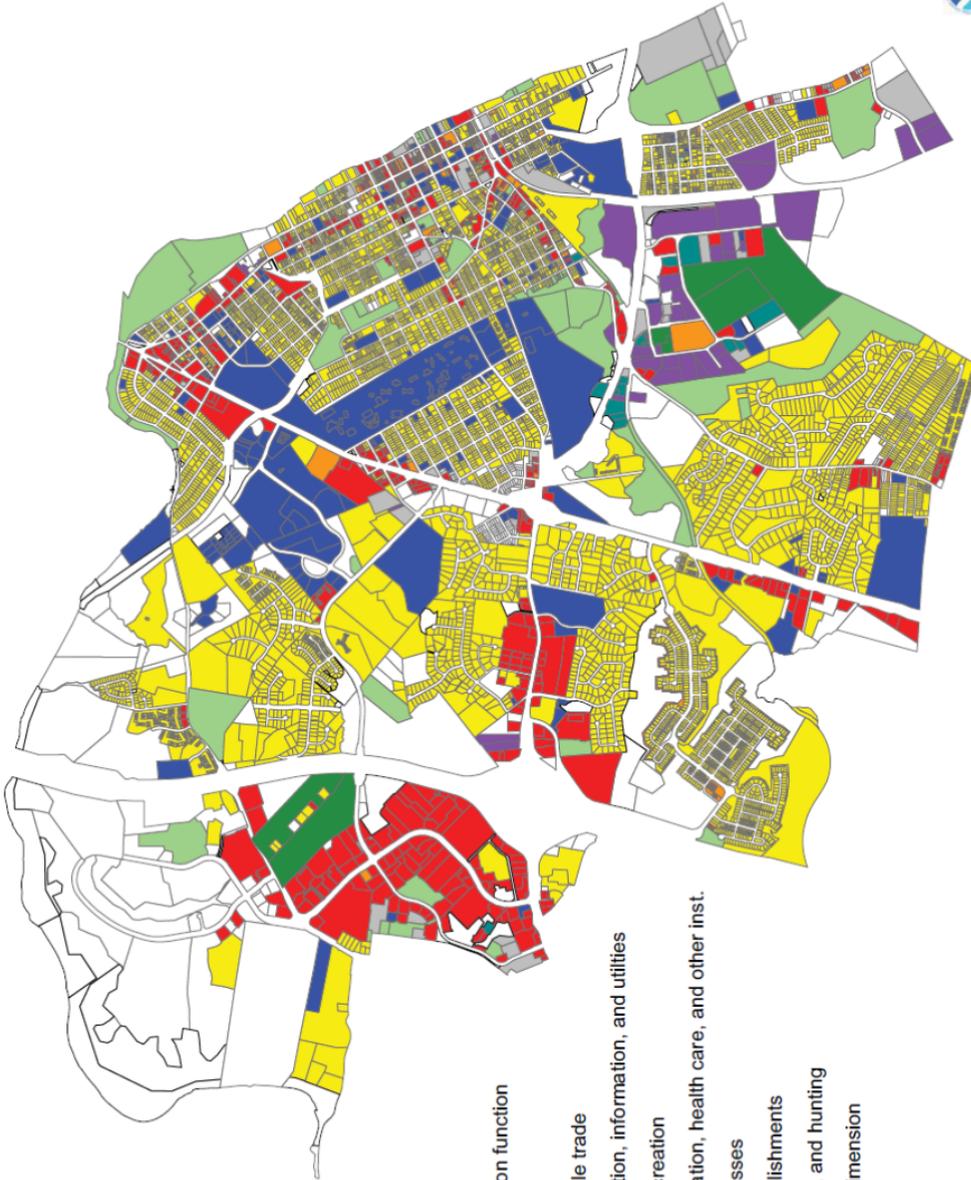
Faculty supervision and report costs

<b>Project or Grant Name:</b>	City of Fred Land Use Classification			
<b>Employee Name:</b>	Jackie Gallagher			
<b>FOAPAL:</b>				
<b>Hourly Rate:</b>	\$ 38.00			
<b>Date of Work</b>	<b>Description of work</b>	<b>Start Time</b>	<b>End Time</b>	<b>Number of Hours</b>
Jan 3 2011	consolidation of student pilot files, reading, prep for meeting with city & GWRC	8.30	11.30	3
Jan 3 2011	meeting with GWRC	2.30	3.30	1
Jan 9 2011	prep readings and expectations/syllabus for students	2	3	1
Jan 10 2011	class meeting with students	3	4	1
18-Jan	prep for meeting at 11	8.15	9.15	1
18-Jan	meeting with GWRC & City downtown	11	11.3	0.5
18-Jan	followup discussions with Steve	2	3	1
19-Jan	follow up questions	9.3	10	0.5
19-Jan	procedure developed	10	10.3	0.5
21-Jan	class meeting; troubleshooting computers	12	1.3	1.5
28-Jan	prep for class & class	11.3	1	1.5
31-Jan	backing up, trouble shooting, double checking, working out sampling method	8.3	10	1.5
1-Feb	met Mary at Stafford	2.3	3.3	1
2-Feb	met with students	8.3	9	0.5
8-Feb	loaded & checked Junos	2	3	1
9-Feb	daily backups, exploration, troubleshooting	8.3	10	1.5
11-Feb	meeting, preparation, checking	12	1.3	1.5
23-Feb	daily backups, exploration, troubleshooting	8.3	10	1.5
25-Feb	meeting preparation, checking, student meeting	12	1	1
3-Mar	checking data	9	10	1
4-Mar	response to Kevin/city	9	10	1
9-Mar	daily backups, exploration, troubleshooting	8.3	9.3	1
11-Mar	meeting preparation, student meeting	12	1	1
16-Mar	daily backups, exploration, troubleshooting	8.3	9.3	1
18-Mar	meeting preparation, checking	8.3	9.3	1
18-Mar	student meeting	12	1	1
18-Mar	loaded & checked Junos	2	3	1
23-Mar	daily backups, exploration, troubleshooting, meeting preparation, checking	8.3	9	1
25-Mar	student meeting	12	1	1

28-Mar	metadata preparation	8.3	9.3	1
1-Apr	student meeting	12	1	1
7-Apr	back ups, checking data	8.3	9.3	1
8-Apr	commenting on paper, paper organization notes, email to Kevin	8.3	10.3	2
8-Apr	student meeting	12	1	1
15-Apr	backup; checking data	8.3	9.3	0.5
22-Apr	metadata checking;	8.3	9	0.5
2-May	checking data			2
	field checking			2
	metadata entry			1
	writing report			1
<b>Total Hours for Project</b>				<b>45.00</b>
<b>Hourly Rate times Hours Worked</b>				<b>\$ 1710.00</b>

<b>Project or Grant Name:</b>	City of Fred Land Use Classification			
<b>Employee Name:</b>	Stephen P. Hanna			
<b>FOAPAL:</b>				
<b>Hourly Rate:</b>	\$45.00			
<b>Date of Work</b>	<b>Description of work</b>	<b>Start Time</b>	<b>End Time</b>	<b>Number of Hours</b>
3-Jan	launch meeting	2:30PM	3:30PM	1
18-Jan	meeting with Jackie	2:00pm	3:00pm	1
21-Jan	instruction on imagery and classification	12:00pm	12:30pm	0.5
2-May	initial review of completed work	10:30AM	11:00AM	0.5
3-May	checking data	9:00AM	11:00AM	2
5-May	checking data	9:00AM	11:00AM	2
10-May	checking data	1:00pm	2:00pm	1
11-May	editing and writing preliminary report	10:30AM	12:00PM	1.5
10-Jun	preparing final report	10:00am	10:30am	0.5
<b>Total Hours for Project</b>				<b>10.00</b>
<b>Hourly Rate times Hours Worked</b>				<b>\$450.00</b>

# Fredericksburg Tax Parcels by American Planning Association's LBCS Function

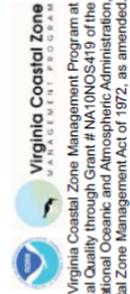


**Economic Functions:**

- Residence or accommodation function
- General sales or service
- Manufacturing and wholesale trade
- Transportation, communication, information, and utilities
- Arts, entertainment, and recreation
- Education, public administration, health care, and other inst.
- Construction-related businesses
- Mining and extraction establishments
- Agriculture, forestry, fishing, and hunting
- Not applicable to function dimension
- Mixed-use
- To be determined

1:28,000

Sources: Tax Parcels provided by City of Fredericksburg  
 Layer data from APN's Land Based Classification Standards  
 Data compiled by students at University of Maryland  
 Map provided by Dr. Stephen Hanna, UMW



This project was funded, in part, by the Virginia Coastal Zone Management Program at the Virginia Department of Environmental Quality through Grant # NA10N05419 of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended.

**Project Deliverables on Compact Disk**

See Envelope that follows this page

Deliverables also can be found and downloaded from GWRC FTP Site at:

[http://www.gwrcftp.org/Regional\\_Planning/Coastal\\_Zone\\_Management/FY2010/TECHNICAL%20ASSISTANCE/City%20Land%20Use/](http://www.gwrcftp.org/Regional_Planning/Coastal_Zone_Management/FY2010/TECHNICAL%20ASSISTANCE/City%20Land%20Use/)

**Product #4:**

**Calculation of Fredericksburg Tree Canopy and Impervious Surface Area**

## Comparative Summary: CITYgreen Land Cover Analysis for City of Fredericksburg

## 30-meter resolution (LANDSAT/CCAP) vs. 1-meter (NAIP)

Land Cover by City Area	Imagery Resolution	Land Cover (Acres)					
		Impervious Surfaces: Buildings & Structures	Impervious Surfaces: Paved	Open Space: Grass & Scattered Trees & Urban Bare	Trees	Water Area	Total
Ward 1	1-meter	202.4	901.0	765.8	1,354.4	35.3	3,258.9
	30-meter	1,417.0		718.3	1,102.1	33.4	3,270.8
	Difference	-313.6		47.5	252.3	1.9	-11.9
Ward 2	1-meter	68.0	157.5	126.6	174.9	4.0	531.0
	30-meter	412.3		82.3	33.1	2.7	530.4
	Difference	-186.8		44.3	141.8	1.3	0.6
Ward 3	1-meter	102.9	318.3	418.6	834.5	5.2	1,679.5
	30-meter	756.3		373.4	546.6	3.8	1,680.1
	Difference	-335.1		45.2	287.9	1.4	-0.6
Ward 4	1-meter	89.3	275.1	290.0	584.7	8.2	1,247.3
	30-meter	621.6		199.7	418.5	28.9	1,268.7
	Difference	-257.2		90.3	166.2	-20.7	-21.4
City Total	1-meter	461.0	1,651.4	1,600.9	2,960.7	53.5	6,727.5
	30-meter	3,203.7		1,372.5	2,113.6	38.0	6,727.9
	Difference	<b>-1,091.3</b>		<b>228.4</b>	<b>847.1</b>	<b>15.5</b>	<b>-0.4</b>
	% Difference	<b>-42.24%</b>		<b>14.27%</b>	<b>28.61%</b>	<b>28.97%</b>	<b>-0.01%</b>

**Interpretation:**

30-meter imagery-based land cover classification compared to 1-meter imagery-based land cover data:

1. Overstates the City's impervious surface area by 1,091.3 acres, or 42.24%.
2. Understates the area in "Open Space: Grass, scattered trees and urban bare area" by 228.4 acres or 14.27%
3. Understates the tree canopy by 847.1 acres or 28.61%.
4. Understates the amount of surface water area by 15.5 acres or 28.97%.

**Sources:**

1. American Forests, 2009 LANDSAT imagery classified to be consistent with C-CAP imagery data.
2. Virginia Department of Forestry, Land Cover Classification Study using 1-meter 2008 National Agricultural Imagery Program (NAIP) data.

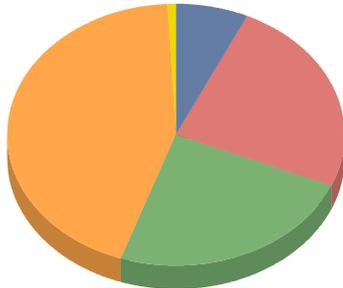
**Additional CITYgreen Reports follow this page.**

# Analysis Report

for

## Fredericksburg City 2008

Source: 1-meter NAIP



Land cover in acres and percentages

■ Impervious Surfaces: Buildings/ structures	461.0	6.9%
■ Impervious Surfaces: Paved	1,651.4	24.5%
■ Open Space - Grass/Scattered Trees	1,600.9	23.8%
■ Trees	2,960.7	44.0%
■ Water Area	53.5	0.8%
Total:	6,727.5	100.0%

**Tree Canopy: 2,960.7 acres (44.0%)**

### Air Pollution Removal

Nearest air quality reference city: **Washington DC**

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr.</u>
Carbon Monoxide:	13,196	\$6,476
Ozone:	102,929	\$363,653
Nitrogen Dioxide:	52,784	\$186,489
Particulate Matter:	87,094	\$205,441
Sulfur Dioxide:	42,227	\$36,443
<b>Totals:</b>	<b>298,230</b>	<b>\$798,502</b>

*Dollar values are based on 2009 dollars*

### Carbon Storage and Sequestration

Tons Stored (Total):	<b>127,404</b>
Tons Sequestered (Annually):	<b>992</b>

### Stormwater Management

#### Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	3.25
Curve Number reflecting existing conditions:	80
Curve Number of replacement land cover:	92

Dominant Soil Type: **B**

Replacement land cover type: (existing condition)

Impervious Surfaces: Buildings/ structures

Additional cu. ft. storage needed: **24,402,203**

Construction cost per cu. ft.: **\$4.75**

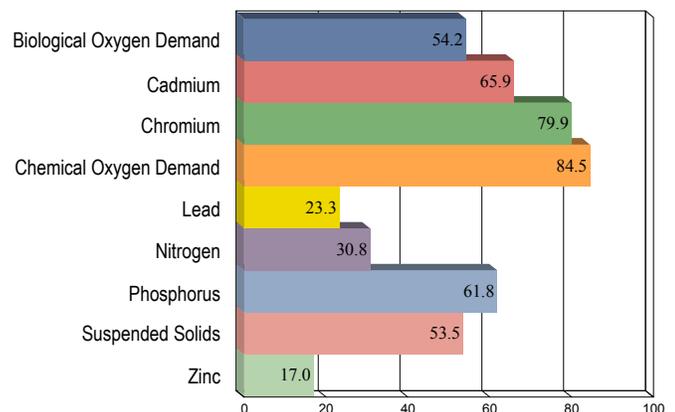
**Total Stormwater Value: \$115,910,466**

**Annual Stormwater Value: \$10,105,603**

(based on 20-year financing at 6% interest)

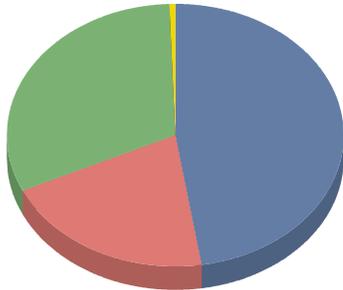
#### Water Quality (Contaminant Loading)

Percent change in contaminant loadings



# Analysis Report

for  
**Fredericksburg City 2009**  
(30 meter resolution)



Land cover in acres and percentages

Category	Acres	Percentage
Impervious Surfaces	3,203.7	47.6%
Open Space - Grass/Scattered Trees	1,370.1	20.4%
Trees	2,113.6	31.4%
Urban: Bare	2.4	0.0%
Water Area	38.0	0.6%
<b>Total:</b>	<b>6,727.9</b>	<b>100.0%</b>

**Tree Canopy: 2,113.6 acres (31.4%)**

### Air Pollution Removal

Nearest air quality reference city: **Washington DC**

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr.</u>
Carbon Monoxide:	9,420	\$4,623
Ozone:	73,478	\$259,602
Nitrogen Dioxide:	37,681	\$133,129
Particulate Matter:	62,174	\$146,658
Sulfur Dioxide:	30,145	\$26,016
<b>Totals:</b>	<b>212,898</b>	<b>\$570,028</b>

*Dollar values are based on 2009 dollars*

### Carbon Storage and Sequestration

Tons Stored (Total):	<b>90,950</b>
Tons Sequestered (Annually):	<b>708</b>

### Stormwater Management

#### Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	3.25
Curve Number reflecting existing conditions:	84
Curve Number of replacement land cover:	93

Dominant Soil Type: **B**

Replacement land cover type: (existing condition)

Impervious Surfaces: Buildings/ structures

Additional cu. ft. storage needed: **18,383,653**

Construction cost per cu. ft.: **\$4.75**

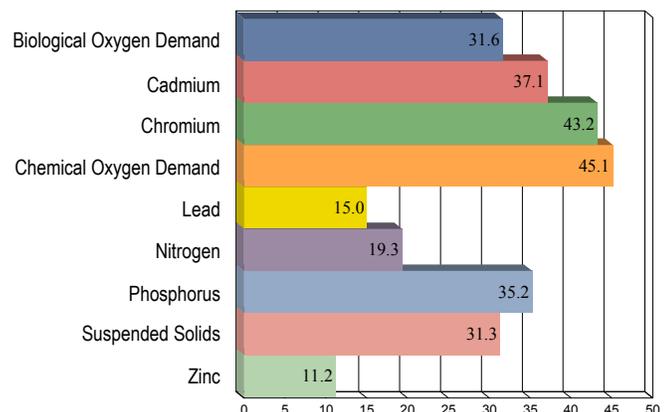
**Total Stormwater Value: \$87,322,354**

**Annual Stormwater Value: \$7,613,161**

(based on 20-year financing at 6% interest)

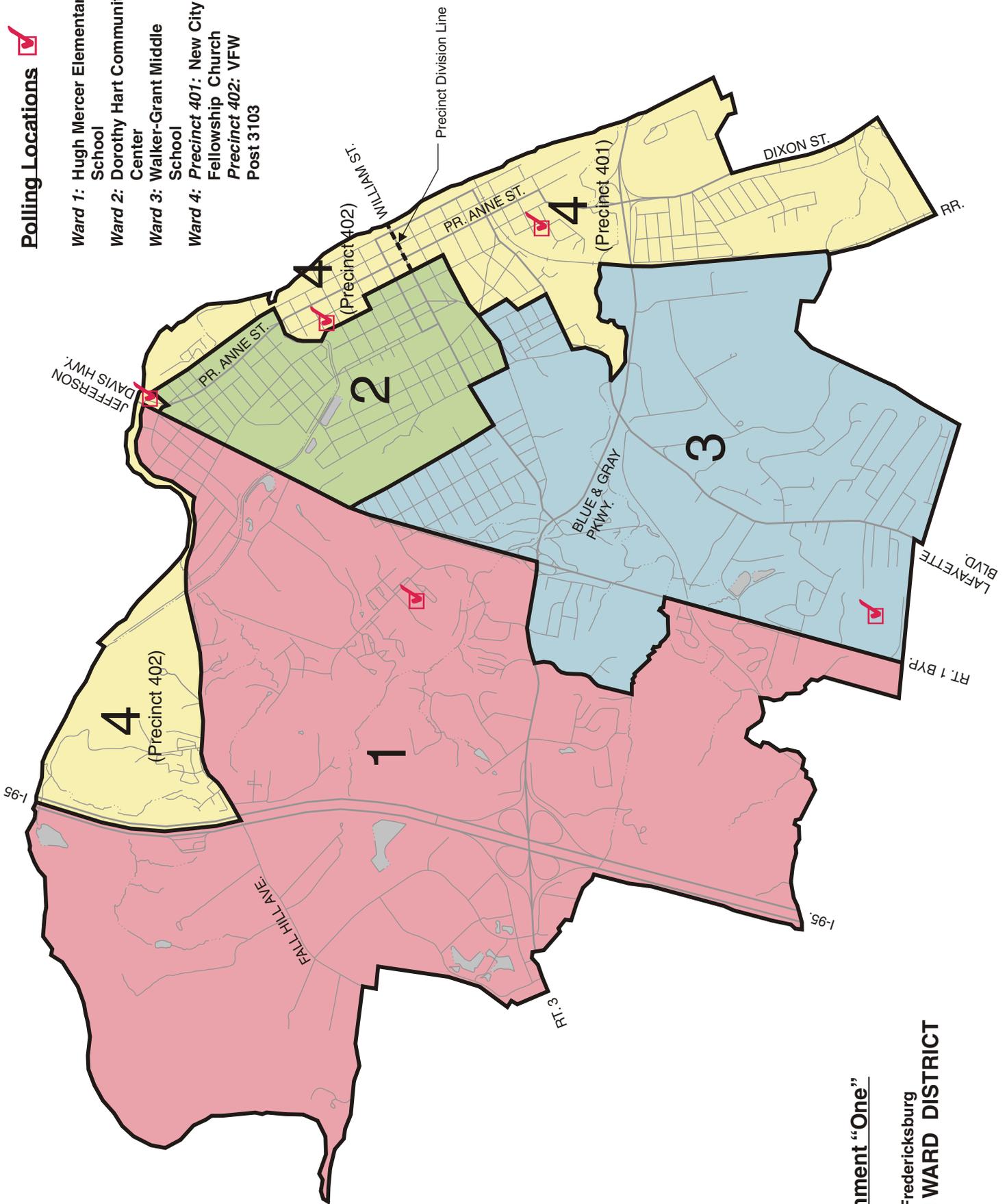
#### Water Quality (Contaminant Loading)

Percent change in contaminant loadings



**Polling Locations** 

- Ward 1:** Hugh Mercer Elementary School
- Ward 2:** Dorothy Hart Community Center
- Ward 3:** Walker-Grant Middle School
- Ward 4:** Precinct 401: New City Fellowship Church  
Precinct 402: VFW Post 3103



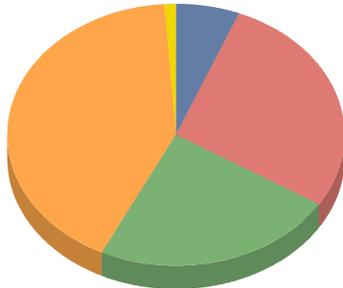
**Attachment "One"**

City of Fredericksburg  
**FOUR WARD DISTRICT**

# Analysis Report

for  
**Fredericksburg Ward 1 2008**

Source: 1-meter NAIP



Land cover in acres and percentages

■ Impervious Surfaces: Buildings/ structures	202.4	6.2%
■ Impervious Surfaces: Paved	901.0	27.6%
■ Open Space - Grass/Scattered Trees	765.8	23.5%
■ Trees	1,354.4	41.6%
■ Water Area	35.3	1.1%
Total:	3,258.9	100.0%

**Tree Canopy: 1,354.4 acres (41.6%)**

## Air Pollution Removal

Nearest air quality reference city: **Washington DC**

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr.</u>
Carbon Monoxide:	6,037	\$2,963
Ozone:	47,086	\$166,357
Nitrogen Dioxide:	24,147	\$85,311
Particulate Matter:	39,842	\$93,981
Sulfur Dioxide:	19,317	\$16,671
<b>Totals:</b>	<b>136,428</b>	<b>\$365,283</b>

*Dollar values are based on 2009 dollars*

## Carbon Storage and Sequestration

Tons Stored (Total):	<b>58,282</b>
Tons Sequestered (Annually):	<b>454</b>

## Stormwater Management

### Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	3.25
Curve Number reflecting existing conditions:	82
Curve Number of replacement land cover:	93

Dominant Soil Type: **C**

Replacement land cover type: (existing condition)

Impervious Surfaces: Buildings/ structures

Additional cu. ft. storage needed: **10,554,366**

Construction cost per cu. ft.: **\$4.75**

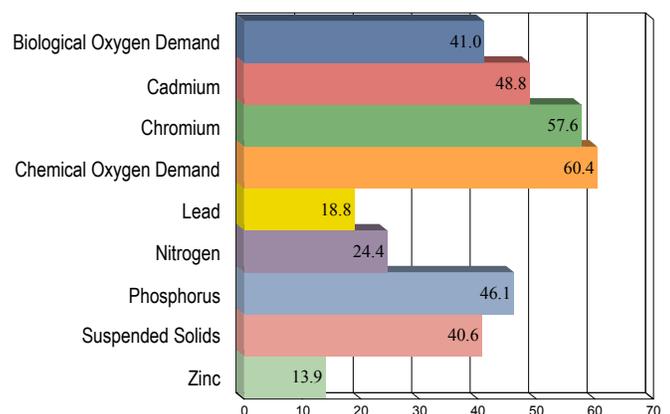
**Total Stormwater Value: \$50,133,239**

**Annual Stormwater Value: \$4,370,844**

(based on 20-year financing at 6% interest)

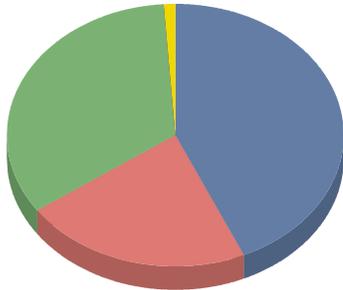
### Water Quality (Contaminant Loading)

Percent change in contaminant loadings



# Analysis Report

for  
**Fredericksburg Ward 1 2009**  
(30 meter resolution)



Land cover in acres and percentages

Category	Acres	Percentage
Impervious Surfaces	1,417.0	43.3%
Open Space - Grass/Scattered Trees	716.3	21.9%
Trees	1,102.1	33.7%
Urban: Bare	2.0	0.1%
Water Area	33.4	1.0%
<b>Total:</b>	<b>3,270.9</b>	<b>100.0%</b>

**Tree Canopy: 1,102.1 acres (33.7%)**

## Air Pollution Removal

Nearest air quality reference city: **Washington DC**

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr.</u>
Carbon Monoxide:	4,912	\$2,411
Ozone:	38,316	\$135,373
Nitrogen Dioxide:	19,649	\$69,422
Particulate Matter:	32,421	\$76,477
Sulfur Dioxide:	15,719	\$13,566
<b>Totals:</b>	<b>111,019</b>	<b>\$297,250</b>

*Dollar values are based on 2009 dollars*

## Carbon Storage and Sequestration

Tons Stored (Total):	<b>47,427</b>
Tons Sequestered (Annually):	<b>369</b>

## Stormwater Management

### Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	3.25
Curve Number reflecting existing conditions:	84
Curve Number of replacement land cover:	93
Dominant Soil Type: <b>C</b>	
Replacement land cover type: (existing condition)	
Impervious Surfaces: Buildings/ structures	
Additional cu. ft. storage needed:	<b>8,913,819</b>
Construction cost per cu. ft.:	\$4.75

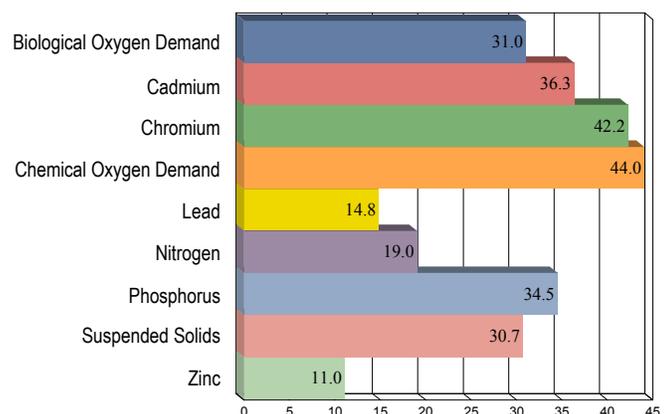
**Total Stormwater Value: \$42,340,641**

**Annual Stormwater Value: \$3,691,450**

(based on 20-year financing at 6% interest)

### Water Quality (Contaminant Loading)

Percent change in contaminant loadings

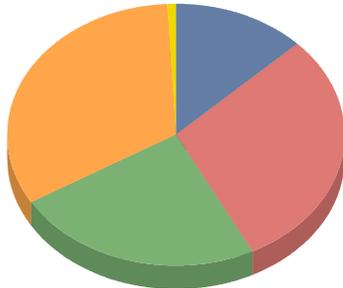


# Analysis Report

for

## Fredericksburg Ward 2 2008

Source: 1-meter NAIP



Land cover in acres and percentages

■ Impervious Surfaces: Buildings/ structures	68.0	12.8%
■ Impervious Surfaces: Paved	157.5	29.7%
■ Open Space - Grass/Scattered Trees	126.6	23.9%
■ Trees	174.9	32.9%
■ Water Area	4.0	0.8%
Total:	530.9	100.0%

**Tree Canopy: 174.9 acres (32.9%)**

### Air Pollution Removal

Nearest air quality reference city: **Washington DC**

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr.</u>
Carbon Monoxide:	779	\$382
Ozone:	6,079	\$21,477
Nitrogen Dioxide:	3,117	\$11,014
Particulate Matter:	5,144	\$12,133
Sulfur Dioxide:	2,494	\$2,152
<b>Totals:</b>	<b>17,613</b>	<b>\$47,158</b>

*Dollar values are based on 2009 dollars*

### Carbon Storage and Sequestration

Tons Stored (Total):	<b>7,524</b>
Tons Sequestered (Annually):	<b>59</b>

### Stormwater Management

#### Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	3.25
Curve Number reflecting existing conditions:	81
Curve Number of replacement land cover:	91

Dominant Soil Type: **B**

Replacement land cover type: (existing condition)

Impervious Surfaces: Buildings/ structures

Additional cu. ft. storage needed: **1,644,858**

Construction cost per cu. ft.: **\$4.75**

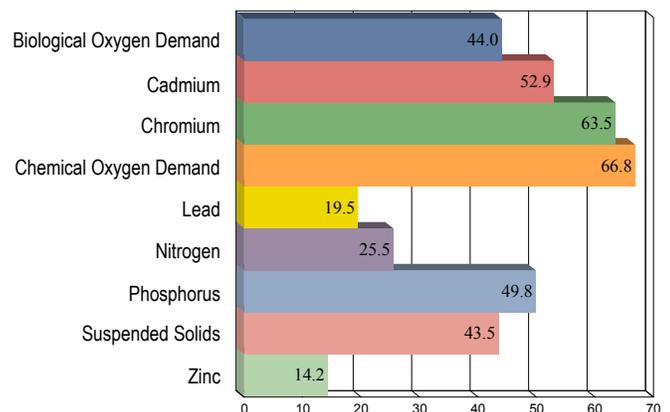
**Total Stormwater Value: \$7,813,074**

**Annual Stormwater Value: \$681,179**

(based on 20-year financing at 6% interest)

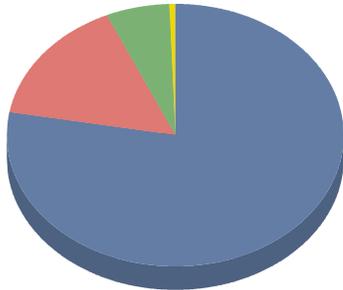
#### Water Quality (Contaminant Loading)

Percent change in contaminant loadings



# Analysis Report

for  
**Fredericksburg Ward 2 2009**  
(30 meter resolution)



Land cover in acres and percentages

Category	Acres	Percentage
Impervious Surfaces	412.3	77.7%
Open Space - Grass/Scattered Trees	82.3	15.5%
Trees	33.1	6.2%
Urban: Bare	0.0	0.0%
Water Area	2.7	0.5%
<b>Total:</b>	<b>530.4</b>	<b>100.0%</b>

**Tree Canopy: 33.1 acres (6.2%)**

### Air Pollution Removal

Nearest air quality reference city: **Washington DC**

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr.</u>
Carbon Monoxide:	148	\$72
Ozone:	1,152	\$4,070
Nitrogen Dioxide:	591	\$2,087
Particulate Matter:	975	\$2,299
Sulfur Dioxide:	473	\$408
<b>Totals:</b>	<b>3,338</b>	<b>\$8,937</b>

*Dollar values are based on 2009 dollars*

### Carbon Storage and Sequestration

Tons Stored (Total):	<b>1,426</b>
Tons Sequestered (Annually):	<b>11</b>

### Stormwater Management

#### Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	3.25
Curve Number reflecting existing conditions:	92
Curve Number of replacement land cover:	94

Dominant Soil Type: **B**

Replacement land cover type: (existing condition)

Impervious Surfaces: Buildings/ structures

Additional cu. ft. storage needed: **384,893**

Construction cost per cu. ft.: **\$4.75**

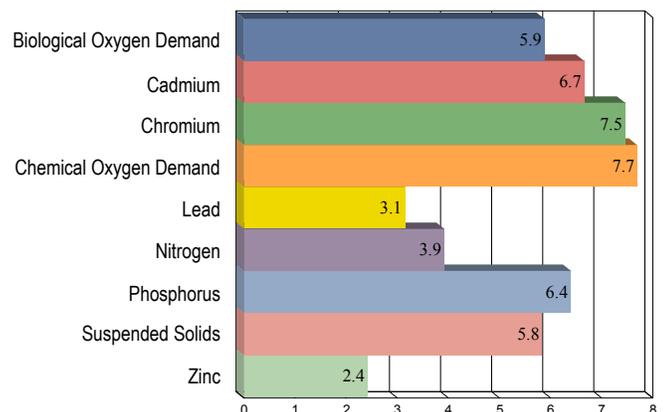
**Total Stormwater Value: \$1,828,244**

**Annual Stormwater Value: \$159,395**

(based on 20-year financing at 6% interest)

#### Water Quality (Contaminant Loading)

Percent change in contaminant loadings



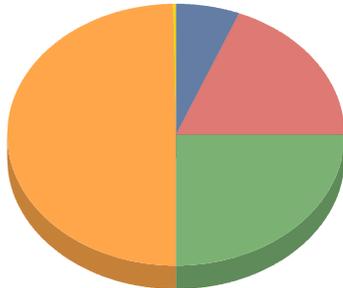
# Analysis Report

for

## Fredericksburg Ward 3 2008

Source: 1-meter NAIP

Land cover in acres and percentages



■ Impervious Surfaces: Buildings/ structures	102.9	6.1%
■ Impervious Surfaces: Paved	318.8	19.0%
■ Open Space - Grass/Scattered Trees	418.6	24.9%
■ Trees	834.5	49.7%
■ Water Area	5.2	0.3%
Total:	1,680.1	100.0%

**Tree Canopy: 834.5 acres (49.7%)**

### Air Pollution Removal

Nearest air quality reference city: **Washington DC**

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr.</u>
Carbon Monoxide:	3,720	\$1,825
Ozone:	29,013	\$102,503
Nitrogen Dioxide:	14,878	\$52,566
Particulate Matter:	24,549	\$57,908
Sulfur Dioxide:	11,903	\$10,272
<b>Totals:</b>	<b>84,062</b>	<b>\$225,075</b>

*Dollar values are based on 2009 dollars*

### Carbon Storage and Sequestration

Tons Stored (Total):	<b>35,911</b>
Tons Sequestered (Annually):	<b>280</b>

### Stormwater Management

#### Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	3.25
Curve Number reflecting existing conditions:	74
Curve Number of replacement land cover:	91

Dominant Soil Type: **B**

Replacement land cover type: (existing condition)

Impervious Surfaces: Buildings/ structures

Additional cu. ft. storage needed: **7,273,863**

Construction cost per cu. ft.: **\$4.75**

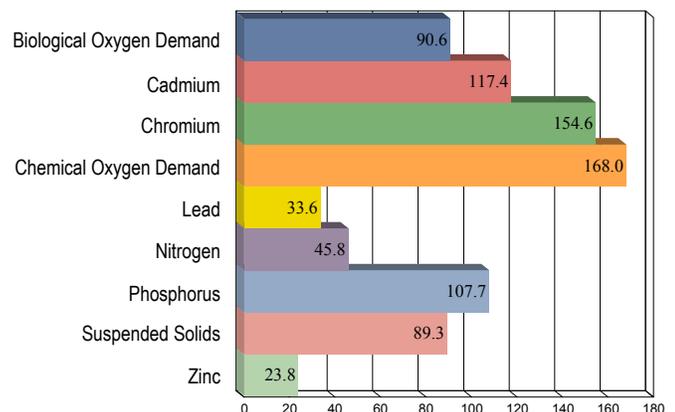
**Total Stormwater Value: \$34,550,850**

**Annual Stormwater Value: \$3,012,301**

(based on 20-year financing at 6% interest)

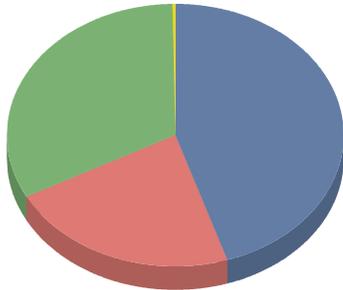
#### Water Quality (Contaminant Loading)

Percent change in contaminant loadings



# Analysis Report

for  
**Fredericksburg Ward 3 2009**  
(30 meter resolution)



Land cover in acres and percentages

Category	Acres	Percentage
Impervious Surfaces	756.3	45.0%
Open Space - Grass/Scattered Trees	373.4	22.2%
Trees	546.6	32.5%
Urban: Bare	0.0	0.0%
Water Area	3.8	0.2%
<b>Total:</b>	<b>1,680.1</b>	<b>100.0%</b>

**Tree Canopy: 546.6 acres (32.5%)**

### Air Pollution Removal

Nearest air quality reference city: **Washington DC**

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr.</u>
Carbon Monoxide:	2,436	\$1,196
Ozone:	19,003	\$67,140
Nitrogen Dioxide:	9,745	\$34,431
Particulate Matter:	16,080	\$37,930
Sulfur Dioxide:	7,796	\$6,728
<b>Totals:</b>	<b>55,061</b>	<b>\$147,425</b>

*Dollar values are based on 2009 dollars*

### Carbon Storage and Sequestration

Tons Stored (Total):	<b>23,522</b>
Tons Sequestered (Annually):	<b>183</b>

### Stormwater Management

#### Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	3.25
Curve Number reflecting existing conditions:	81
Curve Number of replacement land cover:	92
Dominant Soil Type: <b>B</b>	
Replacement land cover type: (existing condition)	
Impervious Surfaces: Buildings/ structures	
Additional cu. ft. storage needed:	<b>5,331,532</b>
Construction cost per cu. ft.:	\$4.75

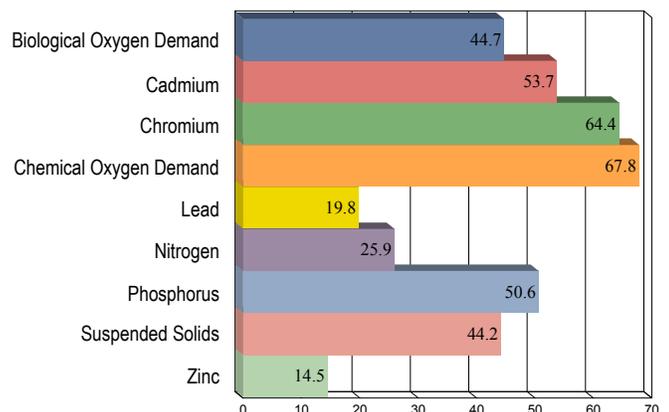
**Total Stormwater Value: \$25,324,779**

**Annual Stormwater Value: \$2,207,930**

(based on 20-year financing at 6% interest)

#### Water Quality (Contaminant Loading)

Percent change in contaminant loadings

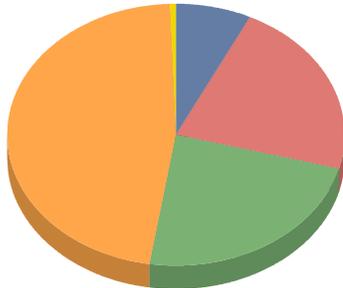


# Analysis Report

for

## Fredericksburg Ward 4 2008

Source: 1-meter NAIP



Land cover in acres and percentages

■ Impervious Surfaces: Buildings/ structures	89.3	7.2%
■ Impervious Surfaces: Paved	275.1	22.1%
■ Open Space - Grass/Scattered Trees	290.0	23.2%
■ Trees	584.7	46.9%
■ Water Area	8.2	0.7%
Total:	1,247.3	100.0%

**Tree Canopy: 584.7 acres (46.9%)**

### Air Pollution Removal

Nearest air quality reference city: **Washington DC**

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr.</u>
Carbon Monoxide:	2,606	\$1,279
Ozone:	20,326	\$71,813
Nitrogen Dioxide:	10,424	\$36,827
Particulate Matter:	17,199	\$40,570
Sulfur Dioxide:	8,339	\$7,197
<b>Totals:</b>	<b>58,894</b>	<b>\$157,687</b>

*Dollar values are based on 2009 dollars*

### Carbon Storage and Sequestration

Tons Stored (Total):	<b>25,159</b>
Tons Sequestered (Annually):	<b>196</b>

### Stormwater Management

#### Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	3.25
Curve Number reflecting existing conditions:	79
Curve Number of replacement land cover:	92

Dominant Soil Type: **B**

Replacement land cover type: (existing condition)

Impervious Surfaces: Buildings/ structures

Additional cu. ft. storage needed: **4,635,116**

Construction cost per cu. ft.: **\$4.75**

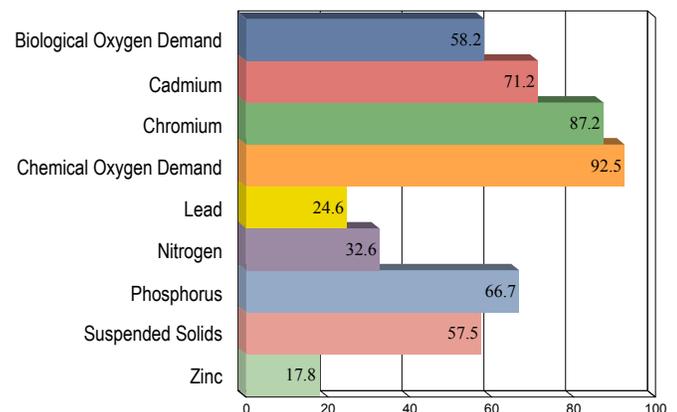
**Total Stormwater Value: \$22,016,802**

**Annual Stormwater Value: \$1,919,525**

(based on 20-year financing at 6% interest)

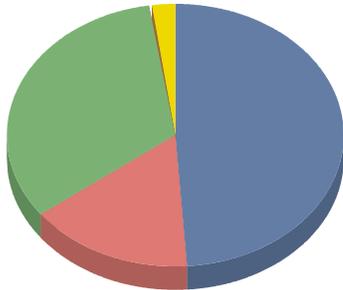
#### Water Quality (Contaminant Loading)

Percent change in contaminant loadings



# Analysis Report

for  
**Fredericksburg Ward 4 2009**  
(30 meter resolution)



Land cover in acres and percentages

Category	Acres	Percentage
Impervious Surfaces	621.6	49.0%
Open Space - Grass/Scattered Trees	198.4	15.6%
Trees	418.5	33.0%
Urban: Bare	1.3	0.1%
Water Area	28.9	2.3%
<b>Total:</b>	<b>1,268.7</b>	<b>100.0%</b>

**Tree Canopy: 418.5 acres (33.0%)**

## Air Pollution Removal

Nearest air quality reference city: **Washington DC**

	<u>Lbs. Removed/yr</u>	<u>Dollar Value/yr.</u>
Carbon Monoxide:	1,865	\$916
Ozone:	14,550	\$51,407
Nitrogen Dioxide:	7,462	\$26,362
Particulate Matter:	12,312	\$29,042
Sulfur Dioxide:	5,969	\$5,152
<b>Totals:</b>	<b>42,158</b>	<b>\$112,878</b>

*Dollar values are based on 2009 dollars*

## Carbon Storage and Sequestration

Tons Stored (Total):	<b>18,010</b>
Tons Sequestered (Annually):	<b>140</b>

## Stormwater Management

### Water Quantity (Runoff Volume)

2-yr, 24-hr Rainfall in inches:	3.25
Curve Number reflecting existing conditions:	85
Curve Number of replacement land cover:	94
Dominant Soil Type: <b>B</b>	
Replacement land cover type: (existing condition)	
Impervious Surfaces: Buildings/ structures	
Additional cu. ft. storage needed:	<b>3,477,702</b>
Construction cost per cu. ft.:	\$4.75

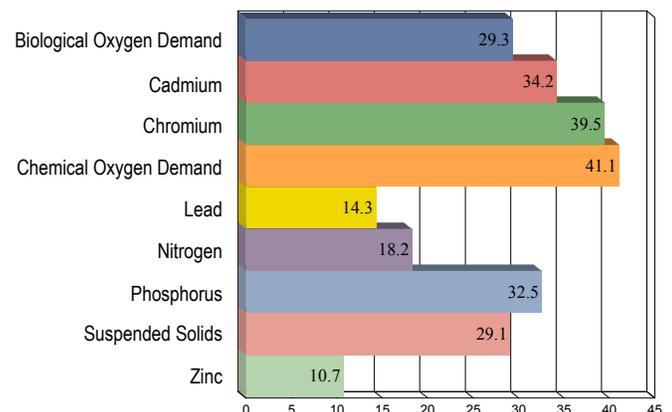
**Total Stormwater Value: \$16,519,086**

**Annual Stormwater Value: \$1,440,209**

(based on 20-year financing at 6% interest)

### Water Quality (Contaminant Loading)

Percent change in contaminant loadings



# A Report on Fredericksburg's Existing and Possible Urban Tree Canopy

## Project Background

The analysis of the City of Fredericksburg's urban tree canopy (UTC) was carried out by the Virginia Department of Forestry. Assistance was provided by the Virginia Geospatial Extension Program (VGEP) at Virginia Tech's Department of Forestry and by the Spatial Analysis Laboratory (SAL) of the University of Vermont.

The goal of the project was to apply the USDA Forest Service's UTC assessment protocols to the City of Fredericksburg. This analysis was conducted based on year 2008 data.

## Why is Tree Canopy Important?

Urban tree canopy (UTC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. Urban tree canopy provides many benefits to communities including improving water quality, conserving energy, lowering city temperatures, reducing air pollution, enhancing property values, providing wildlife habitat, facilitating social and educational opportunities, and providing aesthetic benefits.

## Key Terms

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

**Land Cover:** Physical features on the earth mapped from satellite or aerial imagery such as trees, or water.

**Existing UTC:** The amount of UTC present within the city boundary..

**Possible UTC:** The amount of land that is theoretically available for the establishment of tree canopy within the city boundary. Possible UTC excludes areas covered by tree canopy, roads, buildings, and water. It is the combination of Possible UTC - Vegetation and Possible UTC - Impervious.

**Possible UTC - Vegetation:** The amount of land that is theoretically available for the establishment of tree canopy in non-tree vegetation areas within the city boundary. This excludes areas covered by tree canopy, impervious surfaces, and water.

**Possible UTC - Impervious:** The amount of land that is theoretically available for the establishment of tree canopy in impervious areas. This excludes areas covered by tree canopy, non-tree vegetation, roads, buildings, and water.

## How Much Tree Canopy Does Fredericksburg Have?

Figure 1 shows the urban tree canopy (UTC) analysis for Fredericksburg, which is derived from high resolution aerial imagery. 2979 acres of Fredericksburg is covered by tree canopy (termed Existing UTC). This corresponds to 44.4% of all land area within the city (Table 1). An additional 1603 acres of the city could theoretically be improved to support urban tree canopy (termed Possible UTC), Table 2.

UTC Classes	Existing UTC		
	Acres	% Total Area	% Land Area
<b>Tree Canopy</b>	2979	44.0%	44.4%
<b>Non-Tree Vegetation</b>	1609	23.8%	24.0%
<b>Non-Building Impervious</b>	1658	24.5%	24.7%
<b>Buildings</b>	463	6.8%	6.9%
<b>Water</b>	55	0.8%	0.0%
<b>Total Area</b>	6764	100.0%	100.0%

Table 1: Existing UTC area and percentages for the City \* % Total Area includes area covered by water.

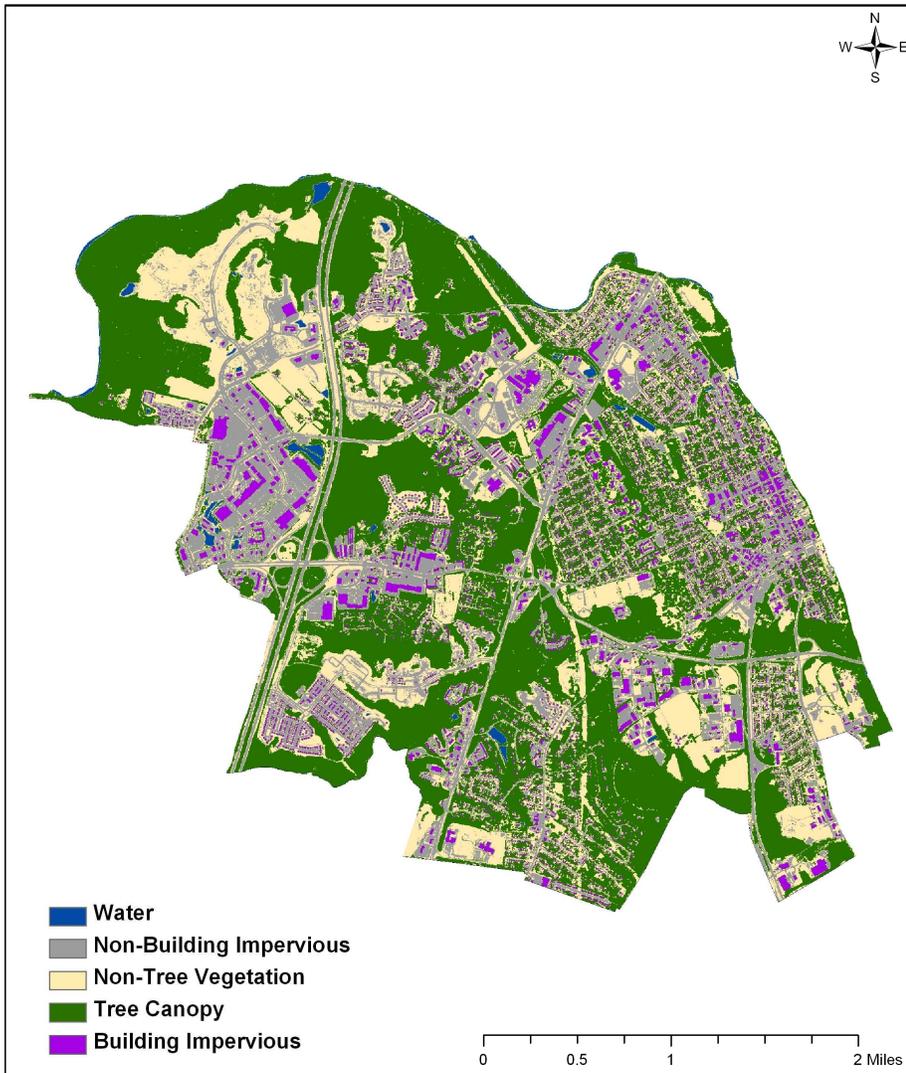


Figure 1: Land cover for the City of Fredericksburg.

## Mapping Fredericksburg's Trees

Using high-resolution (1 meter) National Agriculture Imagery Program (NAIP) imagery acquired in the summer of 2008 (Figure 2a) in combination with remote sensing techniques, land cover data for the city was generated (Figure 2b). An accuracy assessment was conducted. Single trees (tree canopies larger than 16 square meters) were detected with a 93% accuracy.

## Who "Owns" Fredericksburg's Trees?

The detailed land cover mapping conducted as part of this assessment allowed the percentage of Existing and Possible UTC to be calculated for each category of land (Figure 3). Using this data, ownership patterns for Existing UTC and Possible UTC (Figure 4) can be examined.

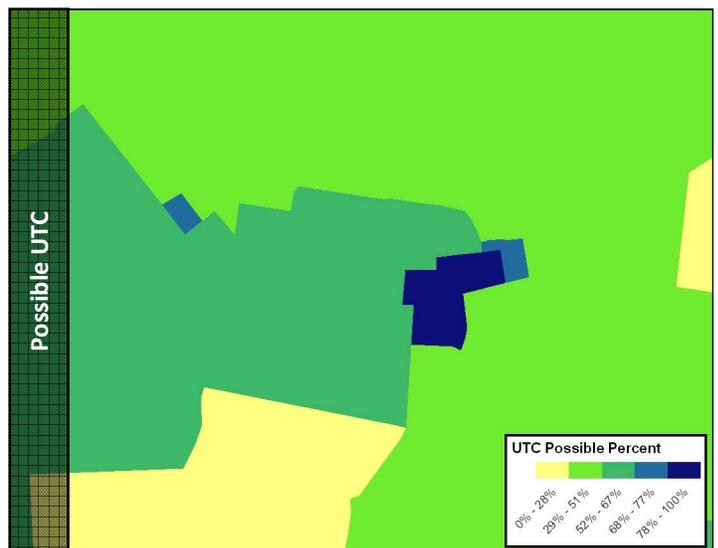
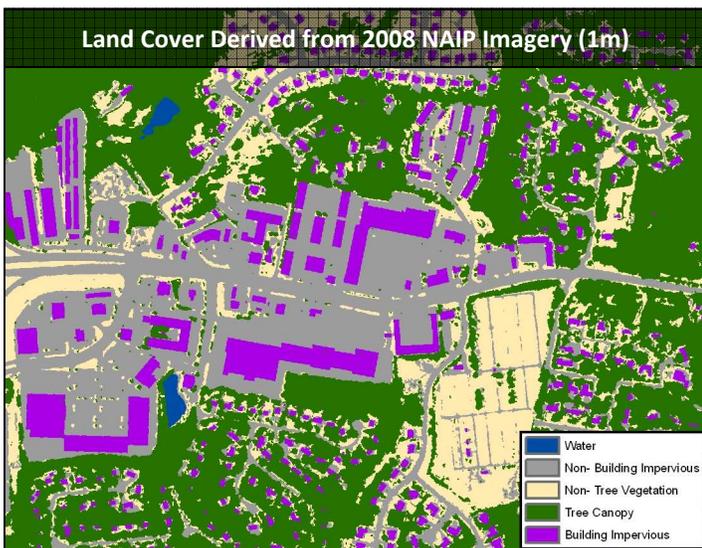
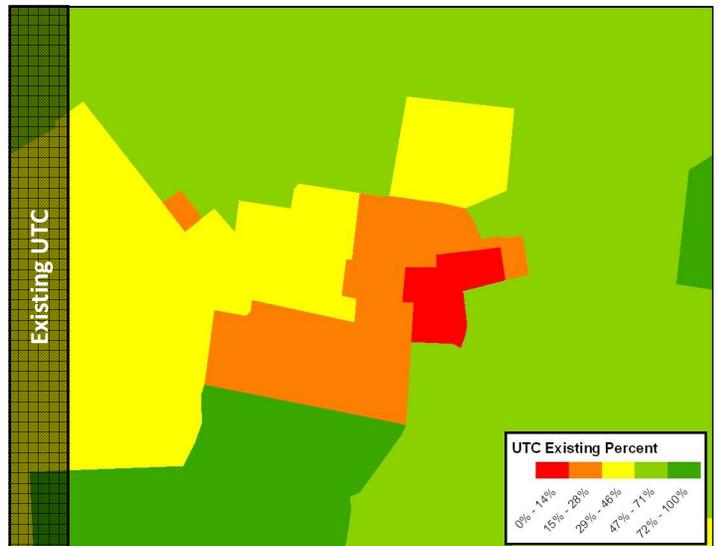
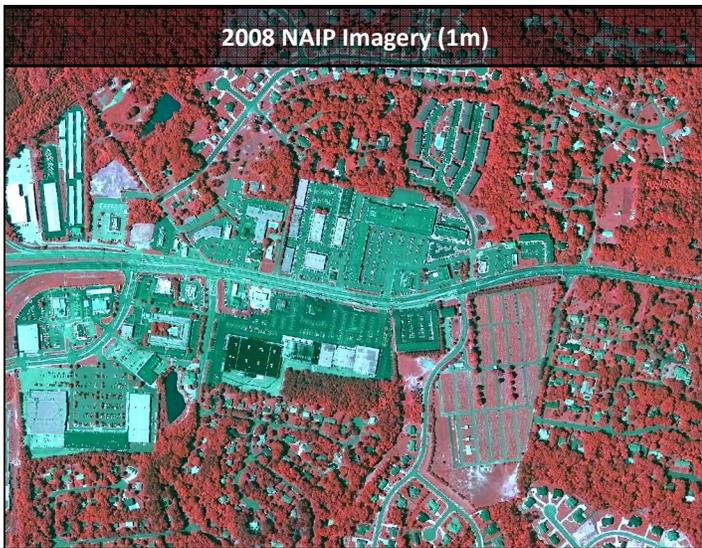
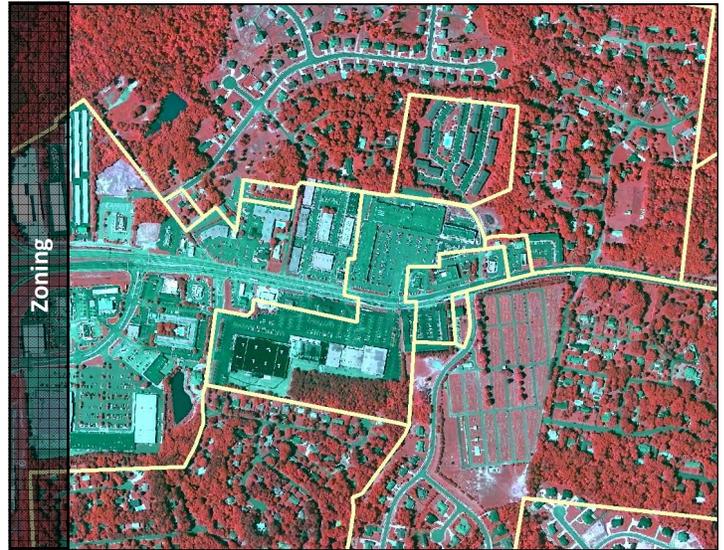
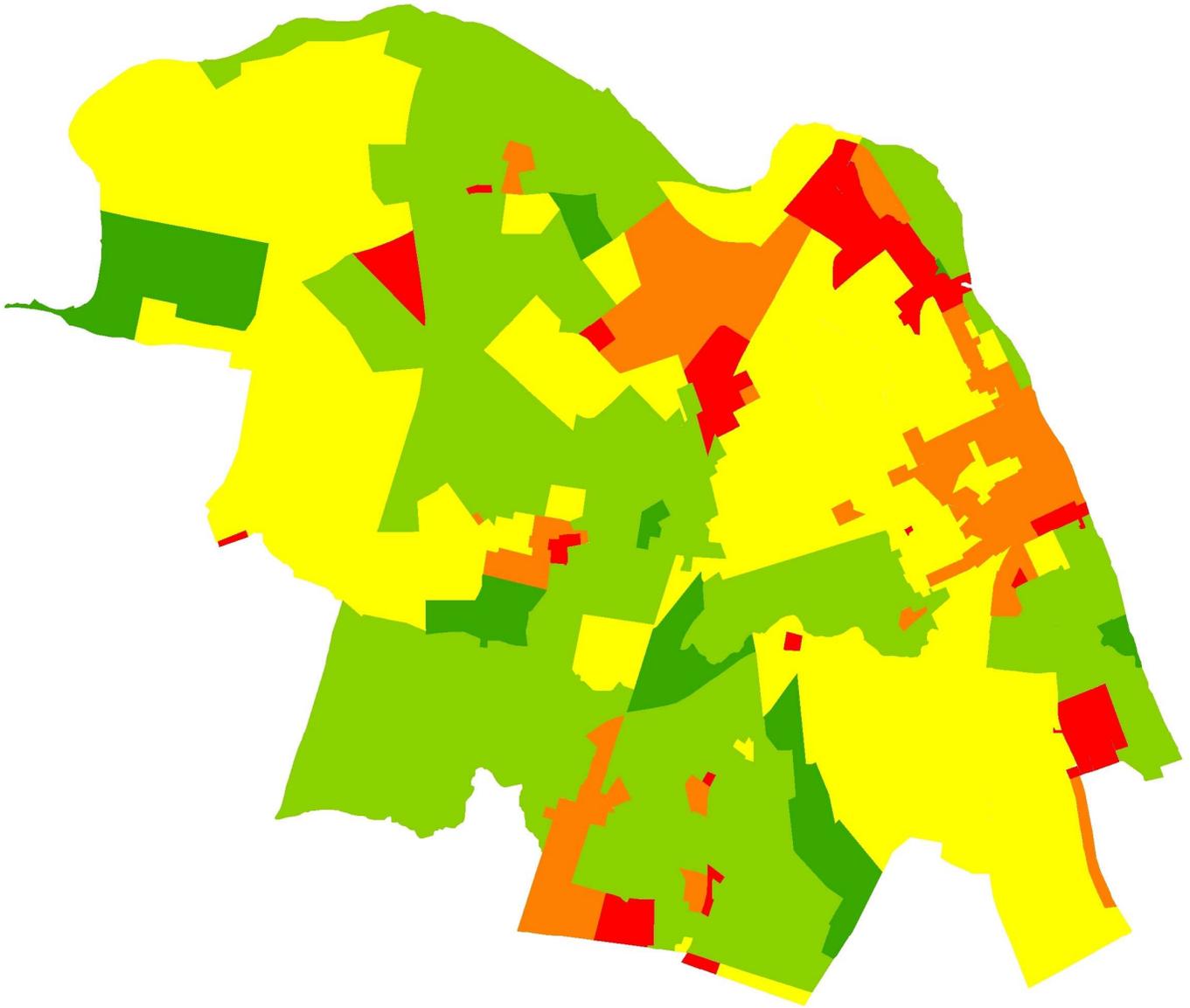


Figure 2a, 2b: Comparison of 2008 NAIP imagery to the resulting high-resolution land cover.

Figure 3: UTC metrics summarized at the property parcel level

# Urban Tree Canopy Analysis Summarized by Zoning - Fredericksburg, VA



0 0.5 1 2 Miles

UTC Existing Percent	
0% - 14%	29% - 46%
15% - 28%	47% - 71%
	72% - 100%



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A partnership of Virginia Tech and Virginia State University

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Figure 4: UTC metrics summarized by Zoning Category.

## Urban Tree Canopy Summarized by Zoning

Using data provided by the City of Fredericksburg, Existing and Possible UTC were summarized by zoning category. This summary excludes any area outside of zoning boundaries and areas covered by water. Based on this analysis Fredericksburg has 44.3% (2953 acres) Existing UTC and 24.0% (1603 acres) Possible UTC (Figure 5). Possible UTC has two components, Possible UTC - Vegetation and Possible UTC - Impervious. 24.0% (1603 acres) of zoning land area is associated with Possible UTC - Vegetation. Possible UTC - Impervious figures are not available due to the lack of Right-of-Way data. Figure 4 shows Existing UTC throughout the City of Fredericksburg.

Using the zoning data provided by the City of Fredericksburg, Existing and Possible UTC were summarized by zoning category (page 5). The zoning category R4 has the largest amount of land area with 1338 acres (Table 3). Zoning Category R1 contains the most existing UTC (24.3%) followed by R4 and R2 with 21.4% and 15.1% Existing UTC respectively. Figure 6 compares zoning categories by the amount of land area within each category. Figure 7 shows the spatial distribution of Possible UTC by zoning category for the City.

UTC Zoning Metrics	Acres	% Zoning Land Area
Parcel Land Area	6671	100.00%
Existing UTC	2953	44.3%
Possible UTC - Vegetation	1603	24.0%
Not Suitable for UTC	443	6.6%

Table 2: Acres and percent land area from UTC metrics summarized by zoning category. \*Not Suitable for UTC includes all water areas some of which may lay outside of zoning boundaries.

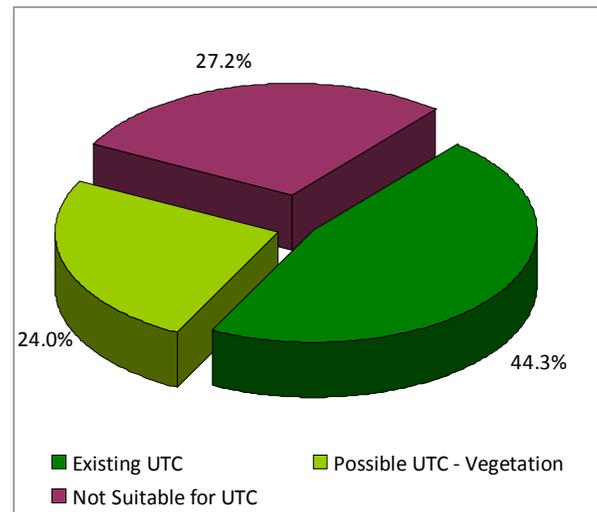


Figure 5: Pie chart showing Fredericksburg UTC distribution.

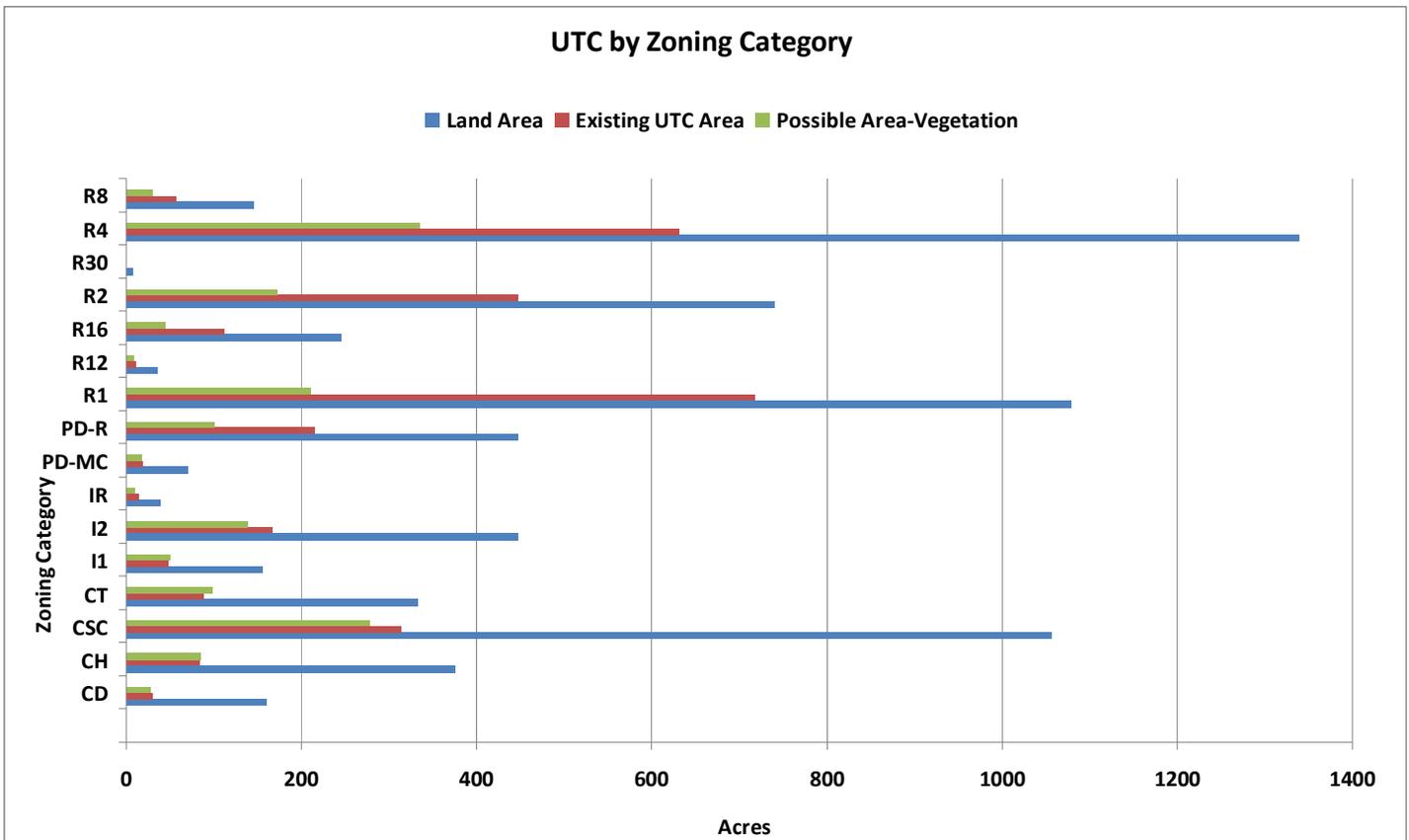


Figure 6: UTC metrics for zoning categories (not including water).

## Urban Tree Canopy Summarized by Zoning Category

Zoning Category	Land Area (Acres)	Existing UTC			Possible UTC Vegetation		
		% Land Area	% Zoning Category	% UTC Type	% Land Area	% Zoning Category	% UTC Type
CD	159	0.5%	18.9%	1.0%	0.4%	17.1%	1.7%
CH	376	1.3%	22.3%	2.8%	1.3%	22.6%	5.3%
CSC	1057	4.7%	29.7%	10.6%	4.2%	26.3%	17.3%
CT	333	1.3%	26.3%	3.0%	1.5%	29.3%	6.1%
I1	156	0.7%	30.1%	1.6%	0.7%	31.7%	3.1%
I2	447	2.5%	37.4%	5.7%	2.1%	31.0%	8.7%
IR	38	0.2%	36.4%	0.5%	0.1%	24.1%	0.6%
PD-MC	70	0.3%	26.8%	0.6%	0.3%	24.8%	1.1%
PD-R	447	3.2%	47.9%	7.2%	1.5%	22.4%	6.2%
R1	1078	10.8%	66.7%	24.3%	3.2%	19.6%	13.2%
R12	35	0.2%	32.6%	0.4%	0.1%	20.6%	0.4%
R16	245	1.7%	45.6%	3.8%	0.7%	17.7%	2.7%
R2	741	6.7%	60.3%	15.1%	2.6%	23.3%	10.8%
R30	7	0.0%	22.8%	0.1%	0.0%	17.4%	0.1%
R4	1338	9.5%	47.1%	21.4%	5.0%	25.0%	20.9%
R8	145	0.8%	39.0%	1.9%	0.4%	20.5%	1.9%

$$\% \text{ Land} = \frac{\text{Area of UTC type for specified land use}}{\text{Area of all land}}$$

The % Land Use value indicates that 0.8% of "R8" land is covered by tree canopy.

$$\% \text{ Category} = \frac{\text{Area of UTC type for specified land use}}{\text{Area of all land for specified land use}}$$

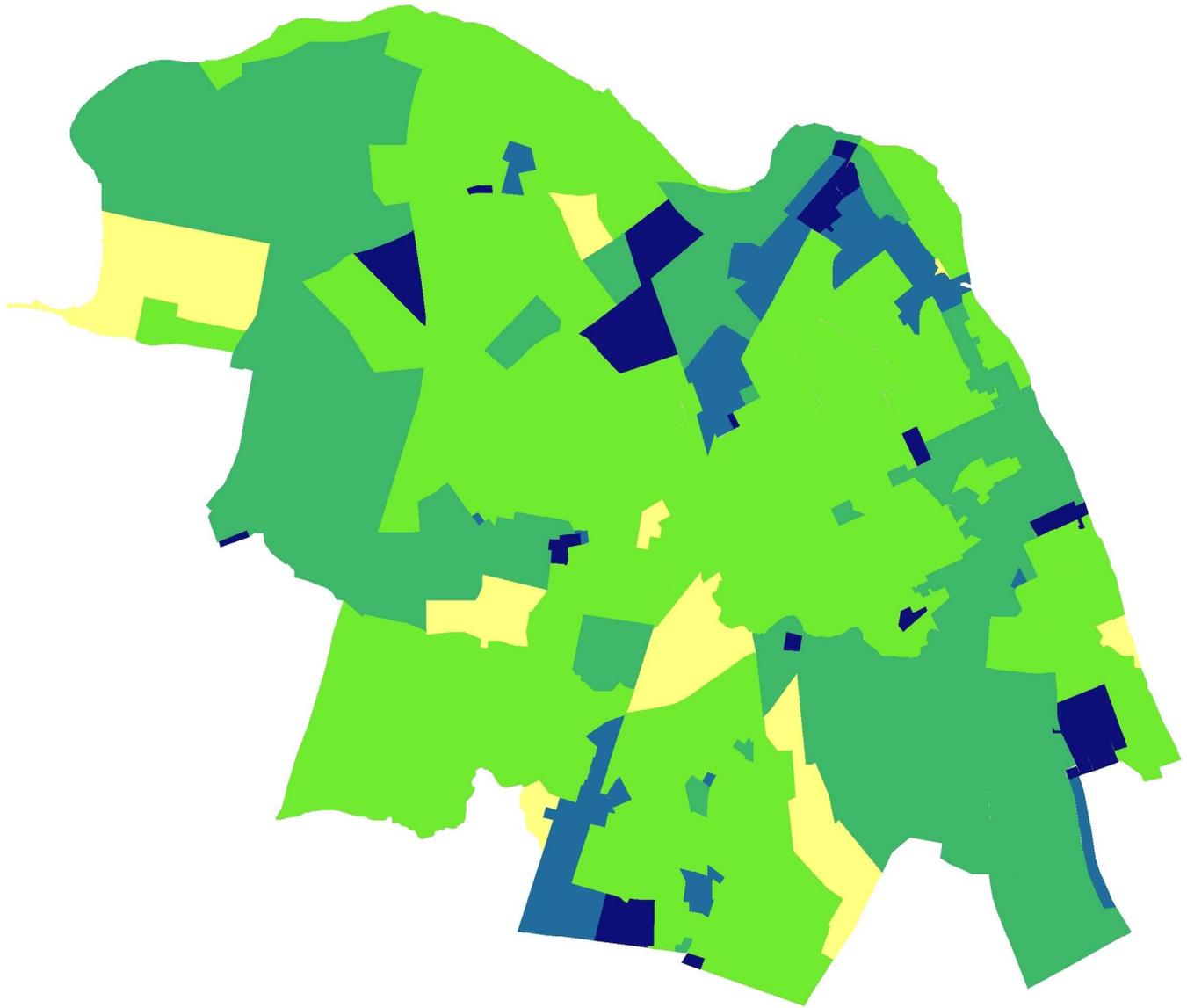
The % Category value indicates that 39.0% of Fredericksburg's land area is tree canopy in areas where the land use is "R8".

$$\% \text{ UTC Type} = \frac{\text{Area of UTC type for specified land use}}{\text{Area of all UTC type}}$$

The % UTC Type value of 1.9% indicates that 1.9% of all Existing UTC lies in areas of "R8" land use.

Table 3: UTC metrics by type, summarized by zoning categories. For each category UTC metrics were computed as a percent of all zoned land in the city (% Land Area), as a percent of land area by zoning categories (% Zoning Category) and as a percent of the area for the UTC type (% UTC Type).

# Possible Urban Tree Canopy Summarized by Zoning - Fredericksburg, VA



UTC Possible Percent	
0% - 28%	52% - 67%
29% - 51%	68% - 77%
	78% - 100%



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A partnership of Virginia Tech and Virginia State University [www.vce.edu](http://www.vce.edu)

VirginiaTech  
Invent the Future



Figure 7: Possible percentage increase of UTC by zoning category .

## Where to Plant Trees?

Decision makers can use GIS to find out specific UTC metrics for a parcel or set of parcels. This information can be used to estimate the amount of tree loss in a planned development or set UTC improvement goals for an individual property.

Attribute	Value
Land Use	Exempt Commercial
Owner	St Peter & Paul Catholic Church
Address	320 Cathedral Street
Existing UTC	5%
Possible UTC	72%
Possible UTC—Vegetation	47%
Possible UTC—Impervious	25%

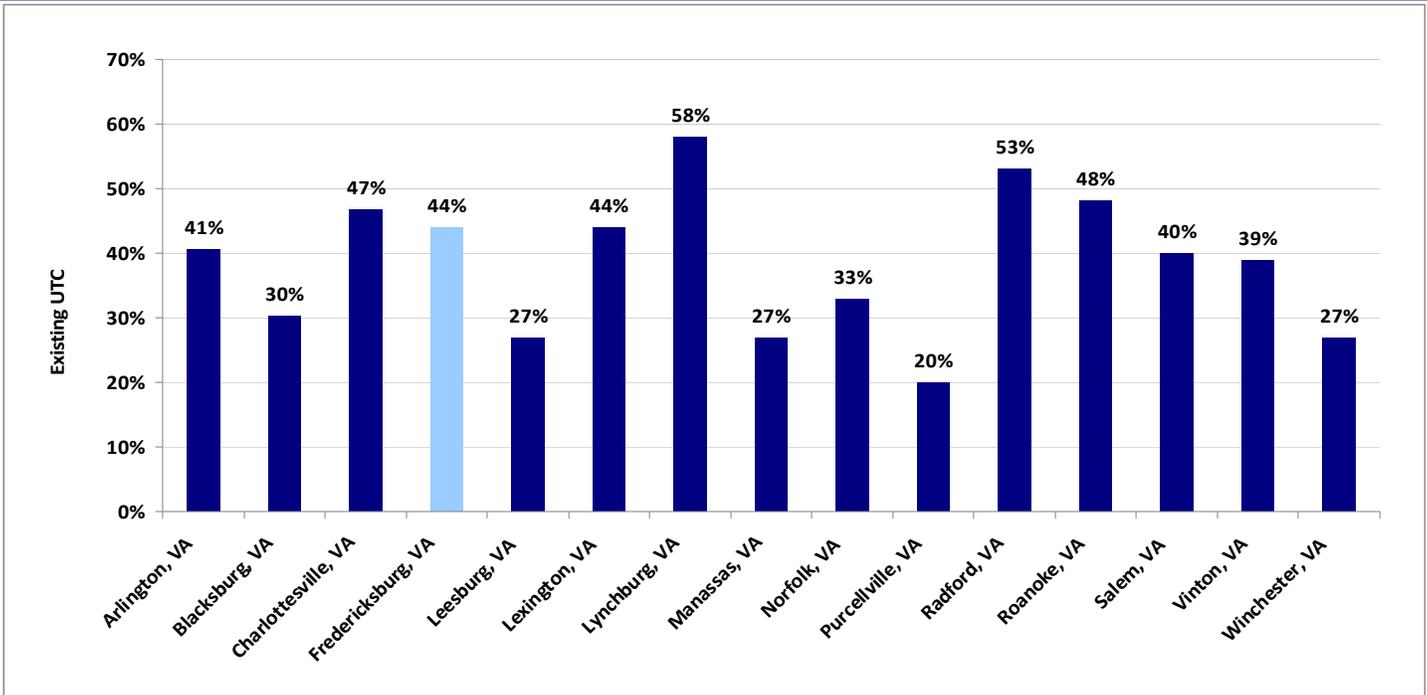


Figure 8: Parcel-based UTC metrics can be used to support targeted UTC.

## Conclusions

- Fredericksburg's urban tree canopy is a vital community asset, reducing storm water runoff, improving air quality, reducing the city's carbon footprint, enhancing quality of life, contributing to savings on energy bills, and serving as habitat for wildlife.
- With 44% tree canopy cover, Fredericksburg has similar coverage to Lexington and slightly less than Charlottesville. Figure 9 shows how Fredericksburg compares to other Virginia localities participating in Urban Tree Canopy Assessments.
- The Zoning Categories with the highest percentage of Possible UTC are R4 and CSC with 20.9% and 17.3% respectively.

## Urban Tree Canopy Comparison



### Prepared by:

Jim Pugh  
GIS/Remote Sensing Technician  
Virginia Department of Forestry  
900 Natural Resources Drive  
Suite 800  
Charlottesville, VA 22903  
(434) 220-9062  
[jim.pugh@dof.virginia.gov](mailto:jim.pugh@dof.virginia.gov)

### Additional Information

The study was conducted with funding from the Virginia Department of Forestry. More information on the UTC assessment project can be found at the following web sites:  
[http://www.cnr.vt.edu/gep/VA\\_UTC.html](http://www.cnr.vt.edu/gep/VA_UTC.html)  
<http://nrs.fs.fed.us/urban/utc/>



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