V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Natural Resources, Environment, and Climate Change

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	10%	0%	30%	0%
111	Conservation and Efficient Use of Water	5%	0%	5%	0%
112	Watershed Protection and Management	15%	15%	20%	0%
123	Management and Sustainability of Forest Resources	20%	30%	15%	0%
124	Urban Forestry	5%	15%	5%	0%
125	Agroforestry	0%	15%	0%	0%
131	Alternative Uses of Land	15%	15%	0%	0%
133	Pollution Prevention and Mitigation	5%	0%	0%	100%
135	Aquatic and Terrestrial Wildlife	8%	0%	10%	0%
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals	0%	0%	5%	0%
403	Waste Disposal, Recycling, and Reuse	10%	0%	0%	0%
605	Natural Resource and Environmental Economics	7%	10%	10%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	20.5	1.0	22.6	0.0
Actual Paid Professional	34.6	1.3	49.3	1.0
Actual Volunteer	14390.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1072975	292381	803607	265319
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1123650	420536	2116315	303035
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
2729396	901984	10924327	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Primary outputs from this program include the following: developing and delivering educational programs such as short courses, workshops, field days and tours, seminars, conducting applied research and link with extension, develop and maintain demonstration areas, developing collaborative partnerships with government officials, state agencies, non-governmental organizations, developing and disseminating educational materials such as extension bulletins, journal articles, conference proceedings, webinars, trade journal articles, DVD's, and developing and maintaining web based educational materials such as short courses, web sites, discussion boards.

2. Brief description of the target audience

Farmers, forest owners, loggers, Christmas tree growers, youth, homeowners, mill owners and workers, private consultants and companies, local **and national** governmental officials, **scientists and extension educators,** private landowners, waste water treatment operators, state and federal agencies, nongovernmental organizations, professional associations and societies, and community groups.

3. How was eXtension used?

The program has three Extension efforts.

1. Forest Farming eXtension Community of Practice - This project uses eXtension to create a national virtual community to synthesize and deliver synchronous and asynchronous forest farming educational programs, encourage and inform forest farming initiatives, compile comprehensive forest farming data, incorporate cutting-edge technology, and equitably address social and biophysical variability. eXtension's optimization metrics capture the community's characteristics, resources, behaviors, and activities.

2. Wood Products Community of Practice- Web site: http://www.extension.org/wood_products Description: The goal of the Wood Products CoP is to disseminate knowledge on the design, production, management, marketing, and environmental impact of wood products to small and large wood products manufacturers

3. Geospacial: Map@syst - Map@Systis a community of practice devoted to the outreach and education for geospatial technologies and their application to today's world. The Map@syst community provides information on using geospatial technologies and how geospatial technologies are making a difference in peoples' lives. may@syst is responsible for the Geospatial Technology resource area within eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	109382	116981	54214	2726

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	41	108	149

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of educational programs offered.

Year	Actual
2013	1712

Output #2

Output Measure

- Number of educational materials and curriculas developed

Year	Actual
2013	149

Output #3

Output Measure

- Number of applied research projects.

Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Acres of land exposed to educational programming efforts.

Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Identifiable impacts reported by agents/specialists

Year	Actual
2013	193

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased number of people adopting at least one new or improved land management practices.
2	Improved natural resource industries that contribute to community viability.
3	Number of participants learning about the quality of their private water supply and about private water system maintenance by participating in a county-based Virginia Household Drinking Water Program water testing clinic.
4	Increase in the number of individuals who gain knowledge as certified nutrient management planners in turf and landscape systems.
5	Increase in the number of acres covered by nutrient management plans in turf and landscape systems due to participation in Extension educational programs.
6	Increase in the tons of compost produced from organic wastes typically land-applied (manure, biosolids) or land-filled (yardwaste, biosolids, industrial sludge) as a result of increased knowledge and skills.
7	Increase in the number of people directly impacted by new or improved land management practices
8	Increased public awareness of climate change, biodiversity, and ecosystem services.
9	Increased number of stakeholders involved in community natural resource management and decision-making.
10	Increase program participants understanding of raw material conversion and modern business management practices.
11	The general public, landowners, and loggers use the forest in alternative and traditional ways to increase value and profit.
12	Increase in the number of acres directly impacted by new or improved land management practices.
13	Increase basic and applied knowledge relating to ecological processes and global climate change
14	Coupled Biochemical/Biophysical Systems to Remove Contaminants from Shallow Groundwater
15	Sequencing the Poison Ivy Transcriptome. In search of the blue print to itchiness.
16	Property Value Effects of Residential Stormwater Infrastructure
17	Salt Tolerance of Mycorrhizal Sorghum

Outcome #1

1. **Outcome Measures**

Increased number of people adopting at least one new or improved land management practices.

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Improved natural resource industries that contribute to community viability.

Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

Number of participants learning about the quality of their private water supply and about private water system maintenance by participating in a county-based Virginia Household Drinking Water Program water testing clinic.

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	8200

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Contrary to the perception of universal access to safe drinking water supplies in the United States, notable struggles to provide access to healthy water remain, particularly among rural communities reliant on privately supplied drinking water systems (e.g. wells). Not surprisingly, as water quality in these systems is not regulated, a recent report by the Centers for Disease Control

noted that while the overall number of waterborne disease outbreaks is declining nationally, the proportion of outbreaks associated with privately supplied systems has increased recently and is of serious concern.

The average person uses as much as 100 gallons of water a day. Imagine having to regularly test water quality and maintain your own water system.

Nearly one quarter (22%) of Virginia's population (1.7 million people) rely on private water supply systems, such as wells, springs and cisterns, for their household water. The majority of households in 60 of Virginia's 95 counties rely on private water systems. In the US, public water supplies are regulated under the Safe Drinking Water Act by the Environmental Protection Agency, which mandates regular testing and water treatment. Homeowners who use private water supplies are completely responsible for routine testing, system maintenance and addressing any water quality problems, should they exist. Lack of knowledge about private water supply management and water quality issues may lead to system neglect and a lack of regular water testing, which can have serious implications for water quality, longevity of the water supply system, and, ultimately, the health and safety of the families who rely on these systems.

What has been done

The Virginia Household Water Quality Program conducted by Virginia Cooperative Extension works to improve the water quality and health of Virginians with private water supplies such as wells, springs, and cisterns. Drinking water clinics are held across the state to give people with private water systems access to affordable water testing, help interpret their test results, and provide the resources to address problems, if needed.

The goal is to provide Virginians reliant on wells and springs with objective information about their water quality and the care and maintenance of their water systems. The program empowers them to be better-informed consumers and better able to make good decisions when it comes to regular testing, water treatment, and system care, and ultimately, protect their health and property values.

Clinics begin with an introduction to household water system care. Key points are water quality risk factors and proper maintenance. Extension agents then train participants to collect their own water samples with provided testing kits. After participants collect their water samples, the samples are taken tested. An interpretation meeting is held to review each participant's results with them.

Results

Since 2008, Extension has conducted 63 drinking water clinics with participants from 81 Virginia counties and tested water samples for about 8,200 people. Twenty-one drinking water clinics serving 27 counties were held in 2013. Eleven counties received funding from a USDA-Rural Health and Safety Education grant. About 1,270 private water supply systems were tested, which provide water for 2800 Virginians. Over 80% of clinic participants reported they have never tested their water, or tested only once before. Statewide, almost half (44%) of all samples did not meet the EPA standard for public systems for total coliform bacteria, and 9% didn't meet the standards for E. coli. One-fifth of samples exceeded the recommended level for lead in first draw samples. An evaluation is conducted immediately after the clinic to find out what actions, if any, participants plan to take in the following year. In 2013, results of a follow-up phone survey comprised of 500 people who participated in clinics between 2009 and 2011 (RR=30%). These results showed that people were actually more likely to take action than they indicated in the post-clinic surveys. According to the phone survey data, 70% of respondents took some action and 64% took more

than one action. Specifically, 38% sought additional testing, 52% pumped out septic tank, 34% performed maintenance on well, 36% shock-chlorinated their well, and 34% purchased water treatment equipment or improved function of existing equipment. It is estimated that if 9% of the private wells were contaminated and these families needed to purchase bottle water to avoiding health and safety concerns it would over $200M/yr to replace their water. These are conservative estimates assuming the 153,000 people consumer 1.5 L/day and the cost of bottle water was $2.50/L. If these private sources of water had to connect to public sources or new systems developed, the cost would be much more. By using effective treatment and management strategies the program participant are developing safer, efficient and cost effective water systems.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #4

1. Outcome Measures

Increase in the number of individuals who gain knowledge as certified nutrient management planners in turf and landscape systems.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Increase in the number of acres covered by nutrient management plans in turf and landscape systems due to participation in Extension educational programs.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Increase in the tons of compost produced from organic wastes typically land-applied (manure, biosolids) or land-filled (yardwaste, biosolids, industrial sludge) as a result of increased knowledge and skills.

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Increase in the number of people directly impacted by new or improved land management practices

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Forestland owners 65 years and older own 41% of Virginia's 10 million acres of private forestland. High land values and taxes cause many heirs to sell land to meet financial obligations; a major force behind an annual loss of 27,000 forested acres. Virginia is on the cusp of the largest inter-generational transfer of family forests ever and landowners need to know how to protect their land. A common barrier to estate planning is using planning tools and having confidence in knowing where to start.

What has been done
To generate awareness of this issue, previous landowner programs have included brief conservation planning sessions and mass media informed the general public. Focusing on Land Transfer to Generation 'NEXT', a 12-hour in-depth short course, was piloted. Program design draws from national curricula and local experts to initiate participant planning. Four short courses have been delivered throughout the Northern District. One hundred sixteen individuals representing 63 family units have completed the course which utilizes the expertise of private legal and financial professionals, conservation specialists and extension agents.

Results
Following short-course participation, landowners can better articulate their land transfer goals and have begun planning. Participants indicated the program would increase the likelihood of their property staying in the family (84 %) and staying in woodland (74 %). Follow-up surveys reveal that in the 6 months following the short-course, over 77% have begun estate planning. Participants estimate an average family savings of $625,000 as a result of this program. As these landowners continue executing their plans, nearly 47,000 acres of land is expected to remain open and family owned. The program has been recognized as one of the most successful land-transition programs by Virginia Department of Agriculture and Consumer Services and fellow

educators have adopted this model.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
124	Urban Forestry
131	Alternative Uses of Land
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
403	Waste Disposal, Recycling, and Reuse

Outcome #8

1. Outcome Measures

Increased public awareness of climate change, biodiversity, and ecosystem services.

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Increased number of stakeholders involved in community natural resource management and decision-making.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Threats to Virginia's forests, waterways, and wildlife have raised concerns about conservation and management of natural resources. Public involvement can expand natural resource agencies' ability to complete more projects that maintain, restore, and monitor natural resources and to educate adults and youth about the natural world. The Virginia Master Naturalist Program is a statewide corps of volunteers providing education, outreach, and service dedicated to the beneficial management of natural resources and natural areas within their communities. Every year, interested Virginians become Master Naturalists through training and volunteer service.

What has been done

The Virginia Master Naturalist (VMN) program, a corps of trained volunteers, provides education, outreach, and service to better manage natural resources and natural areas in Virginia. Volunteer training includes a minimum of 40 hours of classroom and field time in ecology, natural resource management, basic natural history of the animals and plants of Virginia, and skills for teaching and field research. There are currently 29 chapters located throughout the state. An additional 8 hours of advanced training and 40 hours of volunteer service are also required to become certified or re-certified. Volunteer service hours are recorded in four primary areas: education, stewardship, citizen science, and administration. In 2013, the Central Blue Ridge Chapter (MNP-CBR), expanded membership to 36 members by conducting a training series in 2013. Each year members provide volunteer time to better educate the public in wildlife and natural resource conservation.

Results

These volunteers have received 16,211 hours in advanced training. They have also contributed significant volunteer time in the areas of education (20,148 hours), citizen science (24,873 hours), stewardship (20,602 hours), and chapter administration (16,146 hours). These hours amount to $2,014,788 based on the monetary value of volunteer time from the Virginia Employment Commission. Since the program's inception in 2006, these volunteers have contributed 396,300 hours of service with a value of $8,977,388 to the Commonwealth of Virginia. As an example of a local chapter, the MNP-CBR provided instruction to 11 trainees. Eight projects were highlighted by the Chapter. The training alone was made possible by the volunteer efforts of 22 people who together gave 675 hours of community service. Project work by the current 36 MNP volunteers accounts for 1155 hours of community service. Statewide, the MNP has 2,029 members (i.e., individuals that have taken the basic training course and have paid annual dues) and 1,207 active members (i.e., individuals that have taken the basic training course, paid annual dues, and submitted volunteer hours). Our volunteers have received 16,211 hours in advanced training. They have also contributed significant volunteer time in the areas of education (20,148 hours), citizen science (24,873 hours), stewardship (20,602 hours), and chapter administration (16,146 hours). These hours amount to $2,014,788 based on the 2012 monetary value of volunteer time from the Virginia Employment Commission (2013 value not released until April 2014).

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
124	Urban Forestry

Outcome #10

1. Outcome Measures

Increase program participants understanding of raw material conversion and modern business management practices.

Not Reporting on this Outcome Measure

Outcome #11

1. Outcome Measures

The general public, landowners, and loggers use the forest in alternative and traditional ways to increase value and profit.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Forests are Virginia's primary land cover. Because 68% of the Commonwealth's forests are privately owned, private forest landowners (PFLs) are an important link to meet the Commonwealth's goal that Virginia's natural resources will be enhanced. Regionally, private forestland stewardship is a priority issue in the Northern District Forestry and Natural Resources Situation Analysis. Extension's Northern District holds 3.5 million acres of these woodlands. Traditionally, PFLs have been difficult to reach because of their sheer numbers and short ownership tenure. As land continues to be sold and divided into smaller pieces, forestland ownership is turning over. On average, a given piece of woodland will have a new owner every seven years or less. As a result, there is a continual need to educate new landowners and acquaint them with professional assistance availability. Research into landowner decision making highlights the importance of planning, professional assistance and peer influence to increase stewardship while meeting society's demands.

What has been done

A variety of educational offerings provide forest landowners with learning and networking opportunities. Annual Landowners' Woods & Wildlife Conferences and Forestry and Wildlife Bus Tours showcase good management practices and connect landowners with local natural resource professionals. Peer-to-peer learning is facilitated through the Piedmont Landowners Association (PLA), a volunteer lead association that offers monthly educational and networking opportunities. Additional outreach targets forest landowners through online and printed media such as the On-line Woodland Options Course.

Results

An average of 500 landowners, representing approximately 20,000 forested acres, participates in at least one educational offering each year. Participants of management related programs indicated an increase in knowledge and an intention to put practices into place. Follow-up evaluations reveal various implementations such as, completed management plans, controlled invasive plants, improved wildlife habitat and conducted successful timber sales. Approximately 30% of program participants contact a natural resource professional following educational events. One landowner, following recommendations from class, increased the value of his timbersale 150% from $20,000 to $50,000. Due to rapid turnover of landowners in the region, the task of educating landowners is insurmountable through traditional means. The PLA functions as a networking hub and regular education venue for landowners to enhance the management of their land to achieve economic and environmental goals. Average attendance to the monthly meeting included 15 individuals from Rappahannock, Culpeper, Orange, Madison and Greene Counties. The formation of this group has spawned leadership growth in the current and past president who have effectively advocated for forestry interests at the local and regional level. Members have also begun volunteering for Extension Programs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land
403	Waste Disposal, Recycling, and Reuse

Outcome #12

1. Outcome Measures

Increase in the number of acres directly impacted by new or improved land management practices.

Not Reporting on this Outcome Measure

Outcome #13

1. Outcome Measures

Increase basic and applied knowledge relating to ecological processes and global climate change

Not Reporting on this Outcome Measure

Outcome #14

1. Outcome Measures

Coupled Biochemical/Biophysical Systems to Remove Contaminants from Shallow Groundwater

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Denitrifying bioreactors are an emerging technology for nitrogen attenuation that function by supporting ubiquitous soil denitrifiers. Although successful nitrogen removal has been observed in these field scale systems, the majority of studies do not measure denitrification directly. With the lack of data, incomplete denitrification resulting in nitrous oxide emission has been recognized as a potential drawback to implementation. The goal of this research is to optimize complete denitrification while minimizing green house gas emission. Denitrification is quantified and the ratio of the products is compared to environmental factors and carbon media treatment to elucidate design principles for more effective bioreactors.

What has been done
We have developed and demonstrated enhanced nutrient removal (via denitrification, P precipitation and sorption) from several nutrient reduction systems already installed on the Coastal Plain of VA and MD. Intensive agricultural activity on productive Coastal Plain soils can elevate N and P concentrations in groundwater. Indeed, we have consistently measured NO3 levels > 20 mg L-1 and P levels > 2.5 mg L-1, both of which are well above the environmental threshold for eutrophication in surface water. The systems we have developed and demonstrated function under a variety hydro-climatic conditions and influent concentrations and require

relatively little maintenance, making them ideally suited for remediation of diffuse nutrients. Additionally, the limited footprints of these systems remove little agricultural land from production and thus might be more palatable to producers than other nutrient reduction strategies.

Results
The overarching goal of the proposed work is to apply original research improve the health of water resources, with a particular focus on the Chesapeake Bay, by contributing to the development of denitrifying bioreactors that can be implemented strategically within the watershed as highly cost effective component of a broader management scheme to mitigate nonpoint source pollution. Contribution to routine analysis of dissolved gas profiles, employed here to quantify denitrification, and may prove valuable to many aspects of water resources research including nutrient cycling, microbial processes, and characterization of groundwater. Specific results of the project include:
1) 6 installed biofilters/bioreactors, which have allowed us to quantify N reductions as high as 90% and P reductions of up to 60%
2) A novel method to quantify denitrification products, including harmful greenhouse gases.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management

Outcome #15

1. Outcome Measures

Sequencing the Poison Ivy Transcriptome. In search of the blue print to itchiness.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Poison ivy is a native noxious plant common across the eastern United States. Most people whose skin comes into contact with any part of the poison ivy plant develop swollen, itching,

blistering, and oozing skin rashes that last for several weeks. Poison ivy grows well in forests, grasslands, and managed landscapes. Moreover, it was shown that in response to increased carbon dioxide levels poison ivy grows faster, produces more biomass, and makes even more toxic forms of the rash-inducing urushiol. Although the chemical structure of urushiol has been known for decades, there are astonishingly few details about urushiol metabolism in poison ivy. However, more detailed knowledge about urushiol biosynthesis in poison ivy might lead to novel strategies for decreasing urushiol levels in poison ivy populations.

What has been done

Researchers at Virginia Tech is researching various aspects poison ivy molecular biology and chemical ecology. The advent of Next Generation DNA sequencing (NextGen) technologies provide new opportunities to determine the genetic blue prints encoding the metabolic machinery of any living organism. To this end, we took poison ivy seeds and germinated plants that were free from all microbes and extracted out the genetic material (i.e. blue prints?) encoding all the metabolic machinery in poison ivy leaves. Using NextGen DNA sequencing technologies the isolated poison ivy genetic material was translated into digital information that is read by computers to establish the genetic blue prints (genes) responsible for producing all the proteins and enzymes produced in the poison ivy leaves, so called transcriptome. This work was supported by a joint grant from the Virginia Bioinformatics Institutes and Fralin Life Sciences Institutes to the Jelesko lab. Now that we have all the metabolic genes expressed in poison ivy leaves, it is a matter of narrowing the search down to the handful of genes that are the blue prints for making the metabolic machinery responsible for producing urushiol.

Results

A total of 83,165 different protein coding sequences were identified in the poison ivy leaf transcriptome. This number represents not only all the expressed genes, but also includes multiple versions of many genes (e.g. different alleles and gene splice variants). This new knowledge about poison ivy transcriptome is an unprecedented resource for investigating the molecular biology and regulation of urushiol production in poison ivy. By understanding how urushiol is produced in poison ivy, we can begin to develop novel approaches to reduce or stop urushiol production as a means of mitigating the negative impacts of this noxious plant that is expected to become more invasive and more toxic during future climate change.

4. Associated Knowledge Areas

KA Code	Knowledge Area
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals

Outcome #16

1. Outcome Measures

Property Value Effects of Residential Stormwater Infrastructure

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In many areas of the country, urban storm water runoff is a growing water quality problem. To improve storm water programs, regulatory officials are now placing greater emphasis on reducing the volume of runoff. Called green infrastructure or low-impact development, storm water control is increasingly focused on reducing the amount of urban impervious land cover and using vegetative conveyance systems and infiltration areas to reduce negative environmental impacts. While many green infrastructure practices reduce capital infrastructure costs, less is known about the opportunity costs and pecuniary benefits to developers from implementation of green infrastructure to reduce storm water effects.

What has been done
Our research looked at a hedonic property-value model of residential property sale prices regressed on property and location characteristics, which include differing infrastructure design features that affect storm water runoff (street widths, cul-de-sacs, curb and-gutters). The data include 1,360 single-family property transactions in Hanover County, Virginia that occurred in 1995 and 1996.

Results
Results suggest that prohibiting curb-and-gutters and cul-de-sacs would impose an opportunity cost on developers; buyers are willing to pay 1.3 and 7.8% property-price premiums for homes located on a street with a cul-de-sac and curb-and-gutters, respectively. Constructing narrower streets would provide a pecuniary benefit to developers because people would pay approximately 3.5% more for these properties.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

Outcome #17

1. Outcome Measures

Salt Tolerance of Mycorrhizal Sorghum

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Sorghum an important crop, especially in countries of the semiarid tropics of Asia and Africa where it is being used both as a cash crop and staple food source. In 2010, world-wide production of sorghum exceeded 556 million tons; the United States ranked first by producing 9.7 million tons. Other producers including Nigeria, India, Sudan, Ethiopia, Australia Brazil, China (in total 15 counties) produced a substantial amount of sorghum. Although the U.S. exports most of its sorghum, many developing counties consume all of theirs internally. Sorghum is used for making bread, porridge, syrup, cake, cuscus, tortilla, cereal, etc.; and most recently the US is exploring its value as a source of green energy for the production of gasohol. There is great potential for farmers in southeast Virginia to invest in sorghum production both for human consumption (as a gluten-free crop) and forage for animals as well as for the production of syrup and gasohol.

What has been done
At Randolph farm, Virginia State University scientists have been exploring the possible interaction between soil fungi and sorghum plants which could benefit sorghum by helping it adapt to dry and salty environments. The interaction produces a ?fungus-root? mass termed mycorrhizae; which defines the symbiotic relationship that forms between specific fungus and plant species. It is a natural process whereby both parties benefit without causing harm to each other. In this case, the fungus-root system helps the sorghum plant absorb more nutrients and water by increasing the surface area of the root, while the fungus benefits from the sugar that the sorghum plant provides through photosynthesis.

Results
Both greenhouse and field studies conducted at Randolph Farm indicated that mycorrhizae does form in sorghum plants, which helped sorghum to tolerates salt concentrations up to 200 mg/L. In fact, low level of salt (80 ppm) had stimulating effect in sorghum growth regardless of inoculation. Demonstration plots in the field also indicated better growth and yield in mycorrhizal than in non-

mycorrhizal sorghum.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

The business income and natural resource management derived could be affected by natural disasters, changes in the economy, government regulations and public policy changes. The number of acres of land subject to best management practices/conservation plans affected by government regulations and changes in the economy. If greater emphasis is placed on water and environmental quality then even more widespread implementation of these practices will be encouraged. These factors may have immediate impact as they significantly influence items such as production economics, industry infrastructure, marketing systems, and consumer demand. Good economic conditions encourage consumption of value added products and enjoyment of the natural resources. In Virginia, increasing petroleum values in traditional businesses and logistics are a significant challenge. The recent increase in bioenergy production and anticipated future growth of this alternative fuel sources will likely have major impacts. Scope of such impacts is unknown, but anticipated direction has influenced this planned program.

Changes in global food production capacity, energy costs, and epidemic diseases could have unpredictable effects. All external factors affecting personal discretionary spending will affect the implementation of environmentally sound natural resources practices and the number of managers. Natural disasters may affect producers directly but also will affect and impacted natural resource managers. The general economy, public policy and governmental regulations impact production and sales of forestry products. Appropriations and competing programmatic challenges affect the dedication of personnel and programs to the described programs. Population changes affect supply and demand for forestry products.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The goal of the Virginia Household Water Quality Program (VAHWQP) is to improve the water quality and health of the 1.7 million Virginians who rely on private water supplies (wells, springs, and cisterns) for their household water. Many homeowners do not realize that routine testing and maintenance are required, and this lack of knowledge can harm the longevity of water systems, water quality, property values, health and safety of the families who rely on these systems, and ultimately the overall quality of the shared groundwater resource.

Through county VAHWQP drinking water clinics, homeowners collect their own water samples, which are analyzed on campus for 12 chemical and 2 bacteriological constituents. Approximately 4 weeks later, test reports are confidentially returned to participants during an interpretation meeting, where a trained extension agent delivers a presentation that explains the water test results and recommendations for maintenance of water systems and protection of water quality. Participants are provided with recommendations specific to their drinking water quality and system that they would not receive otherwise. Since December 2008, 71 drinking water clinics have been conducted across Virginia, testing water supplies serving over 9,100 people. Statewide, almost half (44%) of all samples did not meet the EPA standard for public systems for total coliform bacteria, and 9% didn't meet the standards for E. coli. One-fifth of samples exceeded the recommended level for lead in first draw samples. An evaluation is conducted immediately after the clinic to find out what actions, if any, participants plan to take in the following year. In 2013, we finalized the results of a follow-up phone survey with 500 people who participated in clinics between 2009 and 2011 (RR=30%) and found encouraging results. People were actually more likely to take action than they indicated in the post-clinic surveys. According to the phone survey data, 70% of respondents took some action and 64% took more than one action. Specifically, 38% sought additional water quality testing, 52% pumped out their septic tank (a potential source of bacterial pollution to the well if not maintained), 34% performed maintenance on well, 36% shock-chlorinated their well, and 34% purchased water treatment equipment or improved function of existing equipment. Eighty percent of participants indicated they would share what they learned as a result of participating in the VAHWQP drinking water clinic with others.

Key Items of Evaluation

In 2013, we finalized the results of a follow-up phone survey with 500 people who participated in clinics between 2009 and 2011 (RR=30%) and found encouraging results. People were actually more likely to take action than they indicated in the post-clinic surveys. According to the phone survey data, 70% of respondents took some action and 64% took more than one action. Specifically, 38% sought additional water quality testing, 52% pumped out their septic tank (a potential source of bacterial pollution to the well if not maintained), 34% performed maintenance on well, 36% shock-chlorinated their well, and 34% purchased water treatment equipment or improved function of existing equipment. Eighty percent of participants indicated they would share what they learned as a result of participating in the VAHWQP drinking water clinic with others.