CHAPTER I

INTRODUCTION

During the last decade, the United States has witnessed tremendous growth in watershed management as a means to a more holistic approach to addressing aquatic resources protection and restoration. In part, the development of watershed management stems from the recognition that earlier water resource programs, which focused on reducing point source pollution, has been unsuccessful at meeting the goals of the 1972 Clean Water Act. Current programs have attempted to improve the process by developing holistic approaches at a watershed level. Today, many federal and state programs support the development of watershed planning and management efforts. Watershed management is achieved through public and private parties collaboratively engaged for the purpose of protecting and restoring a particular water-body and the surrounding land from which water drains into it, the watershed.

Many challenges are associated with developing and implementing watershed management programs. One challenge is that these programs are resource intensive, requiring significant funds to support the multi-faceted activities. In addition, these programs require knowledgeable and skilled water resource professionals who are capable of implementing the technical tasks involved in these activities.

A university can be a valuable resource in watershed management activities. Faculty, students, and in-kind university support can contribute knowledge, technical support, research funds, and personnel to aid and enhance watershed management activities.

OBJECTIVE

The goals of this paper is to explore the integration of service-learning in higher education within watershed management activities and whether service-learning can provide a template through which citizen monitoring models can be developed and implemented elsewhere. This paper is expected to:

1. Exemplify how service-learning programs can be developed and implemented towards watershed applications;
2. Illustrate ways to improve and sustain watershed-based, service-learning programs; and
3. Demonstrate how service-learning programs in watershed applications can meet the needs of today's society while developing future environmental planners, policy makers, and science professionals.

This chapter discusses the issues associated with our nation's water resources and the need to work at a watershed level. The second chapter expands on the understanding of service-learning and looks at the potential benefits of service-learning from both the university and community points of view. The third chapter describes the Stroubles Creek Watershed Initiative, a recent and on-going service-learning project at Virginia Polytechnic Institute and State University (Virginia Tech). The fourth chapter presents the lessons learned from the Initiative. A summary of the paper is provided in chapter five. These chapters combined will show the potential role of service-learning in watershed management activities and the benefits it holds for improving our nation's watersheds, enhancing university and community partnerships, strengthening university research, and enriching education and outreach programs.

THE WATERSHED PROTECTION APPROACH

The United States has witnessed significant progress in improving our nation's water quality over the course of the last quarter century. This success has been achieved primarily through federal, state, and local regulations of point source discharges. Command and control programs established across the nation have reduced the amount of point source pollution entering lakes, rivers, wetlands, estuaries, coastal waters, and ground water. Although these regulatory programs have improved the nation's water quality, serious water pollution problems still persist throughout the country. A 1994 national water quality inventory reported that 40 percent of the surveyed water in the U.S. remains below water quality standards, degrading the quality of our water resources, reducing recreational opportunities, lowering economic prosperity, and threatening drinking water supplies. The report noted that the leading causes of poor water quality found in the survey were pollution from excess sediment, sewage, disease-causing bacteria, fertilizer, toxic metals, and oil/grease in the water (EPA, 1994). These forms of pollution are caused by the cumulative effect of urban, agricultural, and other forms of runoffs not readily identified or captured at a particular point source. This nonpoint source pollution is believed to be developing around the edges of government regulations, where federal policies and statutes are unable to reach (Randolph and Bauer, 1999).

During the last decade, consensus among policy makers began to grow in support for new and innovated programs in water resource management. In response, the U.S. Environmental Protection Agency (EPA) embraced the Watershed Protection Approach (WPA) in 1991 as a new method for protecting and preservation of our nation's water resources. The idea behind the WPA is to develop a water resource management framework that focuses on many water quality and ecosystem problems at a watershed level rather than at the point source or discharge level (EPA, 2002). Watershed in this context is the area of land whereby all the water (both surface and ground water) that drains off it runs to a specific point on a watercourse, usually a confluence of stream or river.

The WPA is recognized as a multidisciplinary and multi-jurisdictional approach that tackles water quality problems through a mix of environmental policies and non-regulatory programs. It reflects the joint efforts of both the public and private sectors to address the issues surrounding their watershed and their community. The WPA promotes ecosystem management with a vision on collaborative watershed management (EPA, 2002).

Since the advent of the WPA, a rippling effect on watershed management has occurred. During the past decade, the United States has witnessed significant growth in the number of watershed management initiatives as means to a more holistic approach to addressing aquatic resource protection and restoration. Today, many federal and state programs and many local and regional communities support the development of watershed management and planning efforts.

CHALLENGES IN WATERSHED MANAGEMENT

The desire by many communities to implement watershed management initiatives has become more than just a need, rather a necessity for ensuring watershed protection across the nation. However, many challenges arise when developing and sustaining watershed management programs. Imperial (1997) describes three challenges associated with developing and implementing watershed management initiatives. First, he states that watershed programs are resource intensive. Such programs require significant funds to support monitoring, surveying, conducting research, developing geographic information systems and other computer models, providing public outreach, and effective management activities. In addition, these programs require knowledgeable and skilled water resource professionals that can implement and manage those tasks.

Watershed programs and activities also require significant data and information. Often, the data needed are widely dispersed, too expensive to obtain, or in some cases, nonexistent. Data that must be gathered are often associated with a high price and require significant time. As a result, disagreements arise among the players involved in the program when determining different priorities and the scope of the project.

Determining the scope of watershed management efforts is the second challenge presented by Imperial (1997). He suggests that a watershed program "*must be a close fit between the geographic scope of the watershed and the problems being addressed*." Determining the scale of a multi-jurisdictional and multidisciplinary project will require working across administrative and political boundaries.

This requirement leads to the third challenge Imperial states - collaboration. Watershed management initiatives are based on the concept of coordinating, communicating, and partnering among multi-disciplined players to achieve shared goals and objectives. As a result, programs will benefit from a team approach that relies on collaborative decision-making. However, this can be difficult if the participants lack the flexibility to negotiate and parties view compromising "as watering down" their organization's mission.

Current programs are recognizing these challenges and are looking at new innovative ways to address these issues. In recent years, there has been a growing interest and support to increase the role of university and colleges in community-based watershed management applications. The integration of a university in collaboration with watershed stakeholders (the community) can be a valuable resource in watershed management programs. In general, faculty, students, and in-kind university support can contribute knowledge, technical support, research funds, and personnel to aid and enhance watershed management activities. These watershed activities can range from environmental planning, policy development, to scientific research. In addition to meeting the social needs, integrating university in watershed activities has the potential to develop future environmental planners, policy makers, and scientists.

Lewicki and Younos (2001) suggest that promoting a "*university-community partnership can be a win-win situation for the university and the public*." They pose that "*the partnership provides a service-learning environment that strengthens the university's research, education and outreach programs, makes the university's programs more relevant to real life issues…[while] significant improvements in the health of our nation's watersheds and the public's health can be expected*."

The following chapters expand on the concept of service-learning and describe the potential benefits of service-learning both from the university and community point of view. In addition, lessons from a case study service-learning program called the Stroubles Creek Watershed Initiative are presented in this paper.

CHAPTER II

THE MEANING OF SERVICE-LEARNING

Many terms have been used to describe the experiential nature of service-learning. These terms range from collaborative learning, community-based education, cooperative education, experiential education, field experiences, to internships (O'Grady, 2000). Furthermore, the meaning of service-learning in higher education may vary depending if the context of the activity is educational, philosophy, or political. It may also depend on whether the activity is dealing with social justice and social change or by the way a university engages with the community (Crews, 2002).

Defining service-learning has been a daunting task, one that has been debated for decades. In recent years, a group of service-learning educators formed the Alliance for Service-Learning in Education Reform (ASLER) in effort to solve this dispute. In 1993, the ASLER came up with the following definition (Wade, 2000):

> *"Service-learning is a method by which young people learn and develop through active participation in thoughtfully-organized service experiences that meet actual community needs, that are coordinated in collaboration with the school and community, that are integrated into each young person's academic curriculum, that provide structured time for a young person to think, talk, and write about what he/she did and saw during the actual service activity, that provide young people with opportunities to use newly acquired academic skills and knowledge in real life situations in their own communities, that enhance what is taught in the school by extending student learning beyond the classroom, and that help to foster the development of a sense of caring for others."*

This definition narrows the application of service-learning to practices that integrates a structured curricular concept and service activity in the experiential experience.

Similar to the definition of the ASLER is the definition used in the National Service Act of 1993 that describes service-learning as a method (O'Grady, 2000):

- *"Under which Students learn and develop through active participation in thoughtfully organized service experiences that meet actual community needs and that are coordinated in collaboration with the school and the community;*
- *That is integrated into the student's academic curriculum or provides structured time for student to think, talk, or write about what the student did and saw during the actual service activity;*
- *That provides students with opportunities to use newly acquired skills and knowledge in real-life situations in their own communities; and*
- *That enhances what is taught in school by extending students' learning beyond the curriculum and into the community and helps to foster the development of a sense of caring for others."*

The significant difference between this definition and the ASLER can be found in the second bullet given above. In the National Service Act of 1993 version, service-learning is described as a method that could be integrated in the academic curriculum *or* that are structured to provide time to think, talk, and write about the service activity (reflection). However, according to the ASLER definition, a true service-learning experience is one that is curriculum-based and provides opportunity for reflection.

The meaning of service-learning that's applied in this document is based on the definition of the National Service Act of 1993. In addition, service-learning in this context reflects the definition used by the Service-Learning Center at Virginia Tech.

Three criteria are used as the bases for defining service-learning at Virginia Tech (James-Deramo, 2002):

1) Students are serving from a disciplinary based of knowledge;
2) Students are increasing their knowledge base through the service experience; and
3) Students are engaging in critical reflection on their service experience

In general, these three definitions highlight four common themes: working with the community, providing opportunity for reflection, fostering active learning, and developing a sense of civic responsibility.

Service-learning is different from many other educational endeavors in that it combines community service with academic learning. In addition, the hyphen used in the phrase symbolizes the central role of reflection in the process of learning through experience (Eyler and Giles, 1999). This form of learning and pedagogy is rooted on experiential education, one that cannot happen within the confines of a classroom, a discipline, or a campus. It involves a strong partnership between an institution and community that enables students to apply their experiences and what they have learned in the classroom to practical problems within the community. Service-learning prepares students to work within a multicultural, dynamic, and demanding environment found within a community. Heffernan from the National Campus Compact states (2001): "*service-learning is premised on experiential education as the foundation for intellectual, moral, and civic growth. This focus on the synergy of the intellectual, moral, and civic dimensions of learning distinguishes service-learning from other forms of experiential education.*" As such, service-learning complements and enhances the knowledge learned from a more traditional teaching and learning environment found in academe with personal experiences derived from a community-based service activity. This form of learning and pedagogy has been found to significantly enrich both the student and faculty (Jacoby and Associate, 1996). Heffernan (2001) indicates that the unpredicted environment of service-learning creates a more authentic learning environment, challenging students and faculty on many levels as it engages in multiple issues of equity, difference, inclusion, access, justice, and power.

SERVICE-LEARNING IN HIGHER EDUCATION

Community service has been a major endeavor of many higher education institutions. Many types of community services through voluntary activities have been found in universities across the nation. These voluntary activities have been included in programs associated with organizations such as the YMCA, 4-H Club, varied campus ministry initiatives, and many Greek-letter societies (Jacoby and Associates, 1996). These programs have played an important role in developing voluntary activities for students and promoting university and community partnership. Such programs have been found to be important because they promote voluntary activities, encourages student leadership development, and support a flexible framework that enables students to follow their own field of interest while working at their own set time (Bridgle, Games, and Malloy, 1999). However, while such programs have played an important role in developing voluntary activities, they contain several shortcomings. Bridgle, Games, and Malloy (1999) point four limitations to this form of community service. First, the learning objectives of these extracurricular volunteering activities are often not clearly articulated nor evaluated. They have found that the learning objectives of these programs are not explicit. Second, these programs often do not keep a formal record of their activities. In most cases, students involved in such programs are able to note their work on their resume but are unable to support these work efforts with official documentations because they do not appear on the transcript of academic work. Third, these programs may not benefit from important institutional resources because they are seldom connected to faculty expertise and other university resources. Lastly, these voluntary activities are limited because they are not always coordinated with the institutional mission.

In contrast, service-learning overcomes some of the shortcomings of voluntary community service activities. The main difference lies in the idea that service-learning is more than serving the community. It instills a purpose of integrating service projects with a structured framework for students to reflect on their service experience or a structured curriculum that promotes student development and growth. As such, service-learning formally integrates community services with academic study. In doing so, service-learning creates a more authentic learning experience that explicitly articulates the learning objectives subject to evaluation, involves faculty and other campus resources in the projects, incorporates the institutional mission, and provides opportunity to represent the learning experiences on the course transcript.

BENEFITS OF INTEGRATING SERVICE-LEARNING

Service-learning has the potential to meet the academic goals of teaching and developing professional students while making inimitable contribution to addressing and solving community, national, and global needs. It is a win-win situation for both the university and the community. Jacoby and Associates (1996) cites several benefits that are frequently found in developing service-learning partnerships. Service-learning has been found to develop the student's habit of critical reflection; deepen their understanding of course content; build a bridge between theory with practice; bring insight to issues underlying social problems; increase their sense of social responsibility; enhance their cognitive, personal, and spiritual development; increase their awareness and understanding of human differences and commonality; and sharpen their abilities to solve problems creatively and to work collaboratively. Lewicki and Younos (2001) state that engaging the university body in service-learning will strengthen the university's research, enhance educational and outreach programs, and create a more authentic learning environment that makes the educational program more relevant to real-life issues.

Several studies have shown that integration of service-learning into academic teaching can benefit students and their learning in ways that other pedagogies do not. In a recent study, "How Service Learning Affects Students," Vogelgesag et al. (2000) found that participation in service had significant positive effects on 11 outcome measures used in the study: "*academic performance (GPA, writing skills, critical thinking skills), values (commitment to activism and to promoting racial understanding), self-efficacy, leadership (leadership activities, self-rated leadership ability, interpersonal skills), choice of a service career, and plans to participate in service after college.*" They found that service-learning adds significantly to the benefits associated to community service for 9 of the 11 outcome measures. In addition, they discovered that service-learning is effective, in part, because it increases the student's personal efficacy, awareness of the world, awareness of one's personal values, and improves the student's engagement in the classroom experience.

SERVICE-LEARNING IN WATERSHED MANAGEMENT

It is safe to say that higher education embraces a rich array of resources and that these resources hold tremendous potential to making significant positive difference in meeting the growing needs of our society. Historically, many institutions of higher education had a strong commitment to serving the community. This commitment is firmly embedded in mission and vision statements of many universities today. As an example, Virginia Tech instills a deep and vital commitment to serving the community through education. This is clearly written in their vision statement that states (Virginia Tech, 2002):

> *"We value the ability to educate the whole person. Through the undergraduate residential learning experience, students have opportunities for leadership and community service. They discover the value of responsibility, self-discipline, community service, and understanding of others. It exposes students to new cultures, social diversity, and new ways to see the world around them. We value heuristic education, which demands that students learn by doing in the classroom, on the job, or through service.*
>
> *However, if there is one attribute that distinguishes Virginia Tech from all but a few of the nation's thousands of higher education institutions, it is the interconnectedness - the interactivity - of the university to the society and constituencies it serves. Virginia Tech is not a citadel of cloistered learning. We believe that universities are most viable when*

> *they are interactive, when they reflect and respond to the problems and challenges of their societies."*

The responsibility of higher education to use its knowledge to further and serve the community is an honorable endeavor. However, between serving the community and educating the student body, institutions have a stronger commitment to educating the student body first. Jacoby and Associates (1996) imply that "*even though serving the community is perceived as a good thing, all good things cannot be the provinces of higher education*." In contrary to traditional community services, developing opportunities for student to engage in serving the community while learning through experience can meet the needs of both the university and the community. The application of service-learning, which has a purpose of integrating service projects with an academic foundation, fits far more clearly into higher education's mission and priorities than the traditional community service programs.

Although subject to political pressures and agendas, colleges and universities have the intellectual and professional resources to be actively engaged in addressing the community needs and issues. In recent years, consensus among water resource professionals have grown in support of integrating and further promoting service-learning programs into community-based watershed management initiatives. Higher education, with its leaders, students, faculty, and staff, can be a key force in watershed management initiatives. Lewincki (2001) states that watershed management activities and other community-based efforts have many and diverse needs for scientific knowledge and technical skills. These community needs can be fulfilled with the support and active involvement of faculty, students, and in-kind university support that can contribute their knowledge and technical expertise in watershed management activities.

In addition to helping the community, higher education can provide an innovative method that engages students in a learning environment that can fulfill the responsibility of educating while serving the community through service-learning. As such, service-learning has the ability to educate our future planning, policy, and science professionals while providing technical support and expertise to community-based watershed activities. As mentioned in the previous chapter, watershed management is a multidisciplinary and multi-jurisdictional approach that reflects the joint efforts of both the public and private sectors to address watershed issues through a collaborative approach. Incorporating university knowledge into community-based watershed activities could make a tremendous contribution to this collaborative effort while enriching educational programs and improving our nation's water resources.

CHAPTER III

THE STROUBLES CREEK WATERSHED INITIATIVE

This chapter describes the Stroubles Creek Watershed Initiative, a recent and ongoing service-learning program at Virginia Tech. The inspiration for developing the initiative came from many active stakeholders in the watershed who were implementing and developing projects for the purpose of monitoring and improving the health of the creek. These stakeholders conceived an idea of creating a central place and program in which projects related to the Stroubles Creek watershed could be housed and coordinated. In 1999, the Virginia Water Resources Research Center (VWRRC) in collaboration with the Service-Learning Center (S-L Center) at Virginia Tech launched the Stroubles Creek Watershed Initiative.

The VWRRC is Virginia's research institute devoted to basic and applied research related to water problems in the state. The VWRRC is also the administrator for the Virginia Service Training for Environmental Progress (STEP), a state-wide university-community partnership for service-learning (Walker et al., 2001). The Service-Learning Center, established in 1995, is the academic unit at Virginia Tech that provides logistical assistance, resource support and standards for best practice to academic curricula and students wanting to incorporate community service into their education mission (Service-Learning Center, 2002). The unique qualities between the VWRRC and the S-L Center have brought depth into the Initiative's mission by identifying ways to involve university faculty, students, and local K-12 students in the restoration and public education efforts of the Stroubles Creek. This partnership deliberately advances the formation of "Learning Communities" dedicated to community service, cross-disciplinary collaboration, and shared leadership among students, faculty, and community partners for the purpose of restoring Stroubles Creek. Learning Communities are defined here as environments that integrate intellectual, social and emotional learning experiences, and engage leaders in working together as a community toward a common goal (James-Deramo and Younos, 2001).

The overall goal of the Stroubles Creek Watershed Initiative is to use the Stroubles Creek watershed, several branches of the creek, and the Duck Pond on the Virginia Tech campus as a system for developing research, educational, outreach, and service-learning opportunities at Virginia Tech. The Initiative is intentionally designed to establish community partnerships among various interest groups within the watershed. This community partnership is expected to coordinate the watershed protection efforts. Current members of this partnership are listed in Appendix I.

The Stroubles Creek watershed is an ideal place for a service-learning program. The Initiative addresses true concerns and needs in the community while providing opportunities for students to learn and work in collaboration with the local community to address these needs. James-Deramo, director of the S-L Center, states that the Initiative clearly meets the three criteria for service-learning at Virginia Tech. James-Deramo (2002) expresses that "*in order to participate in the [Initiative] project, students must have an academic background that prepares them to engage in watershed management activities. Through their specific service activities, students also gain new insights on various aspects of natural resources as well as technical skills for working in the field. As project participants, either as wage or for-credit, the students are required to write about their activities, interact with community stakeholders, and present their findings in* *annual stakeholder summit meetings. These reflective activities thereby connect them--as learners, scientists, and citizens--to a broader community."* To date, 13 service-learners have participated in the Initiative. Of these 13 service-learners, three received credit for their work, three were on wage without receiving credit, and seven received credit and pay for their work with the Initiative.

In addition, the diverse watershed characteristics of Stroubles Creek provide a unique opportunity for interdisciplinary service-learning and research for both students and faculty members. A description of the Stroubles Creek watershed characteristics is given in the next section.

THE STROUBLES CREEK WATERSHED

The Stroubles Creek watershed (VAW-N22R) is a small sub-watershed (5,802 hectares or 14,336 acres) within the New River watershed in southwest Virginia. The headwaters of Stroubles Creek are natural springs that emerge on the northern part of the town of Blacksburg in Montgomery County, Virginia where the watershed is characterized by limestone/dolomite formations, sink holes, and natural springs (see Figure 1). The Stroubles Creek bed is alluvium—flood-plain deposits of stratified unconsolidated sand, silt, and clay with beds and lenses of pebbles and cobles (Sutton et al, 1993).

The 15-kilometer-long freshwater stream discharges into the New River after flowing through urban and urbanizing areas of Blacksburg, the university (Virginia Tech), and agricultural and rural areas (see Figure 1). Major land use changes have occurred within the watershed during the past one-hundred years, primarily residential and agricultural development. In 1900, the urban land use was insignificant; the town was a few square blocks, and the university consisted of a few buildings and experimental agricultural fields. From the mid 1800s to 1930s, deep coal mining was an active industry in the watershed. Currently the land use in the Stroubles Creek watershed is 40% forest, 29% agriculture, 19% urban, 0.24% water, and 12% unknown. One event of significant ecological consequence occurred in 1937 when the natural course of the central branch of Stroubles Creek was altered and partially covered (physical disturbance) in order to accommodate building a drill field on the Virginia Tech campus. At about the same time, a small dam was built to expand an existing small pond for recreational purposes. Currently, the Duck Pond is fed by the two major branches of

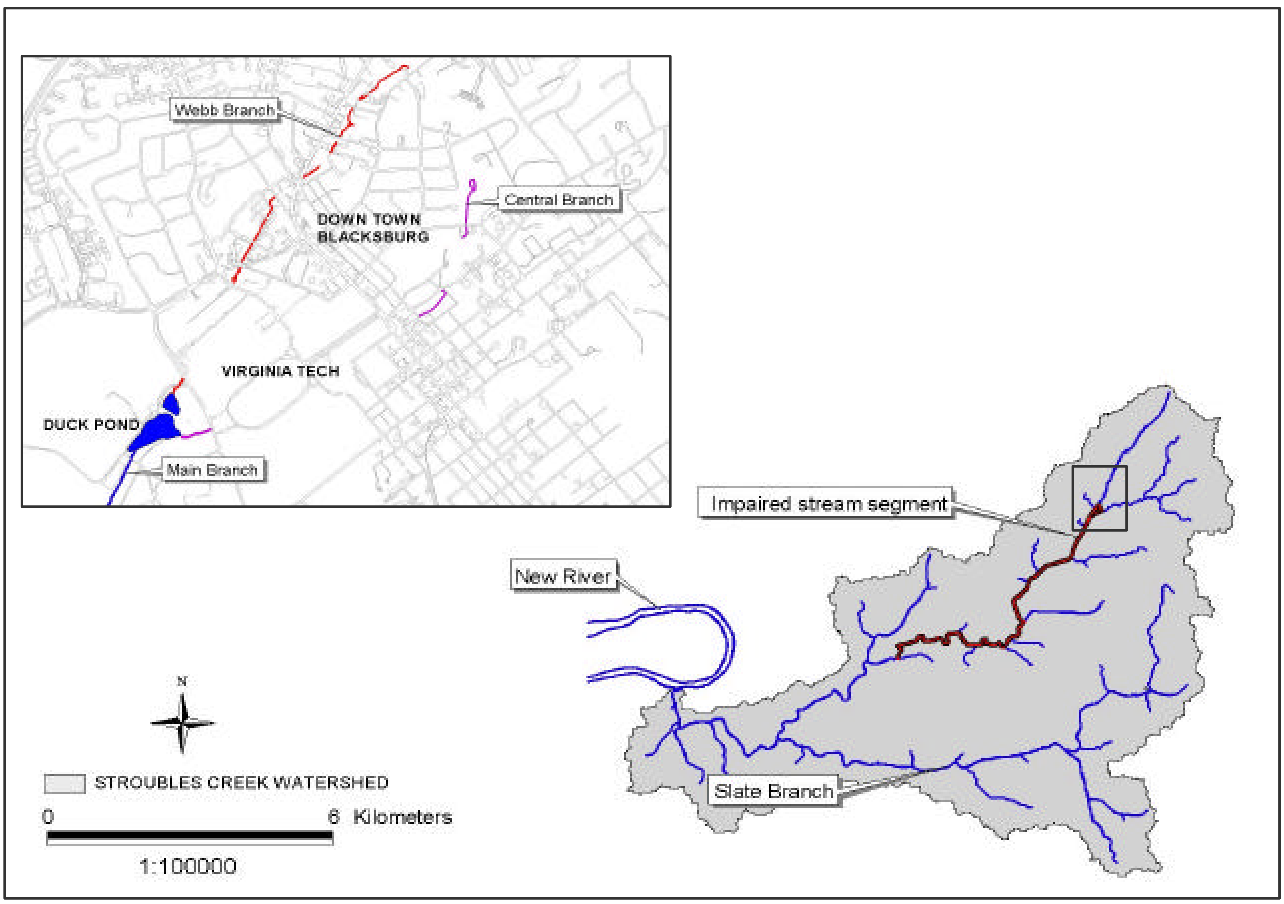


Figure 1. The Stroubles Creek Watershed

Stroubles Creek (see Figure 1). The pond serves as a stormwater management facility for urban runoff from the town of Blacksburg and parts of the university (de Leon and Younos, 2001).

In 1996, the Virginia Department of Environmental Quality (DEQ) conducted a general benthic survey of the Stroubles Creek. The survey identified a 7.84 km segment of the stream violating general benthic standards, including this segment of the creek in the 303(d) impaired water list (DEQ, 1998). Impaired waters are defined as those waters that do not fully support one or more designated uses. Designated uses in Virginia are swimming, fishing, drinking water supplies, and aquatic life. Benthic standards refer to the population and diversity of benthic macroinvertebrates in the stream. An abundant benthic population that is intolerable to pollution is desired for clean streams (de Leon and Younos, 2001). The impairment source in Stroubles Creek is speculated to be sediment and organic storm runoff from nearby agricultural fields and increasing urbanization of the upper portion of the watershed (see Table 1).

Table 1. Total Maximum Daily Load Priority Report for the Stroubles Creek, Virginia.

Impairment Cause:	**Impairment Source:**
General Standard (Benthic)	NPS - Urban/Agriculture
Moderate impact to the biota cause only partial attainment of aquatic life uses. The segment has moderate impact detected by biomonitoring station 9-STE006.69 (Rt. 659 Bridge). The AQM station at 9-STE002.41 (Rt. 659 Bridge near the Radford Army Ammunition Plant) showed two pH exceedances that may suggest possible affects on the benthic community.	The believed source is nonpoint source pollution from agricultural activity and increased urbanization of the upper portion of the watershed.

Source: DEQ, 1998

According to section 303 (d) of the Clean Water Act (CWA), Virginia is mandated to develop a Total Maximum Daily Load (TMDL) plan for impaired streams.

The TMDL plan aims to achieve water quality standards and to implement a stream restoration plan. As a first step, the VWRRC and S-L Center developed the Stroubles Creek Watershed Initiative. The Initiative creates an interdisciplinary program for university faculty and student in partnership with watershed stakeholders to study this watershed and propose restoration strategies.

SERVICE-LEARNING PROJECTS

The goals of the Stroubles Creek Watershed Initiative are to assess the health of the creek, prioritize restoration efforts, foster outreach programs, and facilitate collaboration among watershed stakeholders. Service-learning projects have been developed to meet the Initiative's goals. These projects include the Stroubles Creek Corridor Assessment (SCCA), the database management system, the website, the remote monitoring/data transfer, the urban fish survey, the Duck Pond water quality study, the citizen bulletin board, the SEEDS summer camp, the Stroubles Creek Watershed Stakeholder Summit, and the stakeholder survey. Each project has duration of one full semester to multiple semesters and has provided a blend of research and service work for both students and faculty. Service-learners (students) in each project are selected based on their interest and

Environmental science major, Stephanie Garman, takes a visual survey of the surrounding area of Stroubles Creek. Students from multiple departments participated as service-learners in the Initiative

coursework. Participant academic departments at Virginia Tech include the Urban Affairs and Planning, Environmental Science, Civil and Environmental Engineering, Computer Science, Forestry, Fisheries and Wildlife Sciences, and Biology. The VWRRC and the S-L Center provide the coordination of these projects.

Service-learning projects in which the author has been actively involved are described below. These projects include the Stroubles Creek Corridor Assessment (SCCA), database management system, Stakeholder Summit, website development, citizen bulletin board, and EEDS summer camp.

Stroubles Creek Corridor Assessment

The Stroubles Creek Corridor Assessment (SCCA) is a major component of the Initiative that began in the spring of 2000. It is a service-learning project carried out by students from Virginia Tech and volunteers from the local community. The SCCA is designed to serve both as a model for stream monitoring as well as a research and community outreach program in the watershed. The major goal of the SCCA is to use the program to monitor and document the health of Stroubles Creek and to aid the creek restoration efforts.

The survey area for the stream corridor assessment consisted of three sections within the Stroubles Creek watershed. The first two sections are the two major tributaries of the Stroubles Creek. Headwaters for these streams are springs that emerge within downtown Blacksburg. The two streams eventually converge into the Duck Pond at Virginia Tech (see box in Figure 1). The first tributary is called "Webb Branch". This segment runs along Giles Road and Webb Street, under Prices Fork Road, and below the commuter parking lot behind Burruss Hall (Virginia Tech) and enters the Duck Pond at the intersection of West Campus Drive and Duck Pond Drive near the Virginia Tech golf course. The second tributary is called "Central Branch." This segment emerges just south of Unkous Drive and runs under Owens Street, next to the Blacksburg Fire Station, under college avenue, the Donaldson Brown Hotel and Conference Center and under the Drill Field (Virginia Tech) where it eventually enters the Duck Pond near the amphitheater and the Grove (President's House). The third section is the main branch of Stroubles Creek (see Figure 1) that flows below the Duck Pond to the point where Stroubles Creek merges with Slate Brach (de Leon and Younos, 2001).

Two key components of the SCCA program are protocol design and service-learners. The SCCA Protocol used in this study is based on the concepts developed by the Maryland Department of Natural Resources (DNR) and U.S. Environmental Protection Agency's Volunteer Stream Monitoring program (Yetman, 2000; EPA, 1997). The designed protocols provide a credible stream assessment technique that supplements the information collected by state and local resource management or planning agencies in the Stroubles Creek watershed. The protocol includes three ecological assessment components: watershed characteristic survey, biological assessment, and physiochemical assessment.

Service-learners and volunteers are the second key component of the program. Students and volunteers who participated in the SCCA program came with a variety of experiences and educational backgrounds. College students from several disciplines including Environmental Science, Fisheries and Wildlife Sciences, Forestry, and Biology have been involved with the project. Most of these students have a strong understanding of stream ecology and stream assessment. Many community volunteers, however, came with a wider range of experiences with most having some formal schooling in the natural sciences. Although the students and volunteers have varying degrees of experiences, all were trained on the use of the protocol. The training was conducted through the combined effort of the project coordinator and team leaders. Team leaders are upper-class undergraduate students from Virginia Tech. The students who were recruited for the leadership positions were required to have prior experience in stream monitoring and a solid background in stream ecology. Both the team leaders and volunteers were given a two-week training session on the SCCA protocol.

SCCA project coordinator and team leaders provide a two week trained session for all service-learners and volunteer who participate in the *visual survey*

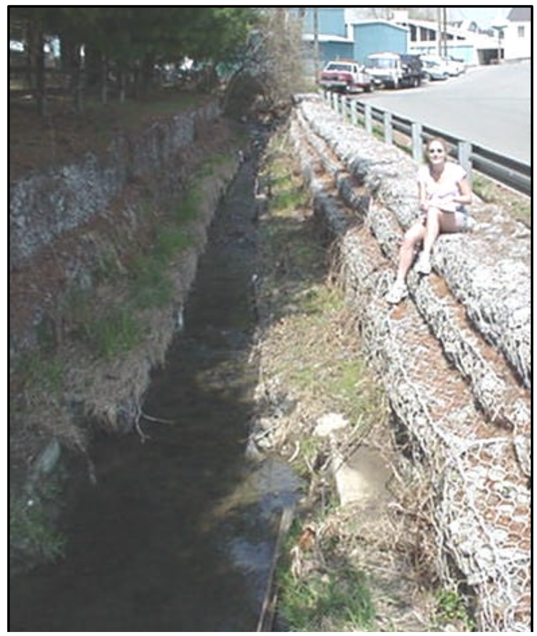
The watershed characteristic survey was the first of the three ecological assessment components to be implemented. The watershed characteristic survey is a two-part method consisting of the *watershed background investigation* and the *visual survey*. A watershed survey is a comprehensive assessment of the geography, land and water uses, screening of potential and actual pollution sources, and the collection of historical information about the stream and its watershed. According to the U.S. EPA, a watershed characteristic survey is one of the most rewarding and least costly activities a volunteer program can undertake (EPA, 1997).

The *watershed background investigation* is generally a one-time activity that requires students collect pertinent information. Collection may include topographic maps, aerial photos, current town and county planning records, historic watershed background, current land use, stakeholders list, and watershed boundary and size. This investigation may provide valuable information about the cultural, natural history, and the land uses surrounding the stream. The data obtained from this investigation may uncover important information that can help in the design of the program's monitoring plan, future activities, and projects (EPA, 1997). This information serves as the baseline for the protocol.

The *visual survey* is the sight-specific or observational evaluation of the stream and its watershed. It requires surveyors to observe and catalog the water and land conditions, the land and water uses, and the changes that take place along a defined stream segment. This investigation requires a team (minimum of two people) to walk a stream segment, observe the surrounding water and land uses, and record the findings in a set of data sheets. The visual survey provided service-learners with the opportunity to work as a team member and as an individual, gain leadership experience, and attain knowledge in the use of geospatial technologies such as a Global Positioning System (GPS).

Visual survey measurements and observations were recorded in data sheets. Measurements used in the survey were done in the International System of Units (SI unit). The boundary delineation of the individual stream segments is measured in meters. One stream segment covers a 61 m x 61 m grid area (3,721 m^2). The grid lines are measured 61.0 m parallel to the flow direction and 61.0 m perpendicular to the flow direction (30.5 m measured outward from the center of the creek towards both stream banks). The spatial locations of the upper and lower boundaries of each site are determined using a handheld GPS. Other measurements include pipe diameters, bank height, and channel width. The use of a tape meter, meter stick, and a handheld GPS unit were sufficient to obtain needed data.

In addition to documenting the general description of the stream, field investigators also took digital photographs of their findings and marked the location of the features on a site diagram (see Appendix II). A site diagram is a quick schematic drawing of the area of the stream segment. It is used to help familiarize the investigator with the terrain and stream features, as well as to provide a visual record of the spatial location of the specific stream features. The application of diagrams and digital photos proved valuable in analyzing and reassessing sites previously surveyed in the Stroubles Creek watershed.



Service-learner, Mandy Stoughton, surveys a stream segment for channel alteration, inadequate buffer, and fish barriers

The *visual survey* is an easily applied approach to rapidly assess the general physical stream condition. It is designed to identify environmental problems within the stream's corridor and provide sufficient information on each problem so that preliminary determination of both the severity and correctability of the problem can be made. The *visual survey* is not intended to replace the more standard biological and physiochemical assessment, but to provide adequate information so that restoration efforts can be prioritized. Specific problem conditions identified during the survey are: channel alteration, erosion site, exposed pipe, pipe outfall, fish barrier, inadequate buffer, in or near stream construction, trash dumping, and unusual conditions. These special conditions are rated for severity, correctability, and accessibility (see Table 2). Students conducting the survey apply their experience gained through training, coursework, and collective professional judgments to the ratings. However, a professor or graduate student was always on site to provide assistance to the service-learners.

Table 2. Severity rating used in the Stroubles Creek Corridor Assessment

Severity Rating	
1 (worst)	Problem areas that appear to have direct and wide reaching impact on the stream's resources. These are the worst problem areas that surveyors have seen or would expect to see. For example, a large construction site adjacent to the stream that does not use proper sediment control.
3 (moderate)	Problem areas that appear to have some adverse impacts at a specific site. These are problems that surveyors have seen or would expect to see much worse problems in that category. For example, a 20 meter reach of erodable bank is moderate when compared to >150 meter reach of a similar condition.
5 (minor)	Problem areas that appear to have minor impacts on the stream's resources. For example, a small amount of trash laying along the stream bank.

Based on guidelines prepared by Yetman (2000)

Severity ratings were based on a 1 to 5 scale, with 1 being the worst condition. Correctability and accessibility were rated from 1 to 5, with 1 being the best condition. The sites with the lowest total number from the summed ratings were those with the worst condition but with the best potential for improvement. As such, the sites with a lower total number from the summed ratings received a high priority for restoration needs. The criteria rating for severity varied among the different conditions found. However, as a general guideline, the surveyors assigned rating values according to Table

2. Service-learners assigning the ratings used their best judgment of the worst and best conditions. Conditions rated with a severe rating of 1 were followed up by a detailed evaluation.

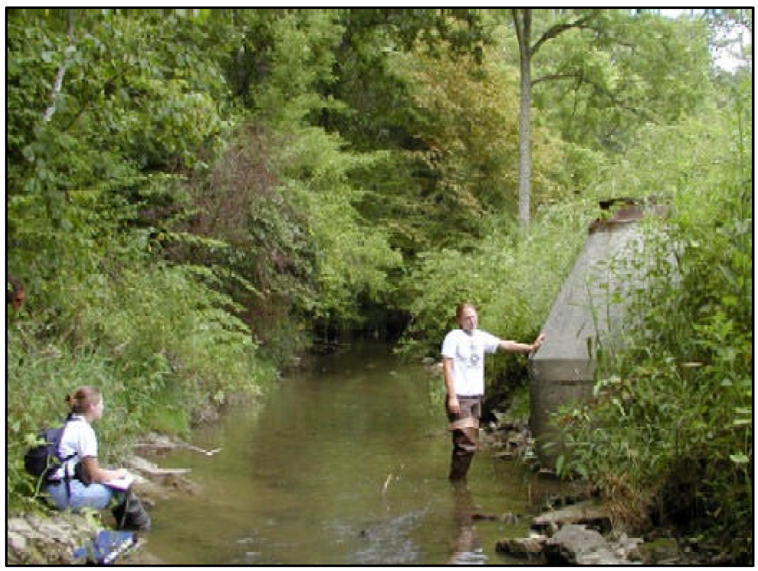
By July 2001, eight service-learners and 26 volunteers had participated in the SCCA. These service-learners and volunteers reached the project's goal to survey 226 stream segments of Stroubles Creek from its headwaters to where the creek meets Slate Branch (see Figure 1). The result from the *watershed characteristic survey* revealed a total of 629 problems along the stream segments. Table 3 shows the number of observed problems reported for each of the specific conditions.

Table 3. The number of times specific problems observed in the 629 surveyed stream segments

Specific Condition	No. of Times	Percent Serverity Rating					
		U	**1**	**2**	**3**	**4**	**5**
Inadequate Buffer	170	0	17.6	21.7	34	18.1	7.6
Erosion Site	107	0	6.5	20.5	43	24.3	5.6
Pipe Outfall	97	12.1	0	25.8	6.19	22.7	34
Channel Alteration	91	1.8	7.7	17.6	38.5	24.2	11
Trash Dumping	49	2	2	8.1	10.1	16.3	61.2
Exposed Pipe	43	2.3	2.3	16.3	37.2	16.3	25.6
Unusual condition	35	31.4	2.9	14.3	11.4	20	20
Fish Barrier	33	0	12.1	21.2	21.1	21.2	33.6
In or Near Stream Construction	4	0	25	0	50	25	0
	629						

* U = unkown ratings

The most frequently observed problem condition found in the three main branches was inadequate buffer, with 34% classified as moderate in the severity rating. Erosion site was the second most frequently observed condition, with 43% classified as moderately severe. The high occurrence of erosion was not a surprise given the amount of channel alteration in the urbanized and agricultural portion of the upper watershed. Pipe outfall was the next highest category to be observed. Of the 97 pipe outfalls identified, 87.6% received a severity rating in the 3-5 rating. In addition, pipe outfall also received one of the highest percentages with unknown ratings. Many pipe outfalls observed in the field were difficult to identify if whether they were still active or part of an old infrastructure no longer in use. Channel alterations were found as frequently as pipe outfall. Most channel alteration occurred in the urbanized section of Stroubles Creek. The next most observed condition was trash dumping. Similar to channel alteration, trash dumping occurred mostly in the urbanized areas of the watershed. Note however that 61.2% of the trash dumping cases required minimum labor to be corrected by small groups of volunteers or service-learners. Exposed pipe is the next most observed condition with 37.2% in the moderate rating. Most exposed pipes observed were sewer manholes located next to the stream banks. This condition was mostly observed in upper branches of Stroubles Creek. However, several sewer manholes were also found close to or next to the stream in the lower part of the watershed. The Blacksburg sewer line uses gravity flow system that runs along Stroubles Creek.

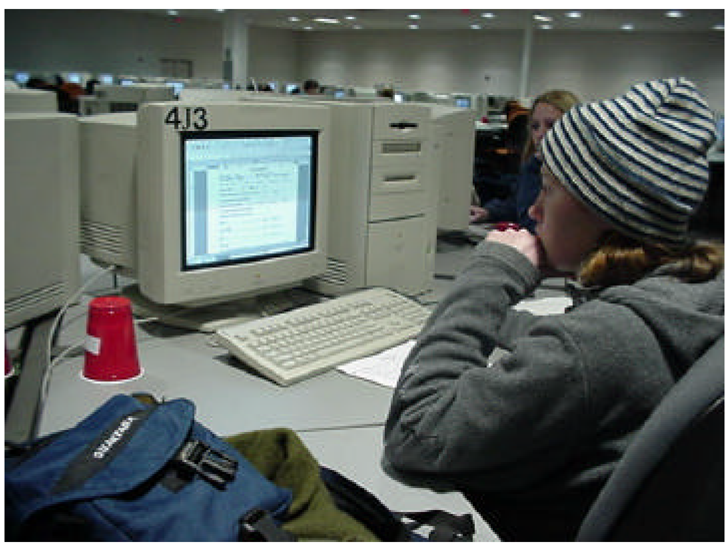


Service-learners take note of an *exposed pipe* (a sewer manhole) located on the banks of Stroubles Creek

Unusual conditions observed in the field were such features as propane tanks and other features not categorized as one of the nine problem conditions. Unusual conditions received the highest unknown rating among all specific problem conditions observed. Fish barrier is next on the list. Most of the fish barriers observed in the field are due to man made trash and woody debris that block the passage of fish. Similar to trash dumping, these problems are easily amendable through minimum clean-up labor of volunteers. In or near stream construction is the last condition on the list. Although there are few construction conditions observed, the problem associated with this conditions are often much higher than other conditions because of vegetation degradation within the area and sediment runoff into the stream. The list in Table 3 reveals a large sum of conditional problems, several of which could be amendable through civic participatory clean up.

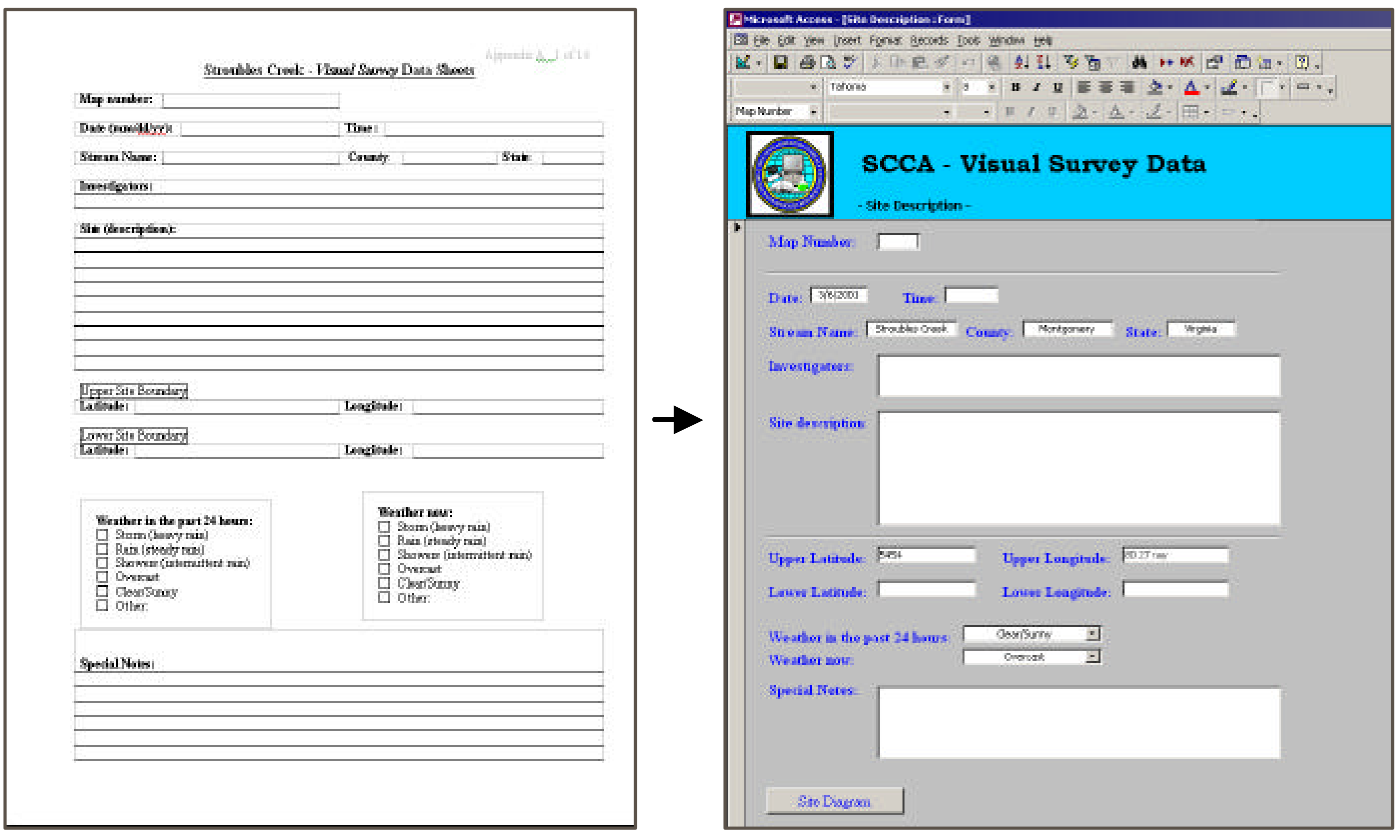
Data Management System

Collection of field information is an important aspect of the watershed monitoring. However, it is equally important to effectively manage that information. Once the field data from the *visual survey* was collected, it was



A service-learner promptly enters the survey data after collecting them out from the field. Service-learners learn how to use a database management system.

brought back to the office, and entered into the database (see Figure 2). The database management system used for this project was Microsoft Access. This database system collectively maintains the data and manages it in a single database file. This system takes advantage of the unique numbering system used in the field by storing the file into individual storage containers called tables. The database allow users to view, add, and update table data through forms, find and retrieve the necessary data needed for queries, and analyze or print data in a specific layout by using reports. Additionally, the database was developed so that users are able to view, update, or analyze the data via the Internet



Data sheets used in the field

Database form used to enter stream data

Figure 2. Application of Microsoft Access Database Management System developed for the Stroubles Creek Corridor Assessment. Service-learners gathered data using data sheets in the field and entered in the database through forms.

by creating data access. The service-learners who collected the data were in charge of entering that data into the database. Data was entered within a week after the information was collected from the field. The service-learners were given the opportunities to learn how to operate within a database system and how to acquire and analyze data through queries.

In addition to storing the data, the database management system was also used to rank the problem conditions observed in the field based on the rating scheme. Ranking of the problem conditions allowed service-learners to prioritize the 226 stream segments by restoration needs. The numbering system applied in the visual survey was key to the prioritization process. In the survey, service-learners used a 4-digit numbering system similar to the Maryland SCA protocol. In this system, the first three numbers refer to the stream segment and the fourth number refers to the team number of the service-learning group who conducted the survey. For example, the first stream segment was given 001 as the first three identification digits, the second stream segment was given 002, and so on. If, per say, team one surveyed stream segment 001, then the map number would be 0011. However, if instead team two surveyed the stream segment, then the map number would be 0012. Team numbers were assigned to the individual survey group before any survey was conducted. Similarly, segment numbers are established at the beginning of the survey.

Specific problems were assigned a site number, a two-letter abbreviation that was associated to the problem (e.g. C.A. for Channel Alteration) followed by a two-digit number corresponding to the segment order of the environmental problem. Referring to the previous example, if the stream segment 0011 had a channel alteration, the data sheet for this segment will have a special condition sheet filled out with a site number CA-01. It is not unusual to identify two or more environmental problems at one site where for example, map number 0011 may have a second channel alteration. In this case, the second channel alteration would be given the same map number but provided with a site number of CA-02. Additional environmental problems or conditions found at the same site were given the same map number but provided with a different site identification number. Site numbers were also marked on the diagram to identify the condition shown and to number digital photos taken of that particular condition. In the example of the channel alteration CA-01, the photo taken of this condition would be given CA-01. The application of this numbering system helped surveyors keep track of the data being collected out in the field, and it proved advantageous when entering information into a database system.

The process of prioritizing the stream took advantage of the unique numbering system described above. The actual process of prioritizing the stream segments applied a simple calculation. The first step to the calculation was the summation of the ratings for each problem condition. This summed value is the *problem condition rating* for each problem condition. Next, the problem condition ratings per stream segment were totaled. This value is the *total sum of all problem condition rating.* The total sum of problem condition ratings was then divided by the *total number of problem condition per site*. The final product provided the ranked value for the individual stream segments. The stream segments were then sorted by their ranked value. Ideally, the stream segments with the lowest ranked value received the highest priority because these are stream segments that are likely to have conditions with low severity, accessible and correctability ratings. The calculation is provided in Table 4.

Table 4. Calculation used to rank the stream segments based on problem condition

Problem condition rating = Severity + Correctability + Accessibility
Stream segment ranking = Total sum of all problem condition rating / Total number of problem condition per site

Stroubles Creek Watershed Stakeholder Summit

Community involvement and project reflection are two critical elements to any service-learning community-based program. The VWRRC hosts several events throughout the school year that advance the university-community partnerships. In conjunction, these events also provide opportunities for service-learners to reflect on their work and to present their achievements during these programs. Such events include the annual Stroubles Creek Forum and the Stroubles Creek Watershed Stakeholder Summit.

The Stroubles Creek Forum is the annual meeting where students and faculty members present their research projects and activities to the university body and local citizens. Similar to the annual forums is the Stroubles Creek Watershed Stakeholder Summit. The first Stakeholder Summit was held on November 2001. The objectives of the first summit were:

- To identify the Stroubles Creek stakeholders
- To get local landowners, merchants, agencies, and partners in the Stroubles Creek watershed together
- To share recently compiled data on the Stroubles Creek condition as was assessed through the Stroubles Creek Corridor Assessment
- To discuss restoration needs for the watershed

- To target methods and actions needed to amend the problems
- To coordinate future plans and activities with watershed stakeholders
- To present the tools stakeholders can use in their local watershed

A list of potential stakeholders was prepared for the Summit. These stakeholders were informed about the Summit via letters, e-mails, web, and through the Blacksburg's Town Council meetings that were televised. As a result, a diverse group of stakeholders attended the summit. The 26 attendees represented local and state agencies, local private businesses, property owners, and multiple departments from Virginia Tech (see Appendix III).

The Stakeholder Summit consisted of two sessions. The first session discussed background information on watershed management and water resource regulations. The second session included presentations on the SCCA methodology and results. The two-part session lead into a discussion period where the stakeholders were given opportunity to add their comments and ideas on the Initiative, the SCCA methods, and the SCCA results. A majority of the comments stressed the importance of enhancing the Virginia Tech-Town of Blacksburg partnership. A Town planner for Blacksburg expressed that the Town has neither the time nor the resources to conduct an assessment such as the SCCA. The planner added that making the SCCA available to the Town via Internet will be very valuable and could even be used in the Town's long-term Master Plan. The stakeholders were impressed and excited about the service-learning research at Virginia Tech.

Other issues such as enhancing local citizen actions and expanding the SCCA in other parts of Montgomery County were also discussed. In sum, the stakeholders supported the Stroubles Creek Watershed Initiative. The stakeholders strongly encouraged the integration of service-learning projects into watershed management activities. Both the VWRRC and the S-L Center believe that improving the university-community partnership will ultimately lead to a healthier Stroubles Creek and community.

Website Development

Community outreach and education is an important element to the Stroubles Creek Watershed Initiative. The VWRRC and the S-L Center have developed many campus-wide, multi-faceted outreach programs as part of the Initiative. The Stroubles

Figure 3. Index page of the Stroubles Creek Watershed Initiative website. (http://www.vwrrc.vt.edu/stroubles/index.htm)

Creek Watershed Initiative website is one project that materialized from this partnership. The website was designed for the purpose of providing information about the Stroubles Creek watershed that can easily be accessible to the public. One specific objective was to centralize all the existing information related to the Stroubles Creek and the Initiative. It was the intent of the website developers to make the site easily accessible, user friendly, and easily understood so that both water resource professionals and non-professional users can obtain valuable information about the watershed at ease. The service-learners who created the website took into considerations the speed of navigating through the site by limiting graphic attributes. In addition, they gave step-by-step instructions throughout the pages specifying the fonts, colors and sizes used, as well as a short description on how to make changes to the site. A set of Html files, specific to each aspect of the Initiative projects and the watershed were created. The index page (See Figure 3) of the website provides links to the main areas of the site, links to the sponsors of the Initiative, a marquee that scroll information on future events of the Initiative, and contact information.

The remainder of the Initiative site was divided into eight major pages. The first page is the Mission & Goals. The page provides a description of the Initiative's goals, objectives, major areas of interest, and the partners who are involved in the initiative. The second page is the Database. The database page is a repository of information related to the Stroubles Creek Watershed, including work developed by other groups related with the watershed. This page is expected to link a data access page to the SCCA database. A data access page is a special type of Web page designed for viewing and working with data from an Internet or intranet. In this website, the data access page will

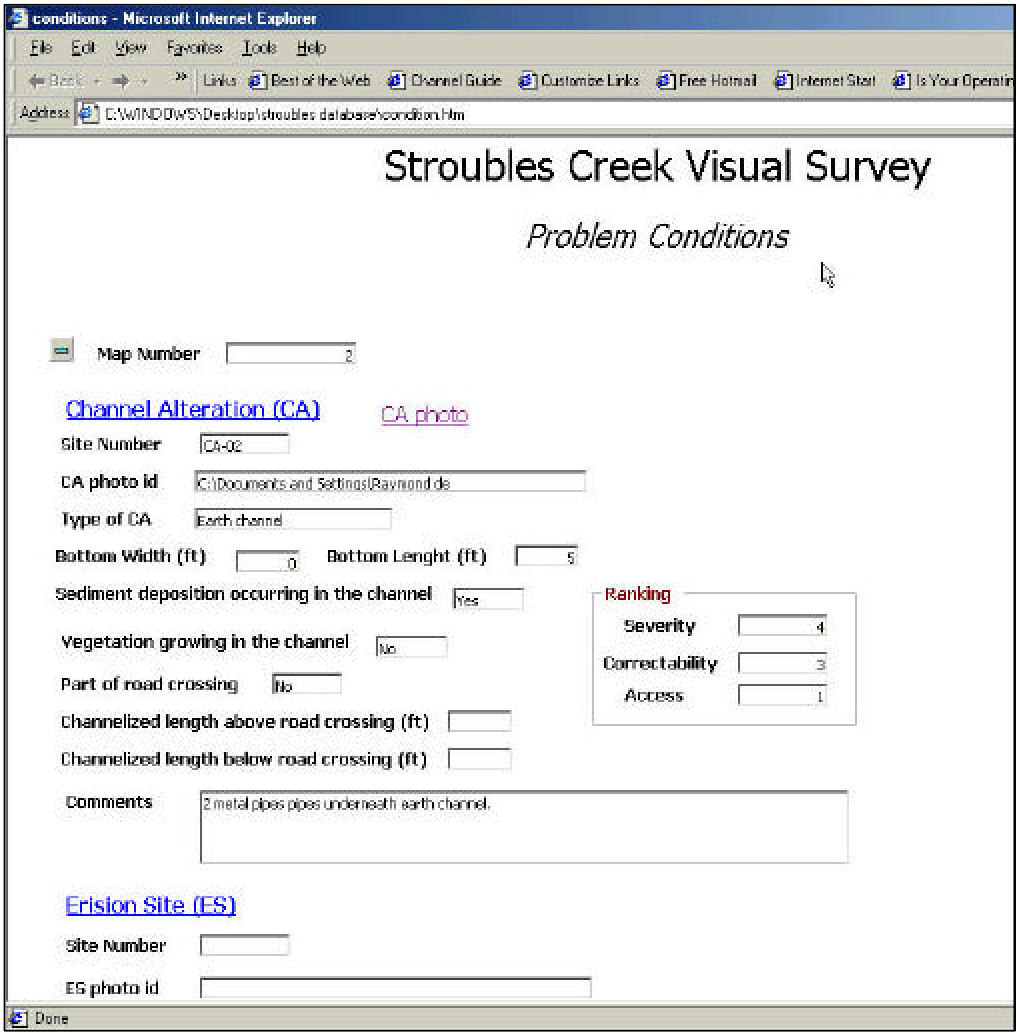


Figure 4. The Stroubles Creek Visual Survey data access page developed for the SCCA project. This data access page will be housed in the Database page of the Initiative website.

allow users to view the SCCA data stored in the Access Database Management System (see Figure 4).

The third page is called Projects. The Projects page provides information on projects currently being developed by the VWRRC and its partners. One such interdisciplinary project is the MOOsburg (see Figure 5). MOOsburg is a graphical virtual environment developed by the Center for Human-Computer Interaction at Virginia

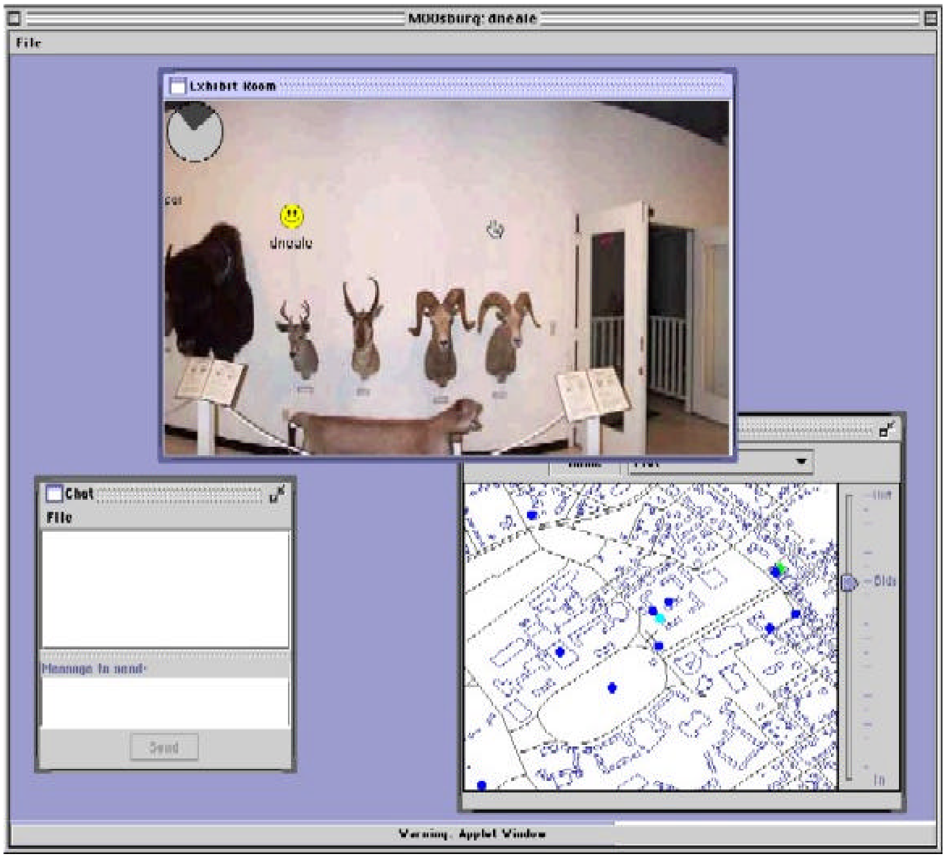


Figure 5. MOOsburg provides a community-based on-line resource model for the Town of Blacksburg, VA. The Initiative is working collaboratively with the MOOsburg project as one of their study group (Center for Human-Computer Interaction, 2002).

Tech. The fourth page is the Publications page. This page provides a list of thesis, reports and other types of publications such as articles or forum records. Much of the information found in the publications page are specific to the Stroubles Creek watershed but other literatures related to water resource management can also be found.

The fifth page is the Watershed Information. The Watershed Information page provides a detailed description of the Stroubles Creek watershed characteristics, historical studies, watershed maps and stakeholders. In addition, this page provides a link to the Stroubles Creek Watershed IMS web page. The Stroubles Creek Watershed IMS (Internet Map Server) page is an interactive web-GIS (Geographic Information System)

Figure 6. A snapshot of the Stroubles Creek Watershed IMS web page. The red box inside the image is the area to be enlarged or zoomed into. Figure 7 shows the image produced from the zoom function.

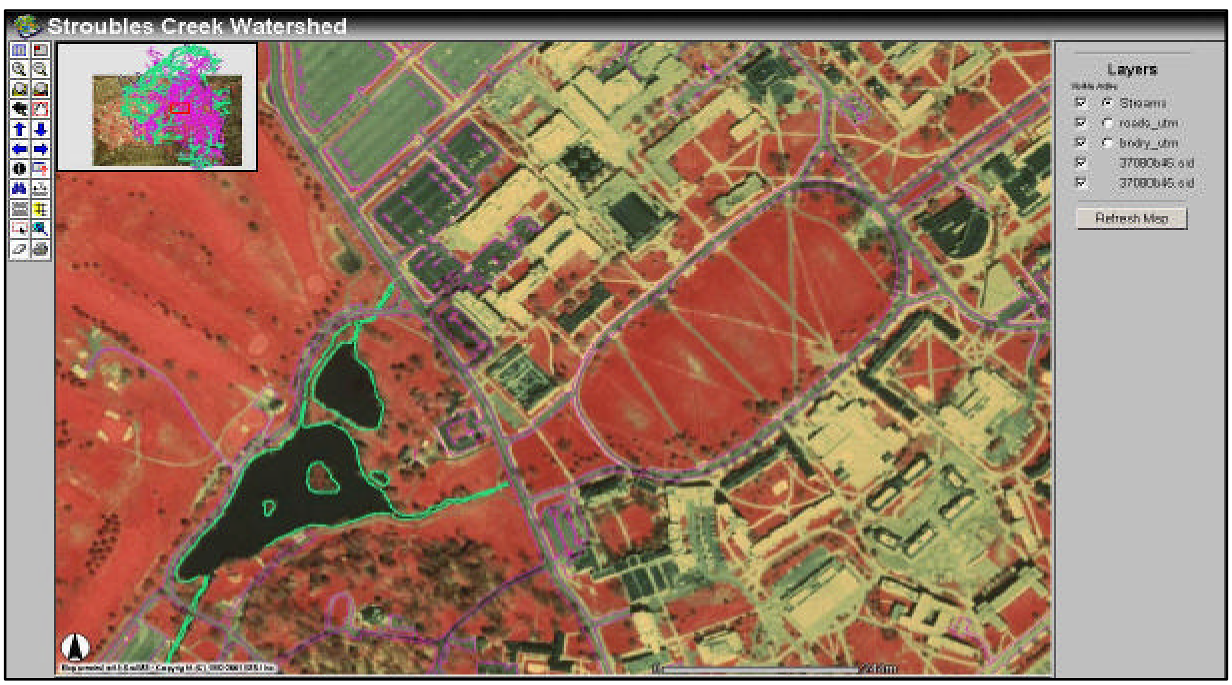


Figure 7. Enlarged area of the map created from the zoom tool.

interface. This web-GIS interface takes advantage the latest ESRI software called ArcIMS (see Figure 6 and 7). The IMS is an on-going project developed by the VWRRC in partnership with the Civil and Environmental Engineering Department at Virginia Tech and the Virginia Tech Library. The Stroubles Creek Watershed IMS contains digital data of the Virginia Digital Ortho Quarter Quads (VA DOQQs) and data of the Montgomery County and the Town of Blacksburg's road and stream GIS layers.

The sixth page is Activities. The Activities page provides a calendar of the events related with the Initiative and other activities in the watershed. Each event indicated on

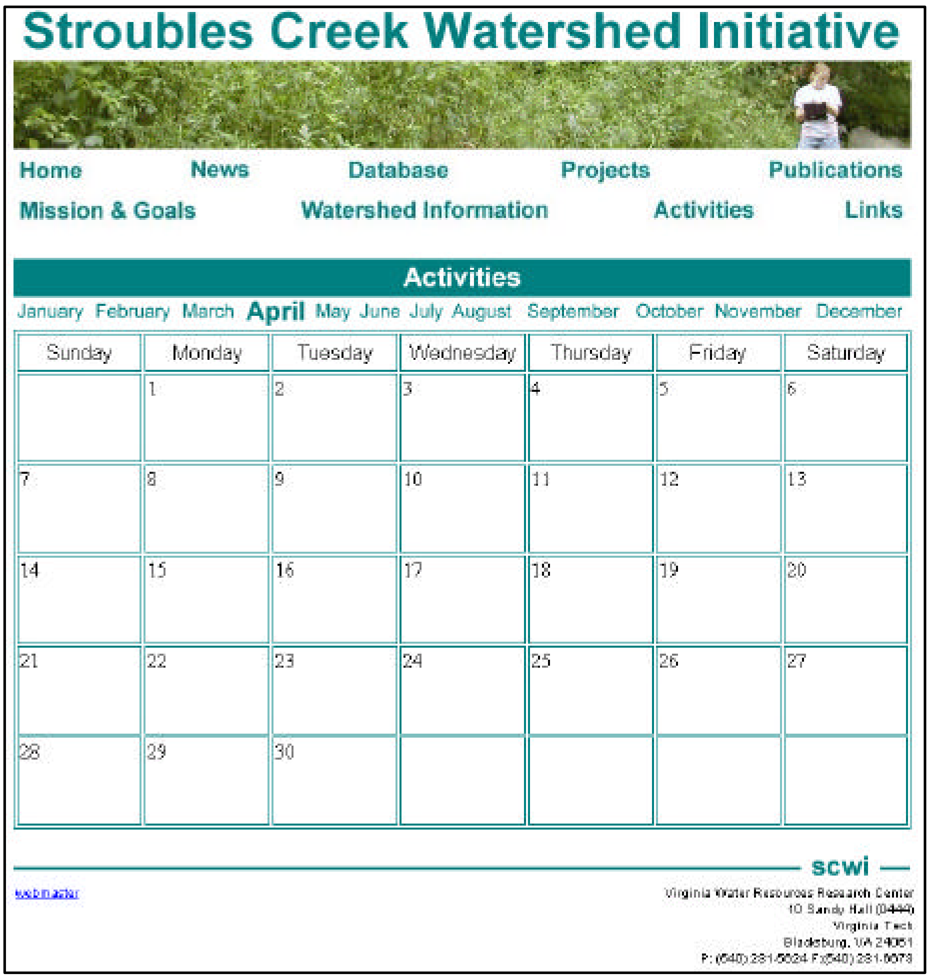


Figure 8. The Activities page for the Stroubles Creek Watershed Initiative website. An interactive calendar where users can view current activities and events happening in the Stroubles Creek watershed.

the calendar are linked to another page that provide additional information on those events including time, place, date, and description (see Figure 8). The last two pages are the News and Links page respectively. The News page provides stories of the initiative and report on the watershed, achievements, grants received, and other press releases. The Links page provides a list of web links to organizations and projects related with the Initiative and other resources related to watershed management. Each web link is provided with a short description of what each link will display.

This website site and other Internet related projects (i.e. MOOsburg and IMS) are on-going projects. These web-based projects and web pages will be enhanced as new information is added. With a good foundation and directions already in place, service-learners who will continue these projects will be able to quickly and easily contribute to the Initiative website. The website can be found at: http://www.vwrrc.vt.edu/stroubles/index.html

The Citizen Bulletin Board

The citizen bulletin board project provides an educational opportunity to K-12 students and local citizens. This bulletin board is the effort between the Phi Sigma Pi fraternity and the VWRRC in collaboration with the University Architect Office at Virginia Tech. The three are working in partnership to create a double-sided bulletin board that provides information about the Stroubles Creek watershed on one side and the Duck Pond on the other facet (see Figure 9). It is expected that the sign will be located next to the Duck Pond gazebo to where many visitors are attracted. Both the website and the citizen bulletin board have the objective of increasing the community's awareness, knowledge and concern about water resource issues and the local watershed. It is hoped

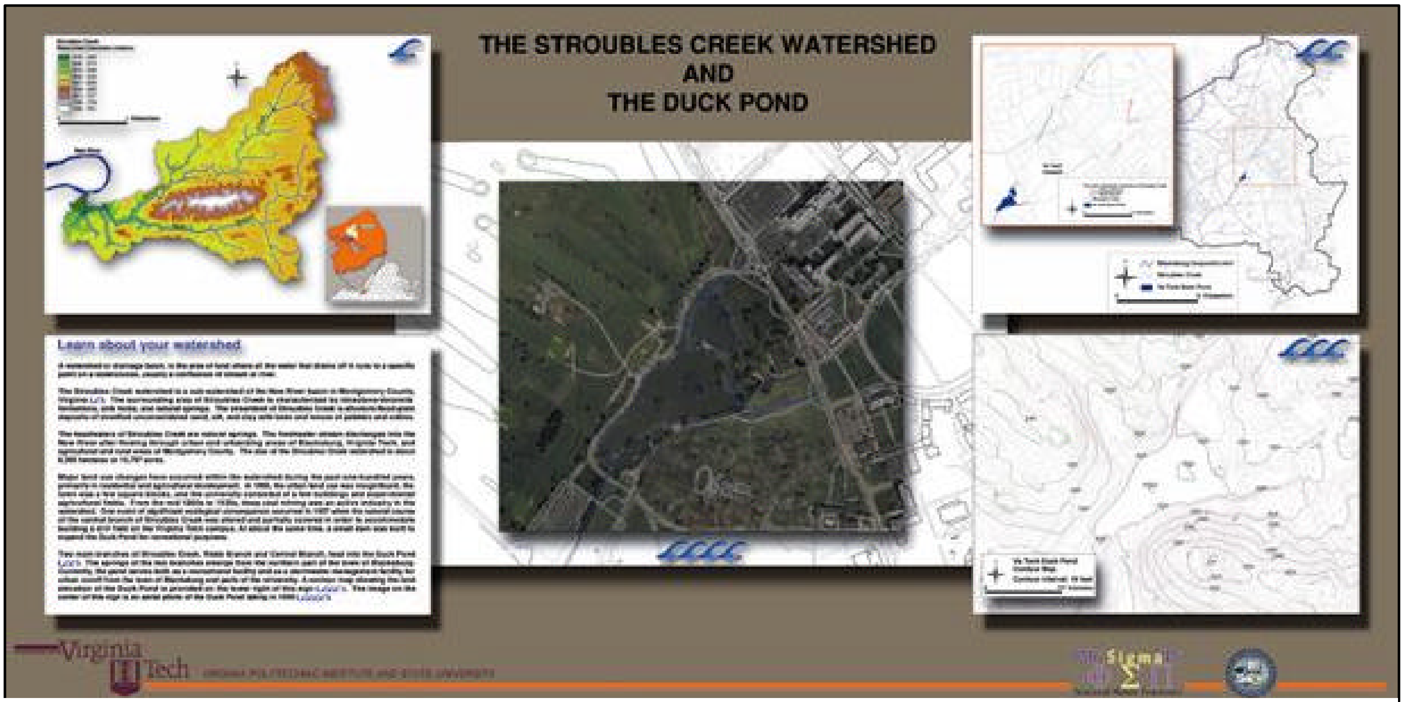


Figure 9. The Stroubles Creek Watershed and Duck Pond *Citizen Bulletin Board.* A service-learning project developed by the VWRRC in collaboration with the Phi Sigma Phi fraternity and the University Architect Office at Virginia tech.

that these outreach tools will help bring awareness within the community to improve local stewardship and the health of Stroubles Creek.

<u>SEEDS summer camp</u>

Seek Education, Explore, DiScover (SEEDS) is a non-profit organization located in Blacksburg, Virginia. Since 1995, SEEDS has provided service-learning opportunities for students at Virginia Tech and students around the local community. In the summer of 2001, service-learners from the VWRRC at Virginia Tech teamed up with SEEDS in the *2001 SEEDS Full Day Summer Field Camps.* Running on its 6th season, the summer camp provided an array of outdoor activities for kids, ages 7-12 years old.

The objective of the VWRRC and SEEDS partnership was to use the summer camp as a service-learning opportunity for students working on the SCCA. It was intended that the partnership would provide opportunities for service-learners to educate the local community on the SCCA. Specifically, the purpose of the SEEDS summer camp project was to make the public aware of the SCCA project and its role in improving the Stroubles Creek Watershed. In addition, it educated the kids about watershed management and the latest tools used in watershed monitoring.

Service-learners, Stephanie Garman and Mindy Waltham, teach kids from the local community about the SCCA *watershed characteristic survey*

During the summer camp a new theme was presented to the kids on a weekly basis. Such themes as *Garden Greens and The Life they Bring* and *Streams, Seams, and the In-betweens* are a few examples of the activities the SEEDS camp offered. Service-learners from the VWRRC provided a weekly, one-hour workshop on the Stroubles Creek watershed and the SCCA service-learning project. The workshops offered hands-on activities teaching the kids about watersheds, the importance of sustaining a watershed, how they can help keep their local watershed clean, and how the corridor assessment will play in the restoration efforts.

A SEEDS summer camper learns how to draw a site diagram of the Duck Pond.

The SEEDS summer camp proved to be an exceptional program for the VWRRC to reach out to the local community and educate them about the issues that surrounds their local watershed. The program was also a great learning experience for service-learners. A report written by two service-learners on their experience in working with the SEEDS summer campers reflect that they gained exceptional experience in preparing, organizing and working with a younger audience. Service-learner, Mandy Stoughton (2001) said, "*Working with the SEEDS kids this summer was probably the greatest and most rewarding experience I had this summer. I especially loved how the kids seemed to be interested in what we were talking about (most of them anyways) and to see their faces light up when we*

Intrigued summer campers learn about GPS from service-learner, Raymond de Leon.

showed them the cool little computer thing (GPS unit) and the neato bugs that we had collected for our macroinvertebrate presentation." VWRRC and SEEDS expect to collaborate again in future summer activities.

ACCOMPLISHMENTS

The service-learning projects presented in the last section illustrate an array of projects intended for the purpose of advancing the Initiative's goals. To date, the Initiative's goal of using the watershed, several branches of the creek, and the Duck Pond as a system for developing research, educational, outreach, and service-learning opportunities at Virginia Tech are being fulfilled. Through the SCCA, the VWRRC and the S-L Center were able to develop a service-learning research project that sparked a collaborative group from the university, local agencies, non-profit organization, and citizen volunteers for the purpose of monitoring and restoring the health of Stroubles Creek. The completion of the first ecological assessment (*watershed characteristic survey*) was a significant accomplishment that demonstrated the commitment and effort of 14 service-learners, 20 volunteers, and faculty members from multiple disciplines. In addition, the SCCA was also a catalyst to other projects such as the database management system, IMS, Stakeholder Summit, Forum presentations, and several workshops. Accomplishing the basic design of the database management system was an important step. The database management system provides opportunities for student to gain experience in working with relational databases while developing a useful system that is expected to house all the SCCA data. Similarly, the IMS project provides opportunities for students to learn and use innovative tools that have the potential to enhance community outreach while moving the Initiative to the next level of geospatial technologies. Although the IMS is still in development, it has the capability to link the SCCA data from the database system and allow that data to be represented in two-dimensional land features that are recognizable and spatially oriented to the earth's surface. Both the database and the IMS are established on solid foundations that pave the way for future service-learners to add their knowledge and new ideas to the projects.

The outreach programs developed by the Initiative are another accomplishment. Establishing educational outreach programs that present watershed management, issues with the Stroubles Creek watershed, and the need of active citizen participation in water resource protection have been a major endeavor. The Stakeholder Summit, Forum presentations, and workshops on the SCCA have enabled the Initiative to reach out to students, agency stakeholders, the university, and local citizens. These outreach programs have proven successful in teaching the local community as affirmed by parents of SEEDS summer campers, local stakeholders, and students who have served in the Initiative.

Although there have been many achievements made towards meeting the goals of the Initiative, there is still significant room for improvement to the Initiative's service-learning program. The overall potential of the Initiative's goals and objectives has not been realized as of yet. Many service-learning projects are still in progress and need to be finalized in order to achieve the needs of both the community and the Initiative. Components of projects that are still on progress, along with their status are given here:

- The database management system (on-going)
- The Initiative website (on-going)

- MOOsburg (preliminary phase)
- IMS (preliminary phase)
- SEEDS summer camp (annually)
- Forum (annually)
- Stakeholder Summit (annually)

On a solid note, the projects that are in progress have been laid on good foundations. Future service-learners are expected to find ease in using the existing framework. However, shortfalls are expected as expressed by many service-learners in the past. These shortfalls are revealed in the Lesson Learned section in the following chapter.

CHAPTER IV

LESSONS LEARNED

The Stroubles Creek Watershed Initiative has made significant progress since its beginning in 1999. The impetus to this progress comes from a strong collaborative partnership between two interdisciplinary academic units that share common goals and ideals. The partnership between the VWRRC and the S-L Center sought an innovative strategy to engaging university faculty, student, and local K-12 students in the restoration and public education efforts of Stroubles Creek through service-leaning. It was the partnership's intent to use the Stroubles Creek watershed, several branches of the creek, and the Duck Pond on the Virginia Tech campus as a system for developing research, educational, outreach, and service-learning opportunities at Virginia Tech. In addition, it was the VWRRC and S-L Center's goals to use the university-community partnership to help remove the Stroubles Creek from the DEQ impaired water list and to coordinate future watershed protection plans for the watershed. In their endeavors, the VWRRC and the S-L Center have built a high-quality service-learning program at Virginia Tech. Many lessons have been learned along the development of the Stroubles Creek Watershed Initiative. Lessons taken from the viewpoints of service-learners who participated in the Initiative and the project coordinator are given below. These perspectives were gathered during weekly meetings between the SCCA project coordinator and the service-learners. The lessons reflect the challenges they faced as well as recommendations they concluded from their experience as s service-learner and project coordinator.

Challenges Faced

While many service-learners cite numerous personal rewards gained by being involved with the Initiative, four common challenges were raised as they reflect on their work. These challenges are sustainability of service-learning in watershed management activities, low participation, time management, and coordinating project activities.

Sustainability of Service-Learning in Watershed Management

Securing the continuity and sustainability of a watershed management application require long-term thinking and effort. However, the problem with most service-learning experiences is that they are generally designed for short-term commitment. Transforming service-learning projects and programs to meet the demands of watershed activities are essential for sustainability to occur. This calls for extending the time requirement of service-learning projects and designing them in ways that would foster long-term commitment by students and faculty members. Incentives for students to stay on longer bases are discussed in the next section.

In addition to increasing the commitment of students and faculty in service-learning programs, it is equally important to increase the role of the community. Since watershed management activities are community-based, public involvement and education are essential to the future success and sustainability of watershed efforts. Increasing the role of service-learning in watershed-based projects can foster public participation as well as education of the local citizens.

Low Faculty and Student Participation

Getting faculty and students to participate and stay committed to the Initiative program have been difficult for both the project coordinator and service-learning leaders.

Too often, few faculty members are interested in joining the Initiative or any service-learning program. Some of the barriers to faculty involvement have been their lack of time and interest in service-learning, or their skepticisms of the role of service-learning in the teaching and student learning. In addition, it has been difficult to gather a consistent number of service-learners and student volunteers to join the Initiative's effort. In general students who partake as service-learners will only participate to the extent to which they have committed themselves. At Virginia Tech, most service-learners are only committed to 15-20 hours of service per semester. However, because watershed activities are time intensive, participants are asked to give more commitment to the projects. Ways to encourage higher student and faculty participation are given in the next section, under *Increase Faculty and Student Participation to Sustain Watershed Management in Service-Learning.*

Time Management

By far, the largest challenge faced by many service-learners involved with the Initiative was time management. The project coordinator and service-learning leaders of the SCCA claim the difficulty of finding time to plan activities as well as implement them during the school week. As such, many time-oriented service-learning activities were done on a weekend basis to work around student schedules and to encourage more students to participate in the activities. Since most service-learning activities were done on the weekend, the projects' agenda had to be revised to meet both the student and volunteer schedules. Therefore, it is important to remember that scheduling a service-learning project needs to be flexible.

Inclement weather conditions also put a damper to the projects' agenda. Service-learners coped with these issues by making their schedule accommodating to meet the goals of the project. Many service-learners endured cold, rainy, sleety, and hot weather conditions. As a result of their commitment, many project goals were met. However, plans for future activities will need to take greater consideration of the student's schedule and provide additional leeway for seasonal conditions.

Project design and planning must also be practical to the school's schedule. As such, school breaks and activities must be considered in project plans. Most projects in the Initiative take more than one semester and takes considerable amount of dedication to work in the projects. It was found that many service-learners involved in the Initiative desire only to partake in the project for one semester. Projects given to these service-learners must be designed so that they are achievable within a semester. In other cases, project agendas are scheduled to be complete within a few semesters. With this situation, new service-learners must be trained. Training of service-learners must also be considered in the program's schedule.

It was found that the scope of the project must be designed with consideration of the students' and the school's schedule and seasonal variations of the area. Future projects that keep these factors in mind should find improvements in managing the project agendas.

Coordinating Project Activities

Coordinating watershed activities can be a daunting task. Both the project coordinator and the service-learners claim that organizing a multi-faceted program such as the Initiative takes significant time and effort. The project coordinator of the SCCA found that orchestrating the *visual survey* among volunteers and service-learners was a test to one's leadership ability and time management skills. In order to improve the efficiency of the project, the project coordinator gave several service-learners the opportunity to take a leadership role in the project. These service-learners were given tasks to direct activities with the supervision of the coordinator. Learning to delegate work efficiently among the service-learners was key to the success of the first ecological assessment. Allocating work to service-learners efficiently gave the project coordinator opportunity to concentrate on other tasks involved with the project.

It is important to recognize and harness the leadership skills found among service-learners. In the SCCA project, many service-learners were interviewed for the leadership positions. The project coordinator conducted the interview and recruited those students that fit the needs of the project, showed leadership skills, and would be compatible with the work ethics of the coordinator. The interview process was a time consuming process but proved very valuable in the long run. The project coordinator found that having a strong team of service-learning leaders makes a significant difference and improvement to coordinating watershed activities.

<u>Lessons from the Stroubles Creek Watershed Initiative</u>

Despite these challenges mentioned, service-learners and project coordinator found that being involved in the Initiative was beneficial to their learning experiences. They believe that these challenges will only prepare them in their professional field. Lessons gathered from their experience as service-learners and project coordinator are listed here. These lessons include: making a purposeful service-learning program;

diversifying the service-learning projects; providing opportunities for reflection on service experiences; incorporating community input; evaluating the service-learning projects; providing opportunities for students to receive wage or credit; and increase faculty and student participation to sustain service-learning in watershed management activities. Summaries of these lessons are given below.

Make a Purposeful Service-Learning Program

Many individual service-learners who participated in the Initiative expressed that connecting the service-learning program to real-life issues made the service more relevant to their learning. Service-learners found that they were able to apply what they learned out in the field back to classroom problems. Likewise, these students applied what they learned in the classroom to make professional decision out in the field. Feedbacks from service-learners conveyed that they gained valuable experience throughout the project. These learned skills ranged from communication skills, team-building skills, leadership skills, working with a multi-cultural and multi-disciplinary team, organizational skills, to technical skills (i.e. technical writing, database development, and geospatial technology applications). In conjunction to gaining valuable experiences, students also felt that they were making a meaningful contribution and difference by serving the community to improve the stream's health. Many service-learners agreed that they felt good about working with the community and seeing a difference in the people's attitudes and awareness. They perceived that their work and time was utilized well.

In addition to making the service-learning experience relevant to student learning, it was equally important that the services being provided by the university were necessary and valuable to the community itself. The Stroubles Creek Watershed Initiative is a valuable program for the local community because it is providing a service that otherwise would be too expensive or nonexistent to the community. As such, the community stands to benefit from university-knowledge and technical resources not found within the community. Likewise, Virginia Tech also gains from this program by increasing its exposure to new research and additional research funds. Furthermore, the environment benefits from this program will contribute to the improvement of the nation's water resources. In sum, developing a meaningful service-learning program can be a win-win situation for all participants.

Diversify Service-Learning Projects

The watershed approach requires a multi-faceted and multi-disciplinary program that responds to the diverse needs of the community. As such, the Stroubles Creek Watershed Initiative sought help from different departments to find service-learners who would be interested in participating with the program. Service-learners who participated in this project came from several disciplines such as Urban Affairs and Planning, Environmental Science, Biology, Fisheries and Wildlife Sciences, Civil and Environmental Engineering, Computer Science, and Forestry. These students brought with them varying degrees of experiences. It was important that these skills were utilized to meet both the student's needs as well as the program's needs. The Initiative program required that student's skills be applied in a meaningful way that can help the student advance in their experience, supplement what they have already learned, and reach the goals of the projects. For example, students who had skills in Geographic Information Systems (GIS) were given the task of developing spatial information of the watershed, while students who had experience in database management were given tasks related to database development and management. It was equally important to diversify the service-learner's experiences by allowing student to learn new skills and technologies they have yet gained. As such, students were encouraged to participate in all facets of the Initiative.

Provide Opportunities for Reflections on Service Experience

Reflection is an important component of any service-learning experience. Reflection can take on many forms from oral presentations, written reports, to group discussions that are directly related to the service-learning project. Reflection provides opportunity for service-learners to present their ideas, conclusions, and concerns. This also provides opportunity for the peers, project leaders, and the community to give feedback to these projects.

It has been a strong goal of the Stroubles Creek Watershed Initiative to provide opportunities for student to reflect on their experiences. On a weekly basis throughout the project, project leaders would meet with the service-learners individually and as a group to discuss their progress, concerns, and to reflect upon what they have experienced. Service-learners were also required to write a summary report after each project to obtain their perspective of the project, the final result of the project, and any concerns or comments they may have. Service-learners were also asked to participate in workshops, the annual Stroubles Creek Forums, and the Stroubles Creek Summit that engaged them to present their findings and experiences to the local community, university, and peers. During these oral presentations, service-learners were provided with structured opportunities to reflect critically on their service experiences.

Provide Community Input

Community input is an essential component of any community-based service-learning program. It is critical that the needs and concerns of the community are heard and incorporated during the development of the program. The community's needs and concerns must be established from the start to make any community-based service-learning program work. The Stroubles Creek Watershed Initiative provides several ways for the community to get involved with the program. Information on the Initiative projects is always advertised throughout the community via media, letters, flyers, the Stroubles Creek Watershed Initiative website, at town council meetings, and through electronic mailing. In addition, the community is always invited to participate in the workshops, forums, and summit that provide opportunities for open discussions.

Evaluate the Service-Learning Program

Evaluation is another key component of any service-learning program. Evaluation provides opportunity for the VWRRC and the S-L Center to evaluate the learning experiences of service-learners as well as evaluating the effectiveness of the Initiative. Evaluation gives the VWRRC and the S-L Center direction on how to improve or change the program. Evaluation is also an opportunity for students to reflect upon their experiences, concerns and any changes to the projects, and the program as a whole. The Project Evaluator for the S-L Center conducted a survey of the service-learner and used a factor analysis to interpret their responses. The outcomes of these surveys are reported for the Stroubles Creek Watershed Initiative and other community-based service-learning programs conducted at Virginia Tech. These reports can be obtained through the S-L Center at Virginia Tech.

Provide Opportunities for Students to Receive Wage or Credit

One of the biggest shortfalls that the project coordinator sees in service-learning at Virginia Tech is that the students enrolled in a service-learning course, on average, are only committed to 15-20 hours of service activity per semester. This length of time may serve well for small projects that require minimal effort but for projects that involve long-term commitment, such as those found in watershed activities, a minimum of 10-15 hours per week may be required. For service-learning in watershed management activities require long-term commitment by all participants. Therefore, it is important to provide opportunities for students to receive wage or credit as compensation for their time and extended commitment. Receiving wage and credit have been found to be good incentives for students to continue with the project over a longer period of time. Students who have received credit or wage for their work on the Initiative have stayed involved for one or more semesters. As a result, many short-term goals (relative to the watershed program) have been accomplished.

Increase Faculty and Student Participation to Sustain Service-learning in Watershed Management Activities

The Initiative partners have high aspirations to enhancing service-learning and the health of Stroubles Creek through its programs. In addition, they have a strong commitment to sustain the Initiative as a model for other service-learning watershed programs. The success of these ambitions will greatly depend upon the active participation of the local citizens, a strong dedication by the university, and a committed group of service-learners working together. The following paragraphs suggest ways in which the Initiative can enhance and sustain service-learning in watershed activities for the future.

The key to sustaining a watershed-based, service-learning project is to think holistically, keeping in mind to plan long-time, provide support, and strengthen participant commitment. The Initiative partners must think long-term. As mentioned in the last section, watershed programs require long-term commitment by all participants. Most activities in a watershed program are time intensive that calls for service-learners to commit more than 15-20 hours per semester. Therefore, expanding service-learning commitment and compensating student for their work are important to sustaining long-term student involvement. Providing opportunities for students to receive credit (both partial and full) or wage for their work have been found to be a good incentive to continue with the program.

Furthermore, additional faculty members must invest in service-learning programs and to develop their curriculums towards watershed management activities. One of the biggest obstacles to service-learning is faculty resistance to participate. Too often, faculty members are reluctant to invest their time or they are skeptical of the educational value of service-learning. The Initiative needs to reach out to faculty members who are willing and are able to incorporate watershed applications in their curriculum as service-learning opportunities. Integrating a stronger curriculum-based, service-learning programs through the Imitative will strengthens the students' learning experience as well as foster semester long service activities. In addition, improving the number of faculty involved with the initiative would strengthen the university's educational programs as well as increasing the university's exposure to new research.

From a university stand point, thinking long-term means providing financial support for the future. Support from the university that promote future watershed activities as well as service-learning projects is key to sustaining the Initiative. As the backbone of the Initiative, the VWRRC and the S-L Center must harness this support and other research funds from the Initiative to foster a university wide service-learning program. This is possible by developing workshops on service-learning and watershed activities to multi-disciplinary faculty and students.

The VWRRC, the S-L Center, and other Initiative partners must also work to strengthen the university-community relationship. As mentioned in the previous chapters, watershed programs are community-based approaches to solving water quality and quantity issues. The community is an integral part of the whole process. Developing programs that will increase communication between the community and the Initiative can only lead to better decision making for the future. As a first step, increasing the role of the Town in the Initiative activities and planning can foster other community-based efforts to develop. This would mean that the Initiative participants must work closer with such Town departments as the planning and engineering, planning commission, and public information.

These suggestions to sustaining the Initiative must also take into consideration the challenges and other lessons discussed in this chapter. It can be expected that together, these challenges and lessons will help guide the Initiative in developing additional and better service-learning program for the future.

NEXT STEPS

The Stroubles Creek Watershed Initiative is expected to continue in its endeavor to enhance both service-learning opportunities at Virginia Tech and to improve the health of Stroubles Creek. Recently, the Initiative has taken steps to conduct the last two ecological assessment of the Stroubles Creek Corridor Assessment. The VWRRC service-learners and the Museum of Natural History at Virginia Tech are working together to determine the monitoring locations for both the biological and physiochemical assessments. Furthermore, they have taken steps to implement the study.

In conjunction to the SCCA, the database management system will be updated to accommodate the data collected for the two ecological assessments. The Initiative's website is expected to host the SCCA database through the use of an access page. A new service-learning website developer has taken lead in enhancing this site. With these new projects comes new addition of service-learners and leaders to the program. These new service-learners bring fresh ideas and skills to the project. The VWRRC and the S-L Center strives to ensure the development of service-learning opportunities in the program.

The Initiative will continue to reach out and educate the local community. In support of a new program developed by the SEEDS, called Science Saturday, the project coordinator of the SCCA has participated in teaching undergraduate students from Virginia Tech about the SCCA and watershed management. In addition, the Initiative plans to enhance service-learning outreach programs by continuing its support and active involvement in the SEEDS summer camp. Furthermore, the Initiative has made plans to host its next annual Stroubles Creek Forum on October 18, 2002, to coincide with the National Water Monitoring Day. The combination of the two events will be called the *Stroubles Creek/Duck Pond Festival.* This gathering is expected to have monitoring activities for kids K-12, a cookout by the pond, lectures on the history of the Duck Pond and Stroubles Creek, and workshops for water resource professionals. It is expected that the University Architect Office at Virginia Tech will dedicate the Duck Pond Citizen Board at this time.

The Initiative intends to continue its work with the Internet Map Server (IMS). It is the Initiative's goal to link the IMS with the database management system and Initiative website. This interface will allow users to spatially view the data collected from the SCCA using an interactive map of Stroubles Creek on the web. Another application the Initiative will continue to develop is the MOOsburg. MOOsburg is the graphical virtual environment developed by the Center for Human-Computer Interaction at Virginia Tech. It is hoped that MOOsburg will enhance communication and activity planning among Initiative partners as well as local community members.

CHAPTER IV

SUMMARY

The problems surrounding the health of our nation's water resources will remain serious unless changes are made through individual awareness and behavior. In the past decade, new methods to solving these water resource issues have emerged. The Watershed Protection Approach (WPA) focuses on many water quality and ecosystem problems at a watershed level rather than at the point source or discharge level. In addition, the WPA requires the joint efforts of both the public and private sectors to address the issues surrounding their watershed and their community. However, this community-based watershed approach has its own challenges and needs such as technical skills, support, data, funds, and coordination. Integrating university-knowledge and resources into the watershed effort can help fulfill many of these needs.

Today, many higher education institutions are meeting these community needs as well as educating future environmental planner, policy, and science professionals through service-learning programs. At Virginia Tech, a collaborative effort between the Virginia Water Resource Research Center (VWRRC) and the Service-Learning Center (S-L Center) has embarked on a service-learning program called the Stroubles Creek Watershed Initiative to restore and protect the health of the creek. While still in its early years, the Initiative has made significant progress to educating the students, the community, and improving the health of the watershed.

The Initiative's progress is best illustrated through achievements of service-learning projects discussed in Chapter III. These projects include the Stroubles Creek

Corridor Assessment (SCCA), the database management system, the website, the citizen bulletin board, the SEEDS summer camp, and the Stakeholder Summit. An important accomplishment is the SCCA that fostered the development of a service-learning research project. As a consequence, the SCCA sparked a group of interdisciplinary participants to work collaboratively to improve the health of the creek and the community. The SCCA demonstrated the commitment and effort of eight service-learners, 26 volunteers, and five faculty members. In addition, the SCCA was also a catalyst to other service-learning projects such as the database management system, IMS, Stakeholder Summit, Forum presentations, and several workshops. These projects proved beneficial to promoting community outreach while moving the Initiative to new levels of research and technology.

Many lessons were learned during the development of the Initiative. Lessons taking from the viewpoints of service-learners who participated in the Initiative and the project coordinator showed that sustainability of service-learning, low faculty and student participation, time management, and project coordination are four major challenges to the Initiative projects. Lessons to over come these challenges and to enhance service-learning experience in the Initiatives are to:

- Make a purposeful service-learning program
- Diversify the service-learning programs
- Provide opportunities for reflections on service experiences
- Provide for community input
- Evaluate the service-learning program.
- Provide opportunities for students to receive wage or credit
- Increase faculty and student participation to sustain service-learning in watershed management activities

Future work on the Initiative is expected to improve on the current projects for the purpose of enhancing both service-learning opportunities at Virginia Tech and the health of Stroubles Creek. Suggestions for enhancing and sustaining the Initiative expressed the need to plan long term, improve faculty, student and community commitment, and to harness university support to further promote service-learning throughout the institutions.

Support for the Initiative has grown since it's beginning in 1999. To date, the Initiative partnership includes students and faculty from the department of Urban Affairs and Planning, Environmental Science, Biology, Fisheries and Wildlife Sciences, Civil and Environmental Engineering, Computer Science, and Forestry. In addition, the Initiative has partnered with several community groups and agencies such as the Town of Blacksburg, SEEDS, New River Planning district, and the Department of Environmental Quality (DEQ). Developing a multi-faceted and multi-disciplinary group will foster innovative solutions to solving the water resource problems surrounding Stroubles Creek.