Project Final Report

for

A Grant Awarded through Section 319(h) Nonpoint Source Implementation Program
Cooperative Agreement (#C9994861-99)

under the

Section 319(h) Kentucky Nonpoint Source Implementation Grant Workplan

Introduction to Stream Geomorphic Assessment and Restoration on a Watershed Scale

Kentucky MOA M-04121023
Kentucky DOW NPS 99-32

April 1, 2004 to September 30, 2005

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Funding for this project was provided in part by a grant from the U.S. Environmental Protection Agency (USEPA) through the Kentucky Division of Water, Nonpoint Source Section, to The University of Louisville Research Foundation as authorized by the Clean Water Act Amendments of 1987, §319(h) Nonpoint Source Implementation Grant #C9994861-99. Mention of trade names or commercial products, if any, does not constitute endorsement. This document was printed on recycled paper.

Acknowledgements

Arthur C. Parola, Jr., Ph.D., Professor of Civil and Environmental Engineering at the University of Louisville and Director of the Stream Institute (ULSI), was the principal for this study, which included supervision of the development of workshop materials and supervision of the Wilson Creek enhancements.

Margi Swisher Jones, Technical Advisor for the Kentucky Nonpoint Source Pollution Control Program, Kentucky Division of Water, provided project oversight and presented lectures on stream impairments and the contribution of sediment and habitat disturbance.

Jon Walker, Forest Hydrologist for the US Forest Service, Daniel Boone National Forest, Winchester, Kentucky, developed and made presentations on the implications of watershed assessment for evaluating watershed problems.

Tony Able, Hydrogeologist for the US Environmental Protection Agency, Watershed Management Branch, Atlanta, Georgia, made a brief presentation on the need for a watershed perspective for developing management techniques that result in long-term improvements to the environment.

William S. Vesely, ULSI Research Project Engineer, managed on site construction activities for the enhancement of the Wilson Creek Restoration. He also was responsible for assembling workshop materials and lead field data collection activities.

Dana S. Kahn Jackman, M.S., ULSI Program Coordinator, administered the project for the Stream Institute and prepared Appendix A. She also facilitated and implemented workshop announcements, correspondence, logistics, and arrangements and served as geologic and educational consultant for development of the training materials.

Mark N. French, Professor of Civil and Environmental Engineering at the University of Louisville, contributed hydrologic background information for workshop development.

David K. Thaemert, M.S., ULSI Research Technologist Senior, Mr. Clayton C. Mastin, ULSI Research Assistant, and Mr. Jeffrey T. Schuchter, ULSI Research Assistant, assisted in the development and assembly of workshop materials

Chandra Hansen, ULSI Research Technical Writer, summarized and analyzed workshop evaluations and was the primary contributing writer of this report.

Honorable LaJuana S. Wilcher, Secretary for the Kentucky Environmental and Public Protection Cabinet, presented the keynote speech for the June 2005 workshop.

Sandi Formica, Executive Director for the Watershed Conservation Resource Center, presented an example of the use of watershed assessment as a strategy for reducing non-point source pollutants in the West Fork of the White River.

At Bernheim Arboretum and Research Forest in Clermont, Kentucky, Ronnie Moore, Natural Areas Technician, operated the equipment required for implementing the enhancements to Wilson Creek; Kani Myer provided the administrative supervision for the enhancement; Adam Dattilo supervised the revegetation and erosion control of Wilson Creek; Jeff Richmer assisted with both the construction and planting; and Jeff Pile assisted with construction. Bernheim Arboretum and Research Forest also provided meeting rooms for the June 2005 workshop and granted access to the research section of Bernheim Forest.

In Stanton, Kentucky, Mr. James E. Allen, Mrs. Betty Cecil, Mr. David F. Creech, and Mr. Fred C. Tuttle granted access to their property for use during the April 2005 workshop's field exercises. We are very grateful to these landowners for allowing workshop participants to access their property and for generously sharing the history of their land and streams that run through their property.

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Executive Summary

Section 319 of the Federal Clean Water Act Amendment of 1987 charges states with the development of programs to manage nonpoint sources of pollution from various land use activities. Educational initiatives implemented through cooperating organizations, agencies and institutions constitute an important component of the Kentucky Nonpoint Source Management Program. The University of Louisville Research Foundation and the Kentucky Division of Water entered into an agreement to implement an educational initiative with the goal of improving the state of knowledge and practice of (1) geomorphic assessment and management of watersheds, and (2) the use of stream restoration to improve water quality and stream habitat on a watershed scale. The three primary objectives established to meet this goal were:

1. The development and delivery of a 4-day workshop for water resources professionals and basin coordinators to introduce stream geomorphic assessment and restoration on a watershed scale.
2. The development and delivery of a similar 2-day workshop for state and municipal government managers responsible for decisions that affect watersheds.
3. The enhancement of the recently completed Wilson Creek restoration to be implemented by incorporating additional habitat structures, modifying flood conveyance areas, extending the zone of native riparian vegetation, and extending the restoration along a tributary. The recent restoration and its enhancement would be used to demonstrate (a) the importance of assessment and its implementation into the design of stream restoration, (b) construction techniques and issues, and (c) how stream restorations can be used to improve watershed conditions.

Two training workshops were planned, developed and delivered: a 4-day workshop for 30 water resources professionals and basin coordinators to introduce stream geomorphic assessment and restoration on a watershed scale; and a 2-day workshop for 17 federal, state and municipal government managers responsible for decisions that affect watersheds. The workshops were delivered as a combination of lectures and field stream walks, including a demonstration of the Wilson Creek restoration enhancement for the second workshop. The enhancement of Wilson Creek included revegetation and stabilization of channel banks, modification of floodplain topography, and the creation and planting of floodplain wetlands.

1. Introduction & Background

Historic land-use activities such as logging and agriculture have contributed to stream instability over much of the Commonwealth of Kentucky. More recent land-use activity such as large-scale channelization for agriculture and flood control, mining, and road construction continue to degrade stream networks. A widespread response of streams to these impacts is channel instability in the form of channel incision and associated bank erosion that releases fine-grained sediments into channel systems to be deposited downstream. This deposition, or siltation, compromises the integrity of gravel bed stream habitats and is one of the leading causes of stream impairment in Kentucky (Kentucky Division of Water, 2002). In addition, channel incision typically results in reduced channel variability and habitat quality. Channel instability also affects flood control. Channel bars and infilling occur in low gradient reaches of channel systems or where backwater is caused by flow obstructions such as bridges and culverts. In these depositional areas, bars deflect flow toward streambanks, causing additional bank erosion and channel migration. Bars and channel infilling reduce channel flood flow capacity. Municipal and state agencies responsible for maintaining flood flow capacity must periodically dredge channels, which further compromises aquatic habitat.

Stream restoration that includes natural channel design, bioengineering and other best management practices is now used widely in the Commonwealth to reverse the trend of continued stream degradation. Effective watershed assessment, however, is not typically completed for restoration projects, despite the importance of conducting watershed assessments and understanding stream systems on a watershed basis. Watershed assessment is critical both for the selection of stream reaches that can benefit from restoration and for effective restoration design. Design of stream restorations that will be self-sustaining requires techniques that create channels that fit into the evolution of a degraded channel system.

Comprehensive watershed assessment incorporates human, biochemical, and physical watershed evaluations. In general, stream reaches cannot be considered “isolated” from the rest of the watershed, even if the reach being restored is in an otherwise “pristine” stream system or watershed. In most cases, the sediment and debris load produced by what is typically a disturbed and evolving upstream watershed will have long-term effects on the evolution of the stream reach being restored. Because channel instability caused by incision is typically initiated from downstream disturbances, the stability of the channel network downstream of the restoration is as critical as the channel network upstream of the restored reach.

One reason for the lack of watershed assessment is the lack of trained personnel who can efficiently conduct assessments. State and federal agency personnel are in need of both workshops to provide them with basic knowledge that will be useful in determining the appropriateness of restorations and how restoration projects may affect watersheds. Watershed resource agencies in the Big Sandy watershed have identified stream restoration and channel stabilization training as a top priority. The goal of this project was to improve the state of knowledge and practice of (1) geomorphic assessment and management of watersheds, and (2) the use of stream restoration to improve water quality and stream habitat on a watershed scale.

The project included three primary objectives to facilitate the accomplishment of this goal. The first objective was to develop and conduct a 4-day workshop designed for water resources professionals and basin coordinators to introduce stream geomorphic assessment and restoration on a watershed scale. The second objective was to develop a similar but less intensive 2-day workshop designed for state and municipal government managers who are responsible for

decisions that affect watersheds: transportation managers, municipal government employees, and state water resource managers. The third objective was to enhance the recently completed Wilson Creek restoration by incorporating additional habitat structures, modifying flood conveyance areas, extending the zone of native riparian vegetation, and extending the restoration along a tributary. Information from the assessment, design, and monitoring of this recently completed restoration was used to illustrate (1) the importance of assessment and its implementation into the design of stream restoration, (2) construction techniques and issues, and (3) how stream restorations can be used to improve watershed conditions.

2. Materials & Methods

Description of the Project Area

The 2700-foot reach of Wilson Creek that was originally restored in 2003 is a third-order stream located within the Bernheim Arboretum and Research Forest about 37 miles south of Louisville, Kentucky. Harts Run tributary flows into Wilson Creek approximately 3280 feet downstream of the restoration site. A relatively mature (more than 50 years) riparian canopy, dominated by white oaks (*Quercus alba*) and sycamores (*Platanus occidentalis*), shades both Wilson Creek and Harts Run.

Wilson Creek, like many Kentucky streams, had previously been channelized and relocated to its floodplain margin adjacent to the valley hill slope for agricultural land-use. As a result of these modifications, the channel had incised and was entrenched and confined, with a bankfull capacity comparable to a 10-year event. Using a combination of analytical and empirical (Rosgen, 1996) assessment and design techniques, parameters for channel slope, bankfull dimensions, channel pattern beltwidth, and bend radius were developed. The restoration produced a sinuous channel of approximately 3147 feet in length.

Stream Geomorphic Assessment Methods

Numerous anthropogenic impacts to streams within the Commonwealth, including those associated with silviculture, agriculture, transportation and mining, were identified by Coleman (1971). Simpson (1999) detailed probable sources of stream impact timelines back to the mid-nineteenth century for eastern and western portions of the state. Their work indicates the extent of channel modifications throughout the state and on large and small systems alike. These physical modifications (e.g., a prismatic channel constructed of a riffle-pool system) often cause channel instability and may severely debilitate the ecological function of the system. Given these historical impacts, it can be deduced from current physical conditions that these systems proceed through an evolutionary process and may approach an equilibrium condition. Evolutionary models have been developed for various conditions and stream types (Simon and Hupp, 1986; Watson et al., 1986; Simon, 1989; and Rosgen, 1996), many of which have some application to systems within the Commonwealth.

These morphological adjustments are the response to catchment inputs—specifically, discharge, debris and sediment—and thus require an understanding of hydraulic, geologic and morphologic elements of the system. Considering these adjustment processes, Mackin (1948) defined a graded stream as one in which, over a period of years, slope is delicately adjusted to provide, with available discharge and prevailing channel characteristics, just the velocity required for the transportation of the load supplied from the drainage basin. It is thought that, over time, the more frequent discharge events of lesser magnitude are the dominant control on channel morphology (Wolman and Miller 1960). This dominant discharge has been associated to a bankfull morphological channel form (Leopold and Maddock 1953), though is debated amongst various researchers (Williams, 1978; Pickup and Warner, 1976, reviewed in Knighton, 1998). More recent work by Rosgen (1994, 1996) has integrated these concepts into stream assessment methods and an expansive stream classification system extensively utilized throughout the United States. These assessment methods, and the hydraulic, sediment transport and morphologic concepts which form their basis, provide the framework used in this program for watershed assessment and stream restoration.

A major component of the methodology developed by Rosgen (1996) is the classification of streams based primarily on channel geometric similarity and channel materials. Although the training materials developed in this project use many of the field techniques and the classification system from Rosgen (1996), they are also supplemented with other more general geomorphic concepts summarized in such references as Knighton (1998), Thorne (1998), and Thorne, Hey, and Newson (1998), and with hydraulic and sediment transport concepts that can be found in such text as Chow (1959), Henderson (1966), Chanson (1999) and Julien (1995). Because the bank erosion process is typically an important component of stream assessments, extensive information on the full cycle of bank retreat, including such processes as mass failure, the impact of vegetation, basal erosion, piping, and weathering and erosion of mass failure debris, have been included. In addition, methods of evaluating the rate of bank erosion developed by Rosgen (1996) have also been included.

Stream Restoration Methods on a Watershed Scale

Stream restoration activities are broadly defined herein as activities undertaken to enhance, rehabilitate and/or recreate stream systems which are physically and biologically sustainable and functional. Kentucky streams have been impacted by landuse changes in its watersheds and direct channel modification over the last 150 years (Coleman 1971). Land clearing, silviculture, agriculture, mining and transportation have had widespread direct and indirect impacts to Kentucky streams.

Attempts to improve stream habitat have been ongoing for greater than 10 years within the Commonwealth. Advancements in the fields of hydraulics, geomorphology and ecology during this time have significantly influenced the approach to stream geomorphic assessment and restoration techniques. The effective use of these techniques requires detailed physical and biological assessment of stream conditions such that considerations for the complexity and dynamics of natural fluvial systems can be incorporated into channel design. In addition to the application of fundamental principles of ecology, geomorphology and hydrology, the specific regional characteristics of the stream systems must be incorporated into natural channel design to develop stable streams with improved ecological function and sustainability.

Field Reconnaissance

Field reconnaissance sessions were conducted over a period of one week in the vicinity of Natural Bridge State Resort Park in order to collect information for use in preparing training materials and to identify locations to be used for field exercises for the April 2005 workshop. The complexity of the assessments conducted during these reconnaissance sessions ranged from developing a set of hypotheses, based on a visual assessment made by simply walking the stream, about the current stream conditions and potential causes of local instability to performing more complete quantitative geomorphic assessments.

Personnel conducting the field reconnaissance identified various landscapes; the fluvial systems formed by them; and the impacts to, failure mechanisms of, and subsequent evolutionary responses of these systems. Reconnaissance activities included the identification of common and significant physical stream impairments, the assessment of the geomorphic response of systems to impairments and their physiographic settings, and the integration of these findings into the Rosgen classification and assessment schemata.

While walking the streams, reconnaissance personnel approached property owners for permission to walk the reaches extending onto or through their land. The property owners also shared the history of their land, its uses, and the streams running through it. In those instances

where access to privately owned land would be needed for the April 2005 workshop field exercises, permission to conduct the field exercises was requested and documented through the use of forms releasing the property holders from any and all liability resulting from the use of their property by the University and participants for the purpose of the workshop.

Workshop Development and Delivery

Two training workshops were planned, developed and delivered: a 4-day workshop designed for 20-to-30 water resources professionals and basin coordinators to introduce stream geomorphic assessment and restoration on a watershed scale; and a 2-day workshop designed for 20 state and municipal government managers who are responsible for decisions that affect watersheds. (See Appendix D for a list of materials submitted with this report and exhibits of announcements and application forms used in the planning and organization of the workshops).

Workshop Planning and Organization

The first workshop, **Introduction to Stream Geomorphic Assessment and Stream Restoration on a Watershed Scale**, was planned as a 4-day training session to be offered in April 2005 for water resources professionals and basin coordinators. Potential venues were restricted to the eastern part of the state to accommodate potential participants from the Big Sandy, Licking and Kentucky River Basin management areas; Natural Bridge State Resort Park was selected as the final venue.

An agenda for the 4-day April workshop was developed and submitted for approval to the Nonpoint Source (NPS) Program. The approved agenda was later provided to workshop attendees as part of their course notebooks. An advertisement and application (see Appendix D) to participate in the workshop was created and provided to the NPS Program for approval. The project manager worked with the Cabinet to distribute the advertisement and application to the electronic mailing list for Kentucky Division of Water's (KDOW) Nonpoint Source Pollution Control Program; to the Natural Channel Design Working Group, including employees of Kentucky Department of Fish and Wildlife Resources, Kentucky Division of Water, Kentucky Transportation Cabinet, Northern Kentucky University, The Center for Applied Ecology, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Forest Service, and the University of Louisville; and to those individuals who had applied to and/or participated in the 2004 Fundamentals of Watershed Assessment and Restoration Workshop. The announcement also eventually circulated through other mailing lists.

A total of 79 individuals applied, while an additional 5 individuals expressed an interest in participating but did not submit an application. To address the Big Sandy watershed resource agencies' identified need for stream restoration and channel stabilization training, priority in selection of participants was given to federal, state and local agency personnel who regulate, conduct or assist in stream restorations in the Big Sandy, Licking and Kentucky River Basin management areas. Of the 79 total applicants, 30 were accepted and the remaining 49 were waitlisted according to how closely they matched the screening criteria; a total of six accepted applicants withdrew before the workshop commenced and the first six waitlisted applicants were admitted in their place.

Applicants were notified of their acceptance and were asked to confirm their attendance within a week by signing and returning a form to release the University of Louisville and the owners of the property to be visited during field exercises from any and all liability, claims, damages, and expenses arising out of their participation in the course field exercises. To assist attendees in preparing for the workshop, accepted applicants were reminded of the course dates

and given a brief overview of the course format, including anticipated meeting times. They were also provided with contact information for the venue and invited to reserve one of the rooms or cabins in the block held for workshop participants.

Once applicants had confirmed their attendance, they were reminded of the anticipated meeting times (8:30 a.m. to 8:30 p.m.), given information regarding the provision or availability of beverages, snacks and meals during the workshop, and asked to identify any applicable dietary restrictions. They were also notified that they would spend time in the field on two days (transported via chartered bus) and were asked to bring supplies: pencils and pens, a notepad, a calculator, a computer notebook/laptop (if possible), a field pack, water bottles, waders, sun protection (hat, sunglasses, sunscreen), rain gear, and insect repellant. To facilitate the distribution of equipment for use by small study and working groups, attendees were asked to confirm whether they were bringing a digital camera and/or laptop computer. Finally, confirmed attendees were given check-in information and driving directions to the venue.

Literature Review for Workshop Materials

A literature search was conducted for documents and books providing information on stream channel physical assessment and stream restoration techniques and methodologies. This literature search included topics on sediment transport, hydraulics and hydrology, and fluvial geomorphology, considering levels of inquiry from watershed to reach scales.

Production of Workshop Materials

The April workshop was planned as a combination classroom- and field-based training in which groups of participants would complete and present an assessment of a watershed as a capstone project. Teaching materials, including class notebooks, were therefore developed to provide a combination of lectures, class exercises and walks of streams in the field. Workshop notebook materials were designed to introduce and illustrate restoration concepts and techniques of geomorphic assessment useful for evaluating stream stability and sedimentation problems on a watershed scale.

A draft notebook for the first workshop was submitted to the NPS Program for approval. After approval of the materials, notebooks for a minimum of 20 but not more than 30 individuals for each workshop were produced. The training materials for the first workshop included the following areas of focus:

- introduction to stream geomorphic assessment and stream restoration on a watershed scale
- basic terminology
- stream response to disturbance: channel evolution
- bankfull flow
- Rosgen stream reach classification
- reach-scale survey techniques
- surface particle sampling: pebble count procedure
- field forms
- legacy effects from historic land and stream use
- bank erosion
- valley forms
- watershed assessment example
- urban streams / stream restoration

Delivery of Workshop

The first workshop was offered over four consecutive days from 12 April through 15 April 2005 at Natural Bridge State Park, Slade, Kentucky. Thirty applicants were accepted and attended the first workshop; all but one participant, who was recalled to his office, completed the four days of training. Participants were provided with the following materials:

- One class notebook containing presentations, field data collection forms and an all-weather notebook, maps, a glossary of terms, and a list of references
- One field notebook containing duplicate copies of the field data collection forms

The training team, composed of the principal investigator, the project coordinator and four assistants, jointly provided the 4-day training. The format included a total of one-and-a-half days of field reconnaissance and data collection and two-and-a-half days of classroom instruction, activities and lecture, including evening sessions and presentations from participant workgroups.

Lectures were primarily the responsibility of the principal investigator. During hands-on workshops, several assistants were available to help participants complete the exercises. In field walks, techniques for assessing sediment sources and geomorphic controls were illustrated. Assistants with backgrounds in the fields of geomorphology, hydrology, characterization and transport of sediments, natural channel forms and design, and stream restoration provided guidance to participants with field assessment and measurement techniques and data analysis methods. Field activities included:

- stream reconnaissance sessions on morphological components of the streams, with emphasis on identification of bankfull features
- utilization of stream gage station data
- topographic surveys of channel planform, profile and cross-section geometry
- substrate composition sampling and analysis
- bank profile measurements and interpretation of geological influences; data analysis methods were designed to classify the reach using Rosgen classification criteria
- assessment of system stability and evolutionary stage
- analysis of stream gage data for rating and flood-frequency curve development
- estimation of sediment mobility

Workshop Planning and Organization

The second workshop, **Stream Geomorphic Assessment and Restoration on a Watershed Scale: An Overview for Water Resource Managers, Planners and Policy Makers**, was planned as a 2-day June training session on stream restoration and stream geomorphology, with an emphasis on sedimentation and impacts on watersheds. The workshop's targeted audience was federal, state and municipal government managers, planners, and policy makers who are responsible for decisions that affect watersheds: transportation managers, municipal government employees, and state water resource managers. Potential venues were restricted to the central part of the state to accommodate the largest number of municipal and government managers; Bernheim Arboretum and Research Forest, location of the Wilson Creek stream restoration site, was selected as the sole venue in order to provide a field demonstration of Wilson Creek restoration and enhancement for agency personnel while also minimizing the amount of time needed to transition between the classroom and the field.

A specific agenda for the workshop was developed and submitted for approval to the NPS Program. The approved agenda was later provided to workshop attendees as part of their course notebooks. An invitation (see Appendix D) to participate in the workshop was created and provided to the NPS Program for approval. The project manager worked with the Cabinet to distribute the invitations to individuals in federal, state and Kentucky municipal agencies involved in stream restoration, including Kentucky Division of Water, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, Kentucky Department of Fish and Wildlife Resources, Kentucky Transportation Cabinet, U.S. Forest Service, and the Kentucky Division of Mine Permits. Twenty invitees confirmed they would attend.

Invitees were reminded of the venue, dates and times of the workshop and related events, given information regarding the provision of beverages, snacks and lunches during the workshop, and asked to identify any applicable dietary restrictions. They were also given contact and listed rate information for six hotels within 15 miles of the workshop location. They were also asked to bring supplies: pencils and pens, a calculator, sun protection (hat, sunglasses, sunscreen), rain gear, insect repellant, and shoes (preferably hiking boots) for walking in shallow, steep headwater streams. Finally, confirmed attendees were given registration information and driving directions to the venue.

Production of Workshop Materials

The delivery of the 2-day workshop was planned as a combination of lectures and field stream walks, including a demonstration of the Wilson Creek restoration. Teaching materials, including class notebooks, were distilled from the 4-day workshop to present in a clear and simple format the critical components of sedimentation, stream instability and geomorphic assessment.

A draft notebook for the workshop was submitted to the NPS Program for approval. After approval of the materials, notebooks were produced for 20 individuals for the second workshop. The training materials for the second workshop included the following areas of focus:

- introduction to stream geomorphic assessment and restoration on a watershed scale
- geomorphic assessment
- basic terminology
- stream response to disturbance: channel evolution
- bankfull stage and flow
- Rosgen stream reach classification
- legacy effects from historic land and stream use
- geologic considerations
- stream restoration I: a general overview
- stream restoration II: natural channel design at Wilson Creek

Delivery of Workshop

The workshop was offered over two consecutive days from 21 June through 22 June 2005 at Bernheim Arboretum and Research Forest, Clermont, Kentucky. Of the federal, state and municipal government managers who were invited to the second workshop, 19 indicated they would participate; 17 attended and all 17 completed the two days of training. Participants were provided with a class notebook containing presentations, maps, a glossary of terms, and a list of references.

The training team, composed of the principal investigator, project coordinator and five assistants, jointly provided the 2-day training. The format included two mornings of field walks of the Wilson Creek restoration and two afternoons of classroom instruction. The field walks were used to illustrate important geomorphic processes occurring on a watershed scale and their impact on stream stability, bank erosion, sediment supply and stream habitat. Lectures were primarily the responsibility of the principal investigator.

Enhancement and Demonstration of Stream Restoration at Wilson Creek

In 2003, the restoration of approximately 3147 feet of the Wilson Creek channel was completed under the project (KDOW NPS 00-15) entitled "Channel Restoration and Riparian Reforestation Along Wilson Creek: A Demonstration Site." The work was overseen by the Kentucky Division of Water and funded by a grant awarded through Section 319(h) Nonpoint Source Implementation Program Cooperative Agreement #C9994861-00. The permits acquired for this prior work made obtaining new permits unnecessary.

The original restoration design allowed for overflow of the banks onto the floodplain. Some low areas along the floodplain were also designed as seasonal wetlands. Once the stream bed was relocated and restored, more than 40 species of vegetation, the majority of which were native to Bernheim, were planted along the banks and in the floodplain. Three factors, however, contributed both to the erosion of the newly constructed streambanks and the floodplain and to the loss of newly sown vegetation: (1) the unexpected delay of seeding until October, which did not allow enough time for the vegetation to adequately cover the banks and floodplain before winter; (2) abnormally high precipitation during the winter following the restoration which led to a higher than normal frequency of out-of-bank events; and (3) relatively low banks of the restored section which were intended to allow for greater frequency of out-of-bank events even with normal precipitation levels but which also introduced a higher risk of erosion during the period preceding the firm establishment of vegetation on the banks and floodplain.

As a consequence of the lack of bank vegetation, bank erosion occurred at many locations along the riffles. In addition, the lack of vegetation on the floodplain surface and the absence of flow resistance and erosion protection of floodplain soil resulted in a loss of floodplain surface material. Erosion was most severe over the upper third of the banks of riffles where flows overtopped the stream banks and on the floodplain surface where the flow dispersed into the floodplain after overtopping the streambanks. Observations during and immediately after flood events indicated that as flow transferred from the channel into the floodplain it accelerated as it passed over the top of the banks.

After several floods, rills formed and concentrated flow leaving the channel. Erosion was initiated from the top of the bank, gradually forming rills that lowered the bank elevation, allowing progressively concentrated flow to exit the channel during subsequent flow events. This problem likely would not have occurred if vegetation had been established on the top of the bank prior to flooding; evaluation of this erosion process and pattern, however, indicated the need for a change in the design of topography of the floodplain near the upper third of the riffles in order to avoid this type of erosion that may be likely before bank and floodplain vegetation is established.

While the original objective of the enhancement of the Wilson Creek restoration had included extending the restoration along Dunn Hollow tributary, the additional expense of the revegetation of the banks and floodplain precluded the tributary work. The originally planned enhancements were therefore modified to include revegetation and stabilization of channel banks, modification of floodplain topography, and the creation and planting of floodplain

wetlands. Restoration enhancements were designed and a BMP plan was submitted to the Cabinet for approval (see Appendix B).

The enhancement project was used to change floodplain topography and establish vegetation on the stream banks in the regions of the channel most susceptible to rapid bank erosion. Figure 1 shows the section of bank prior to changes in floodplain topography and bank revegetation. Figure 2 is an aerial photograph taken after the floodplain topography was altered and the banks were covered in sod excavated from the Wilson Creek valley bottom upstream of the restoration reach.

Floodplain Topographic Changes and Flow Control Berms

The elevation of the floodplain was raised approximately 0.5 to 1.0 feet outside of and on the downstream end of bends and was tapered to the existing floodplain level approximately one-third of the distance down the riffle. This increased the elevation at which flood flows will be able to access the floodplain in the upper third of the riffle.

Four sod berms (see Figure 2 and Figure 3 for examples) were constructed about 0.5 feet above the existing floodplain surface. These berms were constructed perpendicular to the downstream slope of the floodplain at three locations to provide temporary control of the floodplain water surface elevations until vegetation roughened and protected the floodplain.

Increased Flood Conveyance

Flow conveyance was increased in one location near Dunn Hollow tributary to reduce floodplain flow velocity and enhance the natural recovery of the portion of the tributary that traverses the floodplain of Wilson Creek. This was accomplished by excavation of material on the floodplain upstream of the Dunn Hollow tributary, as indicated in Figure 2.

Figure 1 Flow overtops banks as it leaves the bend. Note the erosion control matting is still in place at the toe of the bank downstream of the bend. Ruts have formed in the unvegetated floodplain and on the top of the bank near the flow indication arrows.

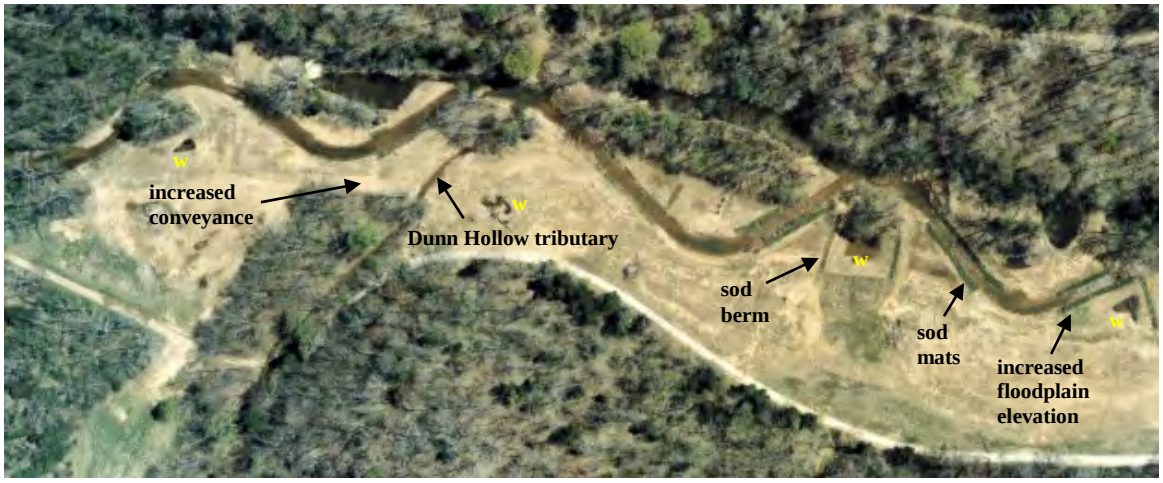

Figure 2 Aerial photo showing elements of floodplain and channel changes (upstream section of restoration). The letter "w" indicates a location of a wetland created during the enhancement project.

Figure 3 Aerial photo showing elements of floodplain and channel changes (downstream section of restoration). The letter "w" indicates a location of a wetland created during the enhancement project.

Revegetation of Banks

Sod mats were placed along the banks of riffles over all but the most upstream riffle. The dark green strips shown in Figure 2 and Figure 3 indicate the extent of the sod mats. Harvested from a floodplain field located approximately 3000 feet upstream of the restoration, the mats

(4-by-8-by-0.75 feet) were cut and transported using a specially designed plate with a cutting edge attached to a Bob Cat. The mats were cut and loaded onto a trailer covered with a thin plate cover to allow for the sod to slide on and off easily without destroying the mat integrity. An excavator and Bob Cat were used to prepare and unload the banks for the sod mats, which were transported four at a time to a riffle where they were unloaded and placed on the streambank.

Erosion Control Fabric

A jute fiber erosion control fabric was used to cover straw and ground cover seed mix on the floodplain surrounding the sod mats. The fabric was staked down using 1.0-foot-long 1"-by-2" wooden stakes with a nail placed through a predrilled hole on the top to hold the matting in place. The edge of the matting was buried on the most upstream side and was overlapped to prevent flow from lifting the fabric. Steel staples approximately 0.5 feet long were placed between stakes to hold the matting in place. The matting was used to cover any loose soil placed on the floodplain and within 12 feet of the edge of sod mats.

Wetlands

Several small floodplain wetlands were created to improve wetland habitat diversity. Some wetlands were created in locations of high groundwater levels between the pre-restoration channels that are now floodplain ponds and the restored channel. Others were created in large areas of floodplain to provide a location of sediment deposition. In May 2005, wetland plugs consisting of 1140 plants of 15 different species (see Table 1) were planted with the assistance of students from St. Leonard elementary school in Louisville, Kentucky.

Enhancement of Reforestation Effort

After construction activities were completed during March of 2005, 500 sycamore and 500 swamp white oak saplings were planted along the riffle areas of the stream in April 2005.

Table 1 Wilson Creek Stream Restoration Site Wetlands Plantings, 2005

Number of Plants	Species Name
76	*Carex comosa*
76	*Carex frankii*
76	*Carex hystericina*
76	*Carex lurida*
76	*Carex scoparia*
76	*Carex tribuloides*
76	*Eleocharis obtuse*
76	*Eleocharis palustris major*
76	*Eupatorium perfoliatum*
76	*Glyceria striata*
76	*Helenium atumnale*
76	*Hibiscus laevis*
76	*Scirpus atrovirens*
76	*Scirpus cyperinus*
76	*Scirpus pungens*

3. Results & Discussion

The training workshops were designed for two primary groups: federal, state and local agency personnel who regulate, conduct or assist in stream restorations in the Big Sandy River Basin Unit; and state and municipal government managers, planners, and policy makers who are responsible for decisions that affect watersheds. The participants of the 4-day April 2005 training included a broad range of personnel: 1 assistant professor of geology; 1 biological science technician; 7 biologists; 2 civil engineers; 1 maintenance engineer; 1 planning engineer; 10 environmental or basin coordinators; 1 environmental inspector; 2 environmental scientists; 1 environmental technologist; 1 nonpoint source technical advisor; and 1 source water protection specialist. Participants represented one public higher education institution, one non-governmental organization, five state agencies, and three federal agencies (see Table 2). Those 43 applicants for whom space was not available included 22 applicants from 1 federal and 4 state agencies; 4 applicants from 3 public higher education institutions; 6 applicants from non-governmental organizations; 15 applicants from private enterprises; and 2 applicants whose interest was primarily personal.

Table 2 April 2005 Workshop Participants' Agency Representation

Number of Participants	Agency Represented
1	Eastern Kentucky University
1	Kentucky Rural Water Association
3	Kentucky Department of Fish and Wildlife Resources
2	Kentucky Division of Abandoned Mine Lands
11	Kentucky Division of Water
5	Kentucky Transportation Cabinet
1	Kentucky Water Resources Research Institute
1	U.S. Army Corps of Engineers
3	U.S. Department of Agriculture, Natural Resources Conservation Service
2	U.S. Fish and Wildlife Service

Participants in the 2-day June 2005 workshop included 1 commissioner, 1 deputy commissioner, 2 regulatory chiefs, 1 branch chief, 2 branch managers, 1 environmental section chief, 2 environmental control supervisors, 3 section supervisors, 1 state field office supervisor, 2 supervisory biologists, 1 environmental scientist, 1 environmental engineer, 1 ecologist, and 1 assistant ranger. These 17 participants represented 5 state and 4 federal agencies (see Table 3). The U.S. Department of Agriculture's Natural Resources Conservation Service was unable to send any personnel to the June workshop. One individual from the Kentucky Department for Natural Resources intended to participate but was unable to attend.

Table 3 June 2005 Workshop Participants' Agency Representation

Number of Participants	Agency Represented
1	Kentucky Division of Mine Permits
4	Kentucky Division of Water
1	Kentucky Department of Fish and Wildlife Resources
1	Kentucky Environmental and Public Protection Cabinet
1	Kentucky Transportation Cabinet, Division of Environmental Analysis
4	U.S. Army Corps of Engineers
3	U.S. Environmental Protection Agency
1	U.S. Fish and Wildlife Service
1	U.S. Forest Service

Measurement of Success

The primary measure of success, which could not be evaluated within the project timeframe, will be an increased level of awareness of the cause and effect of activities within a watershed on stream stability and the use of stream restoration to improve water quality and stream habitat on a watershed scale. Within the duration of this project, the primary measures of success for the two workshops were the level of participation in the workshops (number of people trained) and participant evaluations of the effectiveness of the training within the workshops. Measures of success for the Wilson Creek demonstration include the number of participants attending the field day workshops as well as implementation and demonstration of the restoration enhancement design.

Each workshop garnered a high level of participation. For the April workshop, a minimum of 20 attendees were expected; the workshop was filled to capacity with 30 attendees, 29 of whom completed the entire training. All 30 of the April workshop participants completed workshop evaluations. The June workshop enrollment was planned and confirmed for 20 attendees. Just prior to the workshop, 3 participants had to withdraw, leaving 17 who attended and completed the workshop and visited Wilson Creek for a demonstration of its restoration and enhancement. Fifteen of the June workshop participants completed evaluations.

The primary intent of the evaluation questionnaire was twofold: to measure audience knowledge prior to and after exposure to the training material; and to assess the effectiveness of the workshop content, format, and delivery. Complete verbatim responses to all open-ended evaluation questions and summaries of all closed-ended questions are provided in Appendix C.

Evaluations of the April 2005 Training Workshop

The background and field of work of the participants was diverse. Seven participants identified only biology/ecology as their field of work; one identified only forestry; two identified only geography/geology; and five classified their field of work as "other." The remaining fifteen participants indicated multiple fields of work, including various combinations of biology/ ecology, engineering, forestry, geography/geology, hydrology, and "other."

The types of stream related projects participants identified as something they currently work on or expect to work on were also diverse, though some types of projects were more common than others. More than 65% of the participants identified streambank stabilization (26

participants), implementing best management practices (23 participants), and/or water quality improvements (20 participants) as types of stream related projects they currently work on or expect to work on following the training. See Figure 4 for the distribution of participants' current or expected types of projects.

The evaluation questionnaire asked participants to rate their knowledge of stream geomorphology prior to having attended the training workshop; 8 of 30 (27%) considered themselves "not knowledgeable," 18 of 30 (60%) considered themselves "somewhat knowledgeable," and 4 of 30 (13%) considered themselves "knowledgeable" or "very knowledgeable."

The participants were almost evenly split in their familiarity with the Rosgen stream classification system prior to having attended the workshop: 14 of 30 (47%) had no knowledge of the system or had heard of it but were not familiar with its meaning; 13 of 30 (43%) had known something about the system but were not familiar with its techniques; the remaining 3 participants (10%) had been well acquainted with the system and its techniques.

When asked to describe how their base of knowledge/skills had increased by taking the course, 22 of 30 (73%) indicated "a lot" or "a great deal"; 8 participants (27%) indicated "a little" or "somewhat." Those participants who had started the course with the least knowledge of stream geomorphology and function indicated the greatest level of increase in their knowledge/skills: of the 26 who had originally considered themselves either not knowledgeable or only somewhat knowledgeable, all but 5 characterized the increase of their base of knowledge/skills as "a lot" or "a great deal."

Based on the knowledge and practice they obtained in the course, 24 of the 30 participants (80%) expressed at least some level of confidence in their ability to classify/assess a stream reach and restore a watershed: 8 of 30 (27%) were confident and 16 of 30 (53%) were somewhat confident. Only 6 participants (20%) expressed no confidence, and 4 of those 6 had had little or no knowledge of either stream geomorphology or the Rosgen system prior to taking the course. Some participants characterized their general comfort levels as enough to use in their work and several observed that they expected to grow more confident with additional time and practice. Had the question addressed only stream classification and assessment, however, the confidence levels expressed by participants likely would have been even higher. Four participants specifically identified restoration as something with which they were not yet comfortable. One participant suggested that "a working group of colleagues would make us more comfortable in making assessments & restorations" by providing a network for addressing questions in future situations. In response to question 24's request

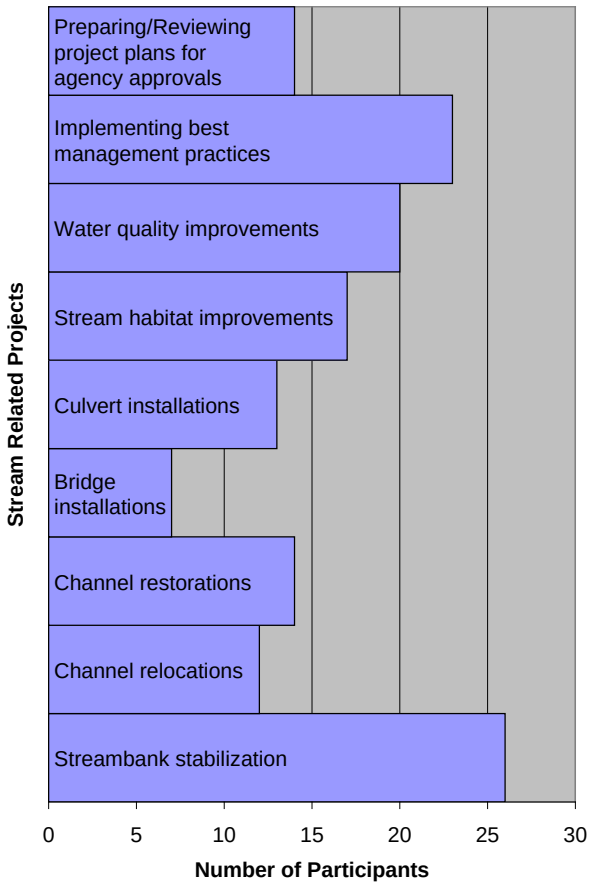

Figure 4 April 2005 Participants' Current or Expected Future Types of Stream Related Projects

for additional comments or suggestions, another respondent made a similar suggestion that a list of participants be distributed at the workshop.

The workshop succeeded in meeting or exceeding the expectations of most of the participants: 24 of 30 (80%) indicated that the course either exceeded their expectations or matched them "a lot" or "a great deal." Of the 6 participants who felt the course matched their expectations "a little" or "somewhat," one explained that he/she had "expected to feel more confident in applying course concepts to stream issues" and felt that further training would be necessary to make usage of the concepts practical; another had "thought there would be more focus on the actual restoration techniques." The classroom and field instructors were overwhelmingly perceived as "very knowledgeable," and were described as "enthusiastic," "impressive," and "approachable."

Participants indicated that the course content was useful for understanding the basic principles of geomorphology, stream assessment methods, and the regional characteristics of Kentucky streams. They found the class presentations, map exercises and binder each to be helpful (see Table 4) in learning the material; 19 to 21 of 30 (63–70%) indicated they helped "a lot" or "a great deal" in learning or understanding the material. Nearly everyone felt the course materials would serve as useful references in the future, describing them as "very well put together," "an effect[ive] reference manual for during class and after," and "a great post-course resource." Two participants felt the materials were useful but having an electronic copy of the PowerPoint lectures or a written copy of the lecture notes would make the course materials even more useful as a future reference.

Table 4 Summary of Learning Outcomes from Various Training Components (April 2005)

	Question	Very little	A little	Somewhat	A lot	A great deal
7)	To what extent did the **class presentations** help you learn the material?	0	2	8	12	8
8)	To what extent did the **class (map) exercises** help you learn the material?	1	1	7	15	6
9)	To what extent did the **field exercises** help you learn the material?	0	0	3	6	19
10)	To what extent did the **guest lecture by Sandi Formica** help you learn the material?	2	2	12	6	2
13)	To what extent did **resources in the binder** help you understand the material?	0	2	8	13	6

Several participants felt the map exercises were helpful preparation for the field exercises; one suggested making the map information available on GIS as well. While participants found the guest lecture to be less useful for learning the course material than other components were, many participants expressed appreciation of the "real life" examples it offered and found them very useful.

Field exercises were seen as more helpful than any other course component: 19 of the 28 participants who answered this question characterized the field exercises as helping them "a great deal" in learning the material, and all participants found them to be at least "somewhat" useful. Participants described the field work as "great!" "critical," "one of the best parts of the class," the "most helpful training," "extremely" helpful and effective, and "invaluable." A common piece of constructive criticism was that the groups for field exercises, projects and

homework be made smaller; at least seven identified the size of the groups as something they would change.

When asked to identify the topics they found most beneficial, several participants again chose the field exercises, indicating that the field observations, instruction and data collection were essential training components. Although field activities accounted for nearly 40% of the training time, some participants recommended that additional time be spent in the field. Participants emphasized the value of "hands on" field data collection and analysis. Group presentations of field materials by attendees provided additional incentive to actively learn stream assessment procedures and their relationship to stream mechanics and dynamics. As one participant commented, "You must understand the materials to be able to present them."

Other topics commonly identified as the most beneficial were the historical perspective, stream disturbance, and basic terminology. Several respondents indicated that the historical perspective was one they hadn't previously considered. At least half of the participants found all of the course topics to be useful, beneficial, or integral to the course and could not identify a single topic that was not useful. Other topics, including the Rosgen classification system, elicited mixed responses: some cited the Rosgen material as the most beneficial, while others found it to be the least useful because it was information they either already had or did not expect to use.

Nearly everyone indicated they would recommend the course if it were offered again, and at least one-third emphasized they would "definitely," "absolutely," or otherwise emphatically recommend the course. Only one participant would "probably not" recommend the course because of the intensive schedule and the course's "lack of mentioning the different restoration practices" and their implementation; a few others would limit their recommendations to people working in particular fields. The intensive schedule was cited more than anything else as something that should be changed to improve the course. At least 14 respondents suggested lengthening the workshop to at least five days to allow the class to finish earlier in the evenings. Several attendees indicated they would like the opportunity to take a follow-up course or even to repeat the one that was offered.

Evaluations of the June 2005 Training Workshop

The background and field of work of the June 2005 workshop participants was somewhat less diverse than in the first workshop but still varied. Six participants identified only biology/ecology as their field of work, and two identified only engineering. The remaining seven respondents indicated multiple fields of work, including various combinations of biology/ecology, engineering, forestry, geography/geology, hydrology, and "other."

The types of stream related projects participants identified as something they currently work on or expect to work on were also diverse, though all types of projects were almost equally represented. More than 73% of the 15 respondents identified implementing best management practices (11 participants) and/or water preparing/reviewing project plans for agency approvals (11 participants) as types of stream related projects they currently work on or expect to work on following the training. See Figure 5 for the distribution of participants' current or expected types of projects.

The evaluation questionnaire asked participants to rate their knowledge of stream geomorphology prior to having attended the training workshop; 1 of 15 (7%) considered him/herself "not knowledgeable," 13 of 15 (87%) considered themselves "somewhat knowledgeable," and 1 of 15 (13%) considered him/herself "knowledgeable." None of the June 2005 workshop participants considered him/herself "very knowledgeable."

The participants were fairly familiar with the Rosgen stream classification system prior to having attended the workshop: only 3 of 15 (20%) had no knowledge of the system or had heard of it but were not familiar with its meaning; 8 of 15 (53%) had known something about the system but were not familiar with its techniques; the remaining 4 participants (27%) had been well acquainted with the system and its techniques.

When asked to describe how their base of knowledge/skills had increased by taking the course, 10 of 15 (67%) indicated "a lot," and 5 participants (33%) indicated "somewhat." Based on the knowledge and practice they obtained in the course, 13 of the 15 respondents (87%) expressed at lease some level of confidence in their ability to classify/assess a stream reach and restore a watershed: 5 of 15 (33%) were confident or very confident and 8 of 15 (53%) were somewhat confident. Only 2 participants (13%) expressed no confidence.

The workshop succeeded in meeting or exceeding the expectations of all of the participants: all 15 respondents indicated that the course either exceeded their expectations or matched them "a lot" or "a great deal." The classroom and field instructors were overwhelmingly perceived as "very knowledgeable," and were described as "excellent."

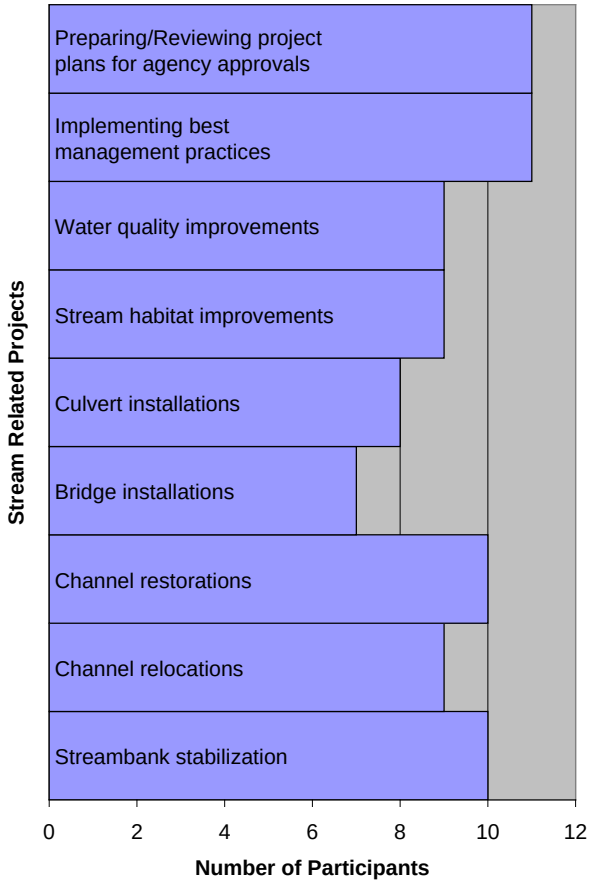

Figure 5 June 2005 Participants' Current or Expected Future Types of Stream Related Projects

Participants indicated that the course content was useful for understanding the basic principles of geomorphology and stream assessment methods and would assist them in reviewing future projects. They found the class presentations, field trips and binder each to be helpful (see Table 5) in learning the material; 14 to 15 of 30 (93–100%) indicated they helped "a lot" or "a great deal" in learning or understanding the material. Nearly everyone felt the course materials would serve as useful references in the future, describing them as "very useful" and "good reference material." One participant felt that summaries highlighting the most important information would be more useful.

Table 5 Summary of Learning Outcomes from Various Training Components (June 2005)

Question	Very little	A little	Somewhat	A lot	A great deal
7) To what extent did the **class presentations** help you learn the material?	0	0	1	6	8
8) To what extent did the **field visits** help you learn the material?	0	0	0	8	7
11) To what extent did **resources in the binder** help you understand the material?	0	0	1	10	4

The field visits were seen as the most helpful course component: all of the 15 respondents characterized the field visits as helping them "a lot" or "a great deal" in learning the material. One participant appreciated the small size of the group, which "helped to keep up and hear discussions." Another felt the field visits "did an excellent job of illustrating the points made in the classroom." When asked to identify the topics they found most beneficial, one participant chose the field exercises. Historical information was the most commonly identified beneficial topic, and only one person felt that any of the topics qualified as "least useful."

Every participant indicated they would recommend the course if it were offered again and consistently rated it as "excellent," "great," and "very good." Compared to other courses of similar length and content, this course garnered quite favorable reviews and was described as "better" and "very good." Several attendees suggested that the course could be lengthened in order to include more information and to more thoroughly cover those topics already introduced, and they indicated they would also like the opportunity to take a follow-up course.

Wilson Creek Demonstration

Enhancements to the Wilson Creek restoration were completed prior to the delivery of the workshops. Participants in the June 2005 workshop, including four personnel from the Kentucky Division of Water, visited the enhancement site and were able to relate the demonstration of the stream restoration and enhancement to the content presented in the classroom lectures.

Other groups also received demonstrations of the Wilson Creek restoration and enhancement, including seven U.S. Fish and Wildlife Service (USFWS) employees who visited Wilson Creek on July 26, 2005. The group included four biologists, a regional coordinator, a state coordinator and an assistant field supervisor, representing offices in Florida, Georgia, North Carolina, Tennessee and Kentucky. All of the group are part of the USFWS private lands habitat restoration program Partner for Fish and Wildlife (PFW) and work extensively in stream enhancement and restoration in the southeastern U.S. Their main objective is to restore stream and riparian habitat for threatened and endangered species and other aquatic species using natural and cost effective processes.

Asked by their regional coordinator to develop a guidance document for PFW's stream restoration work, the group requested an opportunity to review the Wilson Creek site in order to further evaluate and discuss methods and aspects of stream restoration projects. The demonstration would serve to assist the group in establishing guidelines for determining what kind of projects PFW will or will not fund in the future.

4. Conclusions

The interest expressed by agency personnel in expanding their knowledge and practice of stream geomorphic assessment and stream restoration on a watershed scale far exceeded the limits of this project and strongly indicate the need for additional training opportunities. The April workshop was filled to capacity with 30 attendees, almost all of whom indicated they would recommend the course if it were offered again and every participant in the June 2005 workshop would recommend the course. Participants in both workshops indicated they would like the opportunity to take a follow-up course or even to repeat the one that was offered. Participants also observed that the instructors and assistants were highly qualified and able to facilitate their understanding of the course material.

Field exercises were seen as more helpful than any other course component. Many participants commented on the value of field observations, instruction and data collection. Although field activities accounted for nearly 40% of the training time, some participants recommended that additional time be spent in the field. Participants emphasized the value of "hands on" field data collection and analysis. Group presentations of field materials by attendees provided additional incentive to actively learn stream assessment procedures and their relationship to stream mechanics and dynamics.

Several participants in the April workshop did indicate some frustration with the size of the groups to which they were assigned for field exercises, projects and homework; they felt the number of people with whom they worked prevented them from being able to fully take part in activities and discussions, so they suggested that the groups be smaller. Future training sessions should also consider the balance between classroom presentations, field exercises and instructor lectures, logistics of locations and effective use of time. Flexibility in scheduling of field activities should also be included to provide for weather disruptions of field exercises. Evaluations from the April 2005 workshop included suggestions that agendas and course notebooks be made available prior to the beginning of the workshop in order to facilitate participant preparation and planning for the course.

Lessons Learned from the Wilson Creek Enhancement

The use of a wide range of native species in revegetation efforts may help to protect against factors that could inhibit vegetation growth, including uncertain hydrology, drought or flood, and insect predation.

Revegetation of stream restoration projects with a high degree of floodplain access must use plant species capable of rapid growth, which may preclude the exclusive use of native species. Many native species require dormancy periods that will not permit the immediate cover needed to protect the banks and floodplain from erosion.

Fabric should be used for erosion control in projects where the channel slope is high enough to permit erosion of the floodplain. Erosion control fabric not only helps to hold seeds and soil in place during out-of-bank events but also helps to retain soil moisture and promote plant growth during dry periods.

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Appendix A. Financial & Administrative Closeout

Workplan Outputs

Milestone	Expected Begin Date	Expected End Date	Actual Begin Date	Actual End Date
1. Submit all draft materials to the Cabinet for review and approval.	Duration			
2. Submit advanced written notice on all workshops, demonstrations, and/or field days to the Cabinet.	Duration			
3. Plan four-day workshop "Introduction to Stream Geomorphic Assessment and Stream Restoration on a Watershed Scale".	7/2004	7/2004	8/2004	4/2005
4. Design restoration enhancements and submit BMP plan to Cabinet for approval.	7/2004	8/2004	4/2004	4/2004
5. Obtain necessary permits.	7/2004	8/2004	4/2004	4/2004
6. Construct enhancements and plant vegetation.	7/2004	8/2004	4/2004	9/2005
7. Develop and organize workshop materials, including submission of workshop materials for NPS Program approval.	8/2004	8/2004	9/2004	6/2005
8. Conduct four-day workshop for water resources professionals and basin managers.	9/2004	9/2004	4/2005	4/2005
9. Evaluate four-day workshop.	9/2004	9/2004	4/2005	4/2005
10. Plan two-day workshop on stream restoration and stream geomorphology for managers.	10/2004	10/2004	3/2005	6/2005
11. Develop and organize workshop materials, including submission of workshop materials for NPS Program approval.	10/2004	10/2004	2/2005	6/2005
12. Conduct two-day workshop.	11/2004	11/2004	6/2005	6/2005
13. Evaluate two-day workshop.	11/2004	11/2004	6/2005	6/2005
14. Field day demonstration of Wilson Creek Restoration and enhancement for agency personnel.	3/2005	3/2005	5/2005	7/2005
15. Upon request of the Division of Water, submit Annual Report and/or participate in the Cabinet sponsored biennial NPS Conference.	Duration			
16. Submit three copies of the Final Report and submit three copies of all products produced by this project.	9/2005	9/2005	9/2005	12/2005

Budget Summary

The Research Foundation's Detailed Budget:

Budget Categories	319(h) Grant	UofL Research Foundation Match	Total	Final Expenditures	Unspent
Personnel	$45,663	$36,008	$81,671	$80,584.48	$1,086.52
Supplies	$6,960	–	$6,960	$6,683.13	$276.87
Equipment	–	–	–	–	–
Travel	$8,385	–	$8,385	$7,018.82	$1,366.18
Contractual	$52,431	*$20,000	$72,431	$73,185.44	– $754.44
Operating Costs	$25,594	$37,596	$63,190	$62,159.95	$1,030.05
Other	–	–	–	–	–
TOTAL:	$139,033	$93,604	$232,637	$229,631.82	$3,005.18

*In-kind match from Bernheim Arboretum and Research Forest.

The University of Louisville Research Foundation was reimbursed $137,227.98. A total of $1,806.02 federal funds remain unspent. Of the total project budget, $3,005.18 remain unspent:

- $1,086.52 in the Personnel category (fringes were charged at 2% less than expected).
- $ 276.87 in the Supply category (reference materials cost less than expected).
- $1,366.18 in the Travel category (state rate for lodging was unexpectedly honored).
- $ –754.44 in the Contractual category (meeting room fees exceeded estimate).
- $1,030.05 in Operating Costs (overhead on savings in Personnel, Supplies, Travel).

Equipment Summary

No equipment was budgeted nor purchased under this MOA.

Special Grant Conditions

No special grant conditions were specified for this MOA.

Appendix B. BMP Implementation Plan

The enhancement of the Wilson Creek restoration will include changing floodplain topography and establishing vegetation on the stream banks in the regions of the channel most susceptible to rapid bank erosion.

Floodplain Topographic Changes and Flow Control Berms

The elevation of the floodplain will be raised outside of and on the downstream end of bends and will be tapered to the existing floodplain level approximately one-third of the distance down the riffle. This will increase the elevation at which flood flows will be able to access the floodplain in the upper third of the riffle.

Four sod berms will be constructed above the existing floodplain surface. These berms will be constructed perpendicular to the downstream slope of the floodplain at three locations to provide temporary control of the floodplain water surface elevations until vegetation roughens and protects the floodplain.

Increased Flood Conveyance

Flow conveyance will be increased in one location near Dunn Hollow tributary to reduce floodplain flow velocity and enhance the natural recovery of the portion of the tributary that traverses the floodplain of Wilson Creek. This will be accomplished through the excavation of material on the floodplain upstream of the Dunn Hollow tributary.

Revegetation of Banks

Sod mats will be harvested from a floodplain field upstream of the restoration and placed along the banks of riffles over all but the most upstream riffle. The mats will be cut and transported using a specially designed plate with a cutting edge attached to a Bob Cat. The mats will be cut and loaded onto a trailer covered with a thin plate cover to allow for the sod to slide on and off easily without destroying the mat integrity. An excavator and bobcat will be used to prepare the banks for the sod mats.

Erosion Control Fabric

A jute fiber erosion control fabric will be used to cover straw and ground cover seed mix on the floodplain surrounding the sod mats. The fabric will be staked down to hold the matting in place. The edge of the matting will be buried on the most upstream side and overlapped to prevent flow from lifting the fabric. Steel staples will be placed between stakes to hold the matting in place. The matting will be used to cover any loose soil placed on the floodplain and close to the edge of the sod mats.

Wetlands

Several small floodplain wetlands will be created to improve wetland habitat diversity. Some wetlands will be created in locations of high groundwater levels between the pre-restoration channels that are now floodplain ponds and the restored channel. Others will be created in large areas of floodplain to provide a location of sediment deposition.

Enhancement of Reforestation Effort

After construction activities were completed during March of 2005, 500 sycamore and 500 swamp white oak saplings were planted along the riffle areas of the stream in April 2005.

Appendix C. Summary of Participant Evaluations

Part 1: Summary of Workshop Evaluation Responses, April 2005

Participants in the April 2005 4-day workshop were asked to complete a 24 question evaluation of the workshop. Thirty of the thirty participants submitted an evaluation; one participant's evaluation (R30) applies only to the first two days of the workshop, after which he/she had to return to work. The following are complete verbatim responses to all open-ended questions and summaries of closed-ended questions.

1) Which of the following describe your background and field of work (please circle / identify and rank all that apply)?

		Respondents' choices and rank, if indicated																												
	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
Biology / Ecology	16				1		2	1				1	x			x	x	x	x		2	x		x	x				3	x	3
Engineering	7	2						4																		1	1	1	1		2
Forestry	7						1	5		x		2								x	3								3		
Geography / Geology	5	1	1	1				2	x																						
Hydrology	11	3					3	3	x								x							x		2	2	2	3		12
Other (please describe):	10					x				x	x			x	x						1	x	x	x					1		

R05: Env. Science Degree/ Currently with KYTC, Former DEP Inspector
R09: "Environmental Technology" – Program Administration
R10: Watershed coordinator
R13: Environmental (Transportation)
R14: General/Overall Env. Science
R20: Wetland management
R21: Stream restoration
R22: Agriculture with env. jobs
R23: Environmental Science (General)
R28: Soils/reclamation of disturbed lands

2) With which of the following types of stream related projects do you currently work or expect to work following this training (please circle / identify and rank all that apply)?

		Respondents' choices and rank, if indicated																												
	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
Streambank stabilization	26	4	x		x	5	1	4	3		x	3	2	x	4	x	x			3	x	x	x	x	5	3	1	1	1	x	5
Channel relocations	12	8	x		x		2							x	5			x				x		x		1			2		4
Channel restorations	14	6	x		x	6	2	5						x	6							x		x	6	2			3		3
Bridge installations	7				x	1								x	2								x	x							6
Culvert installations	13	5	x		x	2								x	1						x		x	x		4		4	1		7
Stream habitat improvements	17	7	x		x		1	2	2		x	3	3			x	x			2		x		x	3				3		2
Water quality improvements	20	1	x	x	x		1	1	1	x	x	2				x	x	x	x		x		x	1	2				2		9
Implementing best management practices	23	2	x	x	x	3	1	3		x	x	1			3	x	x	x	x		x		x	x	1		2	2	1		8
Preparing / Reviewing project plans for agency	14	3	x		x	4							1					x		1	x			x	4		3	3		x	1

approvals

3) How would you rate your knowledge of stream geomorphology and function BEFORE you took this course?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
Not knowledgeable	8			x		x							x	x						x	x		x					x			
Somewhat knowledgeable	18				x		x	x	x	x	x	x			x	x	x	x	x					x	x	x	x		x	x	
Knowledgeable	3	x																				x									x
Very knowledgeable	1		x																												

4) Which of the choices below best describes your knowledge of the Rosgen stream classification system prior to taking this course?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
No knowledge of this topic	4			x				x			x					x															
Had heard about this system, but was not familiar with its meaning	10				x	x	x						x							x	x		x	x			x		x		
Knew something about the stream types described in this system, but was not familiar with the techniques for determining stream classification	13	x							x	x		x		x	x		x	x	x						x	x		x		x	
Was well acquainted with the stream types and classification techniques used in this system	3		x																			x									x

Comments

R24: Knew about system & techniques; just needed more training.

5) How did the course match your expectations based on the course announcement?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Very little	0																														
b) A little	1																										b				
c) Somewhat	4																c					c						c		c	
d) A lot	7	d		d										d		d		d								d			d		
e) A great deal	11		e		e		e	e	e	e	e	e			e				e					e							
f) Exceeded my expectations	6					f							f							f	f		f		f						

Comments

R01: Expected more on design.
R02: Art has a greal feel for the science, history, and policy of stream restoration. I came away with a new perspective.
R04: Great! I'm too tired for detals. Sorry!
R05: I've been in the env. field for 11 years. This is by far the best couse I've ever taken. Thanks!!
R06: Would have helped to know more of what specific days would entail before leaving town.

R08: Covered exactly what I'd hoped.
R09: Very good course, well-run and well-organized.
R11: Very intensive sessions – lot of very interesting material presented – good training manual materials – practical field work.
R13: Really enjoyed and learned a lot during field trips.
R14: I feel so much more comfortable evaluating stream conditions.
R16: I expected to feel more confident in applying course concepts to stream issues I address in my job. The introductory nature of the course and the complexity of the course concepts will make practical usage difficult. Will need further training to enable me to provide management advice.
R18: As a biologist I will never look at a stream channel the same again.
R22: Very good course information and the field study and exercise was great.
R23: The course certainly met the course announcement however I would have liked to have studied further the actual process & mechanisms available in the actual restoration process.
R24: Have taken other stream assessment & stream design courses but none that focused mainly on Kentucky's landscape.
R25: I feel more course details (ie times, field exercises, etc) should be more detailed in the initial announcement. However, all material was covered.
R26: Thought there would be more focus on the actual restoration techniques (structures, vanes, etc.).

6) Was the information provided to you about how to prepare for the course adequate?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Not at all	0																														
b) A little	3							b																		b		b			
c) Somewhat	5								c								c		c			c				c					
d) Just right	17	d		d		d	d			d	d	d	d	d	d	d		d		d	d				d				d	d	
e) More than adequate	4		e		e																		e	e							

Comments
R04: Great! I'm too tired for detals. Sorry!
R08: Would have helped to know more of what specific days would entail before leaving town.
R09: We were told what to bring, and what to expect – I wish everyone communicated this well before training courses!
R14: The emailings were sufficient and helpful in preparation.
R16: Would have been helpful to have a course agenda/schedule prior to arrival.
R18: I think the basic terminology slides w/ notes & numerous pictures provided before the course would have put people on an equal footing.
R23: Dana was excellent in having us prepared.
R25: See comment above, more detail should be available. I wasn't prepared to spent 14–16 hrs a day on this!
R26: Had everything I needed to be in class and out in the field.
R27: It would have been helpful to have a course outline ahead of time.

7) To what extent did the class presentations help you learn the material?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Very little	0																														
b) A little	2																									b	b				
c) Somewhat	8	c											c	c			c			c		c		c						c	
d) A lot	12			d			d	d	d	d	d							d	d		d							d	d		d
e) A great deal	8		e		e	e						e			e	e							e		e						

Comments
R04: Great! I'm too tired for detals. Sorry!
R09: All the instructors were knowledgeable and well-prepared.
R12: It was hard to retain and understand some concepts because of time restraints.

R13: Groups seemed so large that it made it difficult at times. Would have rather added a day and not stayed so late at night.
R14: This is a lot of material to learn in a short time but it was great. The historical aspects were extremely helpful. I have learned to be much more observant.
R15: You must understand materials to be able to present them.
R16: It was sometimes difficult to grasp new concepts that were only briefly touched-on in the presentations.
R20: I thought the diversity of group backgrounds helped me see a lot more facets of the process than I had before.
R22: Helped in preparation.
R23: Field work was more beneficial.
R25: Field exercises were much more beneficial.
R26: PowerPoints can get monotonous after a while. Maybe break-up presentations with other types of distributing information.
R30: Really appreciate 'watershed' approach!

8) To what extent did the class (map) exercises help you learn the material?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Very little	1																											a			
b) A little	1																								b						
c) Somewhat	7								c				c				c	c		c							c			c	
d) A lot	15	d				d	d	d		d	d			d		d			d		d	d	d	d		d				d
e) A great deal	6		e	e	e							e			e													e			

Comments
R01: Very interesting seeing the Cat Ck. stream course change through time as documented with aerial photography and plotter on a single sheet.
R02: Gave me a more wholistic (watershed) approach to stream restoration & management.
R04: This was a great preliminary to the field exercise. It caused me to look for features in the field that I may not have thought to look for.
R14: Learned to analyze the data on maps.
R15: Visualization through several map types helped learn and prepare for assessment.
R16: Map exercises were definitely helpful in better visualizing concepts, but a handout outlining the experiences would have been very helpful. Time was wasted while we were trying to figure out exacltly what we were supposed to do.
R17: Having the material available on GIS would have been helpful also.
R20: I love maps.
R24: Being in the field first might have helped, not real sure. Maps aren't my best skill.
R25: Good hands-on, intro exercises. A little vague as to what was expected. What was the answer?!?
R26: Good exercise, maybe give the goals and what you're expecting of the groups before we start working.

9) To what extent did the field exercises help you learn the material? Please specify how valuable you found walking the creeks/class discussions and also working as a member of a data collection team along a stream reach.

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Very little	0																														
b) A little	0																														
c) Somewhat	3																	c		c							c				
d) A lot	6												d				d				d							d		d	d
e) A great deal	19	e		e	e	e	e	e	e	e	e	e		e	e	e			e				e	e	e	e			e		

Comments
R01: I had never done a pebble count.
R02: N/A – I helped with the teaching.
R04: The field exercises were great! They were the gel that brought all of the lecture material together for me and solidified it all in my learning process.
R06: Stream walks were very informative, but amount of material was overwhelming. Data collection was great, but unorganized.
R08: Field work was extremely help[ful], doing the project helped clarify thinking.
R09: One of the best parts of the class; really helped to demonstrate the concepts.

R10: The most helpful training was one on one in the field. \ Team approach gives more prespectives.
R11: The class material would not have been nearly as effective without the field work.
R12: Working in smaller groups helps. I liked hearing Dr. Parola's thought processes. Going out in the field & working hands on really helps me remember & understand the information better.
R13: Very valuable in all aspects! ✓+
R14: So much better when you can SEE what is on a map. It was helpful to understand the difference between riffle, run and glides. It was very helpful having the property owner there. It helped to see that "bankfull" is not as easy to determine as a some people think. (I thought it was just me having trouble). :)
R15: Hands on experience after classwork/lecture extremely affective.
R16: Field trips were critical to seeing real-world examples of course concepts. Walking creeks excellent idea, but maybe could shorten this component of the course in future. Group data collection also very helpful in teaching field techniques. Again, a little more guidance in the form of an outline/handout would have made field measurement exercise more time-efficient.
R17: Smaller groups would be better – did not get to do all parts of data collection. An exercise the day before with the equipment would allow participants to be familiarized with it. Break groups so that each group has multi discipline background.
R18: Walking the streams & talking about features was very helpful. The field exercises could have been more useful if we had gone over the use of the equipment & techniques beforehand.
R19: More field time with the instructors is definitely needed. A whole day of data collection is needed to grasp all concepts of data collection.
R20: I only wish we had maybe done more data collection on different reaches.
R21: Good review – I think the class could have benefited by having everyone do all the field exercises – cross-section, profile, cross-section & planform stuff.
R24: Actually walking, talking & seeing really helped me understand several of the informational terms and processes.
R25: The stream reach walking was very beneficial. HOWEVER too much time was spent walking and not enough survey & gethering data. *I was very disappointed with one aspect of the field day. We spent approximately SIX hours walking, looking at streams, their problems & characteristics. This portion was very informative but LONG! When we finally got to eatlunch at 2:30 we were pushed to eat in 10 or 15 minutes because we were behind schedule! I found it very vexing that since the instructors overextended the morning session our lunch/break time was cut too almost nothing. Many of the people in this course aren't accustomed to such physical activity. I found this particularly disrespectful to the group, and poor time management by the instructors. This also resulted in a very late night for most groups.
R26: Good to get outside. Too bad the weather was crappy that day. Need to try to stay on schedule better on the field trip. Cutting lunch short to get the group back on schedule wasn't the best way. Cut some material/discussion instead.
R27: The field exercise helped in understanding and actually seeing what the presentation had described.
R28: Class co-ordinator should 'balance' the teams based upon experience & job duties. That way you get more interaction by non-co workers & each team's expertise is spread around.

10) To what extent did the guest lecture by Sandi Formica help you learn the material?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Very little	2						a																				a				
b) A little	2										b																	b			
c) Somewhat	12			c					c	c		c	c	c			c	c	c	c									c	c	
d) A lot	6				d	d																d	d	d	d						
e) A great deal	2														e											e					

Comments
R01: N/A
R02: N/A – I left before this.
R04: This info was very useful for providing direction to basin stakeholders looking for sedimentation sources.
R08: BUT I was very interested in her project and considered it a valuable talk – I'd like to find a copy of her report.
R09: Interesting presentation.
R11: Her material was very interesting and useful to me but did not help me learn the material.
R14: Helped me understand where the real problems and hopefully the REAL solutions.
R15: Very nice to see in action the assessment process, and especially good results.
R16: She reiterated some of the messages delivered earlier in the course. Interesting to see the results of an intensive study show that the major sediment sourse was streambank erosion – with the next major contribution being construction.
R21: The portion of Sandi's presentation relating to targeting resources/project strategy was useful. Their finding concerning the amount of sediment coming from stream banks was eye opening. This supports what I've been hearing in recent years.
R22: Streambank sediment is more than thought prior to presentation. This may be from increased runoff time.
R23: Very interesting, especially the road study.
R24: Good information. Real life example. Good ending. A very up note to leave on.

R25: A good way to anchor some of the principles we learned this week in a realistic, workable study.
R26: Very little of her presentation seemed to be focused on the stream. Did enjoy the different soil loss contributors though.
R27: Great presentation. Interesting in the demonstrating the development/process of analyzing a watershed. The presentation did emphasize learning about sources outside & inside stream. Did not go into how stream has changed, which class covered.
R29: Interesting on amt. of sediment from unpaved roads.

11) Please describe how your base of knowledge / skills has increased via this course.

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Very little	0																														
b) A little	2																					b					b				
c) Somewhat	6	c	c										c							c									c		c	
d) A lot	14						d			d	d	d		d			d	d	d		d			d	d	d				d		d
e) A great deal	8			e	e	e		e	e						e	e							e								

Comments
R01: Brought up to speed on Rosgen Classification.
R02: I already had a strong base knowledge but I get great new perspectives from Art.
R04: Prior to this class I had a very general understanding of geomorphological processes. This has been expanded to include more detailed knowldege of field procedures and assessment techniques which I can use often in working with basin stakeholders to identify sources and causes for their concerns.
R10: I will be able to evaluate proposals and advise groups about what is possible, what will have impacts (+ or –) on proposed changes, plus side-effects of proposed changes. Not all restoration efforts are helpful.
R14: Understand "bankfull" a little better. Learned how to better evaluate current stream conditions. I can help on a pebble count now! I know how important it is to look closely at the materials in the stream.
R15: From a low knowledge base to a moderate understanding.
R16: Previously (to this course), mainly viewed stream quality issues on a shorter time-scale. This course taught me how to think about stream issues on a broader temporal and geological scale.
R20: I have learned a lot of things I was only vaguely aware of before.
R23: The understanding of headcuts, etc. & the upstream impacts has increased a lot.
R24: Much better understanding of how to take measurements and what to look for in the field.
R25: I feel that I have a much better working knowledge of stream classification and how to identify how & why problems occur.
R26: Was maybe expecting too much from the course, or expecting something different from the course.
R27: I understand the definitions better.
R28: Whole watershed approach is very helpful, installation of control features such as culverts & how this impacts upstream is great.
R29: More familiar with terminology & what parameters are collected.

12) Based on the knowledge and practice obtained in this course, how comfortable would you feel classifying / assessing a stream reach and restoring a watershed?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Very confident	0																														
b) Confident	8	b	b						b		b				b							b				b					b
c) Somewhat confident	16				c	c		c		c		c				c	c	c	c		c		c	c			c	c	c	c	
d) Not confident	6			d			d						d	d						d					d						

Comments
R01: Not enough design to be comforable restoring a watershed. Very comfortable assessing using course content.
R03: This was an Intro class for me, but I do have an understanding to start working with.
R04: I have gained enough knowledge to ask good questions, collect some data, and recognize whether or not a consultant hired knows what they are doing. This will be valuable when working with watershed groups in my basin.
R05: I would enjoy taking a follow-up course.
R08: Actually, with a bit of practice, I feel I could do this confidently. I feel I'm equipped to begin working. Certainly not expert!!
R09: I'd still want the assistance of an "expert."

R11: Now somewhat confident at classifying a stream. Not all confident in stream restoration.
R12: I still need some practice! This could have easily been a 2–3 week course.
R13: Because I knew so little to begin with, I still would not feel confident in all of this – maybe with time.
R14: Much more confident on assessing a stream reach AND accessing a stream restoration area. Don't know if I could plan a stream restoration.
R15: A working group of colleagues would make us more comfortable in making assessments & restorations. It will allow me to understand & be able to question situations in the future.
R16: Would be helpful to hear course concepts presented again to reinforce them before making conclusions/recommendations. Also, would need more guidance on making restoration. recommendations. (Course more hevily weighted toward assesment than restoration technique.
R17: With guidance.
R21: Still sometimes unsure of bankfull at impaired stream segments.
R23: Assessing – confident. Actual restoration – somewhat confident.
R24: I am much better at this, but would like to do a couple projects with others before I would try one myself. Would like to work on this in the future.
R25: I'd like a little more review on actual stream classification before I'm totally comfortable.
R26: Still have difficulty with the stream types (A2, B4, D6?)
R27: This class really has not prepared me for the restoration of a watershed. We worked on the classification/assessment but did not really work on restoration process past assessment. Granted you cannot teach everything in 4 days.
R28: There is a great deal of data that needs collecting historical & what's out there today.

13) To what extent did resources in the binder help you understand the material?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Very little	0																														
b) A little	2													b													b				
c) Somewhat	8		c	c			c	c			c				c			c								c			d	
d) A lot	13	d			d	d							d			d	d			d	d	d		d				d	d		d
e) A great deal	6								e	e		e							e				e		e						

Comments
R04: This will be a great post-course resource!
R08: As you know, pictures were a little hard to see. A CD of Powerpoint presentation would have helped. In fact, it would still help. Could we get one?
R11: The manual is an effect[ive] reference manual for during class and after.
R12: I referred to it quite a bit.
R14: Would have been better if there were only two slides per page. (Kinda hard for some of us "older" folks to read.)
R15: Very helpful, photos esential.
R16: Visual diagrams very helpful during course and will be helpful when referring to them after course.
R18: Include a comprehensive reference section for the sources of diagrams, figures & data.
R20: Very comprehensive and well organized.
R25: Field exercises were more beneficial.
R26: Field exercises/discussion much more effective in relaying the material.
R29: Easier to make notes when the slides are printed off like this.

14) Which topics did you find most beneficial? Why?

R01: The effects stream disturbance has on the whole watershed – headcutting, etc. \ Control Structures
R02: Historical watershed studies– This gives me a better understanding of the restoration objective we should be seeking.
R04: All of them. I don't know how we could have accomplished all of the field work without any single one.
R05: They were all good, but my personal favorite was the discussion on the ice age.
R06: Learning more about Rosgen classification \ Presentations on historical impacts to stream morph.
R08: Urban hydrology – very big right now \ Historical uses - new to me.
R09: Channel Evolution \ Bank Erosion \ Response to disturbance \ These are most applicable to what I do.
R10: all - context (inter-related).
R11: Discussions on stream stresses – hydraulics.

R12: Basic Terminology, Rosgen Reach Classifcation, Stream Response to disturbance.
R13: That we need to consider history & how valuable talking with landowners.
R14: Bankfull discussions – needed to know for stream evaluation. Historical – didn't realize how important this was. Supply reach downstream reach – learned that these areas are extremely important.
R15: Channel evolution was most beneficial to understanding concepts.
R16: Geological perspectve very helpful because it introduced concepts I hadn't previously learned.
R17: Field trip discussions.
R18: Actually conducting a classification on a reach and walking different watersheds and discussing features.
R19: Stream Response to disturbance and Basic terminology. Being so inexperienced in the overall concept of watershed restoration having the basic information really helped.
R20: The discussion of the effects of siltation and tile depth.
R21: 1st day discussions – good review. Field exercise – good review.
R22: The field exercise pointing out items as obstructions, controls, deposits etc.
R23: Upstream affects. Before this course I focused more on downstream effects of disturbances.
R24: Every topic was extremely important. Can't imagine leaving any of them out.
R25: Problems perpetuate upstream, most people assume the opposite. Examining the geology to determine issues is also beneficial.
R26: The historical impacts and the basic terminology of streams helped understand streams and that they've moved over time.
R27: The fieldtrips & gathering data. Channel Evolution was the most beneficial as it showed how and why a stream may do what is going to do. The field trip reinforced the concept.
R28: Basic terminology – term clarification. Geologic – interesting.
R29: Field exercises.
R30: Watershed assessment.

15) Which topics did you find the least useful? Why?

R02: They were all useful.
R04: N/A – all useful.
R05: I thought they were all useful.
R08: I did not consider any of it "not useful" or "of little use."
R09: Urban impacts. This is less appropriate to what I do.
R10: N/A
R11: All useful!
R12: Pebble Count Procedure - Had already done this.
R13: The instructions the nite before the 1st field trip. Would have been better to wait and go over all of it in field?
R14: They were all good and relevant.
R15: None, all seemed pertinent.
R16: N/A
R17: Some of the homework. Might be more useful to break into small groups and have one of instructors have more guidance.
R18: I feel that all the topics were integral to the holistic view. I think the course would be incomplete if something were removed.
R19: I thought all topics covered were very useful.
R23: Useful?? I least enjoyed the classifying of streams.
R24: See above [#14]. *Maybe 1st map exercise*
R25: Most information was beneficial to some degree – in some aspect.
R26: Rosgen stream reach classification. Probably won't ever have to classify a stream.
R27: Group presentations. Too large of groups. Lack of direction.
R28: All topics were beneficial.
R29: Wasting a couple hours walking up Cat Creek just to prove bigger rocks are upstream. \ Too much emphasis on powerpoint presentations. For this type of learning workshop, just have the groups make overhead transparencies.
R30: Rosgen Level 1 variables – Been there.

16) If this course were to be offered again, would you recommend it?

R01: Yes

R02: Yes
R03: Yes – very good hands-on class, good mix of classroom also.
R04: Absolutely! I would like for members of my basin team to be able to take this training class.
R05: Yes
R06: Yes, I would probably take it again myself.
R07: Yes
R08: Absolutely, and I'd really like a chance to take Phase II.
R09: Yes
R10: Yes
R11: Yes, definitely
R12: Yes
R13: Yes!
R14: Absolutely
R15: Yes
R16: Yes, these are relatively new concepts that professionals in water quality field need to know.
R17: Yes
R18: Without a doubt yes.
R19: Yes
R20: Yes. Highly.
R21: Yes
R22: Yes
R23: Yes
R24: Of course. I would also like to take a 2nd level course.
R25: For certain disciplines.
R26: Probably not; just because of the long days/nights and the lack of mentioning the different restoration practices and when & where to use them.
R27: Yes/No. Undecided.
R28: I would recommend it to design engineers. I am in construction & can tweak basic plans but the concepts should be incorporated into the overall design.
R29: Only to a person who loves streams and works in nothing else.
R30: Yes!

17) What would you change to improve the course?

R01: I wanted more design – but that is a separate course.
R02: I would use Lane's Diagram frequently in the presentations... especially to explain aggradation/degradation.
R03: The Friday Morning group talks were a waste of time since we did most of the same info on Thursday.
R04: It would be very helpful to walk through all of the data collection and recording procedures prior to the actual field exercise. Also, small detail, Group 1 should be paired with Reach 1, etc. Reverse numbering was confusing.
R05: Make it even longer – two weeks.
R06: Better organize data collection. Allow entire day for field measurments. Add a day to course rather than work late.
R07: See an active restoration.
R08: Truthfully, it was like field camp – people got tired, I think we needed a little more rest.
R09: More "down time" in evenings – Need to be able to "recharge the batteries."
R10: Classes could be better if smaller.
R11: See # 18.
R12: I would have picked up on more if we'd had more time to complete our field work. Was only able to participate in one or two tasks because we broke into groups. A couple more days would have been helpful.
R13: Add a day and reduced hours/day.
R14: Should water quality testing/analysis be important in this?
R15: Give complete area history prior to field exercises so it can be kept in mind throughout assessment process.
R16: Smaller groups to work on group projects – too many people and personalitites made concensus difficult. More tightly defined group exercises. More explanation of practical applications to stream restoration.

R17: Smaller groups to work on exercises with one of the instructors/helpers to lead/point the group in the right direction.
R18: Smaller group sizes for the field exercises & homework.
R19: I would separate the Reach scale survey (field exercise) into a three day mini course. There was not enough field time to really learn the survey techniques.
R20: If anything I would make it longer and perhaps do more background info.
R21: See item #9
R22: Longer time frame with more field work.
R23: More actual restoration techniques – available materials; the actual How To.
R24: See other suggestions on #24.
R25: Make course time longer – more days, so people aren't spending 14 to 16 hours a day working on this. Maybe include Mondays.
R26: Make it more days with the same amount of information; or cut the information to make the days shorter. To have people leaving past 9:00 pm and commuting is very demanding. Make the days 8–9 hours long instead of 12–13 hours long.
R27: Smaller groups; Better definition and directon of what is expected to present and analyze.
R28:
R29: Make it a 2-part course to where we're not working till 10pm to analyze data. ¶ Have a West Kentucky version to cover flat bottomland streams.
R30: More time in field.

18) Are there any topics not covered that you believe should have been included?

R02: No – everything was covered well.
R04: ?
R05: No
R08: Couple of things (stress load on bed) comment was "we'll cover that later") but no one ever did.
R09: Can't think of any.
R10: None
R11: Case studies of impaired streams which include assessment --> restoration efforts --> results of management/resoration strategies in a real stream.
R12: I would have liked to have seen a few more "urban" areas.
R13: More ideas on restoration – briefly.
R14: Should water quality testing/analysis be important in this? ??
R15: No
R16: No
R19: No
R20: Maybe more on biological indicators.
R21: Maybe water velocity & bankfull discharge.
R23: #17 answer
R24: No; maybe water quality & habitat a little more.
R25: What are some ways to address the problem? Viable fixes? Funding?
R26: Ways to stop the erosion. If you can't fix the whole stream, at least show the techniques to patch them and explain how they work.
R27: Examples of methds to make changes to stream.
R29: Stream "maintenance." What if you don't have a million dollars for a restoration but just want to clean out a logjam or put some riprap on a bend?

19) Do you feel the course materials are complete enough in content and organized such that you will be able to use them as references in the future?

R01: Yes
R02: Yes
R03: Yes
R04: Yes. Many of the materials include explanations and I took notes to augment that so they will be a useful resource.
R05: Yes
R06: Yes
R07: Yet to be determined.
R08: Yes, I think so. I am quite sure I'll use these.
R09: Yes

R10: Yes
R11: Yes
R12: Yes!
R13: Yes
R14: Would like more text to review rather than just slides. Glossary is very good.
R15: Yes, they will be helpful in future.
R16: I hope so! Maybe helpful to add some graphics of Rosgen classification to the course manual.
R17:
R18: Yes, but some speaker notes would be helpful.
R19: Yes
R20: Yes
R21: Probably better for workshop than a reference.
R22: Yes
R23: Yes
R24: Yes
R25: Yes
R26: The materials (notebook, manual) are very well put together. The course (teaching, labs) could use some focus and streamlining so we know what the instructors expect of us.
R27: Yes as far as classifying, but not for restoration.
R28: Yes
R29: For the formulas.
R30: Yes

20) Were the classroom instructors knowledgeable and able to answer your questions?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Somewhat knowledgeable	1																									a					
b) Knowledgeable	2																										b			b	
c) Very knowledgeable	27	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c			c	c		c

Comments
R04: See comment for #21 – ditto.
R05: Great group. Knowledgeable and enthusiastic. Thank you.
R08: I appreciated the instructors - they seemed patient and willing to work with us.
R09: Everyone was very impressive in their depth and bredth of knowledge and experience.
R12: I wasn't always able to understand their answers.
R19: The instructors were great.
R20: Highly impressed.
R24: Very nice, patient, knowledgable & overall wonderful instructors. Like to have different views/ways on how to do things.
R25: Our field guy wasn't very informative, of course he is new to Kentucky. Maybe he should have more experience before assisting with this course.

21) Were the field instructors knowledgeable and able to demonstrate methods of field identification and collection of data?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Somewhat knowledgeable	2																					a				a					
b) Knowledgeable	4								b																		b	b		b	
c) Very knowledgeable	23	c	c	c	c	c	c	c		c	c	c	c	c	c	c		c	c	c	c		c	c	c				c		c

Comments
R02: Clayton was great.

R04: They were very knowledgeable and very approachable. In addition they were focused on helping us understand rather than just answering our questions.
R15: It was very nice to have a knowlegable person around to answer my questions that arose.
R20: There was no question I had they were not able to answer.
R21: Group 2 trainer didn't provide much guidance.
R24: Again great knowledge & patience.
R25: I felt the survey aspect of this course was very disorganized with very little direction given by our particular instructor.
R27: Very little time one on one to gain knowledge or ask questions.
R28: It was great to have guides at each reach.

22) Was the location of the course convenient, comfortable and valuable to you?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Inconvenient	3																										a	a		a	
b) Reasonably convenient	12				b						b		b	b	b		b	b			b				b	b			b		b
c) Very convenient	13	c	c			c	c	c	c	c		c				c			c			c	c	c							

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Uncomfortable	0																														
b) Reasonably comfortable	12				b			b	b	b	b							b	b						b		b	b	b	b	
c) Very comfortable	15	c	c			c	c					c	c	c	c	c					c	c	c	c		c					c

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Not valuable	0																														
b) Reasonably valuable	7													b	b				b								b	b	b	b	
c) Very valuable	20	c	c	c	c	c	c	c	c		c	c	c			c		c		c	c	c	c	c		c					c

Comments
R16: Would have been nice to have more options for meals.
R17: For a week – more food choices would be good.
R18: The quality of State Parks has significantly decreased over the years.
R21: Great place for a workshop.
R24: Food & food choices not good. Maybe a location with better variety might be good.
R25: It would have been nice to have more time to explore the area.
R29: Why does every seminar in this state have to be in east KY? There are people in the state that live west of I-65.
R30: 2-hr commute without travel per diem!

23) Was the timing of this course convenient to you?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
a) Inconvenient	2																											a			a
b) Reasonably convenient	14	b			b		b		b	b		b		b			b	b				b		b		b	b			b	
c) Very convenient	14		c	c		c		c			c		c		c	c			c	c	c		c		c				c		

Comments
R24: Maybe making it a 5 day course would take some of the pressure off. (16–17 hr days too long.) Wed (8am–10pm); Th (7:30 am–11:30pm) People get too tired to think.
R25: Again, I feel the timeline should be rearranged.
R28: Construction season is just starting back up from winter.

R30: Was substituted into course at very late stage!

24) Please let us know any additional comments/suggestions that you may have. Also include any ideas you have for future use of training modules (these may include ways you would like others to use them or how you may use them.

R01: Course ran very smoothly – Thanks to organizers.
R02: I think the Stream Restoration Institue and the KY mitigation program can be drivers to reshape the paradigm of stream restoration and protection in the state. I have seen such a model play out in NC.
R03: Very good class, very informative, always glad to attend a class given by the best informed. Thanks for a good use of my time.
R05: Please have a follow-up course. This one changed my perspective.
R07: Very long days. Not sure how to shorten the day other than adding another day.
R08: 1) I think I'd have spread the material over 5 days – M–F \ 2) Dana was magnificent – the organization, snacks, attention to detail – was great \ 3) I'd prefer to start on time \ 4) Instructors did a good job, Dr. Parola gave some excellent talks.
R09: Maybe add an extra day so that evening sessions won't be as necessary. It's nice to have time to hike or relax a little between classes.
R11: Time spent in field was very helpful. Visiting several drainages was very important. Walking and talking along sections of stream to discuss lecture items was invaluable.
R12: I thought everything went smootly. I really appreciate all the effort & work put into this course. I learned a lot. Thank you.
R14: 1) List of participants \ 2) Future training – Assessing stream restoration projects \ 3) Cool t-shirt with a cool slogan
R15: Keep educating groups like us!
R16: Group presentations and subsequent discussion helped reinforce the course material.
R17: Techniques covered in this class might not be practical for agencies to undertake. Agencies are not able to devote manpower to one watershed. Has to be something beyond the research. A Rapid assessment method is needed.
R19: I would like to see a four day course concentrating on expanding the basic information and then have a separate three day course with one day of instruction on field survey techniques and two days of field work.
R22: Thanks to all trainers, landowners, field crew, UofL.
R23: *Excellent training! – again just a little more 'How to' information on actual restoration projects, not in dept maybe just an overview for information. But overall EXCELLENT.
R24: 5 day – full days --> not such long days. \ Offer follow-up of more indepth trainings at later date. \ Smaller group sizes might work better also.
R25: The snacks were very nice! Also the tour bus was very beneficial – I was very glad we had bathroom facilities. I feel the concepts relayed in the course are very beneficial in assessing the issues involved in the changing process of streams. However I do not feel there is a very realistic way to approaching the problem to fix it. For instance, a downstream landowner changes the stream which causes the upstream landowner some major problems. Who fixes and/or pays for the upstream issues? Should the upstream landowner have to pay to fix something caused by someone downstream? To ge the downstream landowner to change something that is benefiting them doesn't seem realistic. ¶ Another concept I came away with that is good but unrealistic – it seems you need to address problems on a very large scale. how much money would that take? What if one landowner didn't want to participate? In my work we have trouble securing the money to fix several hundred feet of stream – miles would be impossible! ¶ Education of landowners seems to be the key, in my opinion. You had a well rounded group here that will help to get the concepts out. ¶ Overall I think this was a beneficial training that significantly changed how I view any stream work I do in the future. I think you achieved what you set out to accomplish. Thanks for the opportunity!
R26: Good snacks! Excellent/smart way to keep the group happy & attentive. Dana rocks! ¶ The surveying techniques and principles for the field exercise was extremely lacking. I know there are time constraints but you can still do things properly. You need to set a benchmark, do more cross sections, have a centerline profile and come off of it, left & right. ¶ Maybe discuss water's inherit ability/property to erode. Water is going to erode regardless, it just takes longer in certain circumstances.
R27: A lot of information in a little bit of time. Smaller groups, especially in fieldtrips for discussion and going over what was covered in class. This would reinforce the concept better.
R30: Maybe include BEHI/stability rating as additional time in course.

Part 2: Summary of Workshop Evaluation Responses, June 2005

Participants in the 21–22 June 2005 2-day workshop were asked to complete a 24 question evaluation of the workshop. Fifteen of the seventeen participants submitted an evaluation. The following are complete verbatim responses to all open-ended questions and summaries of closed-ended questions.

1) Which of the following describe your background and field of work (please circle / identify and rank all that apply)?

		Respondents' choices and rank, if indicated														
	Total	**R01**	**R02**	**R03**	**R04**	**R05**	**R06**	**R07**	**R08**	**R09**	**R10**	**R11**	**R12**	**R13**	**R14**	**R15**
Biology / Ecology	9		2			X	X	X	X		X	X	X			1
Engineering	5	X		1	X					X				X		
Forestry	2		1													3
Geography / Geology	1														X	
Hydrology	4	X	3	2												2
Other (please describe):	4	X					X							X	X	

R01: Engineering B.S.- 25 years working in Corps Regulatory Program
R06: Watershed and nonpoint source
R13: Facility Environmental Engineer
R14: Natural Resource Mgt.

2) With which of the following types of stream related projects do you currently work or expect to work following this training (please circle / identify and rank all that apply)?

		Respondents' choices and rank, if indicated														
	Total	**R01**	**R02**	**R03**	**R04**	**R05**	**R06**	**R07**	**R08**	**R09**	**R10**	**R11**	**R12**	**R13**	**R14**	**R15**
Streambank stabilization	10	X	X	1	X	X	7	X			X		X		X	
Channel relocations	9	X	X	5	X	X	6	X				X	X			
Channel restorations	10	X	X	4	X	X	5	X			X	X	X			
Bridge installations	7	X	X	2	X	X		X					X			
Culvert installations	8	X	X	3	X	X		X			X		X			
Stream habitat improvements	9	X	X		X	X	4	X			X		2		X	
Water quality improvements	9	X	X			X	1	X	X	X			X		X	
Implementing best management practices	11	X	X		X	X	3	X	X	X		X	X		X	
Preparing / Reviewing project plans for agency approvals	11		X		X	X	2	X		X		X	1	X	X	X

Comments
R15: [I] review all of the above [items preceding the selected option of "Preparing/Reviewing project plans for agency approvals"].

3) How would you rate your knowledge of stream geomorphology and function BEFORE you took this course?

	Total	**R01**	**R02**	**R03**	**R04**	**R05**	**R06**	**R07**	**R08**	**R09**	**R10**	**R11**	**R12**	**R13**	**R14**	**R15**
Not knowledgeable	1								X							
Somewhat knowledgeable	13	X	X	X	X		X	X		X	X	X	X	X	X	X
Knowledgeable	1					X										
Very knowledgeable	0															

4) Which of the choices below best describes your knowledge of the Rosgen stream classification system prior to taking this course?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
No knowledge of this topic	2								X					X		
Had heard about this system, but was not familiar with its meaning	1							X								
Knew something about the stream types described in this system, but was not familiar with the techniques for determining stream classification	8	X		X	X					X	X	X	X		X	
Was well acquainted with the stream types and classification techniques used in this system	4		X			X	X									X

5) How did the course match your expectations based on the course announcement?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Very little	0															
b) A little	0															
c) Somewhat	0															
d) A lot	6				d		d					d	d	d	d	
e) A great deal	8	e		e		e		e	e	e	e					e
f) Exceeded my expectations	1		f													

Comments
R02: Land use history, historic channelization info great!

6) Was the information provided to you about how to prepare for the course adequate?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Not at all	1															a
b) A little	3	b				b								b		
c) Somewhat	2		c												c	
d) Just right	7				d			d	d	d	d	d	d			
e) More than adequate	2			e			e									

Comments
R01: Did not come prepared to go on field trip first day.
R02: Didn't realize we'd walk streams both days.
R05: Need to provide more details in advance. Many people thought that we would only be in the field on the second day.
R06: Great.
R12: Of course had to guess that field work would be both days.
R13: Did not have course agenda in advance. Did not know there would be a field trip on Day 1.

7) To what extent did the class presentations help you learn the material?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Very little	0															
b) A little	0															
c) Somewhat	1															c
d) A lot	6	d			d	d			d				d		d	
e) A great deal	8		e	e			e	e		e	e	e		e		

Comments
R01: Well presented – Sometimes hard to keep up with in manual.
R05: Presentations were very informative.
R15: Introduce some complicated theories and not enough time to cover in detail.

8) To what extent did the field visits help you learn the material?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Very little	0															
b) A little	0															
c) Somewhat	0															
d) A lot	8		d		d				d	d			d	d	d	d
e) A great deal	7	e		e		e	e	e			e	e				

Comments
R01: Small group helped to keep up and hear discussions.
R05: Field trips did an excellent job of illustrating the points made in the classroom.

9) Please describe how your base of knowledge/skills has increased via this course.

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Very little	0															
b) A little	0															
c) Somewhat	5	c			c								c		c	c
d) A lot	10		d	d		d	d	d	d	d	d	d		d		
e) A great deal	0															

Comments
R01: Provided additional perspective.
R05: I always learn new things at these trainings and discover things I should be considering during project review.
R14: I'm not sure how much information can be learned in two days but the information presented was well done!
R15: Gave me some indication on need for more detail assessment at watershed and the need to consider past history.

10) Based on the knowledge obtained in this course, how comfortable would you feel classifying a stream reach?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Very confident	1					a										
b) Confident	4	b		b							b				b	
c) Somewhat confident	8		c				c	c	c			c	c	c		c
d) Not confident	2				d					d						

Comments
R05: Had fairly extensive background info on this.

11) To what extent did resources in the binder help you understand the material?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Very little	0															
b) A little	0															
c) Somewhat	1													c		
d) A lot	10	d	d		d	d	d			d	d		d		d	d
e) A great deal	4			e				e	e			e				

Comments
R01: Good reference material for the future.
R02: Maps (geology especially) very useful.
R05: Always good to have handout pages for PowerPoint presentation.

12) Do you feel the course materials are complete enough in content and organized such that you will be able to use them as references in the future?

R01: Yes
R02: Yes
R03: Yes
R04: Yes
R05: Summary sheets with important parts would be better.
R06: Absolutely (print is a little small).
R07: Yes
R08: Yes
R09: Yes
R10: Yes
R12: Yes

R13: Print type on photos is hard to read.
R15: Yes

13) Which topics did you find most beneficial? Why?

R01: Stream Restoration Section
R02: Historic land use/ legacy sed.; assessment
R03: All of them
R06: Evolutionary process; to integrate into other programs
R07: No particular one, I found all beneficial.
R08: Applied principles for "restoration"
R10: Stress. Field visit.
R12: How history is still effecting the others
R13: Example of stream restoraton (Wilson Creek). Historical information on KY streams.
R15: Historic/geologic preservation - new field of discussion

14) Which topics did you find the least useful? Why?

R01: Geologic History – A little too involved
R02: None
R03: None
R06: None
R06: N/A
R12: None

15) If this course were to be offered again, would you recommend it?

R01: Yes
R02: Yes
R03: Yes
R04: Yes
R05: Yes
R06: Yes
R07: Yes
R08: Yes
R09: Yes
R10: Yes
R12: Yes
R15: Yes, but would recommend longer presentation.

16) What would you change to improve the course?

R01: Lengthen to four–five days and discuss actual restoration planning and design.
R02: Longer... but it was appropriate for mgrs.
R03: None
R04: Nothing really, maybe include more people to train.
R05: For people with little technical background there was way too much information to be digested.
R06: None
R07: Nothing
R08: More time
R10: Show specific topics in course presentation to specific point in the field. Discuss more on how the stream impacts are NOT natural & how they can be restored.
R12: Nothing, but would like to have more indepth course now.
R15: See above [#15]

17) Are there any topics not covered that you believe should have been included?

R01: See #16 [discuss actual restoration planning and design].
R02: No
R03: No
R04: No
R06: No
R10: Discuss/expand how Cumberland Falls is a “Geologic” headcut.
R12: Would like to discuss various methods, materials used at various mitigation projects.

18) Were the classroom instructors knowledgeable and able to answer your questions?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Somewhat knowledgeable	0															
b) Knowledgeable	1															b
c) Very knowledgeable	14	c	c	c	c	c	c	c	c	c	c	c	c	c	c	

Comments
R01: Excellent

19) Were the field instructors knowledgeable and able to answer your questions?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Somewhat knowledgeable	0															
b) Knowledgeable	2														b	b
c) Very knowledgeable	13	c	c	c	c	c	c	c	c	c	c	c	c	c		

Comments (No respondents offered comments on this question.)

20) Was the location of the course convenient, comfortable and valuable to you?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Inconvenient	0															
b) Reasonably convenient	8		b		b	b	b			b			b	b	b	b
c) Very convenient	4	c						c	c			c				

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Uncomfortable	1						a									
b) Reasonably comfortable	6				b				b	b			b	b	b	
c) Very comfortable	6	c	c	c				c				c				c

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Not valuable	0															
b) Reasonably valuable	6		b		b				b				b	b	b	
c) Very valuable	6	c					c	c			c	c				c

Comments
R06: Too cold in classroom on 1st day.

21) Was the timing of this course convenient to you?

	Total	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
a) Inconvenient	0															
b) Reasonably convenient	7		b		b		b			b			b	b	b	
c) Very convenient	6	c		c				c			c	c				c

Comments
R14: We should have this course in the spring when the streams are flowing.

22) How would you rate this course overall?

R01: Exellent overview – will allow me to question proposed restoration projects we review.
R02: Excellent
R03: Excellent
R04: Very good and educational
R06: Great
R07: Excellent
R10: Great. Informative. Useful.
R12: Very good
R13: Good course
R14: Very good information / We need to have just an assessment based class.
R15: Very good

23) How does this course compare with other courses of similar length and content that you have attended?

R01: Better than others
R02: Better b/c of watershed assessment component as well as designs that minimize use of structures.
R03: Practical class
R04: Very high level, very good

R06: A lot of info in a short time period
R10: Better than average
R12: No real similar content to compare with.
R13: N/A
R14: Better
R15: Very good

24) Please let us know any additional comments/suggestions that you may have. Also include any ideas you have for future use of training modules (these may include ways you would like others to use them or how you may use them.

R01: Develop second level course focused on design of restoration projects.
R03: None
R05: Need more ties back to POLKY ISSUES that mangers are dealing with to raise awareness of the importance of this information & how it should be used
R10: Expand on whether improvements can be garnered, ecological and physically. Be careful, & better define: 1) Sediment: Why? For Environmental Agencies biologists sediment is referred to to describe fine particles & impacts to biota. For the f. geomorphologist it is not necessarily just the fine material impact, it is the material/bed load. 2) Reference reach: 2 definitions, one for biological description, another for stream design.

Appendix D. Program Deliverables

See the succeeding pages for the following exhibits:

- April and June 2005 workshop announcements
- April and June 2005 workshop application forms
- Release of liability forms used in the planning and organization of the April 2005 workshop
- Data sheets and pebble count histogram used in the June 2005 field visits
- Aerial photos, maps and grid transparencies used during classroom exercises in the April 2005 workshop

The following materials were also submitted with this report:

- Three copies of the 4-Day workshop notebook
- Three copies of the 2-Day workshop notebook

The notebook for the 4-day workshop includes printed copies of the PowerPoint presentations with lines for note-taking, field data collection forms, maps, a glossary of terms, and a list of references. The 2-day workshop notebook includes printed copies of the PowerPoint presentations with lines for note-taking, maps, a glossary of terms, and a list of references.

UNIVERSITY of LOUISVILLE STREAM INSTITUTE

and the

KENTUCKY ENVIRONMENTAL and PUBLIC PROTECTION CABINET

INTRODUCTION
to
STREAM GEOMORPHIC ASSESSMENT
on a
WATERSHED SCALE

- **For water resources professionals and basin managers.**
- **Four full days of hands-on instruction including fieldwork.**
- **Topics to be covered include:**
  - Channel Forms and Evolution
  - Sediment Sources
  - Characterization of Sediments
  - Channel Classification and Stability
  - Geomorphologic Assessment
  - Stream Restoration
- **Tuesday, April 12, 2005 through Friday, April 15, 2005.**
- **Natural Bridge State Park, Slade, Kentucky.**
- **Apply early: space is limited for this tuition-free course!**

For further information and for submittal of applications please contact:

Dana S. Kahn, M.S., Program Coordinator
Department of Civil and Environmental Engineering
University of Louisville
Louisville, Kentucky 40292
502-852-4567 or dana.kahn@louisville.edu

This work was funded in part by a grant from the U.S. Environmental Protection Agency under §319(h) of the Clean Water Act through the Kentucky Division of Water
to University of Louisville Research Foundation (Grant #C9994861-99).

UNIVERSITY of LOUISVILLE STREAM INSTITUTE

and the

KENTUCKY ENVIRONMENTAL and PUBLIC PROTECTION CABINET

STREAM GEOMORPHIC ASSESSMENT on a WATERSHED SCALE

Tuesday, April 12, 2005 through Friday, April 15, 2005
Natural Bridge State Park, Slade, Kentucky

APPLICATION FOR ENROLLMENT

NAME: _____

JOB TITLE: _____

PLACE OF EMPLOYMENT: _____

PRIMARY RESPONSIBILITIES: _____

_____

_____

_____

PRIOR EDUCATION, TRAINING AND EXPERIENCE IN STREAM GEOMORPHOLOGY: _____

_____

_____

_____

_____

GOALS FOR TAKING THE COURSE: _____

_____

_____

_____

ADDRESS: _____

_____

TELEPHONE NUMBER(S):_____

FAX NUMBER: _____

E-MAIL ADDRESS: _____

PLEASE SUBMIT APPLICATIONS TO DANA S. KAHN, CEE, UofL, BY FRIDAY, 25 FEBRUARY 2005.

YOU WILL BE CONTACTED BY FRIDAY, 4 MARCH 2005 REGARDING ATTENDANCE.

UNIVERSITY of LOUISVILLE
dare to be great

▪ **DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

J.B. Speed School of Engineering
University of Louisville
Louisville, Kentucky 40292

Office: 502-852-6276
Facsimile: 502-852-8851

1 March 2005

Faculty and staff of the University of Louisville, Department of Civil and Environmental Engineering, will be hosting a workshop, Stream Geomorphic Assessment on A Watershed Scale, 12 – 15 April, 2005. This course is being funded in part by a grant from the U.S. Environmental Protection Agency under §319(h) of the Clean Water Act through the Kentucky Division of Water to University of Louisville Research Foundation (Grant #C9994861-99). The course, under the direction of Professor Arthur C. Parola, Jr., PhD, will be based in Natural Bridge State Park, and will introduce stream geomorphic assessment and restoration on a watershed scale to primarily state and federal employees responsible for environmental oversight. In order to reach the goals of the course, to conduct an assessment of a watershed in the Kentucky, Licking and Sandy River Basin region, as defined under the approved work plan, visitation of sites outside of the park are necessary. The methods of watershed assessment are conducted on the surface and do not alter the landscape or waterways.

Individual property holders in the counties of Menifee, Morgan, Powell, and Wolfe have been contacted and have agreed to allow property access for the course, 12 – 15 April 2005, to the instructors and participants. The landowners include:

_____(name)
_____(Address)

The University of Louisville releases the property holder from any and all liability resulting from the use of said property by the University and participants for the purpose of the course.

_____
Shirley C. Willihnganz

_____
Provost

_____
Date

b"h
dskj
bsh_dskj_jd_draft2_release_property_0405

STREAM GEOMORPHIC ASSESSMENT

on a

WATERSHED SCALE

ACCEPTANCE OF PARTICIPATION

Faculty and staff of the University of Louisville, Department of Civil and Environmental Engineering, will be hosting the workshop, Stream Geomorphic Assessment on A Watershed Scale, 12 – 15 April, 2005. This course is being funded in part by a grant from the U.S. Environmental Protection Agency under §319(h) of the Clean Water Act through the Kentucky Division of Water to the University of Louisville Research Foundation (Grant #C9994861-99). The course will be based in Natural Bridge State Park, and will introduce stream geomorphic assessment and restoration on a watershed scale to primarily state and federal employees responsible for environmental oversight. In order to reach the goals of the course, to conduct an assessment of a watershed in the Kentucky, Licking and Sandy River Basin region, as defined under the approved work plan, visitation of sites outside of the park will also be included. The methods of watershed assessment are conducted on the surface and do not alter the landscape or waterways.

I understand that I have been accepted as a participant in the course, and that participation includes sessions in the classroom, in-transit via provided transportation, and in the field. During the field exercises I am aware that I may be exposed to conditions and hazards typical of conducting field work along streams in Kentucky. I will take appropriate precautions for any medical conditions that I have and I will inform course organizers as needed.

I_____(name) accept this opportunity and any risks associated herewith to participate fully in the course, from Tuesday morning, 12 April 2005 through midday, 15 April 2005. I _____ (name), hereby release the University of Louisville and the respective property owners from any and all liability, claims, damages, and expenses arising out of my participation in the field exercises of this course.

_____ _____

Signature Date

_____

_____

Address

b"h
dskj
bsh_dskj_jd_draft3_release_participant_property_0405

UNIVERSITY of LOUISVILLE STREAM INSTITUTE
and the
KENTUCKY ENVIRONMENTAL and PUBLIC PROTECTION CABINET

STREAM GEOMORPHIC ASSESSMENT AND RESTORATION on a WATERSHED SCALE

An OVERVIEW for Water Resource Managers, Planners and Policy Makers

- **Keynote speech by EPPC Secretary LaJuana S. Wilcher.**
- **Two full days of instruction including site visits.**
- **Topics to be covered include:**
  - Geologic and Human Disturbances to Watersheds and Stream Corridors
  - Channel Response and Evolution
  - Sediment Sources, Storage and Stream Reach Stability
  - Characterization of Sediments and Sediment Transport
  - Channel Forms and Reach Classification
  - Geomorphologic Assessment
  - Land-Use Change and Watershed-Scale Assessment
  - The Role of Stream Restoration in Watershed Management for Sediment and Habitat Impairment and Flood Hazard Reduction
- **No fees for registration nor materials.**
- **Tuesday June 21, 2005 and Wednesday June 22, 2005.**
- **Bernheim Arboretum and Research Forest, Clermont, Kentucky.**

For further information and for submittal of enrollment forms please contact:
Dana S. Kahn, M.S., Program Coordinator
The Stream Institute/Civil and Environmental Engineering
University of Louisville
Louisville, Kentucky 40292
502-852-4567 (voice) 502-852-8851 (fax) dana.kahn@louisville.edu (e-mail)

This work was funded in part by a grant from the U.S. Environmental Protection Agency under §319(h) of the Clean Water Act through the Kentucky Division of Water to the University of Louisville Research Foundation (#C9994861-99).

UNIVERSITY of LOUISVILLE STREAM INSTITUTE
and the
KENTUCKY ENVIRONMENTAL and PUBLIC PROTECTION CABINET

STREAM GEOMORPHIC ASSESSMENT AND RESTORATION on a WATERSHED SCALE

Tuesday June 21, 2005 and Wednesday June 22, 2005
Bernheim Arboretum and Research Forest, Clermont, Kentucky

ENROLLMENT FORM

NAME: _____

JOB TITLE: _____

PLACE OF EMPLOYMENT: _____

PRIMARY RESPONSIBILITIES: _____

_____

_____

_____

PRIOR EDUCATION, TRAINING AND EXPERIENCE IN STREAM GEOMORPHOLOGY: _____

_____

_____

_____

GOALS FOR TAKING THE COURSE: _____

_____

_____

_____

ADDRESS: _____

_____

TELEPHONE NUMBER(S): _____

FAX NUMBER: _____

E-MAIL ADDRESS: _____

PLEASE SUBMIT FORMS TO DANA S. KAHN, CEE, UofL, BY FRIDAY, 20 MAY 2005.
YOU WILL BE CONTACTED BY TUESDAY, 31 MAY 2005 REGARDING COURSE LOGISTICS.

Stream: Harrison Fork of Wilson Creek
Location: At pipeline crossing on Col. Beam property
Date: 21-Jun-05
Group: U of L Stream Institute

Cross-Section Data

Point #	Distance (Feet)	Depth (Feet)	Notes	Bankfull Measurement Relative Depth (Feet)	Mean Depth (Feet)	Sub-Width (Feet)	Sub-Area (Feet^2)
1	0	0	TERRACE				
2	1	0.2	TERRACE				
3	2.1	0.57	TERRACE				
4	3.2	1.05	FLOODPLAIN				
5	4.1	1.4	FLOODPLAIN				
6	5.7	1.54	FLOODPLAIN				
7	6.7	1.4	FLOODPLAIN				
8	7.4	2.02	FLOODPLAIN				
9	8.6	2.18	BANKFULL TOB	0			
					0.11	0.4	0.044
10	9	2.4	FRONT OF BANKFULL BREAK	0.22			
					0.425	0.6	0.255
11	9.6	2.81	BANK	0.63			
					0.66	0.8	0.528
12	10.4	2.87	TOE	0.69			
					0.72	1	0.72
13	11.4	2.93	GRAVEL BED	0.75			
					0.845	1.4	1.183
14	12.8	3.12	GRAVEL BED	0.94			
					0.935	1.6	1.496
15	14.4	3.11	GRAVEL BED	0.93			
					0.99	1.2	1.188
16	15.6	3.23	GRAVEL BED	1.05			
					1.035	1	1.035
17	16.6	3.2	GRAVEL BED	1.02			
					1.08	1.8	1.944
18	18.4	3.32	GRAVEL BED	1.14			
					1.2	1.9	2.28
19	20.3	3.44	GRAVEL BED	1.26			
					1.25	1.5	1.875
20	21.8	3.42	GRAVEL BED	1.24			
					1.205	1.1	1.3255
21	22.9	3.35	GRAVEL BED	1.17			
					1.09	1.3	1.417
22	24.2	3.19	GRAVEL BED	1.01			
					0.96	1.1	1.056
23	25.3	3.09	TOE	0.91			
					0.455	0.3	0.1365
24	25.6	2.18	LOW BENCH	0			
25	26.6	2.2	LOW BENCH				
26	27	1.98	BANK				
27	27.4	1.76	HIGH TOP OF BANK				
28	28.2	1.88	FLOODPLAIN				
29	29.5	1.5	FLOODPLAIN				
30	30.7	1.08	FLOODPLAIN				
31	31.8	0.73	TERRACE				
32	33.3	0.25	TERRACE				
33	35.1	0	TERRACE				

Notes:
1. Relative Depth is Measured Depth minus Bankfull Depth from Cross-Section Data (i.e., Relative Depth of bankfull feature is 0).
2. Mean depth is the average relative depth between adjacent points for the bankfull area.
3. Sub-width is measured between adjacent points for the bankfull area.
4. Floodprone width is measured at 2 X Maximum Bankfull Depth.

Bankfull Area	16.4	Feet^2
Bankfull Width	17	Feet
Mean Bankfull Depth	0.97	Feet
W/D ratio	17.6	
Floodprone Width	35.1	Feet
Entrenchment Ratio	2.1	
Riffle Surface d50	38	mm or est.
Rosgen Stream Type		

Stream: Harrison Fork of Wilson Creek
Location: Downstream private drive bridge
Date: 21-Jun-05
Group: U of L Stream Institute

Cross-Section Data

Point #	Distance (Feet)	Depth (Feet)	Notes	Bankfull Measurement: Relative Depth (Feet)	Mean Depth (Feet)	Sub-Width (Feet)	Sub-Area (Feet^2)
1	0	0	TERRACE				
2	1	0.31	TERRACE				
3	4.4	0.66	TERRACE				
4	7.5	1.19	TERRACE				
5	9.8	1.86	FLOODPLAIN				
6	11.6	2.3	FLOODPLAIN				
7	13.9	2.33	FLOODPLAIN				
8	15.3	2.83	FLOODPLAIN				
9	17.5	3.14	ROADWAY RUT				
10	18.5	3.36	ROADWAY RUT				
11	19.7	2.89	FLOODPLAIN				
12	21	2.73	FLOODPLAIN				
13	22.5	3.16	FLOODPLAIN				
14	24.4	3.45	FLOODPLAIN				
15	26.3	3.48	BANKFULL TOB	0			
					0.205	0.6	0.123
16	26.9	3.89	BANK	0.41			
					0.49	0.7	0.343
17	27.6	4.05	BANK	0.57			
					0.76	0.4	0.304
18	28	4.43	TOE	0.95			
					0.985	1.1	1.0835
19	29.1	4.5	GRAVEL BED	1.02			
					0.92	2	1.84
20	31.1	4.3	GRAVEL BED	0.82			
					0.675	2.4	1.62
21	33.5	4.01	GRAVEL BED	0.53			
					0.64	1.6	1.024
22	35.1	4.23	GRAVEL BED	0.75			
					0.65	1.8	1.17
23	36.9	4.03	GRAVEL BED	0.55			
					0.535	2.2	1.177
24	39.1	4	GRAVEL BED	0.52			
					0.57	2	1.14
25	41.1	4.1	GRAVEL BED	0.62			
					0.745	2.6	1.937
26	43.7	4.35	GRAVEL BED	0.87			
					0.815	2	1.63
27	45.7	4.24	GRAVEL BED	0.76			
					0.74	2.5	1.85
28	48.2	4.2	GRAVEL BED	0.72			
					0.76	2	1.52
29	50.2	4.28	TOE	0.8			
					0.4	0.6	0.24
30	50.8	3.48	BENCH	0			
31	52	3.45	BENCH				
32	52.7	2.72	TOB				
33	54.4	2.47	UPPER BENCH				
34	56.1	1.66	UPPER BANK				
35	57.8	0.95	UPPER BANK				
36	59.2	0.16	TERRACE				
37	60.1	0	TERRACE				

Notes:
1. Relative Depth is Measured Depth minus Bankfull Depth from Cross-Section Data (i.e., Relative Depth of bankfull feature is 0).
2. Mean depth is the average relative depth between adjacent points for the bankfull area.
3. Sub-width is measured between adjacent points for the bankfull area.
4. Floodprone width is measured at 2 X Maximum Bankfull Depth.

Bankfull Area	17.0	Feet^2
Bankfull Width	24.5	Feet
Mean Bankfull Depth	0.69	Feet
W/D ratio	35.3	
Floodprone Width	40.4	Feet
Entrenchment Ratio	1.6	
Riffle Surface d50	GRAVEL	mm or est.
Rosgen Stream Type		

Stream: Harrison Fork of Wilson Creek
Location: Bedrock reach further downstream private drive bridge
Date: 21-Jun-05
Group: U of L Stream Institute

Cross-Section Data

Point #	Distance (Feet)	Depth (Feet)	Notes	Bankfull Measurement: Relative Depth (Feet)	Bankfull Measurement: Mean Depth (Feet)	Bankfull Measurement: Sub-Width (Feet)	Bankfull Measurement: Sub-Area (Feet^2)
1	0	0	SLOPE				
2	1	0.55	SLOPE				
3	3.2	1.4	SLOPE				
4	5.1	1.6	TOE OF SLOPE				
5	8.9	1.49	TERRACE				
6	11.3	1.93	TERRACE				
7	13.4	2.51	FLOODPLAIN				
8	16.5	2.62	FLOODPLAIN				
9	18.7	2.53	FLOODPLAIN				
10	21.5	2.65	FLOODPLAIN				
11	22.8	3.13	FLOODPLAIN				
12	24.7	3.53	FLOODPLAIN				
13	25.9	3.65	FLOODPLAIN				
14	28	3.8	FLOODPLAIN				
15	29.4	3.9	FLOODPLAIN				
16	30.6	3.95	BANKFULL TOP OF BANK	0			
					0.42	0.5	0.21
17	31.1	4.79	TOE	0.84			
					0.89	2	1.78
18	33.1	4.89	BEDROCK	0.94			
					0.87	2.8	2.436
19	35.9	4.75	BEDROCK	0.8			
					0.865	2.8	2.422
20	38.7	4.88	BEDROCK	0.93			
					0.86	3	2.58
21	41.7	4.74	BEDROCK	0.79			
					0.84	3.2	2.688
22	44.9	4.84	BEDROCK	0.89			
					0.785	4	3.14
23	48.9	4.63	BEDROCK	0.68			
					0.665	2.4	1.596
24	51.3	4.6	BEDROCK	0.65			
					0.59	1.8	1.062
25	53.1	4.48	TOE	0.53			
					0.265	1	0.265
26	54.1	3.95	TOP OF BANK	0			
27	55.5	3.74	FLOODPLAIN				
28	56.8	3.7	FLOODPLAIN				
29	58	3.33	UPPER SLOPE				
30	59.4	2.71	UPPER SLOPE				
31	60.8	1.49	UPPER SLOPE				
32	62.6	0.2	UPPER SLOPE				
33	64	0	LEVEE				

Notes:
1. Relative Depth is Measured Depth minus Bankfull Depth from Cross-Section Data (i.e., Relative Depth of bankfull feature is 0).
2. Mean depth is the average relative depth between adjacent points for the bankfull area.
3. Sub-width is measured between adjacent points for the bankfull area.
4. Floodprone width is measured at 2 X Maximum Bankfull Depth.

Bankfull Area	18.2	Feet^2
Bankfull Width	23.5	Feet
Mean Bankfull Depth	0.77	Feet
W/D ratio	30.4	
Floodprone Width	36.7	Feet
Entrenchment Ratio	1.6	
Riffle Surface d50	BEDROCK	mm or est.
Rosgen Stream Type		

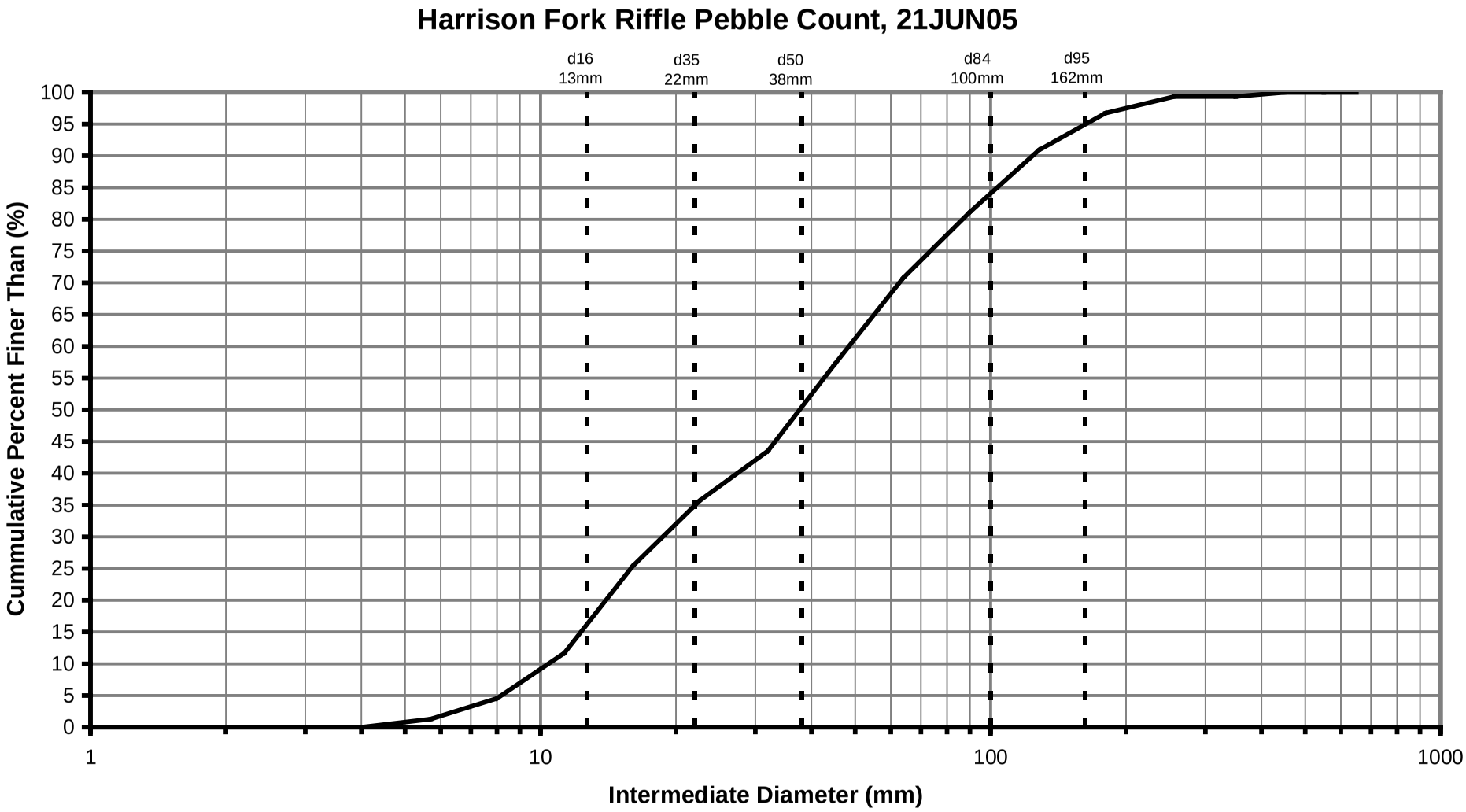
Stream: Harrison Fork of Wilson Creek
Location: Bedrock reach further downstream private drive bridge
Date: 21-Jun-05
Group: U of L Stream Institute

Cross-Section Data

Point #	Distance (Feet)	Depth (Feet)	Notes	Bankfull Measurement Relative Depth (Feet)	Mean Depth (Feet)	Sub-Width (Feet)	Sub-Area (Feet^2)
1	0	0	VALLEY WALL				
2	1.6	1.6	VALLEY SLOPE				
3	2.5	2.1	VALLEY SLOPE				
4	3.8	3.17	VALLEY SLOPE	0			
					0.275	0.6	0.165
5	4.4	3.72	TOE	0.55			
					0.615	2.1	1.2915
6	6.5	3.85	BEDROCK	0.68			
					0.68	0.2	0.136
7	6.7	3.85	BEDROCK	0.68			
					0.92	0	0
8	6.7	4.33	BEDROCK	1.16			
					1.21	2.5	3.025
9	9.2	4.43	BEDROCK	1.26			
					1.235	3.3	4.0755
10	12.5	4.38	BEDROCK	1.21			
					1.195	2.7	3.2265
11	15.2	4.35	BEDROCK	1.18			
					1.155	2.7	3.1185
12	17.9	4.3	BEDROCK	1.13			
					1.11	2.7	2.997
13	20.6	4.26	BEDROCK	1.09			
					1.055	1.7	1.7935
14	22.3	4.19	TOE	1.02			
					0.795	0.1	0.0795
15	22.4	3.74	BEDROCK BANK	0.57			
					0.285	0.6	0.171
16	23	3.17	FRONT OF BANKFULL BENCH	0			
17	23.1	3.08	TOP OF BANKFULL BENCH				
18	23.6	2.88	FLOODPLAIN				
19	24.1	2.84	FLOODPLAIN				
20	24.7	2.64	FLOODPLAIN				
	.						
21	25.7	2.55	FLOODPLAIN				
22	27.3	1.96	TERRACE				
23	28.2	2.06	TERRACE				
24	29.9	1.34	TERRACE				
25	31.1	1.26	TERRACE				
26	32.3	0.98	UPPER BANK				
27	33.6	0	UPPER BANK				

Notes:
1. Relative Depth is Measured Depth minus Bankfull Depth from Cross-Section Data (i.e., Relative Depth of bankfull feature is 0).
2. Mean depth is the average relative depth between adjacent points for the bankfull area.
3. Sub-width is measured between adjacent points for the bankfull area.
4. Floodprone width is measured at 2 X Maximum Bankfull Depth.

Bankfull Area	20.1	Feet^2
Bankfull Width	19.3	Feet
Mean Bankfull Depth	1.04	Feet
W/D ratio	18.6	
Floodprone Width	26	Feet
Entrenchment Ratio	1.3	
Riffle Surface d50	BEDROCK	mm or est.
Rosgen Stream Type		


Harrison Fork Riffle Pebble Count, 21JUN05
d16
13mm
d35
22mm
d50
38mm
d84
100mm
d95
162mm
Cummulative Percent Finer Than (%)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1
10
100
1000
Intermediate Diameter (mm)