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The United South and Eastern Tribe (USET) Proper Functioning Condition (PFC) and Tribal Focused Environmental Risk and Sustainability Tool (Tribal-FERST) Train the Trainers Workshop.

October 6-9, 2014, in Nashville, Tennessee:

PFC Assessment for Management and Monitoring

RESEARCH AND DEVELOPMENT

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PFC Assessment for Management and Monitoring

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Summary

One of the many goals of a Tribe's environmental and natural resource department is to maintain and restore functionality of stream and wetland riparian and upland areas, which could protect Tribal beneficial uses and values for those water bodies. Disturbances occurring within a watershed, or adjacent to a stream corridor, typically cause effects that may temporarily or permanently alter environmental and ecological risk factors. Focusing on where and how water moves and vegetation/soil trends in the riparian system can often determine if important Tribal goals and objectives are being met. It can then be determined what management changes are needed to move the environmental and ecosystem risk factors towards a desired condition. This report focuses on the Workshop's training and assessment of the proper functioning condition of ecosystems for Tribal members.

A stream's primary physical function is to transport water, nutrients, minerals, sediments, and organic matter within a watershed. The appropriate level of transport and deposition can differ broadly within a watershed and between stream reaches. Properly functioning stream and wetland riparian areas are able to sequester pollutants by dissipating energy allowing deposition, creating aquatic and riparian habitat complexity, and improving water quality. Maintaining healthy aquatic and riparian habitats depends on management allowing for and facilitating natural recovery of riparian functions after a disturbance (natural or anthropogenic). Impairment of riparian functions changes hydrologic, vegetative, and geomorphic interrelationships and may trigger cascading environmental effects having long-term consequences. Self-healing through thoughtful management improves stability, water quality, habitats, and resource productivity while keeping water and soil fertility within the riparian system longer.

In this training the United South and Eastern Tribes (USET) were instructed on how to integrate traditional ecological knowledge (TEK) with ecosystem function and ecological and environmental risk science. Instruction was also provided to navigate and apply the Tribal - Focused Environmental Risk Sustainability Tool (Tribal-FERST) in Tribal environmental planning efforts. Through the process Tribal Technical professional participants:

- Become familiar with assessing functional condition of ecosystems,
- Learn about fate and transport of contaminants,
- Hone information access skills, which can be used to achieve adaptive management goals.
- Work with a case study to gain practical experience
- Be introduced to riparian proper functioning condition (PFC) and integrated riparian management.

Stream and wetland riparian Proper Functioning Condition (PFC) is an interdisciplinary assessment protocol focusing on physical structure and functioning in relation to on-site potential. Although qualitative, it is based upon quantitative, or measureable scientific data. An interdisciplinary team conducting PFC assessment in the field uses all relevant field observations, independent knowledge, and life experience (e.g., TEK) to inform the understanding of what is possible (ecological function potential), and what is needed for the system to maintain functions in large flow events and varying climatic conditions. PFC provides a starting point, or understanding of current condition for developing an adaptive management

planning process and also serves as the foundation for an accurate, inclusive risk assessment process.

The combination of ecological function with Tribal-FERST allows a manager to see how a Tribe's cultural practices can be impacted by the way an ecosystem absorbs and releases water, nutrients, and toxins. This workshop session covered:

- Relationships among water, vegetation, and landform,
- Nutrient and trace metal solubility and pH
- Fate and transport of sediment, nutrients, and trace metals (e.g., mercury),
- Phyto-toxification,
- Aquatic benthic macroinvertebrate criteria, and
- How to incorporate TEK into environmental and ecological risk assessment.

Temperature, nutrients, and other environmental variables fluctuate through time and space in relation to diurnal (daily) and annual cycles. Aquatic organisms alter their individual physiology and community structure to adapt to the respective ecosystems' normal range of variation (e.g., floods and droughts). Properly functioning streams and wetland riparian ecosystems provide a steadying influence on water quality and aquatic habitat attributes. Indicators, needed to manage water quality, must focus on the drivers of physical functions (vegetation, hydrology, soil and landform), and not necessarily the way the water appears, so they can lead to early interventions to prevent water quality deterioration and the loss of functional assimilation processes.

List of Acronyms

BMP	Best Management Practice
C-FERST	Community - Focused Environmental Risk Sustainability Tool
DPC	Desired Plant Community
FAC	Faculative
FACU	Faculative Upland
FACW	Facultative Wetland Species
FAR	Functional At Risk
IRMP	Integrated Resource/Riparian Management Plan
LWM	Large Woody Material
NF	Nonfunctional
OBL	Obligate Wetland Species
PAR	Products, Assimilation, Resiliency
PFC	Proper Functioning Condition
PNC	Potential Natural Community
PPC	Potential Plant Community
QAPP	Quality Assurance Project Plan
Tribal-FERST	Tribal-Focused Environmental Risk Sustainability Tool
TEK	Traditional Ecological Knowledge
TERP	Tribal Ecosystem Research Program
TMDL	Total Maximum Daily Load
UPL	Obligate Upland
USACE	United States Army Corps of Engineers
USDI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USET	United South and Eastern Tribes

List of Acronyms (cont.)

WHO	World Health Organization
WPCP	Water Pollution Control Program
WQS	Water Quality Standards

Abstract

The maintenance of wildlife and aquatic habitat is dependent on the development of a riparian area management strategy, which considers and adapts to certain basic ecological and economic relationships. These relationships are functions of riparian and terrestrial ecosystems, growth and reproduction of woody and herbaceous plant communities, hydrologic and geomorphic conditions and processes, soils, sediment, water quality and quantity, recovery rates, upland conditions, cultural, recreation and domestic uses. The class participants determined functional ratings, using the PFC protocol for each field site visited. The methods used in this Workshop were found to work equally well in both eastern and western ecosystems in the United States.

1.0 Introduction

Riparian vegetation is one of the primary ecological attributes affected by human use patterns (i.e., grazing, urbanization, etc.). An inventory or assessment of current vegetation condition in relation to the potential condition is necessary to identify limitation or opportunities. Proper Functioning Condition (PFC) refers to how well the physical processes of energy dissipation, filtering sediment, stabilizing streambanks, ground-water recharge, floodplain development, and maintaining channel characteristics (with vegetation, coarse woody debris, soils, geomorphology, and hydrology appropriate for the potential or capability of the setting) reflect a state of resiliency.

The ultimate goal of a Tribal Water Pollution Control Program (WPCP) is the development and implementation of water quality standards for future protection and sustained use of valuable water resources, protection of public health and welfare, and the enhancement of water quality. The Tribes intend to protect and improve water resources through habitat evaluation, planning, implementation, education, community outreach and communication, and water quality monitoring.

A component of the WPCP is the development of Non-Point Source Program which is intended to identify non-point sources of pollution and mitigate or eliminate them. The U.S. Environmental Protection Agency (USEPA 2006) reports that non-point source pollution is the leading remaining cause of water quality problems. It is also known that non-point source pollution has a direct impact on drinking water and surface water quality and quantity, recreation, fisheries, and wildlife. Non-Point Source Pollution is prevalent in urbanized areas due to agriculture, industry, and impervious surfaces such as roads or the built environment.

Study Area

The USET PFC and Tribal-FERST Train the Trainers Workshop occurred October 6-9, 2014, in Nashville, Tennessee. During this workshop PFC site assessments were completed for Cedar Creek (lotic) and Couchville Lake (lentic). Reconnaissance assessments occurred June 24-27, 2014, which included the West Fork Stones River (lotic). Photos of this workshop can be found in Appendix E.

The Nashville Basin, also known as the Central Basin, was caused by a tectonic uplift of metamorphic and sedimentary material into a dome structure. Tectonic forces uplifting the Nashville Dome fractured the limestone, chert and sandstone strata making it more easily eroded. Subsequent erosional process scoured and transported the fractured material creating the Central Basin. The former Nashville Dome is evidenced by the underlying Ordovician limestone rock strata all dipping downwards away from the Central Basin. The Central Basin has a combination of undulating and rolling hills and karst topography of deeply pitted limestone sinks and outcrops. Nashville is located in the northwestern portion of the Central Basin. The Cumberland River drains the Central Basin as it flows northwest. In the USET study area (Figure 1) the fractured flat limestone is denuded or has a thin layer (~1-2 m) of overlying soil.

In this workshop/training, the goal is to demonstrate the presence of hidden (leading/lagging) uncertainty in environmental management, and assist in reducing that uncertainty by developing an ecological monitoring program that includes leading indicators.

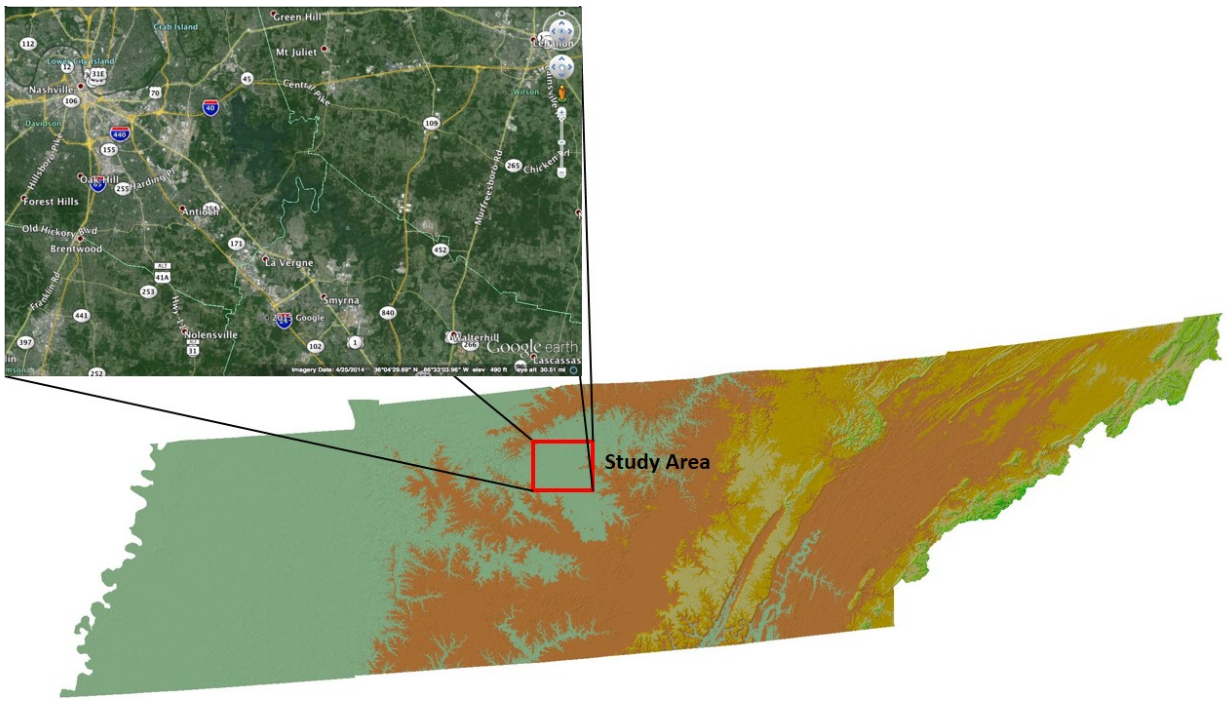

Figure 1. Location Map of the Study Area East of Nashville, TN, in the Central Basin.

Previous studies by the United States Army Corp of Engineers (USACE) indicated non-point source pollution is entering or existing within the confines of the Central Basin. Pollutants include urban and roadway runoff, atmospheric deposition of Carbon and mono-nitrogen oxides, agriculture and sewage effluent discharges, and erosion from streambanks.

The primary objective of this study was to train Tribes to perform a source assessment (nutrients, pathogens, sediment, mercury), water resources management plan, establish/re-evaluate beneficial uses, water quality standards, recommendations to improve conditions, update quality assurance project plans (QAPP), and development of the tribal Integrated Resource Management Plan (IRMP).

Possible outcome of this study is that Tribes will have the ability to develop Tribal adaptive management plans in the future, which will incorporate Clean Water Act Section 106 water quality monitoring program. The objective of the Tribal adaptive management plan is to establish a Cedar Creek and West Fork Stones River ecosystem restoration project to:

- Restore stream plant and animal community complexes in the watershed.
- Reduce stream-bank erosion and improve stream water quality.
- Reconnect the stream channel to its floodplain, raising the water table, improving flood attenuation, and increasing soil moisture retention.
- Improve riparian and aquatic habitat for aquatic communities.

2.0 Methods

Riparian areas are designated as vegetated (i.e., green) zones/areas along lakes, wetlands, rivers, streams, and creeks. Flowing water features such as rivers, streams, and creeks are also referred to as lotic riparian areas. Wetland areas are associated with standing water features such as bogs, marshes, wet meadows, lakes, and estuaries (also referred to as lentic riparian areas). PFC is a methodology for assessing the physical functioning of riparian and wetland areas. The term PFC is used to describe both the assessment process, and a defined, on-the-ground condition of a riparian-wetland area. Stream function is determined by assessing the hydrology, vegetation, and soil/landform attributes. By focusing on physical functioning, the PFC protocol is designed to yield information about the biology of the plants and animals dependent on the riparian-wetland area. PFC provides information indicating how well a riparian-wetland area is physically functioning in a manner allowing for the maintenance or recovery of desired attributes. These attributes might include, for example, fish habitat, biodiversity, or forage, over time.

A riparian wetland or stream is deemed to be “Functional” if the riparian and wetland riparian areas have adequate vegetation, landform, or large woody debris present to dissipate stream energy associated with high water flows, thereby reducing erosion and improving water quality; filter sediment, capture bedload, and aid floodplain development; improve flood-water retention and ground-water recharge; develop root masses that stabilize streambanks against cutting action; develop diverse ponding and channel characteristics to provide the habitat and water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and support greater biodiversity.

As stated in the introduction, Functional at Risk, refers to areas functioning properly, but an existing soil, water, or vegetation attribute makes them susceptible to degradation. The trend is an assessment of apparent direction of change (e.g., upward or downward) in conditions either towards or away from the site potential or site functionality. Trend is determined by comparing the present condition of the stream reach (understood in comparison with other reaches within the same systems (i.e., reference condition)), with previous photos, trend studies, inventories, other documentation, or personal knowledge. The lack of historical information on the condition of a site may lead to a “trend not apparent” assessment unless other clues are present such as the population growth of young woody species (e.g., willows).

Nonfunctional areas do not contain sufficient vegetation, landform, or large woody debris to dissipate stream energy associated with high flows, etc.

3.0 Results

PFC assessments for Cedar Creek, Couchville Lake and West Fork Stones River were completed as part of a tribal train the trainers workshop. Two reaches were assessed on Cedar Creek and Couchville Lake during the workshop (Figure 2). West Fork Stones River, Cedar Creek and Couchville Lake were assessed as part of a workshop reconnaissance survey (Figure 2). Photos of the field sessions and classroom instruction can be found in Appendix E.

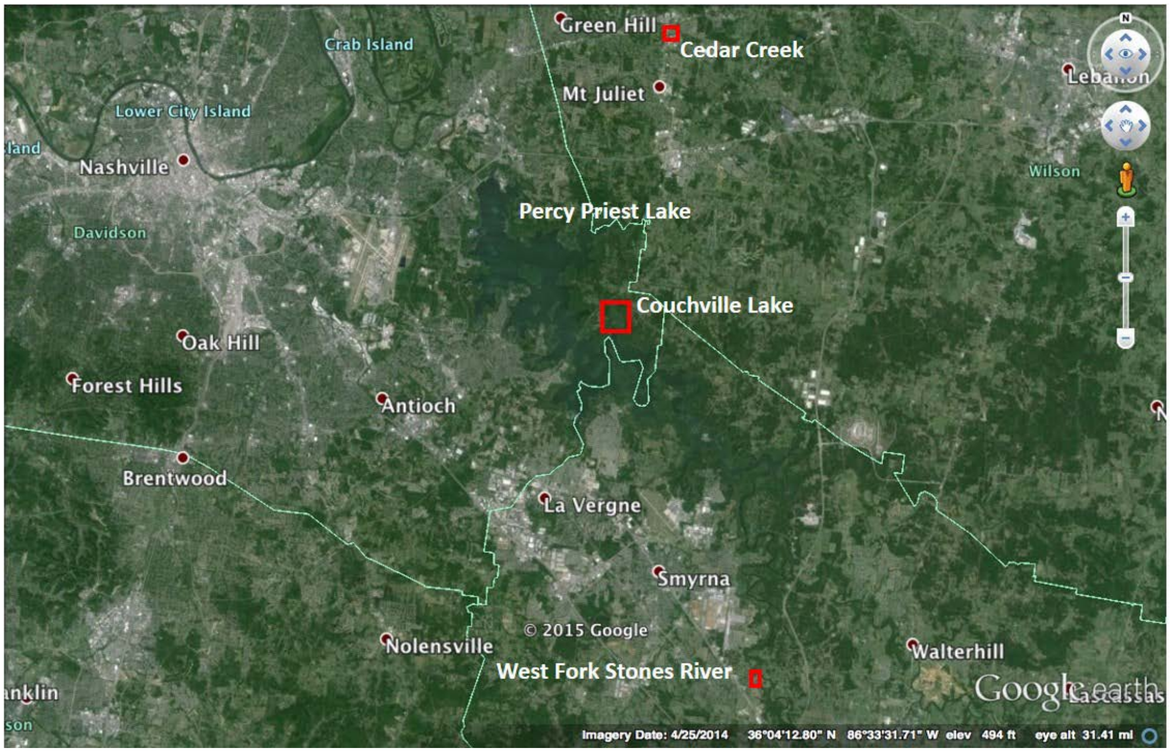

Figure 2. Location of Assessment Reaches on Cedar Creek, Couchville Lake and West Fork Stones River.

Cedar Creek is predominantly a Rosgen F (Appendix F) type stream channel. The reach is impacted by urban development and levee construction. It is also impacted with bridge construction and dams in the downstream section. Dams, predominantly mill dams are prevalent throughout the Central Basin (Figure 2). Purpose of the dams is to control water flow for flood control and navigation. The mill dams were constructed from late 18th through the 19th centuries for the milling of grain, lumber and textiles.

PFC is a qualitative method for assessing stream and wetland riparian area physical processes and how well they are working. PFC is a state of resiliency allowing a riparian-wetland area to hold together during high-flow events with a high degree of reliability. Each riparian-wetland area is judged against its capability and potential (Prichard et al., 1993; Prichard et al., 1996). The capability and potential of natural riparian-wetland areas are characterized by the interaction of the systems hydrology, vegetation and erosion/deposition. Riparian areas are deemed functioning properly when there is adequate vegetative structure present to provide the listed benefits applicable to a particular area. For example, if the system does not have the potential to support fish habitat, that criteria would not be used in the assessment (Prichard et al., 1993; Prichard et al., 1996).

Restoring riparian and upland area functions in ecologically degraded lands reduces the transport of contaminants into streams, lakes, and wetlands areas. Sustainability of these ecosystems is dependent on how well the physical processes of energy dissipation, sediment entrapment, stabilizing stream banks, ground-water recharge, floodplain development, and maintaining channel characteristics reflect a state of resiliency. Understanding how ecosystems work will assist decision makers to identify the connections between form, function, management, and monitoring so that they can better address the underlying causative factors behind ecological degradation.

Assessing stream and wetland functionality involves determining a riparian area's capability and potential using an approach such as the following: 1. Look for relic areas (exclosures, preserves, etc.); 2. Seek out historic photos, survey notes, and/or documents that indicate historic condition; 3. Search out species lists (animals & plants - historic & present), 4. Determine species habitat needs (animals & plants) related to species that are/were present; 5. Examine the soils and determine if they were saturated at one time and are now well drained; 6. Examine the hydrology, establish cross sections if necessary to determine frequency and duration of flooding; 7. Identify vegetation that currently exists. Are they the same species that occurred historically?; 8. Determine the entire watershed's general condition and identify its major landform(s); 9. Look for limiting factors, both human-caused and natural, and determine if they can be corrected through management strategies.

Stream-wetland systems may be prevented from achieving their potential because of limiting factors such as anthropogenic (human) activities. However, most of these limiting factors can be rectified through proper management. Except for permanent construction (e.g., dams, trans-mountain diversions, permanent channel modifications), which are not as easy to correct. The placement of permanent structures (i.e., dams and diversions) can result in a stream-wetland area's flow regime being altered, thus changing the area's capability. For example, cottonwood trees are maintained by periodic flooding, which creates point bars for seedling establishment. A dam or diversion that reduces or eliminates the potential for flooding may remove the potential for cottonwoods to remain in that area. PFC must be assessed in relationship to the area's capability. In this case there is a very large-scale dam which can cause issues of sediment delivery.

3.1 Potential

As described in Prichard et al., 1998, potential is defined as the "…highest ecological status a riparian-wetland area can attain given no political, social, or economical constraints, and is often referred to as the potential natural community (PNC)." The potential plant community (PPC) represents the seral stage the botanical community would achieve if all successional sequences were completed without human interference under the present environmental conditions. For some areas, PFC may occur from early seral to late seral. Desired plant community (DPC) would be determined based on management objectives through an interdisciplinary approach. For example, trout habitat conditions would be optimum from mid-seral to late seral.

Cedar Creek, within the urbanized Central Basin, is a stream ecosystem having an altered potential. At potential Cedar Creek would have a narrow channel with alternate point bars turning into a flood plain with a bedrock floor. Gravel to cobble substrate occurs in most places. Increased sinuosity in current channel, increased establishment of stabilizing trees (e.g,, willow, elm, maple, oak, sycamore), and areas of herbaceous communities (e.g., rushes, sedges) in open areas where sunlight reaches the ground.

Couchville Lake's altered potential is driven by water management in Percy Priest Reservoir. Fluctuations of Couchville Lake levels consistent of a summer high stand followed by a winter draw down of approximately 8 ft. which is between elevations 490 – 482 feet above mean sea level. Vegetation consist of cottonwood, popash, maple, sycamore, and juniper with sedges and rushes in the open areas where sunlight hits the ground.

West Fork Stones River is a Rosgen *E* channel (Appendix F) having gravel to cobble substrate occurring in most places. Increased sinuosity with established stabilizing trees (e.g,, willow, elm, maple, oak, sycamore), and areas of herbaceous communities (e.g., rushes, sedges) in open areas.

3.2 Capability

As described in Prichard et al., 1998, capability is defined as the "…the highest ecological status an area can attain given political, social, or economical constraints, which are often referred to as limiting factors." Capability only applies to constraints land/resource managers cannot eliminate or change through some management action.

Urbanization and historical incision has greatly changed the flow regime throughout the Central Basin.

3.3 Proper Functioning Condition (PFC) – Lotic Checklist: Cedar Creek and West Fork Stones River

3.3.1 Hydrological

Fluvial processes of sediment transport and storage are directly related to stream and wetland riparian habitat dynamics (Hurley and Jensen, 2001). In this section items 1-5 focus on the hydrologic attributes and processes thought to be necessary for maintaining ecosystem integrity (Prichard et al., 1998).

Item 1. Floodplain above bankfull is inundated in "relatively frequent" event.

A floodplain, topographically, is flat area adjacent to a stream (Schmudde, 1968; Alexander and Marriott, 1999). The floodplain is comprised of unconsolidated depositional material (i.e., sediment), and is flooded every 1.5 to 2 years (Schmudde, 1968; Alexander and Marriott, 1999). Natural floodplains vary in character depending on their climatic setting, catchment size and character and, as a consequence, discharge character and sediment load (Prichard et al., 1998). The floodplain is functional if it is normally connected to the stream at the bankfull discharge point, and is flooded in relatively frequent events (Prichard et al., 1998). The floodplain provides additional stream capacity to transport and store water and sediment. If the channel is downcut and flood flows cannot access the floodplain, the floodplain is considered non-functional if it no longer provides hydrologic functions (Prichard et al., 1998).

The objective is to determine if frequent flood flows (1.5 – 2 years) are capable of spreading out on a low-lying area adjacent to the stream. For Cedar Creek there is a very narrow floodplain, which is inundated infrequently. West Fork Stones River has developed a narrow floodplain, which is inundated relatively frequently.

Cedar Creek.

Yes	No	N/A	
	X		Stream is trapped in a wide channel (Rosgen F) by berm along both banks. Incised channel down to limestone bedrock. Bankfull is in channel.

West Fork Stones River.

Yes	No	N/A	
X			Narrow flood plain inside incised channel.

Item 2. Where beaver dams are present are they active and stable.

The objective is to determine if beaver dams are present and are being maintained. For Cedar Creek and West Fork Stones River there are no beaver in the area. This question is Not Applicable.

Cedar Creek.

Yes	No	N/A	
		X	

West Fork Stones River.

Yes	No	N/A	
		X	

Item 3. Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region).

The objective is to determine if the stream is in balance (i.e., shape and size) with its setting. Sinuosity, width/depth ratio, and gradient play important roles in how well a stream dissipates energy (Prichard et al., 1998). The position of a stream in its landscape and watershed setting is a strong determinant of that stream's ability to develop and support significant riparian-wetland resources (Prichard et al., 1998).

Prichard et al., 1998, indicate that a streams ability to develop and support significant riparian resources is dependent on the position of a stream in its landscape and watershed setting, and its expected range of variability for composition of bed and bank material. As well as the streams parameters related to channel size, shape and pattern.

In Cedar Creek, the width:depth ratio and sinuosity are not appropriate for the stream setting.

West Fork Stones River is a Rosgen F channel type (Appendix F), which has the potential to be more sinuous then in Cedar Creek. This section of the Stones River appears to be transitioning/recovering from past channelization activity. In West Fork Stones River the system is attempting to come in line with its setting even though the stream is still too straight from upstream mill dam construction, and the width:ratio is too large. Positive aspects are the development of fine-grained point bars, flood plain and willow recruitment.

Cedar Creek.

Yes	No	N/A	
	X		Straighter and wider than what would be in balance – so higher gradient. Width:depth ratio too large, and not enough sinuosity

West Fork Stones River.

Yes	No	N/A	
	X		Low sinuosity which is geologically controlled, W:D too high, fine grained substrate. Smart weed trapping bedload with willows on small left bank flood plain. Mill dam.

Item 4. Riparian – Wetland area is widening or has achieved potential extent.

Degraded riparian systems recover by capturing sediment in the floodplain. Riparian areas widen via aggradation, along with natural stream adjustments (e.g. widening of flood plain, sinuosity). This improves flood water retention and aids recruitment of plant communities. Recovery is expressed as an increase in riparian vegetation. The objective here is to determine if the riparian area is recovering, or has recovered.

In Cedar Creek the physical restrictions of the channel and urbanization are preventing and/or slowing down widening of the riparian area.

Stones River channel incision has restricted further expansion along the left bank, but smartweed is stabilizing an area and narrowing the channel. On the right bank the riparian area is continuing to widen.

Cedar Creek.

Yes	No	N/A	
	X		Physical restriction on reach being able to achieve potential extent, riparian area is widening for reach, but sections are not progressing, and/or widening at the same rate (i.e., reaching potential at the same rate).

West Fork Stones River.

Yes	No	N/A	
	X		Continuing to widen along the right bank. Close to or has achieved extent within the existing incised channel on left bank.

Item 5. Upland watershed is not contributing to riparian-wetland degradation.

Sediment load to a stream is a function of the watershed geology, soils, vegetation cover and land use. Condition of the surrounding uplands can greatly affect the riparian area. For example, changes in upland condition can change the discharge, timing or duration of stream flow events (Prichard et al., 1998). The objective of this item is to determine if there are changes in the water and/or sediment being supplied to the riparian system. Also, determine if the resulting increases are contributing to the degradation of the system. An answer of "No" indicates the upland is contributing.

As Prichard et al., 1998, describe, it is possible to have a disturbed upland area and not see "major changes" to the riparian area. Indicators of riparian are degradation area braiding of what should be a single-thread channel, mid-channel bars, overloading of point bars, fan deposits from upland erosion sinuosity, or cementing (i.e., increased embeddedness) of the channel substrate.

For reaches Cedar Creek and Stones River, the upland areas are contributing to stream and riparian degradation. Urbanization, roadways, and agricultural field runoff enter the rivers.

Cedar Creek.

Yes	No	N/A	
	X		Urbanized watershed with increased peak flows.

West Fork Stones River.

Yes	No	N/A	
	X		All storm water and ag field drains into river.

3.3.2 Vegetation

The hydrologic and geomorphic processes within the landform setting primarily impact stream riparian areas. For a stream riparian area to achieve functionality some amount of vegetation is required. Items 6-12 deal with vegetation attributes and processes that need to be in working order for a riparian system to function properly. The lateral distribution of vegetation determines the stream riparian areas ability to accommodate periods of floods and drought conditions. In order for the riparian area to persist or improve is dependent on having the appropriate vegetative community (i.e., the right kind and amount of vegetation) to be vigorous and replacing/increasing their numbers and/or extent through recruitment (Prichard et al., 1998). As described by Prichard et al., 1998, degradation of a stream riparian area corresponds with the elimination of or reduction in bank-forming vegetation, encroachment of upland vegetation onto floodplains and levees and increase in the extent of eroded banks and stream bars at the expense of vegetated communities on levees and floodplains.

Item 6. Diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery).

Prichard et al., 1998, indicate for a stream riparian system to recover, or maintain, it has to have more than one age class of wetland plants. Note: this question is not referring to all possible age classes are present. It is asking if the age classes present are providing recruitment to maintain, increase or allow recovery of an area. Prichard et al., 1998, states that most riparian areas will recover or maintain with two age classes, as long as one of the age classes is young (recruitment) and the other is middle aged (i.e., replacement). Older/mature age classes are well attached to existing water tables and can persist even with degraded conditions.

The objective of the item is to determine the age class distribution of at least one to two species of plants.

For both reaches there is a sufficient distribution of diverse age classes. In Cedar Creek and Stones River young, middle and old age classes are represented for trees species. However, the maintenance of different age classes among the herbaceous community is not well represented. Most likely from the tree canopy preventing enough light (i.e., solar radiation) to reach the riparian area floor/ground.

Cedar Creek.

Yes	No	N/A	
X			Young, middle aged and old trees present.

West Fork Stones River.

Yes	No	N/A	
X			Young, middle aged and older trees present.

Item 7. Diverse composition of riparian-wetland vegetation (for maintenance/recovery).

Stream riparian areas require the appropriate vegetation to be present if they are to function properly. This means having two or more riparian wetland species present. Diversity for maintenance or recovery applies primarily to the presence (availability) of those species with high erosion control potential (stabilizers) within a community.

The objective of this item is to determine and document if the existing species composition is sufficient for maintenance or recovery.

For the Cedar Creek there is sufficient diversity of vegetation community, predominantly attributed to woody material.

In Stones River there is a diversity of woody vegetation. However, lack of stabilizing herbaceous vegetation.

Cedar Creek.

Yes	No	N/A	
X			Willows, sycamore, poison oak, watercress, nettle, rye grass – lacking in key herbaceous species.

West Fork Stones River.

Yes	No	N/A	
X			Willow, need late stage herb/sycamore/bull rush.

Item 8. Species present indicate maintenance of riparian-wetland soil moisture characteristics.

Plants occurring in riparian wetland areas are hydrophytes (Prichard et al., 1998). They have to be in contact with the water table.

The objective of this item to determine the water table level is being maintained or is moving towards its potential extent as indicated by the presence of stream riparian plant communities.

A functional riparian system will have obligate wetland (OBL – e.g., cattails, Baltic rush, pondweed, willow, alder, etc.) or facultative wetland (FACW – spiked rush, ferns, oak, sycamore, cottonwood, etc.) plant communities on a perennial reach. A "no" response for this question will be given if facultative upland or upland (drier site plants) dominant the reach.

For Cedar Creek key woody species are present, but not on old left bank floodplain (new levee and ball field). Vegetation present is saying more about water levels within the channel than retention and maintenance of soil moisture. Soil core indicates a leached iron clay that is poor for moisture retention. Water mostly ponded on surface or ran off.

For the Stones River the riparian plant species present indicates the presence of obligate and facultative wetland plant communities,

Cedar Creek.

Yes	No	N/A	
	X		Not on old riparian floodplain (new levee and ball field). Soil indicates poor water absorbing capacity clay. Vegetation telling us more about water levels than water retention.

West Fork Stones River.

Yes	No	N/A	
X			Vegetation indicating a higher soil water retention potential.

Item 9. Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high stream flow events [community types present].

All stream banks erode to some degree as part of a streams natural process. Riparian plants are very effective at stabilizing stream banks, filtering runoff, shading and protection of fish habitats, enhancing aesthetics and controlling downstream flooding. Unstable banks can lead to extensive bank failures and add large volumes of sediment to the stream.

The objective of this item is to document that the streambanks have the right plant community types for recovery and maintenance of the riparian wetland area. Most plants that are obligate and facultative wetland have root masses capable of withstanding high-flow events (Prichard et al., 1998).

Cedar Creek and Stones River trees are, generally, are primary stabilizing plant community.

Cedar Creek.

Yes	No	N/A	
X			Trees are generally stabilizers.

West Fork Stones River.

Yes	No	N/A	
X			Trees providing the primary stabilizers.

Item 10. Riparian-wetland plants exhibit high vigor.

For most stream riparian wetland areas, plant size, shape and leaf color during the growing season can be used to discern vigor (i.e., robustness, health).

The objective of this item is to determine if the stream riparian plants are healthy and robust, or are in a weakened/stressed state and leaving the area. As riparian plants weaken or leave an area the reach is subject to degradation.

For Cedar Creek and Stones River the riparian plant community is exhibiting some robustness. Plant communities in the mid to lower reaches of Stones River show more vigor than those near the sediment depleted area below the mill dam.

Vegetation indicates a fairly high concentration of nutrients in Cedar Creek and Stones River.

Cedar Creek.

Yes	No	N/A	
X			Lot of water and nutrients.

West Fork Stones River.

Yes	No	N/A	
X			Some sediment deposition. High nutrients.

Item 11. Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows. ***[enough?]***

Normal channel migration is essential for creating and maintaining a variety of aquatic and riparian habitats (Prichard et al., 1998). To prevent excessive erosion is to have adequate vegetative cover to dissipate the erosive forces acting on the channel. Therefore, benefits of riparian vegetation communities are the ability to dissipate flow energy (i.e., create low velocity zones), for the deposition of sediments, which aids flood plain development. Also, storage of water, protect stream banks, which is crucial in obtaining proper functioning condition. Maintenance and recovery of a riparian wetland area is dependent on the having the “right plants”, recruitment, and the “right amount” to achieve its potential function.

The objective of this item is to determine if there is an adequate “amount” of vegetation present to dissipate stream energies from high-flow events.

For Cedar Creek and Stones River the amount of vegetative cover is adequate.

Cedar Creek.

Yes	No	N/A	
X			Trees and smartweed in channel, 60-70% canopy cover.

West Fork Stones River.

Yes	No	N/A	
X			Trees and smartweed in channel, 50-60% canopy cover.

Item 12. Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery).

Stream riparian continuum is in a state of dynamic stability when it is functioning properly (Prichard et al., 1998). Large Woody Material (LWM) plays a prominent role in regulating channel morphology, habitat and dissipation of energy. Woody material helps create physical habitat diversity, fish cover, pool development, and undercut banks. LWM is recruited as part of natural channel migration (e.g., bank erosion, landslides, etc.).

The objective of this item is to determine is woody material essential for system, and if necessary is the woody material present in size and number.

For Cedar Creek and Stones River (LWM) is essential for the stream to reach its potential. Large woody material is present throughout both watersheds. However, flow regime, especially in Cedar Creek, transports most woody material through the system. Or, woody material is transported up onto the banks. Lack of stream bottom variability (i.e., mostly flat) is not allowing for woody material to become snagged, or becoming a stable snag.

Cedar Creek.

Yes	No	N/A	
X			Large woody debris found on the banks. Storm surge is such available large woody material is transported through the system, or becomes snags on the banks at higher flow marks.

West Fork Stones River.

Yes	No	N/A	
X			Large woody debris found on the banks.

3.3.3 Erosion Deposition

Stream channels are constantly in motion adjusting to fluxes in stream flow and sediment being supplied by the watershed (Prichard et al., 1998). Items 13-17 deal with the erosion and deposition attributes and processes necessary for a system to function properly.

Item 13. Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy.

Channel and floodplain characteristics will vary depending on channel type (Rosgen, 1996). For stream riparian systems to function properly, flow energy has to be dissipated during high-flow events (Appendix F) (Prichard et al., 1998; Rosgen, 1996). In a functioning system energy is reduced through floodplain access and channel characteristics which creates resistance to downstream movement (Prichard et al., 1998).

The objective of this item is to determine if the channel characteristics are adequate to dissipate stream energy.

For Cedar Creek floodplain is narrow to nonexistent. Levees, steep banks, no overflow channels, and lack of channel and stream substrate characteristics. Wide deep flushing flows wash out wood and bar forming sediment.

For Stones River flood plain is not wide enough to dissipate flow energy. However, there are upstream grade controls.

For both Cedar Creek and Stones River, presence of trees is almost adequate to dissipate energy as long as there is no further removal of woody material. However, sediment supply is inadequate.

Cedar Creek.

Yes	No	N/A	
	X		Floodplain is narrow to nonexistent. Levees, steep banks, no overflow channels. Lack of channel characteristics. Wide deep flushing flows washing out wood and bar forming sediment.

West Fork Stones River.

Yes	No	N/A	
	X		Narrow floodplain. Not wide enough to dissipate flow energy, but there are some upstream controls – Nice Mill Dam

Item 14. Point bars are revegetating with riparian-wetland vegetation.

Lateral movement and formation and extension of point bars is part of the natural depositional process for some stream channel types. Point bars are predominant in Rosgen C channel types (Appendix F) (Rosgen 1996). It is important vegetation colonizes the deposits as they extend over time to maintain balance (Prichard et al., 1998). If vegetation cannot maintain a balance, high flow events will accelerate erosional processes, which can result in degradation of the stream riparian system (Prichard et al., 1998). To achieve balance the right riparian wetland plants need to have root masses capable of withstanding high stream flow events.

The objective of this item is to establish that riparian plant communities are capturing recent depositional events on point bars and maintaining the natural balance of the stream system.

For Cedar Creek point bar development is present. This item was not applicable for this reach.

For Stones River stabilization of point bars below Nice Mill Dam is generally inadequate. Smartweed has created a monoculture. However, it is difficult to determine if the smartweed is stabilizing sediment or has created a toe-hold into the fractured limestone bedrock. Or, both stream management and recreational activity are impacting the recruitment of sediment and stabilizing plant species.

Cedar Creek.

Yes	No	N/A	
		X	Currently no point bar development. Sediment recruitment is predominantly clam shells. Smartweed is capable of sending roots into the fractured limestone bedrock.

West Fork Stones River.

Yes	No	N/A	
	X		Smartweed is capable of sending roots into the fractured limestone bedrock.

Item 15. Lateral stream movement is associated with natural sinuosity.

Lateral stream movement usually occurs through bank erosion and point bar development (Prichard et al., 1998), and is associated with natural sinuosity. “Natural” rates of channel migration will vary by stream type and available material (Appendix F) (Prichard et al., 1998; Rosgen 1996).

The objective of this item to is to determine if the active channel is slowly progressing across its valley floor. Excessive lateral movement will impact the overall function of the riparian area.

For Cedar Creek and West Fork Stones River incision has confined the active channel. For Cedar Creek flood control, housing development and recreational activity for parks is impacting the streams ability to migrate within its valley floor. However, Cedar Creek is working against its levee constraints on the left bank (i.e., ball field).

In West Fork Stones River the channel is confined by incision and upstream disruption by Nice Mill Dam. However, establishment of smartweed along the left back is moving the main channel towards the right bank where the flood plain is expanding.

Cedar Creek.

Yes	No	N/A	
X			In places lateral stream movement associated with natural sinuosity within current channel. However, bedrock inhibits lateral movement.

West Fork Stones River.

Yes	No	N/A	
X			Lateral movement is associated with natural sinuosity.

Item 16. System is vertically stable. *[not downcutting]*

Natural streams transport water, sediment and other material out of the watershed. Natural disturbances or anthropogenic activities will impact the equilibrium conditions of the stream channel. Processes of degradation and aggradation may result in bank instability and changes in channel pattern (Prichard et al., 1998). During basinwide adjustments, the stage of channel evolution will usually vary systematically (Prichard et al., 1998). The lack of a systematic relation between stage of channel evolution and distance upstream/downstream indicates that the stability problems are local in nature (Prichard et al., 1998). For example, redirection of flow caused by a structure.

The objective of this item is to document if the channel adjustments are occurring at a “natural” or an accelerated rate (e.g., nick point, headcut).

Cedar Creek and Stones River are vertically stable and showing no signs of vertical instability. Both systems have been incised to bedrock.

Cedar Creek.

Yes	No	N/A	
X			Not downcutting. Limestone bedrock preventing further incision.

West Fork Stones River.

Yes	No	N/A	
X			No further incision. Limestone bedrock preventing further incision.

Item 17. Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition).

As streams transport water and sediment out of a watershed any excessive erosion or deposition indicates the system is out of balance with the material being supplied.

The objective of this item is to identify if the riparian wetland area is out of balance with the stream flow and material being supplied.

Cedar Creek is in balance with the sediment and water being supplied. However, damming within the watershed is inhibiting sediment transport.

Stones River is not in balance. Nice Mill Dam is preventing supply of sediment. Lack of sediment supply is preventing further advancement of the Stones River through channel evolutionary process.

Cedar Creek.

Yes	No	N/A	
X			Yes, but mill dams inhibit sediment being transported through the stream network.

West Fork Stones River.

Yes	No	N/A	
	X		Lack of sediment transport slowing down channel evolution process.

3.4 Proper Functioning Condition (PFC) Lentic Checklist: Couchville Lake

Fluvial processes of sediment transport and storage are directly related to stream and wetland riparian habitat dynamics (Hurley and Jensen, 2001). The PFC checklist is designed to address the common attributes and processes needing to be in working order for a lentic riparian-wetland area to function properly.

3.4.1 Potential

Couchville Lake has an altered potential driven by water management in Percy Priest Reservoir. Couchville Lake has a consistent summer pool, but winter draw down can be up to 8 ft. J. Percy Priest lake draw down is typically conducted between Oct-Mar according to the USACE project guide curve. Limestone bedrock has developed a karst topography of sinks, pot holes and underground streams. Vegetation present consists of American Elm, Black Walnut, Red Maple, Red Oak, popash, willow, sycamore, maple, sedges and rushes.

3.4.2 Hydrology

The term “wetland hydrology” encompasses all hydrologic characteristics of wetland areas that are periodically inundated, or has soils saturated to the surface at some time during the growing season (Prichard, et al., 1999). These areas are inundated, or saturated, to the surface for sufficient duration to develop hydric soils (i.e., anaerobic soil conditions) and support vegetation adapted to anaerobic soil conditions (Prichard, et al., 1999).

Hydrology is often the least exact of the parameters. It is essential to establish that a wetland area is periodically inundated or has saturated soils during the growing season (Prichard et al. 1994).

Item 1: Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events.

Water creates and maintains all wetlands. Water is the dominant factor determining the nature of soil development and the plant community structure in a wetland (lentic) system (Cowardin et al., 1979). The purpose of Item 1 is to document the wetland is inundated (i.e., saturated) long enough in duration and occurs frequently enough to maintain wetland characteristics.

Couchville Lake is hydrologically connected to Percy Priest Lake. Lake levels are controlled by this hydrologic connection and will fluctuate 1-2 feet throughout the year, allowing for the riparian area to be saturated. However, soil cores indicate the saturation zone is very narrow, about 10-15 feet from the waterline.

Yes	No	N/A	
X			

Item 2: Fluctuation of water levels is not excessive.

Periodic flooding, or saturation, of the wetland areas is necessary to promote and sustain (Obligate Wetland Species) OBL and (Faculative Wetland Species) FACW vegetation. Flood pool storage elevations are between 490.5 - 504.5 feet above mean sea level. Water level changes must be within the range of plant tolerance. The purpose of Item 2 is to determine if the water level changes are within the limits capable of sustaining riparian-wetland vegetation.

Yes	No	N/A	
X			Yes, but lake has a winter draw down.

Item 3: Riparian-wetland area is enlarging or has achieved potential extent.

Depending on a lentic area's site characteristics, degradation can result in accelerated sedimentation (filling in faster), or loss, or lowering, of the water table (Prichard, et al., 1999). Either process will have a detrimental effect on the riparian-wetland vegetation and community structure.

Deposition around shorelines provides more shallow water area for emergent vegetation (Prichard et al., 1999). Excessive sediment results in a decrease in the spatial extent of the wetland as the perimeter area shrinks with declining catchment capacity.

A loss, or lowering, of the water table results in loss of vegetation vigor (i.e., water stress), lowered production, and eventually a complete loss of riparian-wetland vegetation (Prichard et al., 1999).

The objective of Item 3 is to determine if the riparian wetland area is degrading, recovering or has recovered.

Yes	No	N/A	
X			Has achieved potential extent. However, a few areas are showing some riparian area expansion because of the setting. Riparian maybe impacted by some local management.

Item 4: Upland watershed is not contributing to riparian-wetland degradation.

The objective of Item 4 is to determine if the surrounding uplands are affecting the condition of a riparian-wetland area. Alteration in upland condition influences the magnitude, timing, or duration of overland flow events (Prichard et al., 1999). This in turn affects the riparian wetland functionality. The focus is on whether the uplands are, or are not, contributing to degradation, and not on the condition of the uplands.

Yes	No	N/A	
X			Upland area is not contributing.

However, construction of Percy Priest Reservoir has altered timing and duration of water levels in Couchville Lake.

Item 5: Water quality is sufficient to support riparian-wetland plants.

The purpose of Item 5 is to determine if water quality is being maintained (Prichard et al., 1999). The toxicological impacts to ecosystems occurs when there is too low or too high nutrient and trace metal concentrations. The effect also occurs for sediment. For example, nutrient (i.e., nitrogen, phosphorus) concentrations exceed the capability of the wetland vegetation community to absorb them, and or the concentrations are too low to maintain vigor. Maintenance of water quality is important for riparian wetland areas to produce the kind of vegetation necessary for proper functioning condition.

Yes	No	N/A	
X			High nutrient levels.

Total maximum daily load (TMDL) for the area indicate nitrogen and phosphorus are a problem. Nitrogen loads also occur from atmospheric NOx from the greater Nashville area, and trapped within the Central Basin topography.

Item 6: Natural surface or subsurface flow patterns are not altered by disturbance (i.e., hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities).

The objective of Item 6 is to determine if surface or subsurface flow patterns are being maintained. A change in flow patterns may mean a change in vegetation type (e.g., wetland species to upland species). Alteration of surface or subsurface flow patterns may affect the functionality of a site, by creating a site unable to dissipate energies and function properly.

If the natural surface or subsurface flow patterns of lentic areas are altered, the timing, frequency, magnitude, and duration of inundation or saturation can be affected, with corresponding changes to the soils and vegetation (Prichard et al., 1999). This would indicate that the wetland plant community may be impacted during drought conditions, which is suggested in Items 10-12.

Yes	No	N/A	
	X		Presence of upstream dams/mill dams, historical road ways, and park have created an altered potential

Surface flow patterns in and around the Couchville Lake have been altered over the couple of hundred years of human use. Park and paved bike path is channeling flow into the narrow wetland area and then into the lake.

Item 7: Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway).

Some lentic riparian-wetland areas have been altered through the addition of structures designed to capture more runoff, thus creating a more permanent or larger wetland (Prichard et al., 1999). When structures are placed to with/without intent to alter a riparian-wetland area, it is very important that the structure is designed and maintained to accommodate safe passage of flows (Prichard et al., 1999). The purpose of Item 7 is to determine if these structures are accommodating safe passage of flows.

Yes	No	N/A	
X			Safe passage of flows because of impact from Percy Priest Dam releases.

3.4.3 Vegetation

Items 8-15 address vegetation attributes and processes that should be in working order for a lentic riparian-wetland system to function properly (Prichard et al., 1999). In assessing functionality, the whole complex (i.e., landform, vegetation community structure) should be considered in order to understand such items as age class distribution and species diversity. For a wetland area to persist, and/or improve, the plant species or communities of interest must be both healthy (vigorous) and replacing or increasing their numbers or extent through recruitment into the community. The site should be evaluated by determining if the right kinds and proportions of species of community vegetation types are those found in lentic riparian-wetland areas (Prichard et al., 1999). For example, many lentic riparian-wetland areas do not have the soil and hydrology conditions needed to support tree or shrub species.

Riparian-wetland plants are classified into five types based on the likelihood of their occurrence in wetlands or nonwetlands (Reed 1988). These classes are: obligate wetland (OBL), facultative wetland (FACW), facultative (FAC), facultative upland (FACU), and obligate upland (UPL). OBL species are likely to occur in wetlands >99 percent of the time, whereas FACW species occur in wetlands between >67-99 percent of the time. The FAC species are likely to occur in wetlands 33-67 percent of the time; FACU species are likely to occur 1-<33 percent of the time. UPL species almost never (<1 percent) occur in wetlands.

Item 8: There is diverse age-class distribution of riparian wetland vegetation (recruitment for maintenance/recovery).

In most cases, a riparian-wetland area should have more than one age class of wetland plants present for maintenance or recovery – i.e., a sufficient number of age classes are present to provide recruitment to maintain an area or to allow an area to recover (Prichard et al., 1998). Most riparian-wetland areas can maintain their numbers with two age classes. Provided one of the age classes is young for recruitment, and the other is middle aged (i.e., replacement). Older/mature age classes are well attached to existing water tables and can persist even with degraded conditions (Prichard et al., 1998). Most herbaceous riparian wetland plants spread through seed and rhizomes (Prichard et al., 1999). A lack of spreading by wetland plants may indicate a lack of age class diversity. This is possibly due to a change in site conditions.

The objective of Item 8 is to determine the age class distribution of at least one to two species of plants.

Yes	No	N/A	
X			Lack of younger in over growth areas (i.e., older successional tree growths). Has potential to provide recruitment as an areas opens up to sunlight.

Item 9: There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)

In addition to diverse age-class distribution, diverse species composition is important for maintenance and recovery (Prichard et al., 1998; Prichard et al., 1999). The objective of Item 9 is to determine and document if the existing species composition is sufficient for maintenance or recovery. Basically, two or more riparian-wetland species are present, but varies by the potential of the site to support a given number of species. Site characteristics can give a competitive advantage of a particular species over other species. Capability of the site must also be considered (Prichard et al., 1999). If the hydrology has been altered by some activity in the upper watershed, altered flows into the wetland may limit the types of species that can survive (Prichard et al., 1999).

For this wetland area there is a diversity of vegetation community predominantly in the herbaceous and woody material.

Yes	No	N/A	
X			Sedges, bull rushes and a diverse composition of trees (e.g., willows, sycamore, etc.).

Item 11: Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g., storm events, snowmelt).

Lentic riparian-wetland areas can have open water, or wet meadows with standing water some part of the year. The objective of Item 11 is to determine if the shorelines/soil surfaces have the right plants, or community types, present and in abundance to protect the riparian-wetland area from erosion – i.e., those species with root systems *capable* of withstanding such events (Prichard et al., 1998; Prichard et al., 1999).

Most perennial plants that are OBL and FACW have root masses capable of withstanding erosional events, while most FACU and UPL plants do not (Prichard et al., 1999). Typically, herbaceous species with rhizomes, or stolons, which form a continuous mat of roots (rather than isolated individual bunch grasses) are most effective (Prichard et al., 1999).

Yes	No	N/A	
X			

Item 12: Riparian-wetland plants exhibit high vigor.

The objective of Item 12 is to determine if the stream riparian plants are healthy and robust, or are in a weakened/stressed state and diminishing from the area. As riparian plants weaken or leave an area the wetland is subject to degradation. The aboveground expression is a reflection of the condition of the root system and the ability of riparian-wetland species to hold an area together (Prichard et al., 1999). During the growing season plant size, shape and leaf color can be used to discern vigor (i.e., robustness, health).

For this wetland the riparian plant community is exhibiting some robustness indicating higher nutrient loads.

Yes	No	N/A	
X			

Item 13: Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows.

Vegetation filters sediment, aids floodplain development, protects shorelines, etc. All of which dissipate energies associated with wind action, wave action, and overland flow events. The purpose of Item 13 is to determine if there is an adequate amount of vegetation present to dissipate energies from these events (Prichard et al., 1999).

For a riparian wetland area to maintain/recover, composition and abundance of the right plants, recruitment, etc., are necessary/essential for the system to function properly (Prichard et al., 1998; Prichard et al., 1999).

For this wetland there is adequate vegetative cover.

Yes	No	N/A	
X			

Item 14: Frost or abnormal hydrologic heaving is not present.

The objective of Item 14 is to determine if frost or hydrologic heaving is occurring, and determine if it is occurring at a normal or aggravated rate. Frost or hydrologic heaving occurs when soil pores contain free water conducive to the development of segregated ice lenses or crystals and when temperatures drop below freezing (Prichard et al., 1999). This is a natural process which is aggravated by impacts that either seal parts of the surface, which restricts water infiltration between plants, or reduces pore space by compaction between plants (Prichard et al., 1999). Excessive removal of vegetation, acting as thermal cover, can exaggerate the effects of freezing resulting in vegetated hummocks (i.e., increasing elevation develop between the sealed or compacted interspaces).

Yes	No	N/A	
X			

Item 15: Favorable microsite condition (i.e., woody material, water temperature, etc.) is maintained by adjacent site characteristics.

The objective of Item 15 is to determine if microsite conditions are necessary for proper functioning, and if the adjacent site characteristics are maintaining those conditions.

Some riparian-wetland areas require very specific conditions to sustain temporal water budgets (Prichard et al., 1999). If seasonal inflows, outflows, and/or evapotranspiration characteristics are significantly altered, the type and extent of the riparian-wetland area can also be altered (Figure 2). Adjacent site characteristics can directly influence both inflow and outflow by buffering surface runoff (Prichard et al., 1999).

Changes in vegetation type and abundance can change the evaporation to transpiration rate. In some riparian-wetland areas, adjacent site characteristics can affect vegetation recruitment potential on-site by shading, temperature modification, available seed germination sites, etc. (Prichard et al., 1999). If functionality is dependent on these particular species, then the adjacent site characteristics must also be maintained (Prichard et al., 1999).

Yes	No	N/A	
X			Woodland forest.

3.4.4 Erosion and Deposition

Wetland riparian habitats are constantly in motion adjusting to fluxes in stream flow and sediment being supplied by the watershed (Prichard et al., 1998). Items 16-20 deal with the erosion and deposition attributes and processes necessary for a system to function properly.

Item 16: Accumulation of chemicals affecting plant productivity/composition is not apparent.

Maintaining a chemical balance of essential trace metals and nutrients in a lentic riparian-wetland area is necessary to maintain functionality. Toxic effect to plant communities occurs if there is an imbalance in the water and soil chemistry of essential nutrients and trace metals, and an increase of organic chemicals (i.e., herbicides, pesticides, etc.). Accumulation of harmful chemicals can potentially affect plant and soil microbial composition and/or productivity (Prichard et al., 1999). The objective of Item 16 is to determine if the vegetation productivity/composition is being affected by chemicals.

Yes	No	N/A	
X			Is not apparent.

Surface water quality data indicated there is a potential for excessive nutrients to occur in the watershed.

Item 17: Saturation of soils (i.e., ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils.

The objective of Item 17 is to determine whether hydric soils are being created or maintained in areas that should have hydric soils. Hydric soils are developed and maintained through frequent flooding, ponding, or saturation for a long enough time for anaerobic conditions to develop (Prichard et al., 1999).

For Couchville Lake, which is also evident throughout the Central Basin, soil type (clay) is not conducive for the infiltration of water. Saturation is only within a couple of feet from the shoreline.

Yes	No	N/A	
	X		Soil type (clay) not conducive for the infiltration of water.

Item 18: Underlying geologic structure/soil material/permafrost is capable of restricting water percolation.

The objective of Item 18 is to identify whether geologic structure and/or underlying soil material is being maintained. Lentic, or standing water, riparian-wetland areas often have an underlying soil material/type capable of maintaining, or persisting over long periods of time. For example bedrock, clay layer, or caliche that is a hardened deposit of calcium carbonate, which creates a bowl effect. This underlying material restricts water percolation, producing permanent or seasonal ponding, saturation, or inundation (Prichard et al., 1999). This underlying material has to be maintained for an area to function properly. If the underlying bowl (i.e., impervious layer) is breached the wetland area can no longer hold water thus maintaining existing hydrology and associated vegetation.

Couchville Lake is hydrologically connected to the Stones River and Percy Priest Reservoir. The limestone karst topography of the Central Basin is not capable of restricting water percolation.

Yes	No	N/A	
	X		No. Couchville Lake is hydrologically connected to Stones River and Percy Priest Reservoir.

Item 19: Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition).

The purpose of Item 19 is to identify if water and sediment are being supplied to the wetland at a natural rate for the system to maintain or improve functions. Over geologic time, lentic riparian-wetland areas will follow a natural successional process of fill with sediment and converting to an upland area type (Prichard et al., 1999). This conversion/successional change can be accelerated by activities within a watershed, such as road building, logging, water diversions, farming, or grazing, if not properly managed (Prichard et al., 1999). Too many roads, roads in the wrong location, or roads constructed in a manner to channelize stream conditions may/will accelerate erosion within a watershed. This erosion may result in excessive amounts of sediment being supplied to a riparian wetland area, filling it faster (Prichard et al., 1999) and decreasing its function potential. If flows increase, or have been increased by construction activity, the resulting increased energy will form headcuts (incision) endangering the entire system. The increased flows and increased sediment load will change the type of riparian-wetland (i.e., marsh to lake) system (Prichard et al., 1999).

Yes	No	N/A	
X			No excessive erosion.

Item 20: Islands and shoreline characteristics (i.e., rocks, coarse and/or large woody material) are adequate to dissipate wind and wave event energies.

The intent of Item 20 is to address those systems that **do not** require vegetation (Prichard et al., 1999). Riparian-wetland areas with islands and shorelines have to be able to dissipate energy during wind action and wave action events to function properly (Prichard et al., 1999). Islands and shorelines need characteristics to dissipate wind and wave action. Presence of rocks, woody and/or herbaceous material will dissipate energies associated with wind and wave action.

For Couchville Lake shoreline characteristics are adequate to dissipate wind and wave energies.

Yes	No	N/A	
X			

3.5 Functional Rating

Cedar Creek.

Functional – At Risk – Upward. Upper third of thermometer (see Appendix A, Summary

Determination, for an illustration). Yes – Upstream channel condition, Road encroachment (road runoff from highway), Augmented flows, and downstream bridge development, storm water levees and mill dams.

West Fork Stones River.

Functional-At Risk – Trend is Not Apparent. Yes – Flow regulation, Upstream channel condition, Road encroachment (road runoff from highway), Nice Mill Dam.

Couchville Lake.

Proper Functioning Condition – trend is upward. At lower end of PFC. There are no factors contributing to unacceptable conditions outside the control of the manager.

4.0 Discussion

When determining whether a riparian-wetland area is functioning properly, the condition of the entire watershed, including the uplands and tributary watershed system, is important. The entire watershed can influence the quality, abundance, and stability of downstream resources by controlling production of sediment and nutrients, influencing streamflow, and modifying the distribution of chemicals throughout the riparian-wetland area. Riparian-wetland health (functioning condition), an important component of watershed condition, refers to the ecological status of vegetation, geomorphic, and hydrologic development, along with the degree of structural integrity exhibited by the riparian-wetland area. A healthy riparian-wetland area is in dynamic equilibrium with the streamflow forces and channel aggradation/degradation processes producing change with vegetative, geomorphic, and structural resistance. In a healthy situation, the channel network adjusts in form and slope to handle increases in storm flow/snowmelt runoff with limited perturbation of channel and associated riparian-wetland plant communities.

"When adequate vegetation, landform, or large woody debris is present to dissipate energy associated with high flows, then a number of physical changes begin to occur. Such as reduced erosion, sediment filtering, and improved habitat for fish, water-fowl, and other uses. The physical aspects have to be in working order to sustain the channel characteristics that provide the habitat for these resource values" (Pritchard et al., 1998).

As pointed out by Pritchard et al., 1998, areas not functioning properly, need change in management practices to allow recovery (e.g., acquire adequate vegetation). For example, change requiring vegetation leads to other physical changes allowing the system to begin to function. Therefore, recovery, starts with acquiring the right element(s) to dissipate energy, support physical process and provide the foundation to sustain the desired conditions.

The Nashville Basin, or Central Basin, is underlain by Ordovician limestone. Topography of the Central Basin is relatively flat to gently rolling with low to moderate gradient streams and rivers, which drain towards the northwest into the Cumberland River.

Stream substrate is limestone bedrock interspersed with rock rubble riffle areas, silty basins, and some sand and gravel reaches. Land cover is urban with small farms and cattle operations. Limestones leach nutrients, predominantly phosphorus, and are very productive. Algae and rooted vegetation (i.e., smartweed and willow) are abundant in the stream channel.

Soils in the Central Basin are a clayey material with low hydraulic conductivity, and appear to be easily eroded (Figure 3). Water has a tendency to pond and runoff than to saturate. Lack of saturation potential indicates why the riparian zone at Couchville Lake, Stones River and Cedar Creek are not much wider than a few feet.

Figure 4. **Side Channel Draining Charlie Daniels State Park Situated Along the Left Bank of Cedar Creek Assessment Reach.**

State of Tennessee's water quality assessment indicates that habitat alteration and siltation are primary pollutants in the watershed (USEPA, 2012). Organic enrichment, nutrients and pathogens are secondary pollutants. State of Tennessee attributes this to population explosion in the Central Basin within the last couple of decades. Sediment erosion and destruction of riparian habitat happen through construction. Due to past bank and channel alterations and riparian vegetation removal many streams within the Central Basin (Cedar Creek, Stones River) watershed have unstable and eroding banks (Figure 4). This erosion can release a surprising amount of sediment downstream.

Analysis of a PFC assessment is to observe the 'No' answer and their justification. For Couchville Lake, a natural lake ecosystem in the Stones River watershed, the No's are Item 6 – natural surface or subsurface flow patterns; Item 17 – Saturation of soils; Item 18 – Underlying geologic Structure capable of restricting water percolation.

Couchville Lake was rated as being PFC, but at the lower end. This is mostly as a result of changes in water flow in to and out of the Lake. Groundwater in the fractured limestone bedrock of the Central Basin flow through a system of higher irregular solution channels (Brahana and Bradley, 1986). Solution channels, or cavities, are expanded openings along joints and fractures by dissolution of the limestone bedrock (Brahana and Bradley, 1986). It is through these channels and cavities that Percy Priest Lake and Couchville Lake are connected. Therefore, lake level changes in Percy Priest impact lake levels in Couchville Lake.

Item 17, saturation of soils (i.e., ponding, flood frequency, and duration) is sufficient to compose and maintain hydric soils. Most soils in the central and southeastern section of the Central Basin formed from weathering of the limestone bedrock (North, et al., 1977). Sediment cores taken at Couchville Lake indicate soil saturation (i.e., formation of wetland anoxic soil conditions) is limited. Wetland soils form a narrow band of approximately 10-15 feet along the western margin of the lake. Soils around Couchville Lake are more conducive for runoff than absorption.

North, et al., 1977, described the Talbot soil around the Percy Priest reservoir area as well drained with moderately slow permeability and limited depth to bedrock. Low available water capacity and shallow depth to bedrock outcrop are the main soil limitations.

For Cedar Creek and West Fork Stones River the PFC assessments were different. Cedar Creek was assessed as Functional-At-Risk. Cedar Creek was considered to have an upward trend. West Fork Stones River the trend was not apparent but was assessed as Proper Functioning Condition.

Hydrological difference is on the West Fork Stones River the floodplain was deemed to be above bankfull on relatively frequent events. Also, the West Fork Stones River has developed, and/or is developing, more of a floodplain in the incised channel than Cedar Creek. However, the ‘No” answers for Items 3, 4 and 5 were similar. Both lotic systems are incised into the limestone bedrock and are evolving, widening inside the downcut channel. Water quality issues occur from contribution of storm water into the streams. Cedar Creek has been urbanized with a narrow riparian area. West Fork Stones River is predominantly rural with a few urban areas, but soils have low permeability and high runoff during storm events.

Maintenance of soil moisture is visible in Item 8. On Cedar Creek vegetation species present are saying more about water levels that water retention. Vegetation along the West Fork Stones River indicates better soil moisture characteristics, but the riparian area is fairly narrow. Overall soils within the Central Basin are not providing characteristics to retain water and create wetland habitat.

For erosion and deposition parameters Item 13 existing channel characteristics are not present to dissipate stream energy in Cedar Creek and West Fork Stones River. For both reaches the floodplain is narrow to nonexistent. West Fork Stones River has a couple of overall channels, but in both cases the presence of levees with steep banks and lack of woody debris inhibit the ability of the streams to dissipate high flows. Mill dams and flood control structures prevent sediment (Item 17) from being transported through the stream network.

5.0 Conclusions and Recommendations

State of Tennessee has identified habitat alteration and siltation are primary pollutants in the Central Basin watersheds. In the State of Tennessee's total maximum daily load (TMDL) for the Stones River indicates that habitat alteration and siltation has had severe consequences on aquatic organisms and fish populations. Several agencies are working to restore streams in the Central Basin. Best management practices (BMPs) include re-establishment of bank vegetation, providing off-channel watering areas for cattle, and improving erosion management during road-building.

PFC assessments for Cedar Creek and West Fork Stones River indicate that channel evolution has slowed resulting in an altered potential. For the Cedar Creek this means a long drawn out process of re-establishing a new floodplain within its current incised channel. For the West Fork Stones River the altered potential has resulted in the ecosystem being stuck, or pickled. By this, the system is unable to improve, or trend upward.

Army Corps of Engineers indicated they do not manage the riparian habitat other than to manage water moving through the watersheds. However, the State of Tennessee has identified methods for improving habitat alteration by:

- Organizing stream cleanups removing trash, limbs and debris by hand or winch before they cause blockage.
- Avoiding use of heavy equipment to "clean out" streams.
- Planting vegetation along streams to stabilize banks, provide habitat, additional flood protection, and nutrient and pollution filtration.
- Encouraging developers to avoid extensive culverting or relocation of streams, and removal of riparian vegetation.

These activities indicate why floodplain characteristics (Item 13, specifically large woody material) are not present within the channel. However, water quality issues (e.g., organic enrichment, nutrients and pathogens) are result of low permeability of the soils and bedrock and the expanded impervious surface from urbanization. Possible best management practices (BMPs) to mitigate and/or eliminate for non-point source pollutants include:

1. Initiating a bacterial source tracking study
2. Continuing surface water monitoring
3. Educating the public about waterbody health
4. Implement creek bank protection and enhancement
5. Work with flood control projects to get water on the land longer - maintain and restore the hydrologic connectivity of streams, meadows, wetlands, and other special aquatic features by identifying roads and trails that intercept, divert, or disrupt natural surface and subsurface water flow paths. Implement corrective actions where necessary to restore connectivity.

6. Identify other management practices, for example, road building, recreational use, grazing, and timber harvests that may be contributing to the observed degradation.
7. Conducting an annual litter removal program
8. Commence exotic vegetation removal and native plant restoration.

By the use of PFC assessment and using the results in Tribal management planning, Western Tribes have made remarkable results in improving Tribal ecosystems. Although there are many differences between western and eastern ecosystems in the United States, PFC can also be used to great effect by Eastern Tribes. The foundations for maintenance and recovery of desired Tribal values can be determined by the PFC assessment. The laws of physics still apply. The riparian-wetland areas are functioning properly when adequate vegetation, landform or large woody debris is present. This dissipates stream energy associated with high flows, filters sediment and captures bed flow, aids flood plan development, improves flood water retention and groundwater recharge and will stabilize the streambanks. The PFC process is an easy and simple way to explain how the environment works and how anyone can work to make a difference.

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Notice

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7.0 References

Alexander, J., and Marriott, S.B., 1999, Geological Society, London, Special Publications, *Geological Society, London, Special Publications,* v. 163; p. 1-13 doi:10.1144/GSL.SP.1999.163.01.01

Brahana, J.V., and Bradley, M.W., 1986, Preliminary Delineation and Description of the Regional Aquifers of Tennessee-The Central Basin Aquifer System. U.S. Geological Survey Water-Resources Investigation Report 82-4002, 40 pgs.

Cowardin, L.M., Carter, V., Golet, F. and LaRoe, E. 1979. Classification of Wetlands and Deepwater Habitats of the United States. USDI, FWS/OBS-79/31, Washington, DC. 103p.

Hurley, M., and Jensen, M.E., 2001, Geomorphic Patterns, Processes, and Perspectives in Aquatic Assessments, in A Guide Book for Integrated Ecological Assessments, Jensen, M.E., and Bourgeron, P.S., Editors, Springer Verlag, 536 pages.

Jensen, L.A. Ryel, R., and Platts, W.S. 1089. Classification of Riverine/Riparian Habitat and Assessment of Nonpoint Source Impacts, North Fork Humboldt River, Nevada. Report to the U.S. Department of Agriculture, Forest Service, Intermountain Research Station. White Horse Associates, Smithfield, UT 165 p.

North, O.L., Cox, T.E., Dollar, H.D., Hall, W.G., Hinton, R.B., McCowan, C., and McCroskey, C.E., Soil Survey of Davidson County, Tennessee. U.S. Department of Agriculture, Soil Conservation Service Report, 127 pgs.

Prichard, D., Barrett, H., Gebhardt, K., Cagney, J., Hansen, P.L., Clark, R., Mitchell, B., Fogg, J., Tippy, D., 1993, Riparian Area Management: Process for Assessing Proper Functioning Condition, U.S. Department of the Interior, Bureau of Land Management, Technical Reference 1737-9, 1993; Revised 1995, 1998.

Prichard, D., Berg, F., Hagenbuck, W., Krapf, R., Leinard, R., Leonard, S., Manning, M., Noble, C., and Staats, J., 1996, Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas, Technical Reference 1737-16, 1999; Revised 2003, U.S. Department of the Interior, Bureau of Land Management.

Prichard, D., Anderson, J., Correll, C., Fogg, J., Gebhardt, K., Krapf, R., Leonard, S., Mitchell, B., and Staats, J., 1998, Riparian Area Management, A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas; Technical Reference TR1737-15, Department of the Interior, Bureau of Land Management (BLM).

Prichard, D., Clemmer, P., Gorges, M., Meyer, G., and K. Shumac, K.. 1999. Riparian Area Management: Using Aerial Photographs to Assess Proper Functioning Condition of Riparian-Wetland Areas. TR 1737-12. Bureau of Land Management, BLM/RS/ST-96/007+1737, National Business Center, CO. 37 p.

Reed, P., Jr. 1988. National List of Plant Species that Occur in Wetlands: Intermountain (Region 8). Biological Report 88(26.8), USDI Fish and Wildlife Service, Fort Collins, CO. 76 p.

Rosgen, D. (1996) Applied River Morphology, Wildland Hydrology, Pagosa Springs, CO. 390 p.

Schmudde, T.H. 1968. Floodplains. *In:* FAIRBRIDGE, R. W. (ed.) *The Encyclopedia of Geomorphology*. Reinhold Book Corporation, New York, 359-362 pp.

Tennessee Section of the American Water Resources Association (TS-AWRA), 2012. Proceedings from the 22nd Tenessee Water Resources Symposium, Montgomery Bell State Park, Burns, Tennessee, April 11 – 13, 2012.

U.S. Environmental Protection Agency. December 2006. Wadeable Streams Assessment, A Collaborative Survey of the Nation's Streams. EPA 841-B-06-112. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, D.C.

U.S. Environmental Protection Agency. 2012. Tennessee Water Quality Assessment Report, Assessed Waters of Tennessee by Watershed, http://ofmpub.epa.gov/waters10/attains_index.search_wb?p_area=TN&p_cycle=2012

8.0 Quality Assurance Summary

A Quality Assurance Project Plan (QAPP) was use for this work entitled, "Development of ORD/NERL's Community – Focused Exposure and Risk Screening Tool (C-FERST) and Tribal-Focused Environmental Risk and Sustainability Tool (Tribal-FERST)", approved on July 6, 2013. This Report does not include environmental data collected by the USEPA. The Environmental Sciences Division Director and Quality Assurance Manager reviewed laboratory notebooks annually. There were no findings requiring corrective actions. There were no deviations to methods or general or specific limitation on the use of the results.

Appendix A: Proper Functioning Condition (PFC) Lotic Checklist

Lotic Checklist

Name of Riparian-Wetland Area:			
Date:		**Segment/Reach ID:**	
ID Team Observers:			
Potential/Capability:			

Yes	No	N/A	HYDROLOGICAL
			1) Floodplain above bankfull is inundated in "relatively frequent" events. **Notes:**
			2) Where beaver dams are present they are active and stale. **Notes:**
			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region). **Notes:**
			4) Riparian-wetland area is widening or has achieved potential extent. **Notes:**
			5) Upland watershed is not contributing to riparian-wetland degradation. **Notes:**
Yes	**No**	**N/A**	**VEGETATION**
			6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery). **Notes:**
			7) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery). **Notes:**
			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics. **Notes:**
			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events. *[community types present]* **Notes:**
			10) Riparian-wetland plants exhibit high vigor. **Notes:**
			11) Adequate riparian-wetland vegetative cover is present to protect banks and dissipate energy during high flows *[enough?]* **Notes:**
			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery). **Notes:**

Yes	No	N/A	EROSION DEPOSITION
			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy. **Notes:**
			14) Point bars are revegetating with riparian-wetland vegetation. **Notes:**
			15) Lateral stream movement is associated with natural sinuosity. **Notes:**
			16) System is vertically stable. [not downcutting] **Notes:**
			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition). **Notes:**

SUMMARY DETERMINATION

Functional Rating:

____ Proper Functioning Condition

____ Functional – At Risk

____ Nonfunctional

____ Unknown

Trend for Functional – At Risk:

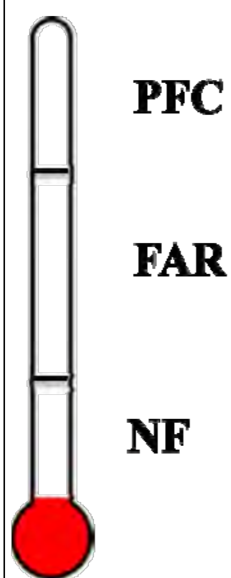
____ Upward

____ Downward

____ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ____ No ____



If yes, what are those factors?

____ Flow regulations

____ Mining activities

____ Upstream channel conditions

____ Channelization

____ Road encroachment

____ Oil Field water discharge

____ Augmented flows

____ Other (specify)

Are factors contributing to unacceptable conditions within the control of the manager?

Yes ____ No ____

If yes, what are those factors

- Lotic riparian-wetland areas are considered to be in proper functioning condition when adequate vegetation, landform, or large woody debris is present to:
- Dissipate stream energy associated with high waterflow, thereby reducing erosion and improving water quality;
- Filter sediment, capture bedload, and aid floodplain development;
- Improve flood-water retention and ground-water recharge;
- Develop root masses that stabilize streambanks against cutting action;
- Develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses;
- Support greater biodiversity

Appendix B: Proper Functioning Condition (PFC) Lentic Checklist

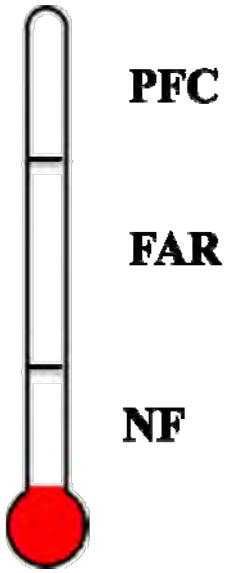
Lentic Checklist

Name of Riparian-Wetland Area:			
Date:		**Segment/Reach ID:**	
ID Team Observers:			
Potential/Capability:			

Yes	**No**	**N/A**	**HYDROLOGICAL**
			1) Riparian-wetland area is saturated at or near the surface or inundated in “relatively frequent” events. **Notes:**
			2) Fluctuation of water levels is not excessive. **Notes:**
			3) Riparian-wetland area is enlarging or has achieved potential extent. **Notes:**
			4) Upland watershed is not contributing to riparian-wetland degradation. **Notes:**
			5) Water quality is sufficient to support riparian-wetland degradation. **Notes:**
			6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e., hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities). **Notes:**
			7) Structure accommodates sage passage of flows (e.g., no headcut affecting dam or spillway). **Notes:**
Yes	**No**	**N/A**	**VEGETATION**
			8) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery). **Notes:**
			9) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery). *[species present]* **Notes:**
			10) Species present indicate maintenance of riparian-wetland soil moisture characteristics. **Notes:**

			11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g., storm events, snowmelt). *[community types present]* **Notes:**
			12) Riparian-wetland plants exhibit high vigor. **Notes:**
			13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows [enough?] Notes:
			14) Frost or abnormal hydrologic heaving is not present. **Notes:**
			15) Favorable microsite condition (i.e., woody material, water temperature, etc.,) is maintained by adjacent site characteristics. **Notes:**
Yes	**No**	**N/A**	**EROSION DEPOSITION**
			16) Accumulation of chemicals affecting plant productivity/composition is not apparent. **Notes:**
			17) Saturation of soils (i.e., ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils. **Notes:**
			18) Underlying geologic structure/soil material/permafrost is capable of restricting water percolation. **Notes:**
			19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition). **Notes:**
			20) Island and shoreline characteristics (i.e., rocks, coarse and/or large woody material) are adequate to dissipate wind and wave events energies. **Notes:**

SUMMARY DETERMINATION

Functional Rating: ____ Proper Functioning Condition ____ Functional – At Risk ____ Nonfunctional ____ Unknown **Trend for Functional – At Risk:** ____ Upward ____ Downward ____ Not Apparent **Are factors contributing to unacceptable conditions outside the control of the manager?** Yes ____ No ____	 	**If yes, what are those factors?** ____ Flow regulations ____ Mining activities ____ Upstream channel conditions ____ Channelization ____ Road encroachment ____ Oil Field water discharge ____ Augmented flows ____ Other (specify) **Are factors contributing to unacceptable conditions within the control of the manager?** Yes ____ No ____ **If yes, what are those factors? ______________**

____

____

Lentic riparian-wetland areas are functioning properly when adequate vegetation, landform, or debris is present to: Dissipate stream energy associated with wind and wave action, and overland flow from adjacent sites, thereby reducing erosion and improving water quality; Filter sediment, capture bedload, and aid floodplain development; improve flood- water retention and ground-water recharge; Develop root masses that stabilize islands and shoreline features against cutting action; restrict water percolation; Develop diverse ponding characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and Support greater biodiversity.

Appendix C: Cedar Creek Proper Functioning Condition (PFC) Lotic Checklist

Lotic Checklist

Name of Riparian-Wetland Area:	Cedar Creek
Date: 10/8/14	**Segments/Reach ID:** Charlie Daniels Park
ID Team Observers:	T-FERST / PFC Class Nashville TN

~~Potential/Capability:~~ Altered Potential Narrower Channel w/Alternate bars turning into a floodplain w/ bedrock floor but gravel bed in most places - Somewhat increased Sinuosity

YES	NO	NA	HYDROLOGICAL
	✓		1) Floodplain above bankfull is inundated in "relatively frequent" events. **NOTES:** Bankfull w/in channel that is wide & Bedrock bottom
		✓	2) Where beaver dams are present they are active and stable. **NOTES:**
	✓		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region). **NOTES:** Straighter & wider than what would be in balance so higher gradient
	✓		4) Riparian-wetland area is widening or has achieved potential extent. **NOTES:** Not quite wide enough channel to form new floodplain
	✓		5) Upland watershed is not contributing to riparian-wetland degradation. **NOTES:** Urbanizing watershed with increased peak flows

YES	NO	NA	VEGETATION
✓			6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery). **NOTES:**
✓			7) There is diverse composition of riparian wetland vegetation (for maintenance/recovery.) *[species present =]* **NOTES:** Smartweed poison oak Va creeper, a grass (wild rye) moss Maple, cedar, oaks, Hickory, Sycamore, Hackberry, Osage Orange, Willow
	✓		8) Species present indicate maintenance of riparian-wetland soil moisture characteristics. **NOTES:** Not on old riparian floodplain (now levee & ball field)
✓			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events. *[community types present]* **NOTES:** Trees are generally stabilizers
✓			10) Riparian-wetland plants exhibit high vigor. **NOTES:**
✓			11) Adequate riparian–wetland vegetative cover is present to protect banks and dissipate energy during high flows.[enough?] **NOTES:** 100% canopy
✓			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery). **NOTES:**

N

YES	NO	NA	EROSION DEPOSITION
	✓		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy. **NOTES:** wide deep flushing flows wash out wood & bars
		✓	14) Point bars are revegetating with riparian-wetland vegetation. **NOTES:** Eventually will have point bars to revegetate
✓			15) Lateral stream movement is associated with natural sinuosity. **NOTES:**
✓			16) System is vertically stable. [*not downcutting*]. **NOTES:** limestone floor
✓			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition). **NOTES:**

SUMMARY DETERMINATION

Functional Rating

_____ Proper Functioning Condition
__✓__ Functional – At Risk
_____ Nonfunctional
_____ Unknown

Trend for Functional – At Risk

__✓__ Upward
_____ Downward
_____ Not Apparent

Are Factors Contributing to Unacceptable Conditions Outside the Control of the Manager?

Yes __✓__ No _____

If Yes, What Are Those Factors?

_____ Flow Regulations
_____ Mining Activities
__✓__ Upstream Channel Conditions
_____ Channelization
__✓__ Road Encroachment Downstream bridge
__/__ Oil Field Water Discharge
__✓__ Augmented Flows Development
__✓__ Other (*Specify*) Storm water, levees

Are Factors Contributing to Unacceptable Conditions ~~Outside~~ within the Control of the Manager? ?

Yes __✓__ No _____

If Yes, What Are Those Factors?

TEPA encourages BMPs & does TMDLs for listed streams

Lotic riparian-wetland areas are considered to be in proper functioning condition when adequate vegetation, landform, or large woody debris is present to:

- Dissipate stream energy associated with high waterflow, thereby reducing erosion and improving water quality;
- Filter sediment, capture bedload, and aid floodplain development;
- Improve flood-water retention and ground-water recharge;
- Develop root masses that stabilize streambanks against cutting action;
- Develop diverse ponding and channel characteristics *to provide* the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses;
- Support greater biodiversity.

(Revised 2014)

Appendix D: Couchville Lake Proper Functioning Condition (PFC) Lentic Checklist

Lentic Checklist

Name of Riparian-Wetland Area:	Crouchville Lake		
Date:	10/8/14	**Segments/Reach ID:**	
ID Team Observers:	Sherm Bob Brian John Dan		

sink holes in woods

Potential/Capability: Altered Potential - Driven by water mgmt in Percy Priest Reservoir - fortunately w/ a consistent summer pool un " w/ a winter drawdown of 8 ft.

YES	NO	NA	HYDROLOGICAL
✓			1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events. **NOTES:**
✓			2) Fluctuation of water levels is not excessive. **NOTES:** But has winter drawdown
✓			3) Riparian-wetland area is enlarging or has achieved potential extent. **NOTES:**
✓			4) Upland watershed is not contributing to riparian-wetland degradation. **NOTES:**
✓			5) Water quality is sufficient to support riparian-wetland plants. **NOTES:**
	✓		6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e., hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities). **NOTES:** creates altered pot
✓			7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway). **NOTES:**

YES	NO	NA	VEGETATION
✓			8) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery). **NOTES:**
✓			9) There is diverse composition of riparian wetland vegetation (for maintenance/recovery.) *[species present =]* **NOTES:** bullrush sedges (at least one rhyzomatous
✓			10) Species present indicate maintenance of riparian-wetland soil moisture characteristics. **NOTES:**
✓			11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g., storm events, snowmelt). *[community types present]* **NOTES:**
✓			12) Riparian-wetland plants exhibit high vigor. **NOTES:**
✓			13) Adequate riparian–wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows. [enough?] **NOTES:**

YES	NO	NA	
✓			14) Frost or abnormal hydrologic heaving is not present. **NOTES:**
✓			15) Favorable microsite condition (i.e., woody material, water temperature, etc.,) is maintained by adjacent site characteristics. **NOTES:** Forest

YES	NO	NA	EROSION DEPOSITION
✓			16) Accumulation of chemicals affecting plant productivity/composition is not apparent. **NOTES:**
	✓		17) Saturation of soils (i.e., ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils. **NOTES:** except in lake
	✓		18) Underlying geological structure/soil material/permafrost is capable of restricting water percolation. **NOTES:** Connected to PP Reservoir
✓			19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition). **NOTES:**
✓			20) Islands and shoreline characteristics (i.e., rocks, coarse and/or large woody material) are adequate to dissipate wind and wave event energies. **NOTES:**

SUMMARY DETERMINATION

Functional Rating

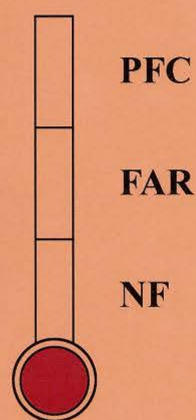
- ✓ Proper Functioning Condition
- ____ Functional – At Risk
- ____ Nonfunctional
- ____ Unknown

Trend for Functional – At Risk

- ✓ Upward
- ____ Downward
- ____ Not Apparent

Are Factors Contributing to Unacceptable Conditions Outside the Control of the Manager?

Yes ____ No ✓



If Yes, What Are Those Factors?

- ____ Flow Regulations
- ____ Mining Activities
- ____ Upstream Channel Conditions
- ____ Channelization
- ____ Road Encroachment
- ____ Oil Field Water Discharge
- ____ Augmented Flows
- ____ Other (*Specify*) ____

Are Factors Contributing to Unacceptable Conditions ~~Outside~~ within the Control of the Manager?

Yes ✓ No ____

If Yes, What Are Those Factors?

water regulating

Lentic riparian-wetland areas are properly functioning when adequate vegetation, landform, or debris is present to:

- Dissipate energies associated with high wind action, wave action, and overland flow from adjacent sites, thereby reducing erosion and improving water quality;
- Filter sediment and aid floodplain development; improve flood-water retention and groundwater recharge;
- Develop root masses that stabilize islands and shoreline features against cutting action; restrict water percolation;
- Develop diverse ponding characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and
- Support greater biodiversity.

(Revised 2014)

Appendix E: Charlie Daniels Park, Couchville Lake, and Classroom

Figure 1. Cedar Creek at Charlie Daniels Park, Stream Banks and Flood Plain.

Figure 2. Cedar Creek at Charlie Daniels Park, Stream Banks and Vegetation.

Figure 3. Cedar Creek at Charlie Daniels Park, Vegetation.

Figure 4. Cedar Creek at Charlie Daniels Park, Vegetation.

Figure 5. Cedar Creek at Charlie Daniels Park, Vegetation.

Figure 6. Cedar Creek at Charlie Daniels Park, Vegetation.

Figure 7. Cedar Creek at Charlie Daniels Park, Vegetation, Woody Debris and Rocks.

Figure 8. Cedar Creek at Charlie Daniels Park, Stream Bank and Vegetation.

Figure 9. Cedar Creek at Charlie Daniels Park, Stream Bank Vegetation.

Figure 10. Cedar Creek at Charlie Daniels Park, Vegetation.

Figure 11. Cedar Creek at Charlie Daniels Park, Stream Bank Vegetation and Flood Plain.

Figure 12. Cedar Creek at Charlie Daniels Park, Erosion.

Figure 13. Cedar Creek at Charlie Daniels Park, PFC Workshop Participants, Hydrology and Vegetation.

Figure 14. Cedar Creek at Charlie Daniels Park, PFC Workshop Participants, Hydrology and Vegetation.

Figure 15. Cedar Creek at Charlie Daniels Park, PFC Workshop Participants, Hydrology and Vegetation.

Figure 16. Cedar Creek at Charlie Daniels Park, PFC Workshop Participants, Hydrology and Vegetation.

Figure 17. Cedar Creek at Charlie Daniels Park, PFC Workshop Participants, Biology.

Figure 18. Cedar Creek at Charlie Daniels Park, PFC Workshop Participants, Soils.

Figure 19. USET PFC Classroom Instruction.

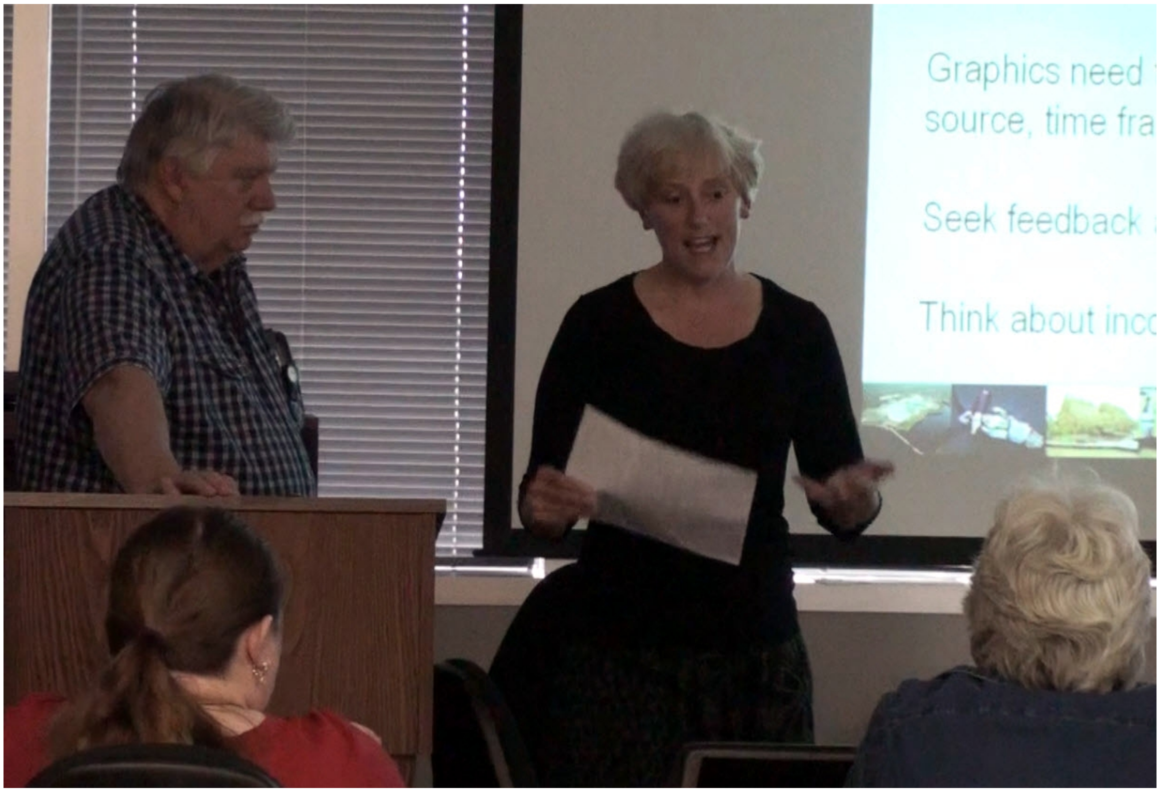


Figure 20. USET PFC Classroom Instruction.

Figure 21. USET PFC Classroom Instruction.

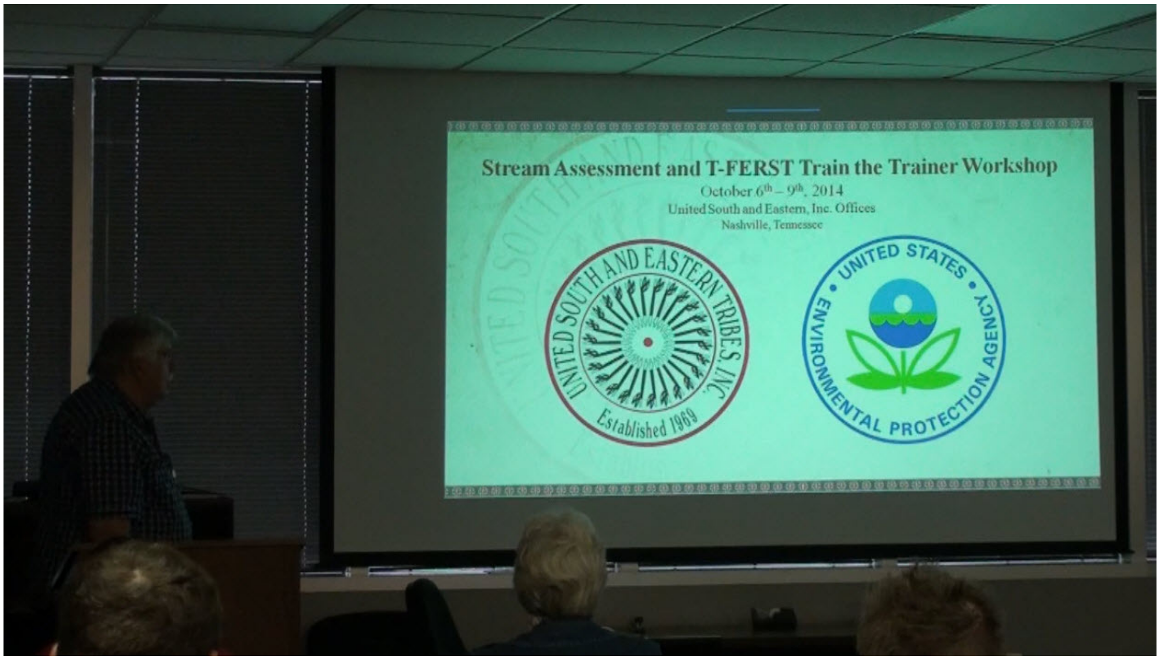


Figure 22. USET PFC Classroom Instruction Materials.

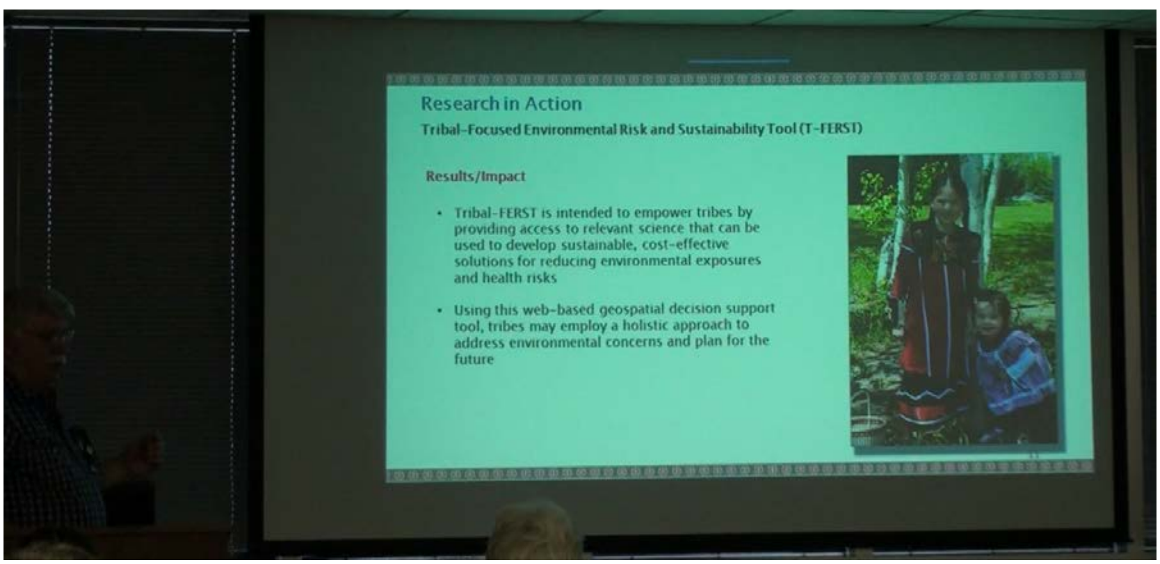


Figure 23. USET PFC Classroom Instruction Materials.

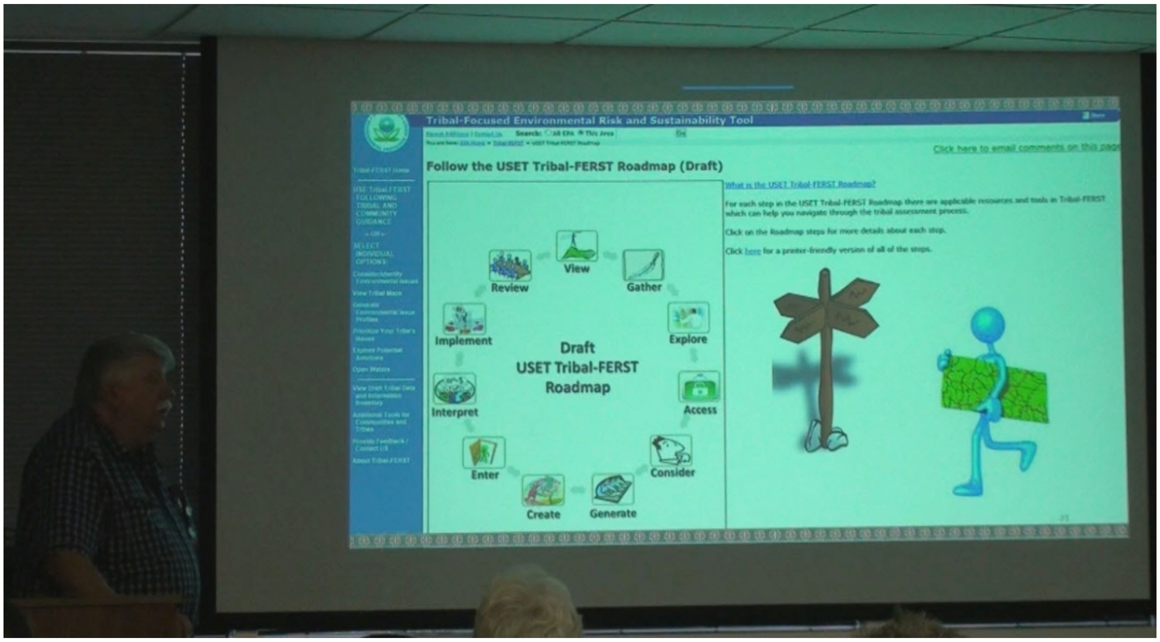


Figure 24. **USET PFC Classroom Instruction Materials.**

Figure 25. **Cedar Creek at Charlie Daniels Park, PFC Workshop Participants, Soils.**

Figure 26. Cedar Creek at Charlie Daniels Park, PFC Workshop Participants, Hydrology and Vegetation.

Figure 27. Couchville Lake.

Figure 28. Couchville Lake.

Figure 29. Couchville Lake.

Figure 30. Couchville Lake.

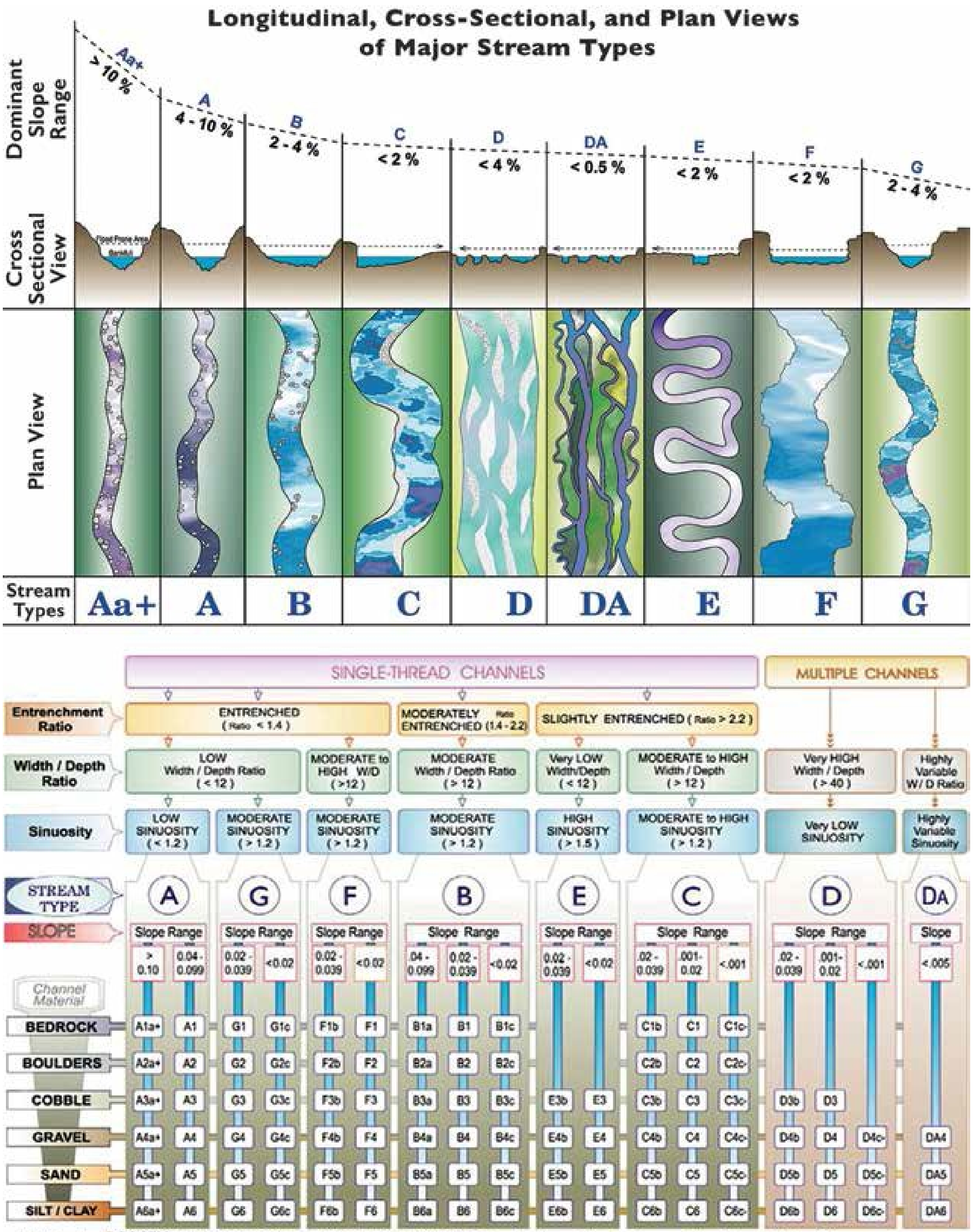
Figure 31. Couchville Lake.

Figure 32. Couchville Lake.

Figure 33. Couchville Lake.

Figure 34. Couchville Lake.

Appendix F: Rosgen Classification System (Rosgen 1977)



KEY to the ROSGEN CLASSIFICATION of NATURAL RIVERS. As a function of the *"continuum of physical variables"* within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units, whiles values for ***Width / Depth*** ratios can vary by +/- 2.0 units.

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