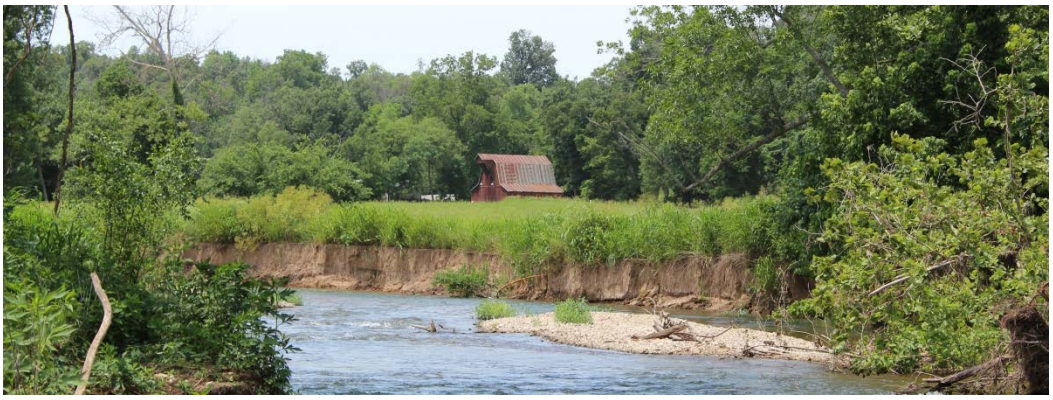
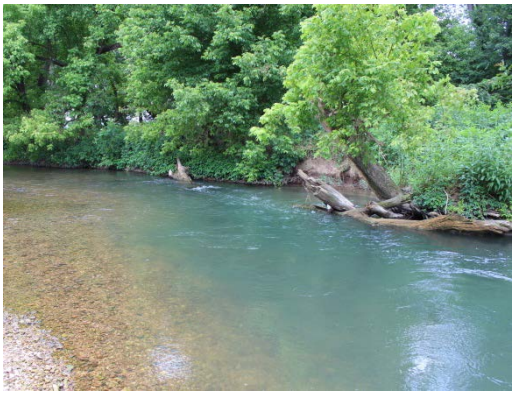
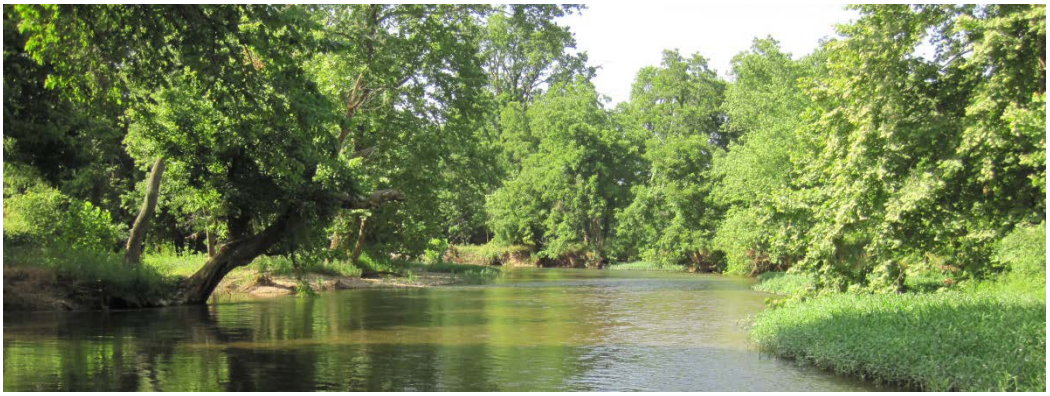
Prospectus

Osage Creek Mitigation Bank

Benton and Washington Counties, Arkansas







August 12, 2013

Prepared by:
Watershed Conservation Resource Center
380 W. Rock St.
Fayetteville, AR, 72701
wcrc@watershedconservation.org
(479) 444-1916

Table of Contents

1. Introduction **1**

1.1 Mitigation Bank Development 1

1.2 Need and Technical Feasibility 1

Watershed-based Planning 2

Local and Regional Benefits 3

1.3 Goals and Objectives 3

2. Bank Establishment and Operation **4**

2.1 Site Selection 4

2.2 Ecological Suitability 5

Land Use 5

Stream Condition 6

Morphology and Hydrology 6

Soils 7

Vegetation 7

Species of Greatest Conservation Need 7

2.3 Summary of Mitigation Activities 8

3. Proposed Service Area **9**

4. Bank Ownership and Long-term Management Strategy **9**

4.1 Sponsor and Landowner 9

4.2 Financial Assurances 9

4.3 Monitoring, Reporting, and Long-term Management 9

4.4 Bank Expansion 10

4.5 Sponsor Qualifications 10

5. References **11**

List of Appendices

Appendix A: Figures

Figure 1: Location of the Proposed Osage Creek Mitigation Banking Areas in Relation to Illinois River and Osage Creek Watersheds A-1

Figure 2: Location of Proposed Osage Creek Mitigation Banking Areas in Relation to the Regional Area and Local Vicinity A-2

Figure 3: Overview of the Proposed Osage Creek Mitigation Bank – Area 1 ..... A-3

Figure 4: Overview of the Proposed Osage Creek Mitigation Bank – Areas 2, 3A and 3B A-4

Figure 5: Soils Map for Area 1 ..... A-5

Figure 6: Soils Map for Area 2 ..... A-6

Figure 7: Soils Map for Areas 3A and 3B A-7

Figure 8: Proposed Conservation Actions – Area 1 ..... A-8

Figure 9: Proposed Conservation Actions – Area 2 ..... A-9

Figure 10: Proposed Conservation Actions – Areas 3A and 3B A-10

Figure 11: Proposed Service Areas for the Osage Creek Mitigation Bank A-11

Appendix B: Site Photographs

Figure 1: Index of Photograph Points for Area 1 ..... B-1

Figure 2: Index of Photograph Points for Area 2 ..... B-2

Figure 3: Index of Photograph Points for Areas 3A and 3B B-3

Site Photographs ..... B-4 to B-16

Appendix C: Tables

Table A: SGCN recorded near mitigation site in the Osage Creek Watershed C-1

Table B: SGCN near mitigation site in the Illinois Watershed C-2

Table C: SGCN in the Osage Creek Watershed C-4

Table D: Global ranking codes for conservation status C-6

Table E: State Ranking codes for conservation status C-6

1. Introduction

1.1. Mitigation Bank Development

The Watershed Conservation Resource Center (WCRC) proposes to establish the Osage Creek watershed mitigation bank located in Northwest Arkansas. Osage Creek is a major tributary to the Illinois River, and its watershed is primarily located in Benton County with southern portions lying in Washington County (Figure 1). The bank will be known as the Osage Creek Mitigation Bank and will offset unavoidable adverse impacts to stream and other aquatic resources authorized by the Clean Water Act section 404 permits and other Department of Army permits. Compensatory mitigation will be carried out at streams, wetlands, or riparian areas through restoration, enhancement, establishment, and/or preservation. The proposed mitigation bank will focus on the restoration of the river channel and the enhancement of riparian areas to generate stream mitigation credits. The Osage Creek Mitigation Bank will be developed in accordance with the Compensatory Mitigation for Losses of Aquatic Resources - Final Rule (DOD & EPA, 2008) under the guidance of the Interagency Review Team established by the US Army Corps of Engineers Little Rock District (LR District). The Osage Creek Mitigation Bank will consist of multiple sites and will be operated and managed by the WCRC. Properties associated with the bank will be held in suitable conservation easements.

1.2. Need and Technical Feasibility

Northwest Arkansas is one of the fastest growing areas in the country with Benton County seeing an increase in its population by 44% and Washington County by at least 29%, since the year 2000 (U.S. Census, 2000, 2010). Though the recent economic down-turn in 2008 has slowed this growth, urban development and highway projects are on the rise again, which will most likely result in unavoidable adverse impacts to aquatic resources in the Illinois River watershed in Northwest Arkansas. The upper Illinois River watershed that lies in Arkansas has several stream/tributary segments that are designated as 'Ecologically Sensitive Waterbodies' that are known to provide habitat within the existing range of threatened, endangered or endemic species of aquatic or semi-aquatic organisms, including the Arkansas darter, least darter, Oklahoma salamander, Ozark cavefish, and cave snails and crayfish. In addition, within the area of the watershed that lies in Oklahoma, the Illinois River is designated as a 'Scenic River' and impoundments provide drinking water to Oklahoma residents. Therefore, it is important to preserve aquatic resources and protect and improve the water quality within its watershed. Currently, there is not an established mitigation bank site located within the boundaries of the Illinois River watershed, with the nearest approved site being in the Elk River watershed, which confluences with the Arkansas

River in Oklahoma. To help protect the water quality and aquatic resources of the Illinois River watershed there is a need for mitigation sites within its own watershed. Mitigation sites in the Osage Creek watershed will directly compensate for losses that occur in the Illinois River watershed. The Osage Creek Mitigation Bank will provide an option to permittees to purchase stream mitigation credits from a bank that has mitigation sites where their impacts to aquatic resources have occurred. Figure 1 shows the location of the Osage Creek watershed and other major tributaries within the Illinois River watershed.

Watershed-based Planning: Streambank erosion is known to be a source of both sediment and nutrients in Northwest Arkansas. Based on a comprehensive watershed assessment, accelerated streambank erosion has been identified as contributing 66% of the average annual sediment load to the West Fork White River (ADEQ 2004). The Illinois River Watershed Partnership (IRWP) with stakeholder involvement developed a watershed-based plan for the Illinois River watershed that lies within Arkansas called the 'Watershed-based Management Plan for the Upper Illinois River Watershed, Northwest Arkansas (FTN 2012). The management strategy' recommends the implementation of best management practices that improve water quality, such as riparian restoration and streambank stabilization. The plan also presents a comparison of prioritization approaches for impaired reaches. Four of seven prioritization approaches identified the upper Osage Creek as having a high priority for needing restoration, five out of six for the Little Osage, and two out of three for the lower Osage. These evaluations included water quality data collected by the Arkansas Water Resource Center (AWRC 1996), which indicated that sediment and nutrient in-stream concentrations ranged from medium to high. Also, the Arkansas Natural Resource Commission (ANRC) has identified the upper Illinois River watershed as a high priority for sediment and nutrient load reduction efforts (ANRC 2012). Restoration of streambanks and unstable sections of river will reduce both sediment and nutrient loadings to streams (WCRC, 2012).

The WCRC also conducted a study of the upper 30 mi^2 of Osage Creek for the City of Rogers that identified sections of river and tributaries in need of stream restoration to reduce sediment and nutrients to Osage Creek and improve the biological function of Osage Creek and subsequently the Illinois River (WCRC 2008). Site specific management recommendations focused on actions that would improve stream function at a specific location identified through an intensive assessment of stream channels and riparian areas. Stream corridor protection areas were also identified for

preservation that had high quality riparian areas, provided water quality benefits along with terrestrial and aquatic habitat, and had potential recreational opportunities.

Local and Regional Benefits: The Osage Creek Mitigation Bank will focus on restoring unstable sections of river based on watershed-scale and individual site assessments. A natural channel design approach will be used as the basis for restoration planning and implementation (USDA 2007). The Osage Creek Mitigation Bank will provide a variety of local and regional benefits:

- High quality stream restoration will be designed and implemented based on the natural tendency of the river system that will stabilize banks while creating and enhancing aquatic habitat and forested riparian areas.
    - Aquatic habitat will be further enhanced –
        - better assimilation of nutrients in the water column
        - creation of stable and diverse riffle, pool, run, and glide bed features that
            - supports the different life phases of aquatic inhabitants
            - improve water oxygenation and temperatures
        - Reduced siltation of gravel beds
    - As the improved riparian areas mature, the trees will provide shade and help to maintain lower water temperatures during summer months
    - Reduction of phosphorus and nitrogen loads resulting from streambank erosion will reduce the potential for algae blooms, which can negatively affect sensitive aquatic species
- Healthy riparian areas will be created by planting native plants and removing invasive plants
- When the opportunity arises, riverine wetlands will be created, enhanced, and/or preserved
- Creating an Osage Creek Mitigation Bank helps to direct needed funding and efforts to a high priority watershed in need of stream restoration and improved water quality.
- High quality stream restoration projects that will generate stream credits will be implemented that reduce sediment and other contaminants to the stream system, thus protecting and improving water quality within the Illinois River watershed and 303 (d) listed stream segments.

1.3. Goals and Objectives

The goal of the Osage Creek Mitigation Bank is to restore unstable sections of Osage Creek that are contributing excessive amounts of sediment and nutrients from

accelerated streambank erosion. Stream channels and streambanks where restoration takes place will be stabilized so that the dimension, pattern, and profile of the channel will be maintained and aquatic resource function will be maximized. The objectives of the Osage Creek Mitigation Bank are to provide

- Compensatory mitigation that replaces aquatic resource functions and services lost to unavoidable adverse impacts to streams and other aquatic resources authorized by permits issued by the U.S. Army Corps of Engineers.
- USACE permittees the ability to purchase mitigation credits to replace damaged or destroyed aquatic resources with high quality river restoration credits within the Illinois River watershed.
- A mechanism to fund and maintain high quality river restoration in a state priority watershed in which segments of stream are impaired that will result in environmental improvements to both aquatic resources and water quality.

2. Bank Establishment and Operation

2.1. Site Selection

Osage Creek forms a 132,000 acre (206 mi^2) watershed that lies in the Ozark Highlands Ecoregion. The watershed is a major tributary to the upper Illinois River. The Osage Creek and upper Illinois River watersheds are part of the Illinois River HUC, and the Illinois River continues to flow west to Oklahoma and then Southwest to the Arkansas River (Figure 1).

Three mitigation sites have been selected in the Osage Creek watershed and their locations are shown in Figure 2. The first mitigation site is on lower Osage Creek and is west of Springdale, Arkansas, near the confluence with the Illinois River (Figure 3). The site is on the north side of old highway 68 and includes 4,000 linear feet of Osage creek and 1,400 feet of intermittent and ephemeral tributaries. The second and third mitigation sites are shown in Figure 4. Area 2 is located in Upper Osage Creek and is adjacent to the City of Rogers wastewater treatment plant and includes 6,200 feet of perennial streams and 1,700 feet of ephemeral stream. Areas 3A and 3B are located just off of I-540 in the headwaters of Osage Creek. Area 3A is located to the west of the intersection of I-540 and New Hope Rd. There are 2,600 feet of perennial stream channels in Area 3A. Area 3B is located on Turtle Creek just to the east of I-540 near the confluence with Osage Creek. Area 3B includes 3,500 feet of ephemeral stream channel. These mitigation sites were selected for the following reasons:

- These sites are associated with impaired segments of Osage Creek and they all have accelerated streambank erosion and have been identified as areas needing stream restoration (WCRC 2008)
- Both aquatic habitat and riparian areas need to be restored
- The restoration potential is high for Areas 1 and 2 because the properties are associated with areas where flooding is relatively frequent creating the potential for long-term ecological restoration to occur.
- The main property owners have indicated that they want the stream reaches and riparian areas to be restored
- Areas 1 and 2 have existing riverine wetlands and ephemeral streams that will be enhanced, restored, or preserved as part of the mitigation bank and the opportunity to restore wetlands within existing pasture areas
- There are some existing high quality riparian areas with mature hardwood trees and understory of native shrubs, grasses, and wildflowers that will be preserved
- Areas 3A and 3B are spring-fed and have habitat needed for the restoration of sensitive species.
- Area 3A and 3B are headwater streams located in a highly urbanized area and present the opportunity for the restoration of aquatic habitat and water quality of urban streams

Photos of the three areas are shown in Appendix B. A mitigation plan will be developed and implemented for Areas 1 and 3, initially. A mitigation plan will be developed for Area 2 at a later time.

2.2. Ecological Suitability

Land Use

Area 1: Historically, the land adjacent to the river was cleared and used as a cattle operation with hay production. Some riparian areas along the river were not cleared and mature native trees can be found where there is not extreme streambank erosion. The predominant grasses grown in the pasture area are Bermuda and Fescue. The landowner uses rotational grazing for his cattle operation on the east side of the river. Cattle are fence from the stream with the exception of one access point to the river for water. On the west side of the river, the landowner cuts and bales hay.

Area 2: This property is primarily used for hay production with the predominant grasses being Bermuda and Fescue.

Area 3: These properties are within the City of Rogers that include commercial and residential areas. Area 3B has adjacent pasture where hay is still being harvested.

Stream Condition

Both Osage Creek and Turtle Creek are perennial streams and the proposed mitigation sites have 4,000 feet of highly erodible cut-banks that range from 5 to 10 feet in height (Appendix B). A combination of channel incision, increased peak flow from urbanization, low radius of curvature to bankfull width ratios, erodible bank materials, and lack of a forested riparian area is resulting in accelerated streambank erosion causing land loss, vegetation loss, and poor aquatic habitat. There are some ephemeral tributaries that are moderately stable and flow to Osage Creek. There are also several side channels and riverine wetlands that will be included in the mitigation bank. Forested riparian areas can be found periodically throughout the sites. Some of the cut banks have no forested riparian and are eroding into pasture land.

Morphology and Hydrology

The site is located in the United States Geological Survey 8-digit HUC 11110103, which is the Illinois River HUC (Appendix A, Figure 1). The drainage area at each site is approximately 206 square miles for Area 1, 32 mi^2 for Area 2, and 21 mi^2 and 12 mi^2 for Areas 3A and 3B, respectively. The stream flows through a broad alluvial valley with the presence of a wide flood plain and multiple alluvial terraces. Osage Creek generally flows from the northeast to southwest. The terraces are positioned laterally with gentle, down-valley elevation relief. The proposed areas are generally located on the valley floor of Osage Creek, and there is little topographic variability throughout the proposed project areas with the exception of the depressions associated with abandoned channel meanders which now act as riverine wetlands.

In general, streams in the proposed mitigation areas are Rosgen stream type C4, which are characteristic of wide alluvial terraced valleys (Rosgen, 2010). Stream flow is both surface water and groundwater driven. Air photos indicate wetland areas within the adjacent flood-prone area that appear to be old meander bend scars. There is potential for enhancement and restoration of the wetland areas located within the banking areas.

Instability observed at all of the proposed mitigation areas is likely the result of hydrological changes that have occurred as the watershed has been converted from a savannah prairie and forest landscape to an agricultural landscape and then, most significantly, into a urban landscape in the headwaters. The development that has

occurred in the recent past has introduced significant amounts of highly concentrated impervious surfaces that have resulted in more frequent flood events. These frequently occurring flood events are likely driving the stream instability that is being observed in the Osage Creek watershed.

Soils

A soils map of each site is shown in Appendix A, Figures 5-7 and based on the Natural Resource Conservation Service's (NRCS) Soil Survey Geographic (SSURGO) (NRCS, 2004). The major soils at the site are typical for floodplains and include Healing silt loam, Secesh gravelley silt loam, and Waben very gravelly silt loam

Vegetation

The overall mitigation footprint for each of the areas is approximately 52 ac, 30 ac, 8 ac and 16 ac for areas 1, 2, 3A and 3B, respectively. Forty-three percent of proposed mitigation Area 1 is composed of forested areas. There are approximately 16.5 acres of riparian forest at Area 1. Area 2 has a significant and well established riparian along the majority of the stream channel. Areas 3A and 3B lack a high-quality riparian buffer due to the proximity of urbanization to these areas. A cursory inspection of the sites identified several tree species including: American sycamore (*Platanus occidentalis*); bitternut hickory (*Carya cordiformis*); black cherry (*Prunus serotina*); black oak (*Quercus velutina*); black walnut (*Juglans nigra*); black willow (*Salix nigra*); boxelder (*Acer negundo*); common hackberry (*Celtis occidentalis*); common serviceberry (*Amelanchier arborea*); green ash (*Fraxinus pennsylvanica*); honey locust (*Gleditsia triacanthos*); northern red oak (*Quercus rubra*); osage orange (*Maclura pomifera*); pawpaw (*Asimina triloba*); red mulberry (*Morus rubra*); river birch (*Betula nigra*); silver maple (*Acer saccharinum*); slippery elm (*Ulmus rubra*); and white oak (*Quercus alba*).

Native shrubs and grasses observed in the riparian areas included: American pokeweed (*Phytolacca americana*); American water-willow (*Justicia americana*); blackberry (*Rubus* sp.); common buttonbush (*Cephalanthus occidentalis*); common elderberry (*Sambucus canadensis*); common greenbrier (*Smilax rotundifolia*); dock (*Rumex* sp.); duck potato (*Sagittaria latifolia*); eastern daisy fleabane (*Erigeron annuus*); inland sea oats (*Chasmanthium latifolium*); muscadine grapes (*Vitis rotundifolia*); purple passionflower (*Passiflora incarnata*); smooth sumac (*Rhus glabra*); spice bush (*Lindera benzoin*); Virginia creeper (*Parthenocissus quinquefolia*); and Virginia wild rye (*Elymus virginicus*).

Species of Greatest Conservation Need

There are over 60 species of fish, aquatic invertebrates, reptiles, and mammals that are listed as 'species of greatest conservation need (SGCN)' either by the federal and/or

state government agencies that have been observed near or in close proximity of the mitigation site (ANHC 2012; AWAP 2006). A summary of these species and their global ranking can be found in Appendix C, tables A - E.

2.3. Summary of Mitigation Activities

A map showing the proposed actions for each area is shown in Appendix A, Figures 8-10. The overall mitigation plan concept for each of the proposed areas is to design and implement stream restoration actions on Osage Creek and tributaries that will 1) create and enhance aquatic habitat, 2) stabilize streambanks and eliminate them as a source of contaminants that degrade water quality and impair aquatic resources, 3) restore, enhance, and preserve riparian areas along Osage Creek, tributaries, and side channels, and 4) preserve and restore wetland areas. Natural channel design principles will be used as a basis for the mitigation plan and design variables.

- *River Channel:* Reference reach data will be used to develop appropriate channel dimensions, pattern, and profile. A new channel alignment will be constructed for Osage Creek at Area 1. The alignment will be based on observed meander geometry ratios for intrinsically stable sections along Osage Creek. Where the existing patter is utilized and streambank erosion is currently ongoing, the channel boundary will be stabilized by toe-wood structures to create multiple benches whose elevations are based on the river's ability to transport flow and bedload. Construction materials will be mostly rock, wood, and natural fiber erosion control fabrics. Toe-wood bench structures made of predominantly rock and trees will be constructed with root wads, generally located no-higher than the low-flow water surface elevation. The root wads will serve as a hard surface to dissipate stream energy, but at the same time provide habitat for fisheries. Toe-wood structures will be built along eroding cut-banks. Two elevations of benches will be constructed to help dissipate flood waters as they rise. The benches will be finished with soil mattresses that serve as a medium for establishing native plants that provide habitat and reduce surface erosion. Rock vanes will be used to help deflect flow away from the bank where appropriate. These vanes also create scour pools that make excellent fish habitat. Both the toe-wood benches and rock vanes will maintain healthy pool depths and provide cover for fish. The design will also result in stable riffle, glide, and run bed features that will support habitat diversity for aquatic species. Areas where there is not severe streambank erosion will be enhanced and preserved.
- *Riparian Areas:* Forested riparian will be established in conjunction with channel stabilizing methods, where the eroding streambanks are cutting into the pasture

land. Existing forested riparian will be enhanced, preserved, or extended. Pasture land between forested areas will be planted with native trees, shrubs, grasses, and/or wildflowers. Riparian areas along tributaries and wetlands will be established, enhanced, and preserved.

- *Wetland Areas:* Existing wetlands will be preserved. If opportunities arise based on the site conditions, wetlands will be established.

3. Proposed Service Area

The proposed service areas are shown in Figure 8. The proposed primary geographic service areas are:

- Illinois River HUC 11110103
- Elk HUC 11010003
- Lower Neosho HUC 11070209
- Robert S. Kerr Reservoir HUC 11110104
- Lake O' Cherokees HUC 11070206

The proposed secondary service areas are:

- Frog-Mulberry HUC 11010004
- Dardanelle Reservoir HUC 11010005

4. Bank Ownership and Long-term Management Strategy

4.1. Sponsor and Landowner

The WCRC is the bank Sponsor of the Osage Creek Mitigation Bank and will manage the bank property for the operational life of the bank. Area 1 will be the first location where mitigation actions will be undertaken followed by Area 3. The property associated with Area 1 is owned by a private landowner who has agreed to hold the property in a conservation easement according to the banking instrument to ensure perpetual protection of the mitigation site. The operational life of the bank ends once the mitigation credits have been sold and the restoration is deemed to be self-sustaining.

4.2. Financial Assurances

If necessary, the Sponsor will make available adequate financial assurances in the form of a bond or escrow account based on the estimated repair and maintenance costs determined by the Sponsor and in coordination with the LR District Engineer.

4.3. Monitoring, Reporting, and Long-term Management

The Sponsor shall monitor and report on the progress and condition of the Osage Creek Mitigation Bank toward achieving the goals and performance standards stated in the banking instrument. The Sponsor shall take all reasonable actions necessary to maintain or repair the site due to any problems that arise that may prevent the site from achieving the goals outlined in the final banking instrument. The Sponsor will maintain and protect the site until it is self-sustaining. When mitigation actions are initiated on Areas 2 and 3, conservation easements that will protect these areas to perpetuity will be obtained.

4.4. Bank Expansion

The Sponsor may request that additional mitigation sites in need of river restoration be added to the Osage Creek Mitigation Bank at a future time. The Sponsor will submit a mitigation plan to the LR District for each proposed expansion of the Osage Creek Mitigation Bank for their approval.

4.5. Sponsor Qualifications

Committed to making a difference through conservation and restoration, the WCRC has secured over 2.3 million dollars in federal grants and has leveraged a similar amount of local funding and in-kind services, to conduct watershed-based initiatives in Arkansas. The WCRC is recognized for its expertise in designing and implementing stream restoration plans using a natural channel design approach. Working with multiple landowners and partners, the WCRC has successfully implemented six stream restoration projects that include over 6,000 feet of restoration and stabilization including projects on small urban stream and large rivers in rural settings. For all of these projects, the WCRC provided project management and collected the field data, conducted the stream stability assessment, developed the restoration design along with construction drawings and specifications, obtained and coordinated construction materials, obtained required permitting and flood plain management approval, provided construction oversight, and developed and implemented site re-vegetation plans. The WCRC continues to monitor, evaluate, and maintain all of these sites. Implementation of these projects has resulted in the reduction of sediment and phosphorus loadings in the Beaver Lake and Illinois River watersheds. The stream restoration projects have protected city parks, utility infrastructure, a historic cemetery, and private property during high flow events including significant flooding in 2011. Through the success of these projects, the WCRC has been able to secure additional funding to restore additional streams, improving water quality and aquatic habitats throughout Arkansas.

5. References

Arkansas Department of Environmental Quality (ADEQ), Environmental Preservation Division. S.J. Formica, M.A. Van Eps, M.A. Nelson, A.S. Cotter, T.L. Morris, J.M. Beck. *West Fork - White River Watershed - Data Inventory and Non-point Source Pollution Assessment*. ANRC – EPA 319(h) Project Final Report. 2004.

Arkansas Natural Heritage Commission (ANHC), Webpage "Research & Data, Rare Species Search," http://www.naturalheritage.com/research-data/rarespecies-search.aspx: Accessed, July 19, 2012.

Arkansas Natural Resource Commission (ANRC), Webpage "arkansaswater.org," Retrieved July 21, 2012.

Arkansas Wildlife Action Plan (AWAP), 2006, Webpage "Species of Greatest Conservation Need", http://www.wildlifearkansas.com/strategy.html: Accessed, July 19, 2012.

Department of Defense (DOD) and Environmental Protection Agency (EPA), April 10, 2008. Compensatory Mitigation for Losses of Aquatic Resources. Final Rule. Federal Register. Vol. 73, No. 70: pp. 19594-19705.

FTN Associates, Ltd., *Watershed-Based Management Plan for the Upper Illinois River Watershed, Northwest Arkansas,* Prepared for the Illinois River Watershed Partnership and Arkansas Natural Resources Commission, 2012

Rosgen, Dave. *Watershed Assessment of River Stability and Sediment Supply (WARSSS).* Fort Collins: Wildland Hydrology, 2010

Rosgen, D.L., 1996, *Applied Fluvial Geomorphology,* Wildland Hydrology, Pagosa Springs, CO

Standard Operating Procedures, Compensatory Mitigation, Little Rock District Regulatory Office, U.S. Army Corps of Engineers, http://www.swl.usace.army.mil/regulatory/pdf/compensatorymitigationguidelines.pdf: Accessed August 2010.

United States Census Bureau. (2010). State & County QuickFacts: Washington County, AR, Retrieved July 21, 2012 from http://quickfacts.census.gov/qfd/states/05/05143.html

U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). National Engineering Handbook, Part 654: Stream Restoration Design, Chapter 11 Rosgen Geomorphic Channel Design. 2007.

U.S. Department of Agriculture (USDA), Natural Resources Conservation Service, SSURGO Soils, General Information, Washington County Arkansas, 2004

Watershed Conservation Resource Center, *Final Report – White River Streambank Restoration Project*, Submitted to Arkansas Natural Resources Commission, 2012

Watershed Conservation Resource Center, Sediment and Nutrient Evaluation of Blossom Way Branch, Submitted to Arkansas Natural Resources Commission, 2008