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CACHE RIVER
WATERSHED-BASED MANAGEMENT PLAN

NOVEMBER 21, 2016

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WATERSHED-BASED MANAGEMENT PLAN

Prepared for

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CACHE RIVER WATERSHED-BASED MANAGEMENT PLAN
EXECUTIVE SUMMARY

WATERSHED DESCRIPTION

The Cache River in northeastern Arkansas is a tributary of the White River. Its largest tributary is Bayou DeView, which joins the Cache River just upstream of the White River. The Cache River originates in southern Missouri, entering Arkansas in Clay County. Bayou DeView originates on Crowley's Ridge in Greene County. The Cache River watershed in Arkansas covers 1,956 square miles and includes portions of 12 counties: Clay, Craighead, Cross, Greene, Jackson, Lawrence, Monroe, Poinsett, Prairie, Randolph, St. Francis, and Woodruff. The watershed is primarily rural, with approximately 73% of the watershed used for agriculture, primarily crop production. Approximately 12% of the land in the watershed is classified as wetland, the majority of which is bottomland hardwoods located in the lower Cache River watershed. Approximately 8% of the land cover in the watershed is forest, the majority of which is located in the upper Cache River watershed on Crowley's Ridge.

WATER RESOURCES

The Cache River watershed includes over 3,300 miles of streams and ditches. Drainage upstream of Grubbs has been significantly altered from natural conditions. Several decades ago, almost all streams in this portion of the watershed were channelized, and an extensive network of drainage ditches developed. Downstream of Grubbs, there has been less alteration, and some restoration, of the natural drainage. In the lower Cache River watershed, there are large areas of protected bottomland hardwood wetlands, including the Cache River National Wildlife Refuge and a number of State Wildlife Management Areas. The bottomland hardwood wetlands of the lower Cache River watershed have been designated as wetlands of international importance as habitat that supports migrating birds, primarily waterfowl. Because of the low elevation and relief of the watershed, flooding is common in those areas of the watershed not on Crowley's Ridge.

WATER QUALITY

The Cache River and its tributaries have many designated uses set forth by the Arkansas Pollution Control and Ecology Commission, including Aquatic Life Support, Primary and Secondary Contact Recreation, and Domestic, Industrial, and Agricultural Water Supply. However, portions of the Cache River and its tributaries have been identified as not supporting one or more of these designated uses due to high levels of turbidity from sediment, minerals, lead, and/or copper. Nonpoint sources have been identified as the primary sources of these pollutants in the Cache River watershed. These nonpoint sources include runoff from croplands, and erosion from: croplands, pasture, gullies and head cuts, land clearing on Crowley's Ridge, streambanks, stream channels, and ditches.

NONPOINT SOURCE MANAGEMENT

The Cache River watershed has been selected, using a risk matrix process, as a priority watershed for the 2017-2022 Arkansas Nonpoint Source Pollution Management Plan (NPS management plan). As an action item of the NPS management plan, this nine-element, watershed-based, nonpoint source pollution management plan was prepared for the Cache River watershed. This plan targets erosion and sediment management with the expectation that activities to reduce erosion and sediment will also reduce the other pollutants of concern in the watershed.

This plan is intended to address the entire Cache River watershed. Because of differences in the hydrology, water quality issues, and pollutant sources upstream of Grubbs (i.e., upper Cache River watershed) versus downstream of Grubbs (i.e., lower Cache River watershed) much of the information in the plan is presented separately for these two areas. This includes discussion of current and historical water quality and quantity data from the watershed, as well as recent research in the watershed. Past, existing, and currently planned nonpoint source pollution management and outreach activities are also summarized.

Several water quality studies have been conducted that rank or characterize sediment loads from the 12-digit HUC subwatersheds of the Cache River. For this plan, the 12-digit HUC subwatersheds are ranked based on the number of studies that identify subwatersheds with impaired streams as having high sediment loads. Subwatersheds of the upper Cache River watershed are ranked separately from the subwatersheds of the lower Cache River watershed. The rankings for this plan are illustrated on Figures ES.1 and ES.2 (figures included at end of summary). The eight subwatersheds (five from the upper Cache River watershed and three from the lower Cache River watershed) with impaired streams that three or more studies identified as having high sediment load, are the focus of the implementation portion of the plan. Table ES.1 lists these subwatersheds along with the pollutants and nonpoint sources to be targeted.

Through several watershed meetings, stakeholders from the upper and lower Cache River watersheds identified suites of nonpoint source pollution management practices that could be implemented in the recommended subwatersheds (Tables ES.2 and ES.3). These practices, along with estimates of associated pollutant load reductions and relative costs for their implementation, are included in the plan. Examples of available sources of technical and funding assistance for implementation of management practices are also identified.

Watershed processes and systems are dynamic. Therefore, an adaptive management approach is recommended for the Cache River watershed and outlined in this plan. As part of this approach, continued water quality and biological monitoring is recommended so that progress toward the vision and goals for the Cache River watershed can be tracked. As goals and objectives are accomplished, or resources change, this plan may be modified accordingly. The proposed schedule and milestones for implementing the activities outlined in this plan is shown in Table ES.4.

Table ES.1. The seven subwatersheds below were ranked highest in the plan for the presence of water quality issues.

Subwatershed name (HUC)	Target sources	% Pollutant Load Reduction Target
Number Twenty Six Ditch-Cache River (80203020301)	Streambank erosion and surface erosion of cropland and pasture	TSS: 13% Sulfate : 10%
Swan Pond Ditch-Cache River (80203020205)	Streambank erosion and surface erosion of cropland and pasture	TSS: 13% Sulfate: 10%
Mud Creek-Big Creek Ditch (80203020501)	Streambank erosion and surface erosion of cropland, pasture, and forest	Lake Frierson TSS: % Lake Frierson Copper: NA*
Lost Creek Ditch (80203020502)	NA	Copper: NA
Overcup Ditch (80203020405)	Streambank erosion	TSS: 35% Lead: NA
Culotches Bay Slough-Cache River (80203020806)	Streambank erosion	TSS: 35% Lead: NA
Maloy Bayou-Cache River (80203020807)	Streambank erosion	TSS: 35% Lead: NA
Rogers Bayou-Big Creek Ditch (80203020503)	Runoff from developed areas, and surface erosion from cropland, pasture, and forest	Copper: NA

*Recent measurements of this pollutant in this subwatershed indicate that the previously impaired waterbody is likely to be meeting water quality standards. Therefore, this pollutant will be addressed through continued or additional monitoring to determine the impairment status. Management practices specifically addressing this pollutant are not recommended in this plan. If necessary, management practices to address this pollutant can be included in future updates of this plan.

Table ES.2. Management strategies collaboratively recommended for the upper Cache River watershed.

Recommended Practice	Stakeholder Comments
Drop Pipes	This is an effective practice, when correctly installed and maintained. Collared drop pipes and drop pipes with flashboard risers are most commonly used.
Irrigation water management	There are a number of irrigation water management practices recommended by NRCS. Stakeholders using these practices are using, and losing, less water.
Nutrient management	Interest in and use of variable rate fertilization practices is increasing in this area.
Cover crops	Interest in this practice is increasing. Cropping rotation must be considered when selecting cover crops to prevent the cover crop from becoming a problem weed.
Two-stage ditches	At least one farmer stakeholder refused to use this practice because it takes up too much land that could be used for growing. It was suggested that this may be a good practice to deal with stormwater from developed areas.
Filter strips, buffer strips, field borders	Stakeholders supported the use of field borders. Filter strips were suggested for use around towns to reduce impacts of stormwater runoff.
Tailwater recovery	This practice was suggested as a way to reduce nutrient and sediment runoff while increasing habitat. It was suggested that at least part of the recovery pond be set up to function as a wetland.
Reduced tillage	This practice is not widely used in the upper Cache River watershed.
Sediment basins	Sediment basins were suggested to trap sand coming off Crowley's Ridge.
Grassed waterways	No comments
Wildlife habitat	Holding water on fields during the winter is a relatively common practice in the upper Cache River watershed. Some landowners are planting switchgrass for quail habitat. Want to keep beaver out.

Table ES. 3. Management strategies collaboratively recommended for the lower Cache River watershed.

Recommended Practice	Stakeholder Comments
Land leveling	Widely practiced in the watershed.
Stream buffer zones	Stream buffer zones are widely used in Woodruff County. Most were developed through the WREP.
Cover crops	Effectiveness of cover crops is being studied in Bayou Bartholomew watershed.
Winter water storage	There are several incentive programs for this practice. This practice allows infiltration to recharge groundwater, as well as providing waterfowl habitat.
Meander restoration	Reforestation of riparian areas and reconnecting the stream with reforested floodplains provides multiple benefits, including reduced flooding upstream, and filtering/collection of sediment and nutrients.
Filter strips, field borders	A stakeholder raised the concern that filter strips and/or field borders may slow down field drainage.
Channel and ditch maintenance	Drainage ditches can become overgrown within two years to the point that flooding increases. Grubbing the Cache and DeView main channels to remove logs and debris would improve drainage. It was suggested that this effort begin at the mouth of the rivers and proceed upstream, to reduce negative effects of the work.

Table ES.4. Cache River watershed-based plan implementation schedule and milestones.

Activity	Action (lead)	Start	End	Milestones (3-5 yrs)	Indicator	Long Term Goal
TMDL	Sulfate TMDL (ADEQ)	2018	2019	ANRC, Greene County Conservation District request sulfate TMDL	EPA approved TMDL	Sulfate water quality standard met in impaired stream reaches on the draft 2014 303(d) list
Monitoring	Dissolved copper and lead data collection for removal of stream segments in recommended subwatersheds from state impaired waters list (ADEQ)	2017	2022	Biennial 305(b) assessments, 303(d) lists	Attainment or nonattainment classification	Determine if impaired stream reaches in recommended subwatersheds meet dissolved copper and lead water quality standards
	Synoptic surveys in recommended subwatersheds to characterize TSS/sediment, and sulfate loads (Conservation Districts)	2018	2020	Survey completed Data analyzed Target areas identified	Critical areas designated for TSS and sulfate loading	Identify target areas for erosion and runoff control management strategies to achieve state sulfate and turbidity standards
	Lake Frierson synoptic survey (AGFC, Arkansas Parks and Tourism)	2018	2020	Survey completed Data analyzed	Attainment or nonattainment classification	Determine if Lake Frierson meets dissolved copper numeric water quality standards
	Annual ambient water quality monitoring (ADEQ, USGS)	2017	2050	Four years of water quality data collected	Number of long term water quality stations Number of sampling events	Identify and track changes in water quality over time
	ADEQ roving monitoring program sampling in Cache River watershed (ADEQ)	2019	2020	Roving monitoring program sampling initiated in Cache River region	Number of sampling stations Number of sampling events	Determine if impaired waterbodies in recommended subwatersheds meet numeric water quality standards

Table ES.4 Cache River watershed-based plan implementation schedule and milestones (continued).

Activity	Action (lead)	Start	End	Milestones (3-5 yrs)	Indicator	Long Term Goal
Monitoring	Edge-of-field monitoring contracts in Overcup Ditch subwatershed (NRCS)	2017	2030	Five nine-year contracts established for edge-of-field monitoring	Number of contracts Number of monitoring stations Acres monitored Number of sampling events	Characterize, and track changes in, water quality of runoff from crop fields where BMPs are implemented
	Cache River NWR water quality monitoring network (USFWS)	2018	2050	Water quality monitoring network established, sampling and analysis logistics finalized, and at least one sampling event	Number of monitoring sites Number of sampling events Number of samples	Characterize, and track changes in, water quality within the NWR
	Cache River NWR biological monitoring program (USFWS)	2018	2050	Biological monitoring program set up and ready for first round of biological surveys	Number of survey locations Number of species tracked Number of surveys completed	Characterize, and track changes in, of biological communities within the NWR
	Fish survey of Cache River (AGFC)	2018	2020	Fishery survey initiated	Number of survey locations Number of surveys completed	Characterize fish communities in the Cache River watershed
	Fish and macroinvertebrate survey of project area for phase 2 meander restoration (TNC)	2016	2020	Pre-restoration fish and macroinvertebrate surveys completed	Number of survey locations Number of surveys completed	Characterize pre-restoration fish and macroinvertebrate communities in the channelized sections of the lower Cache River
Information & Education	Field Days (County Conservation Districts)	2016	2030	1 to 3 field days held in recommended 12-digit HUC subwatersheds	Number of field days in recommended subwatersheds Number of attendees	Increase acceptance and use of BMPs that protect and improve water quality
	Informational booth at County fairs (County Conservation Districts)	2018	2050	Booths at 10 county fairs in counties of the Cache River watershed	Number of fairs attended Number of people visiting booths	Increase awareness of water quality issues and BMPs in Cache River watershed

Table ES.4 Cache River watershed-based plan implementation schedule and milestones (continued).

Activity	Action (lead)	Start	End	Milestones (3-5 yrs)	Indicator	Long Term Goal
Information & Education	Articles about Cache River water quality issues and/or appropriate BMPs (interest groups)	2018	2023	At least three articles in local newspaper or interest group newsletter	Number of articles Number of readers	Increase awareness of water quality issues and BMPs in Cache River watershed
	Presentations on Cache River water quality issues and/or appropriate BMPs (interest groups)	2018	2023	At least three presentations at interest group meetings or conferences	Number of presentations Number of people attending presentations	Increase awareness of water quality issues and BMPs in Cache River watershed
Supplemental Watershed Implementation Plans	Prepare and implement supplemental watershed implementation plans in recommended 12-digit HUC subwatersheds with turbidity and sulfate impairments (County Judges)	2017	2022	Supplemental watershed implementation plan developed for at least one recommended 12-digit HUC subwatershed	Number of implementation plans accepted	All water quality criteria met in impaired stream reaches listed in final 303(d) list within recommended subwatersheds
Implement Management Strategies in recommended 12-digit HUC subwatersheds	Middle Cache MRBI (NRCS)	2012	2018	At least five new contracts for management practices in Overcup Ditch subwatershed	Number of contracts Number of practices Number of acres treated	Turbidity and dissolved lead water quality criteria met in 2008 and 2014 impaired stream reaches in Overcup Ditch subwatershed
	EQIP General (NRCS)	2015	2022	Contract for management practices in at least one recommended 12-digit HUC subwatershed	Number of contracts Number of practices Number of acres treated	All water quality criteria met in 2008 and 2014 impaired stream reaches within recommended 12-digit HUC subwatersheds

Table ES.4 Cache River watershed-based plan implementation schedule and milestones (continued).

Activity	Action (lead)	Start	End	Milestones (3-5 yrs)	Indicator	Long Term Goal
Implement Management Strategies in recommended 12-digit HUC subwatersheds	Management practices in recommended 12-digit HUC subwatersheds (County Conservation Districts)	2018	2022	Begin implementation of management practices identified in supplemental watershed implementation plan(s)	Implementation goals outlined in supplemental watershed implementation plan(s)	All water quality criteria met in 2008 and 2014 impaired stream reaches within recommended 12-digit HUC subwatersheds
	Regional Conservation Partnership Program (stakeholders)	2017	2023	Funding of Regional Conservation Partnership Program obtained from NRCS	Number of practices Number of acres treated	All water quality criteria met in 2008 and 2014 impaired stream reaches within recommended 12-digit HUC subwatersheds
	Expansion of Cache River NWR (USFWS)	2015	2030	100 acres in Culotches Bay Slough and Maloy Bayou subwatersheds added to Cache NWR	Number of acres acquired in recommended subwatersheds	Reduce streambank erosion All water quality criteria met in Cache River Acquire all lands within Cache River NWR acquisition boundary
	Conservation Easements (Farm Service Agency)	2014	2030	At least one Conservation Reserve Program contract for riparian easement in one recommended subwatershed	Number of contracts in recommended subwatersheds Number of acres under contract	All water quality criteria met in 2008 and 2014 impaired stream reaches within recommended 12-digit HUC subwatersheds
Evaluate	Annual voluntary forestry BMP assessment (Arkansas Forestry Commission)	2002	2050	Two biennial surveys completed (2017 and 2020)	Published assessment reports	Estimate and document extent of forestry BMP implementation, and identify areas to focus BMP education efforts

Table ES.4 Cache River watershed-based plan implementation schedule and milestones (continued).

Activity	Action (lead)	Start	End	Milestones (3-5 yrs)	Indicator	Long Term Goal
Evaluate	Biennial water quality assessment (ADEQ)	2016	2022	EPA approved final 303(d) list post 2008	Attaining and nonattaining stream reaches in Lower Little River watershed	All water quality criteria met in Lower Little River impaired stream reaches listed in final 2008 and/or 2014 303(d) lists
	Track implementation of BMPs in Cache River watershed (ANRC)	2017	2022	Biennual report of implementation activities in watershed	Linear feet/acres of BMPs implemented Water quality improvement	All water quality criteria met in Lower Little River impaired stream reaches listed in final 2008 and/or 2014 303(d) lists
Update Cache River Watershed Management Plan	Public Meetings (ANRC)	2023	2023	Organize public meetings	Number of attendees	Stakeholder input to watershed management planning
	Update Watershed Management Plan (ANRC)	2023	2023	Obtain implementation data from ANRC Conduct evaluation activities	Updated watershed management plan completed Recommended 12-digit HUC subwatersheds identified Stakeholder relationships continued/ improved	Maintain watershed management plan as a living document that reflects stakeholder interest and concerns related to improving water quality in the Lower Little River watershed

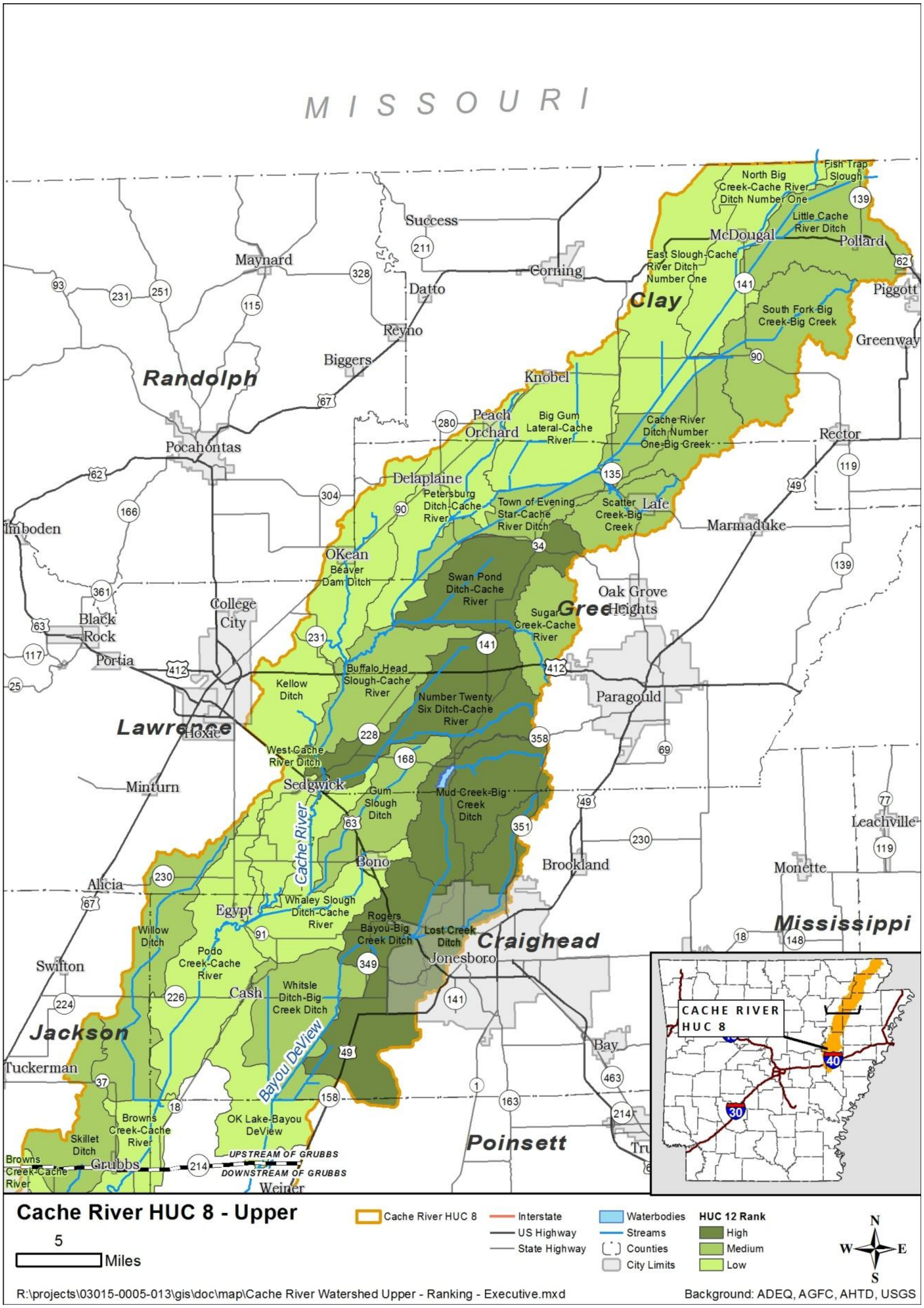

Figure ES.1. Plan ranking of upper Cache River watershed 12-digit HUCs for turbidity/sediment issues.

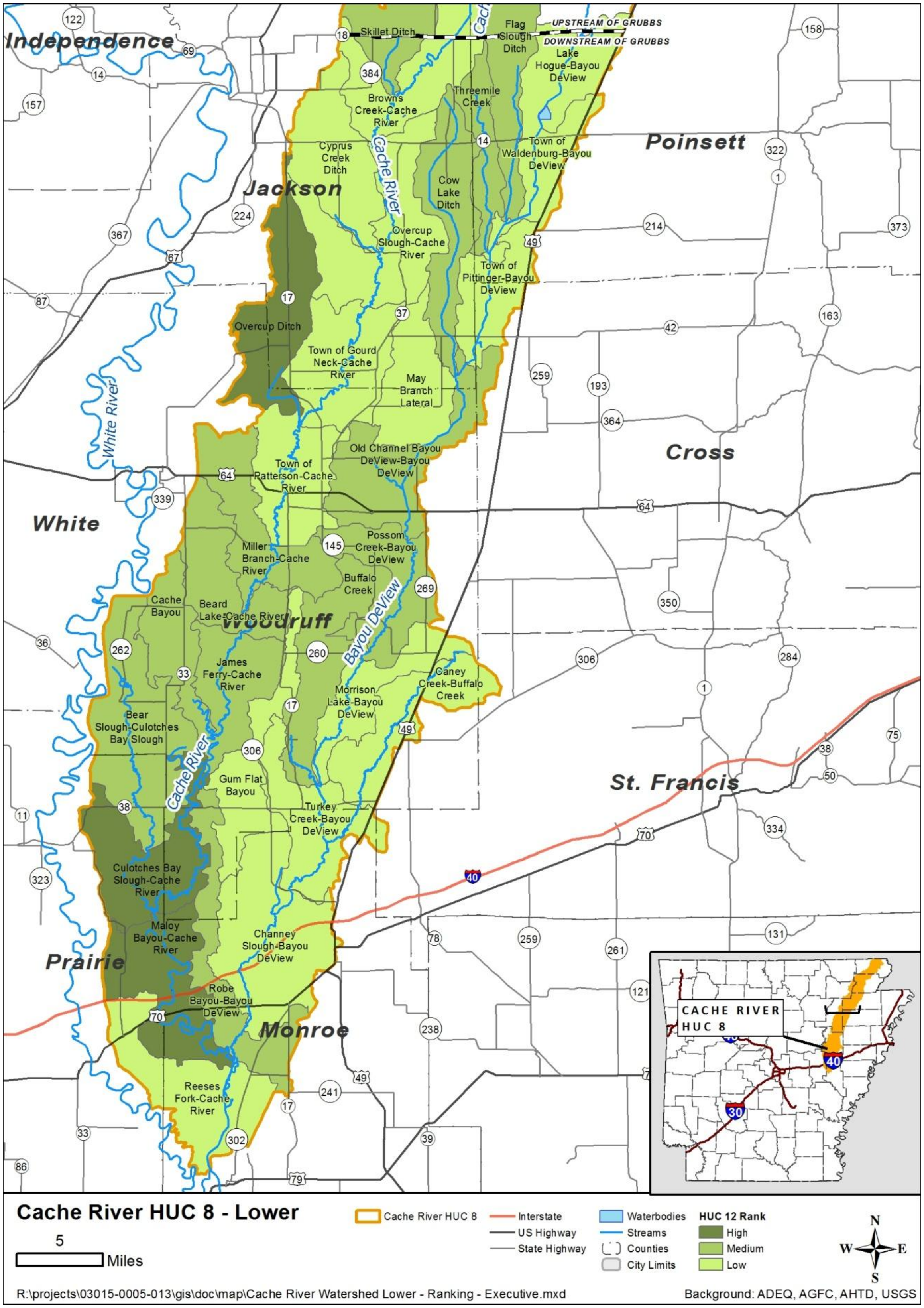

Figure ES.2. Plan ranking of lower Cache River watershed 12-digit HUCs for turbidity/sediment issues.

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LIST OF ACRONYMS

AACD	Arkansas Association of Conservation Districts
ac	Acre
ADEQ	Arkansas Department of Environmental Quality
ADPT	Arkansas Department of Parks and Tourism
AFGC	Arkansas Game and Fish Commission
AHTD	Arkansas State Highway and Transportation Department
ANHC	Arkansas Natural Heritage Commission
ANRC	Arkansas Natural Resources Commission
ASU	Arkansas State University
BEHI	Bank erosion hazard index
BMP	Best management practice
CAFO	Confined animal feeding operation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
cm	centimeter
col/ 100 ml	Colonies per 100 milliliters
DO	Dissolved Oxygen
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FEMA	Federal Emergency Management Agency
FSA	USDA Farm Services Agency
Ft msl	Feet above mean sea level
FTN	FTN Associates, Ltd.
gpm	gallons per minute
HUC	Hydrologic unit code
mg/L	milligrams per liter
MRV	Mississippi River Valley
NASS	United States Department of Agriculture National Agricultural Statistics Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source pollution
NRCS	Natural Resources Conservation Service
NTU	Nephlometric turbidity units
MRBI	Mississippi River Basin Initiative
MS4	Municipal Separate Storm Sewer System
RCRA	Resource Conservation and Recovery Act
SGCN	Species of Greatest Conservation Need
SMCL	secondary maximum contaminant level
su	standard units
TDS	Total Dissolved Solids

LIST OF ACRONYMS (CONTINUED)

TNC	The Nature Conservancy
TMDL	Total Maximum Daily Load
TSS	total suspended solids
U of A	University of Arkansas
ug/L	micrograms per liter
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFS	USDA Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WMA	Wildlife Management Area

1.0 INTRODUCTION

1.1 Document Overview

The Cache River watershed (hydrologic unit code [HUC] 08020302) has been identified as a nonpoint source priority watershed by the Arkansas Natural Resources Commission (ANRC) 2011-2016 Nonpoint Source (NPS) Pollution Management Plan. The goal of the priority watershed program is to reduce pollutants so that all streams achieve their designated uses through implementation of a watershed-based management plan that includes the nine elements recommended by the US Environmental Protection Agency (EPA) (EPA 2008). This document contains the nine-element watershed-based plan for the Cache River watershed.

This document follows the organization developed by the EPA Watershed Plan Builder (EPA 2011). Section 2 describes many of the features of the watershed. Section 3 lists water quality standards along with available monitoring and resource data. Section 4 discusses pollutant sources in the watershed, utilizing information from a number of studies. Section 5 provides information on pollutant loads in the watershed, and identifies critical areas of the watershed for addressing nonpoint source pollution. Section 6 identifies watershed goals and objectives. Section 7 discusses management strategies for controlling nonpoint source pollution in the Cache River watershed. Section 8 outlines the overall management plan, with schedule, list of activities, and indicators and monitoring to track progress and effects.

The Cache River watershed is large, and many characteristics of the river and watershed change roughly halfway down the watershed. Therefore, in many of the plan elements, the upper and lower Cache River watersheds are addressed separately.

Watershed-based management plans developed using Clean Water Act Section 319 funding must address nine planning elements required by EPA to manage and protect against nonpoint source pollution. Table 1.1 provides a roadmap for where the required planning elements are addressed in this plan.

Table 1.1. The required nine planning elements to manage and protect against nonpoint source pollution and the location of the elements within this plan.

Element	Description	Location in this plan
1	The identification of causes, sources of pollution, and extent of water quality impairment	Sections 3.0 and 4.0
2	Expected load reductions once management actions are implemented	Section 8.2
3	A description of nonpoint source pollution management actions that stakeholders can participate in and help to implement, especially in critical areas	Section7.0
4	An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon	Sections 8.5 through 8.7
5	Education and outreach strategies to encourage stakeholders to learn more about selecting, designing and implementing management actions	Section 8.8
6	A schedule for implementing identified management measures	Section 8.3
7	A description of measureable milestones along the way to a fully implemented vision	Section 8.3
8	A set of criteria that can be used to determine if water quality is improving towards attaining water quality standards	Sections 6.0 and 8.11
9	A monitoring component to determine if implemented management actions are really improving water quality	Sections 8.9 and 8.10

1.2 Process

Development of the Cache River watershed-based management plan followed the steps outlined by the EPA in the *Handbook for Developing Watershed Plans* (EPA 2008):

1. Building partnerships,
2. Characterizing the watershed,
3. Finalizing management goals and identifying solutions, and
4. Designing an implementation program.

1.2.1 Team

ANRC worked with consultants to develop this watershed-based management plan, utilizing the input of watershed stakeholders. Stakeholders who participated in development of this plan include county judges, conservation districts, farmers, landowners, US Fish and Wildlife Service (USFWS), US Army Corps of Engineers (USACE), The Nature Conservancy

(TNC), Arkansas Game and Fish Commission (AGFC), Natural Resources Conservation Service (NRCS), Arkansas Department of Agriculture, agribusiness, Ducks Unlimited, Drainage Districts, and Arkansas Forestry Commission.

1.2.2 Public Participation

Eight public meetings were held as part of the process of developing the Cache River watershed-based management plan, four meetings at Jonesboro in the upper Cache River watershed and four at McCrory in the lower Cache River watershed. The purposes of these public meetings were to inform stakeholders of the plan and the process for developing it, and to request and obtain stakeholder input for the plan. In particular, stakeholder input was sought in identifying priority issues in the upper and lower watersheds, recommending subwatersheds for implementation of management strategies, and selecting appropriate management strategies for addressing nonpoint source pollution in the watershed. Sign in sheets from the public meetings and the meeting summaries are included as Appendix A.

1.3 Adaptive Watershed Management

This Watershed-Based Plan for the Cache River watershed was developed to include the adaptive management concept. This plan was developed using information available as of 2015, based on the current understanding of the condition of, and processes at work in, the watershed. Watershed processes and systems are dynamic, and our understanding of them changes over time. Adaptive management is an iterative process of evaluating the results of management, and adjusting actions based on what has been learned, in order to achieve sustainable watershed management. Adaptive management involves goal-setting, implementation of management strategies to work toward the goals, monitoring the results of management, evaluation of the results of management, and revision of goals and/or management strategies, which are then implemented, monitored, evaluated, and so on. All of these elements of adaptive watershed management are included in this plan.

2.0 WATERSHED DESCRIPTION

2.1 Physical and Natural Features

2.1.1 Watershed Boundaries

The Cache River watershed, identified by the US Geological Survey (USGS) Hydraulic Unit Code (HUC) 08020302, is located in east central Arkansas, between Crowley's Ridge and the White River (Figures 2.1 and 2.2). The headwaters of the Cache River originate in Butler County, Missouri and flow southwesterly through nine counties before its confluence with the White River near Clarendon, Arkansas. Headwaters of Bayou DeView, the main Cache River tributary, begin north of Jonesboro, Arkansas, on Crowley's Ridge and flow southwesterly through five counties before joining the Cache 10 miles above its confluence with the White River (The Nature Conservancy [TNC] 2005). The watershed has a maximum width of 18 miles, is approximately 143 miles in length, and covers an area of 2,021 square miles (1.3 million acres) (Memphis District US Army Corps of Engineers [USACE] 2011, TNC 2005). The boundary between the upper and lower Cache River watersheds is roughly State Highway 214/18. This plan addresses only the portion of the Cache River watershed within the boundaries of Arkansas.

2.1.2 Hydrology

The Cache River flows 203 river miles, 114 miles in natural channels and 89 in straightened, ditched channels, and Bayou DeView flows 107 river miles, 42 in natural channels and 65 miles in straightened ditched channels (TNC 2005).The Cache River and its major tributaries are all free-flowing streams. The Cache River has been classified as a perennial stream (Hunrichs 1983).

The Cache River is hydraulically connected to the surface aquifer underlying the watershed. When surface water levels are higher than the groundwater level, water moves from the Cache River into the aquifer. When surface water levels are lower than the groundwater level, water from the aquifer may discharge to the Cache River, contributing to base flow (Gonthier and Kleiss 1996, Broom and Lyford 1981).

The flow regime of the Cache River watershed has experienced hydrologic alteration that continues to the present day. The characteristics of the alterations are complex and involve changes to the magnitude, frequency, and duration of both high- and low-flow events, and changes to the rates of increase and decrease of streamflow along the rising and fallings limbs of hydrographs (TNC 2005).

2.1.2.1 Upper Cache River Watershed

The Cache River originates in just north of the Arkansas-Missouri border, entering Arkansas in Clay County as Cache River Ditch No. 1. The upper Cache River is almost entirely channelized. Tributaries to the upper Cache River are also ditches.

Crowley's Ridge is located east of the Cache River in Clay, Greene, and part of Craighead Counties. The ridge influences flow in the upper Cache River, primarily in Clay and Greene Counties (USACE 2015a). Major Cache River tributaries in the upper Cache River watershed, with headwaters on Crowley’s Ridge, include Big Creek Ditch No. 10, Ditch No. 8, Swan Pond Ditch, No. 26 Ditch, and Gum Slough Ditch. The Cache River receives no runoff from Crowley’s Ridge south of Jonesboro. Petersburg Ditch, Beaver Dam Ditch, and Willow Ditch are major tributaries from west of the upper Cache River.

Bayou DeView originates on Crowley’s Ridge, north of Jonesboro, as Big Creek. There are two impoundments on Big Creek north of Jonesboro, the largest being Lake Frierson. From Lake Frierson, Big Creek flows south, along the west side of Jonesboro. Lost Creek, a major tributary of Big Creek, also originates on Crowley’s Ridge, and flows through northern Jonesboro to join Big Creek. Lost Creek is also impounded at its upper end. Several other tributaries to Big Creek are also impounded on Crowley’s Ridge. Big Creek is channelized from Lake Frierson all the way to State Highway 214. Lost Creek is channelized from where it enters Jonesboro to where it joins Big Creek. The only other major tributaries to Big Creek in the upper Cache River watershed are Whistle Creek (from the east), and Johnson Ditch (from the west).

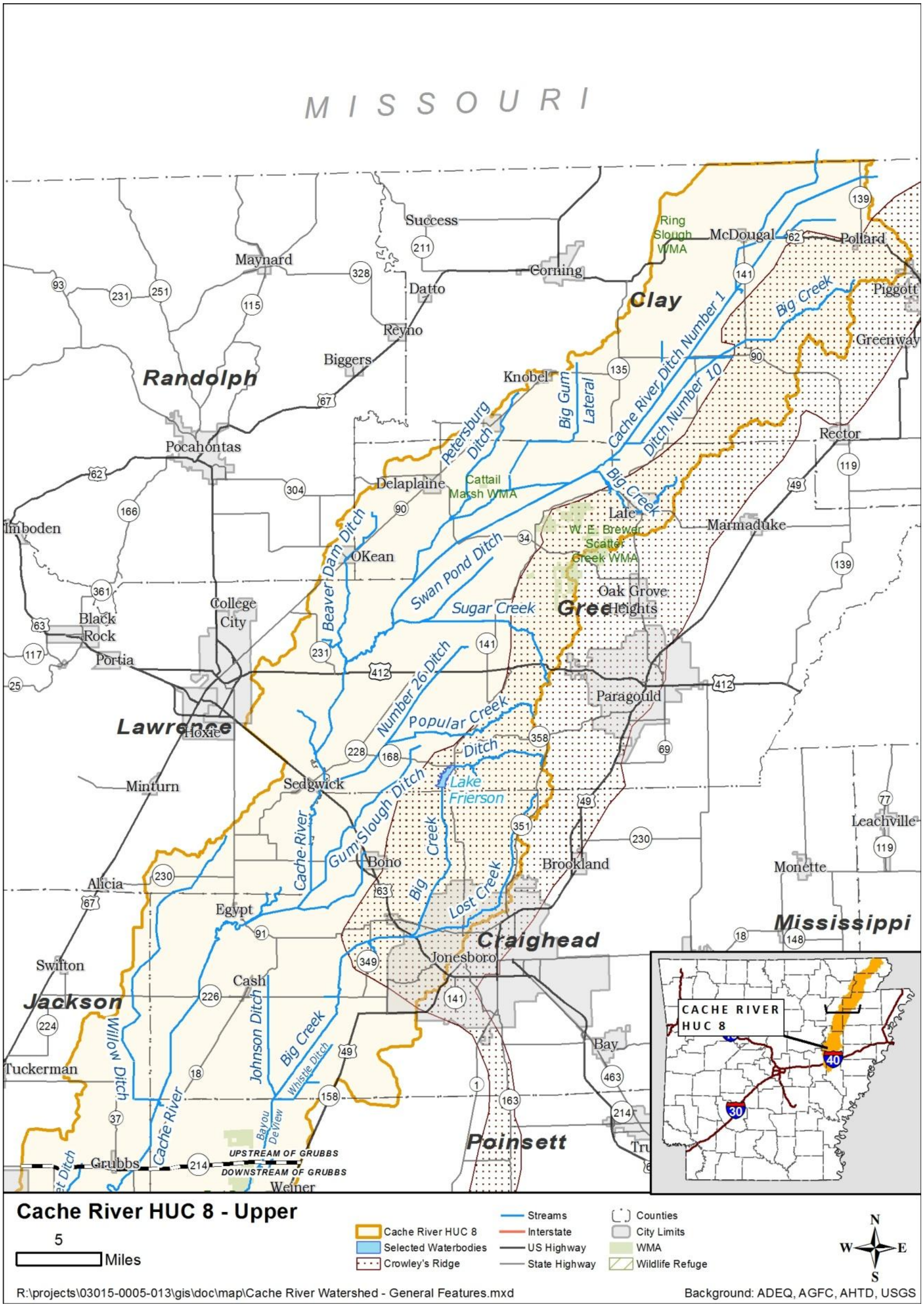


Figure 2.1 Upper Cache River watershed map.

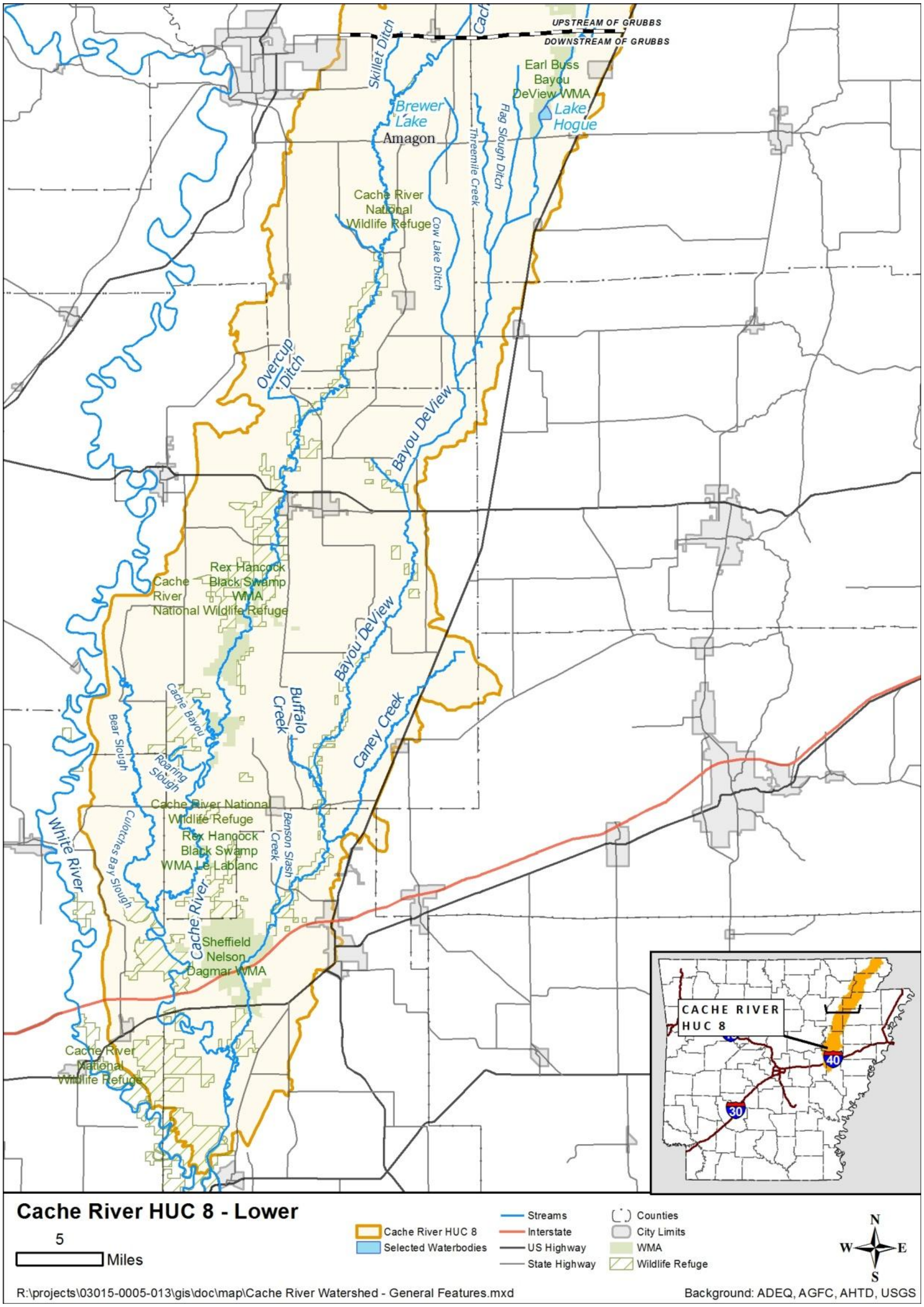


Figure 2.2. Cache River Watershed Lower – general features.

2.1.2.2 Lower Cache River Watershed

South of State Highway 18, the Cache River runs entirely in natural channels, except for the last seven miles, which are channelized. Major tributaries to the lower Cache River include Skillet Ditch, Overcup Ditch, Cache Bayou, Roaring Slough, Culotches Bay Slough, and Bayou DeView. In Jackson County, many of the Cache River tributaries are channelized. South of Jackson County, tributaries are primarily unaltered. The lower Cache River flows into the White River, near Clarendon.

Big Creek becomes Bayou DeView at State Highway 214. Bayou DeView parallels the Cache River as it flows south, joining the Cache River south of Interstate 40. Bayou DeView north of State Highway 64 is channelized in a number of places. South of State Highway 64, Bayou DeView runs in a natural braided channel. Major tributaries to Bayou DeView in the lower Cache River watershed include Flag Slough Ditch, Cow Lake Ditch, Buffalo Creek, and Caney Creek. All of these tributaries except Caney Creek drain the land between the Cache River and Bayou DeView. In Monroe County, there are numerous connections between Bayou DeView and the Cache River.

The lower Cache River flows into the White River. The White River significantly influences hydrology in the lower seven miles of the Cache. During White River flood events, flow in the lower seven miles of the Cache River can run upstream, which contributes to sediment deposition in the meanders. The typical hydrograph in the area shows increased flooding during the late winter and early spring, with prolonged periods of flooding followed by a slow receding of floodwaters. This section of the Cache River was channelized in the early 1970s (USACE Memphis District 2011).

2.1.3 Climate and Precipitation

The Cache watershed falls within the humid subtropical climatic region. The climate of the area is generally moderate with long, hot summers and short, moderately cold winters. July and August are the warmest months of the year (Figure 2.3). The months of November, December, April, and May have the highest average rainfall (Figure 2.4). The upper Cache River watershed is slightly cooler and drier than the lower Cache River watershed (Figures 2.3 and 2.4). On average, there are around 240 freeze-free days in the upper Cache River watershed. In the lower Cache River watershed the number of freeze-free days averages between 250 and 260 (NOAA National Centers for Environmental Information 2015).

2.1.4 Surface Water Resources

2.1.4.1 Upper Cache River Watershed

The Arkansas Department of Environmental Quality (ADEQ) identifies approximately 320 miles of streams in the upper Cache River watershed (ADEQ 2014a). The Arkansas Watershed Information System identifies approximately 1,366 miles of streams and 315 miles of ditches in the upper Cache River watershed (Center for Advanced Spatial Technologies 2006). There are a number of reservoirs on headwater streams of Bayou DeView on Crowley's Ridge. Lake Frierson, a 335-acre impoundment of Big Creek on Crowley's Ridge, is a significant publicly owned lake. There are also aquaculture ponds in Greene County (United States Department of Agriculture [USDA] National Agricultural Statistics Service [NASS] 2014). All together, there were 9,325 acres of open water in the upper Cache River watershed in 2010, and 29,192 acres of wetlands. The majority of the wetlands, 28,355 acres, are bottomland hardwoods (Homer, et al. 2015).

2.1.4.2 Lower Cache River Watershed

ADEQ identifies approximately 320 miles of streams in the lower Cache River watershed (ADEQ 2014a). The Arkansas Watershed Information System identifies approximately 1,586 miles of streams and 88 miles of ditches in the lower Cache River watershed (Center for Advanced Spatial Technologies 2006). Brewer Lake is an impoundment located near the Cache River in Jackson County. Lake Hogue is a 280 acre impoundment located on the east side of Bayou DeView in Poinsett County. There are also aquaculture ponds in the watershed in Poinsett and Jackson Counties. All together, there were 9,453 acres of open water in the lower Cache River watershed in 2010, and approximately 130,000 acres of wetlands. The majority of the wetlands, 119, 806 acres, are bottomland hardwoods (Homer, et al. 2015).

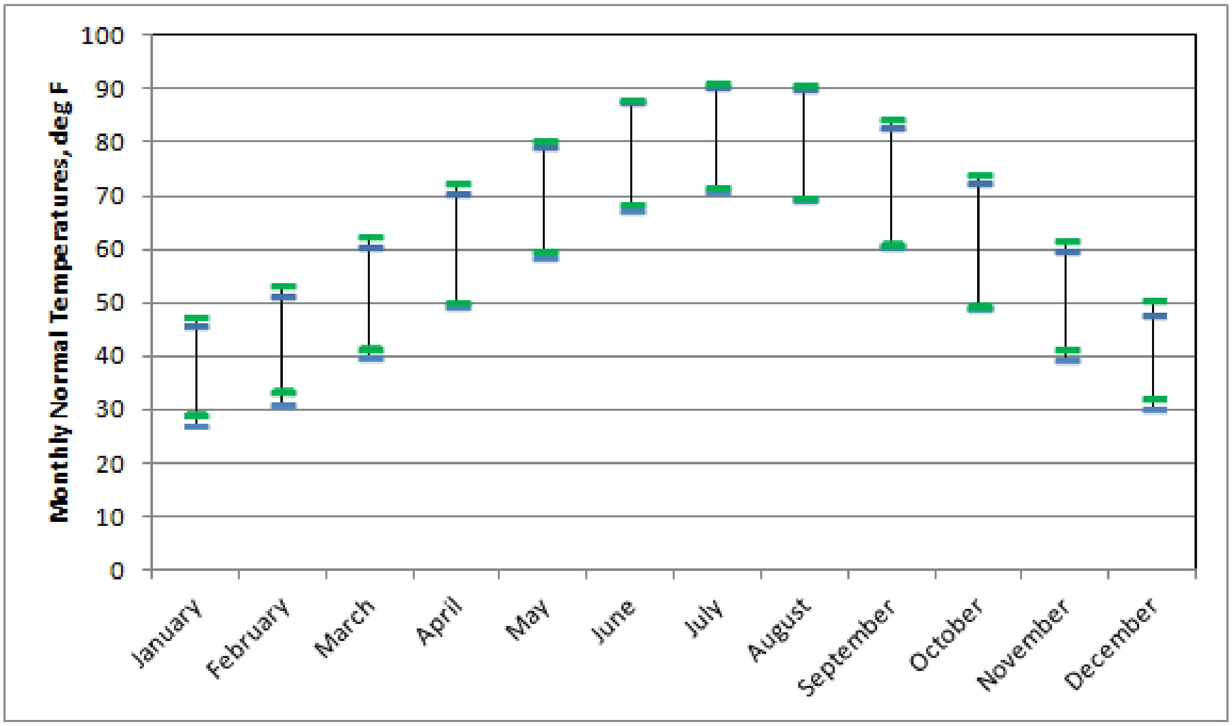


Figure 2.3. Normal monthly high and low air temperatures for the upper Cache River watershed (blue) and the lower Cache River watershed (green).

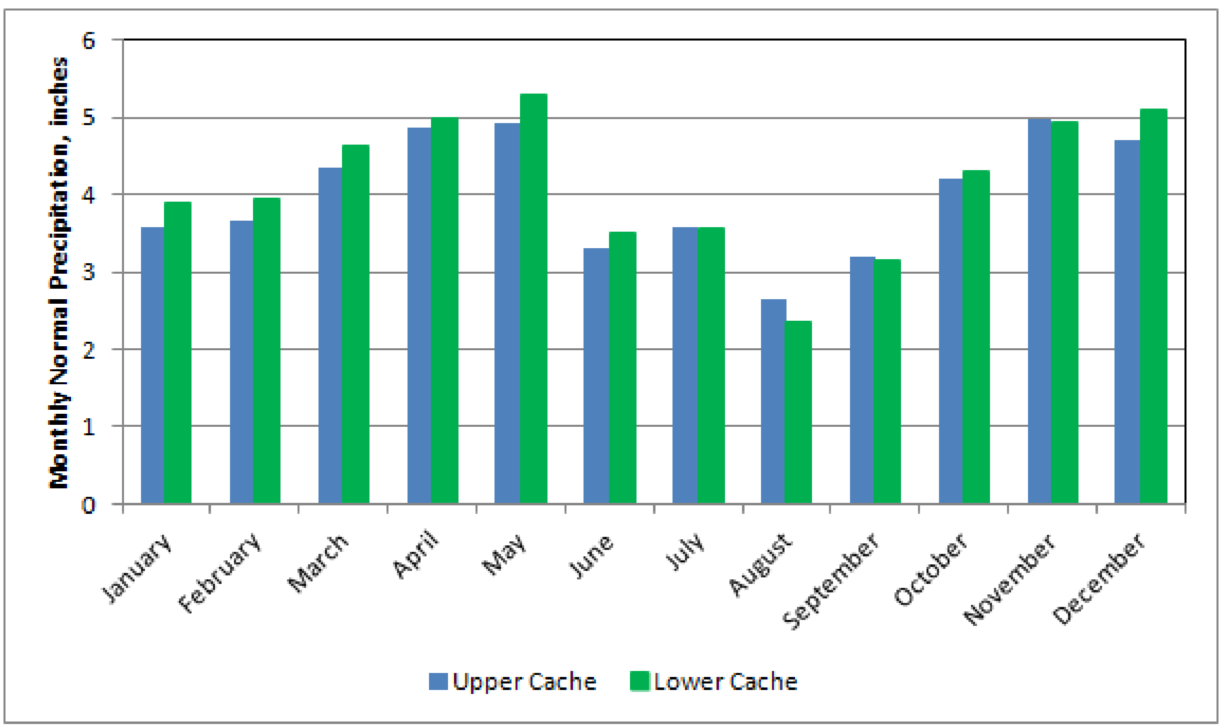


Figure 2.4. Normal monthly total precipitation for the upper and lower Cache River watersheds.

2.1.5 Groundwater Resources

Aquifers in the Cache River watershed consist of various geologic units mainly of unconsolidated and alternating layers of sands, gravels, silts, and clays (Table 2.1). In this setting, fine-grained material impedes flow and serves as confining units, and coarse-grained material serves as aquifers. The primary aquifer in the watershed is the Mississippi River Valley (MRV) alluvial aquifer, a regional aquifer that occurs in several states.

Table 2.1. Geohydrology of the Cache River watershed.

Province	Section	Group	Formation	Hydrogeologic Unit Name
Coastal Plain	Mississippi Alluvial Plain and West Gulf Coastal Plain	--	Alluvium, Terrace Deposits	Mississippi River Valley alluvial aquifer
		Jackson	Jackson	Vicksburg-Jackson confining unit
		Claiborne	Cockfield Formation	Cockfield aquifer
			Cook Mountain Formation	Middle Claiborne confining unit
			Sparta/Memphis Sand	Sparta/Memphis Sand aquifer
		Wilcox	Undifferentiated	Upper– Lower Wilcox aquifer
		Midway	Porters Creek Clay	Midway confining unit
			Clayton Formation	

The MRV alluvial aquifer is the uppermost aquifer in the Cache River watershed. This aquifer is typically divided into two hydrologic units based on lithology: a lower unit consisting of coarse sands and gravels that serves as the primary aquifer and an upper unit that consists of fine sand, silt, and clay that can serve as a confining unit in some locations. Primary recharge to the aquifer is from precipitation, in the areas where the clay layer is absent. Rivers may act as a source of recharge, or serve as a drain for the aquifer, depending on river stage and groundwater levels. Reported yields range from 400 to 5,000 gallons per minute (gpm), with yields of 2,000 gpm commonly cited. The yield appears to be dependent on the thickness, sediment size and distribution, and other physical characteristics (Kresse, et al. 2014).

The Cache River watershed encompasses land in two Critical Groundwater Areas. In 1998, Prairie County was designated part of the Grand Prairie Critical Groundwater Area. The aquifers of concern in this critical groundwater area are the MRV alluvial aquifer and the Sparta/Memphis Sand aquifer. In 2009, the portions of the Cache River watershed in Clay, Greene, Craighead, Poinsett, and Cross Counties, west of Crowley's Ridge, were designated part of the Cache Critical Groundwater Area. The aquifers of concern in this critical groundwater area are the MRV alluvial aquifer, and the Sparta/Memphis Sand aquifer.

2.1.5.1 Upper Cache River Watershed

There are three recognized aquifers that occur in the upper Cache River watershed, the MRV alluvial aquifer, Sparta/Memphis Sand aquifer, and Wilcox aquifer Figure 2.5. The uppermost aquifer is the MRV alluvial aquifer. The USGS Mississippi Embayment Regional Aquifer Study model of the MRV alluvial aquifer includes the upper Cache River, indicating that there is believed to be a hydraulic connection between the upper Cache River and the MRV alluvial aquifer (Clark and Hart 2009).

The Sparta/Memphis Sand aquifer underlies MRV alluvial aquifer in some areas of the upper Cache River watershed (Figure 2.5). The Sparta/Memphis Sand is primarily composed of thick bedded sands with minor clay layers that may hydraulically separate the sand beds. In the Memphis Sand subcrop area, the Sparta/Memphis Sand underlies the MRV alluvial aquifer and is hydraulically connected to the alluvial aquifer. This hydraulic connection serves as an important recharge source to the Sparta/Memphis Sand. Groundwater in the Sparta/Memphis Sand generally flows east and southward (Kresse, et al. 2014).

Crowley's Ridge acts as acts as a barrier to flow in the MRV alluvial aquifer from the east side of the ridge to the west side. The exception to this constraint is found in areas, such as Poinsett County, where the Sparta/Memphis Sand sub crops beneath the silt and loess deposits of the ridge. Here, the Sparta/Memphis Sand aquifer may act as a conduit through the ridge allowing for some induced flow from the east side, where the aquifer transmissivity is higher, and recharge from the Mississippi River is available. However, the amount of clay in the Sparta/Memphis Sand in this area is uncertain and the flow through the ridge is not easily quantified (Kresse, et al. 2014).

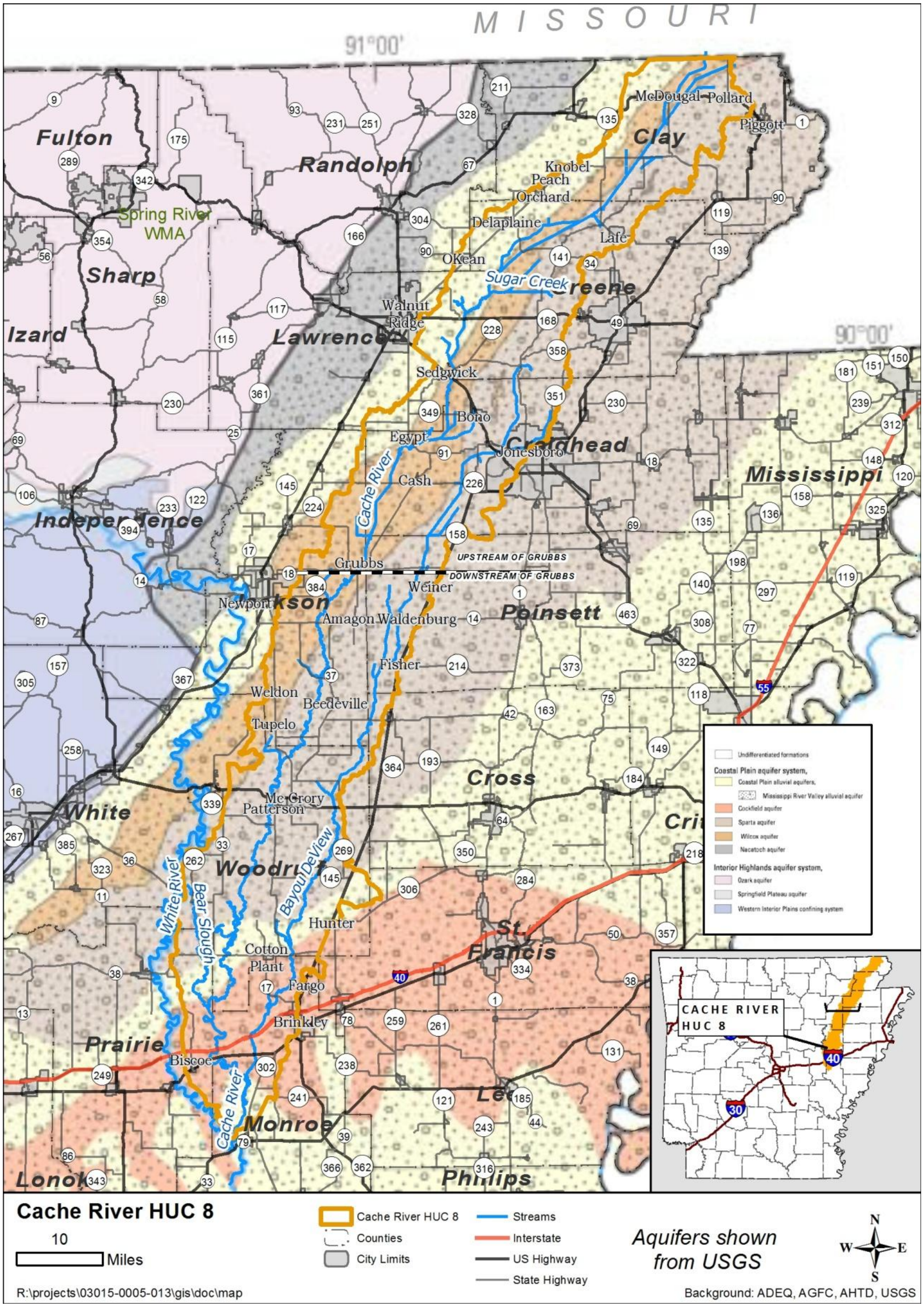


Figure 2.5. Aquifers of the Cache River watershed (Kresse, et al. 2014).

The Wilcox Group underlies the MRV alluvial aquifer in some areas of the upper Cache River watershed (Figure 2.5) Two of the three aquifer units used to represent the Wilcox Group are present in the watershed: lower Claiborne-upper Wilcox aquifer (hereafter referred to as the upper Wilcox), and the lower Wilcox aquifer. The upper Wilcox aquifer consists of thin interbedded layers of sands and clays with lignite. The upper Wilcox aquifer includes sands of the overlying Carizzo Sand that are hydraulically connected with sands of the upper Wilcox Group. The lower Wilcox aquifer consists of three major sand units that are collectively referred to as the lower Wilcox. The lower sand unit known as the "1,400-foot sand" is recognized throughout most of the Mississippi Embayment, which is a common term used for the lower Wilcox aquifer in northeastern Arkansas. The lower Wilcox aquifer is considered confined (Kresse, et al. 2014). Remaining discussion of the lower and upper Wilcox aquifers will simply refer to the units as the Wilcox aquifer.

The Wilcox aquifer outcrops in the area of Crowley's Ridge in Clay, Greene, and Craighead Counties. Recharge to the Wilcox aquifer primarily occurs as precipitation in the outcrop area. Wells completed in the Wilcox aquifer typically yield from 500 gpm to greater than 2,000 gpm. Discharge from the Wilcox aquifers is mainly to wells (Westerfield 1991). Regional groundwater flow for the Wilcox aquifer is towards the axis of the Mississippi Embayment.

2.1.5.2 Lower Cache River Watershed

There are four recognized aquifers in the lower Cache River watershed, Mississippi River Valley alluvial aquifer, Sparta/Memphis Sand aquifer, Wilcox aquifer, and Cockfield aquifer (Figure 2.5). The uppermost aquifer is the MRV alluvial aquifer. In the lower Cache River watershed, the Cache River channel is known to be deeper than the silt and clay layer that covers the MRV in much of the Delta, and thus is hydraulically connected to the MRV alluvial aquifer (Gonthier and Kleiss 1996). Crowley's Ridge has less of an impact on flow in the MRV alluvial aquifer in the lower Cache River watershed than in the upper Cache River watershed.

The Sparta/Memphis Sand and Wilcox aquifers underlie the MRV alluvial aquifer in northern areas of the lower Cache River watershed. These aquifers are described in Section 2.3.1.

The Cockfield aquifer underlies the MRV alluvial aquifer in southern areas of the lower Cache River watershed. In the outcrop area and where overlain by the MRV alluvium, the aquifer is unconfined (Figure 2.4). The Cockfield Formation consists of silt, clay, and lignite in the upper portions and sand beds near the base, which form the more permeable portions of the Cockfield aquifer. There is considerable variability in unit thickness. Regional groundwater flow is to the southeast. Recharge to the aquifer occurs as precipitation in the outcrop area and as seepage from the MRV alluvial aquifer in the subcrop area. Discharge from the aquifer occurs to streams in the outcrop area, to adjacent units, and wells. In and near the outcrop area, well depths are typically shallow (less than 200 feet) and yields are generally less than 30 gpm (Kresse, et al. 2014).

2.1.6 Floodplains

The majority of the Cache River watershed outside of Crowley's Ridge is classified as Special Flood Hazard area (Figures 2.6 and 2.7). There are 549,421 acres of designated floodplain in the Cache River watershed.

2.1.7 Topography and Elevation

The Cache River watershed is part of the Lower Mississippi River Alluvial Plain. The bulk of the watershed (87%) is characterized by low-lying flat to very gently rolling broad floodplains, with the only noticeable slopes being natural levees and terraces of active and abandoned stream channels.

Along the eastern edge of the upper Cache River watershed, north of Jonesboro, is Crowley's Ridge, which consists of rolling hills that rise several hundred feet from the surrounding alluvial plains (FTN Associates, Ltd. [FTN] 2012).

Elevations in the upper Cache River watershed range from 520 feet above mean sea level (ft msl) on Crowley's Ridge, to 225 ft msl along the Cache River near State Highway 18. Elevations in the lower Cache River watershed range from 235 ft msl in the north to 160 ft msl at the confluence with the White River.

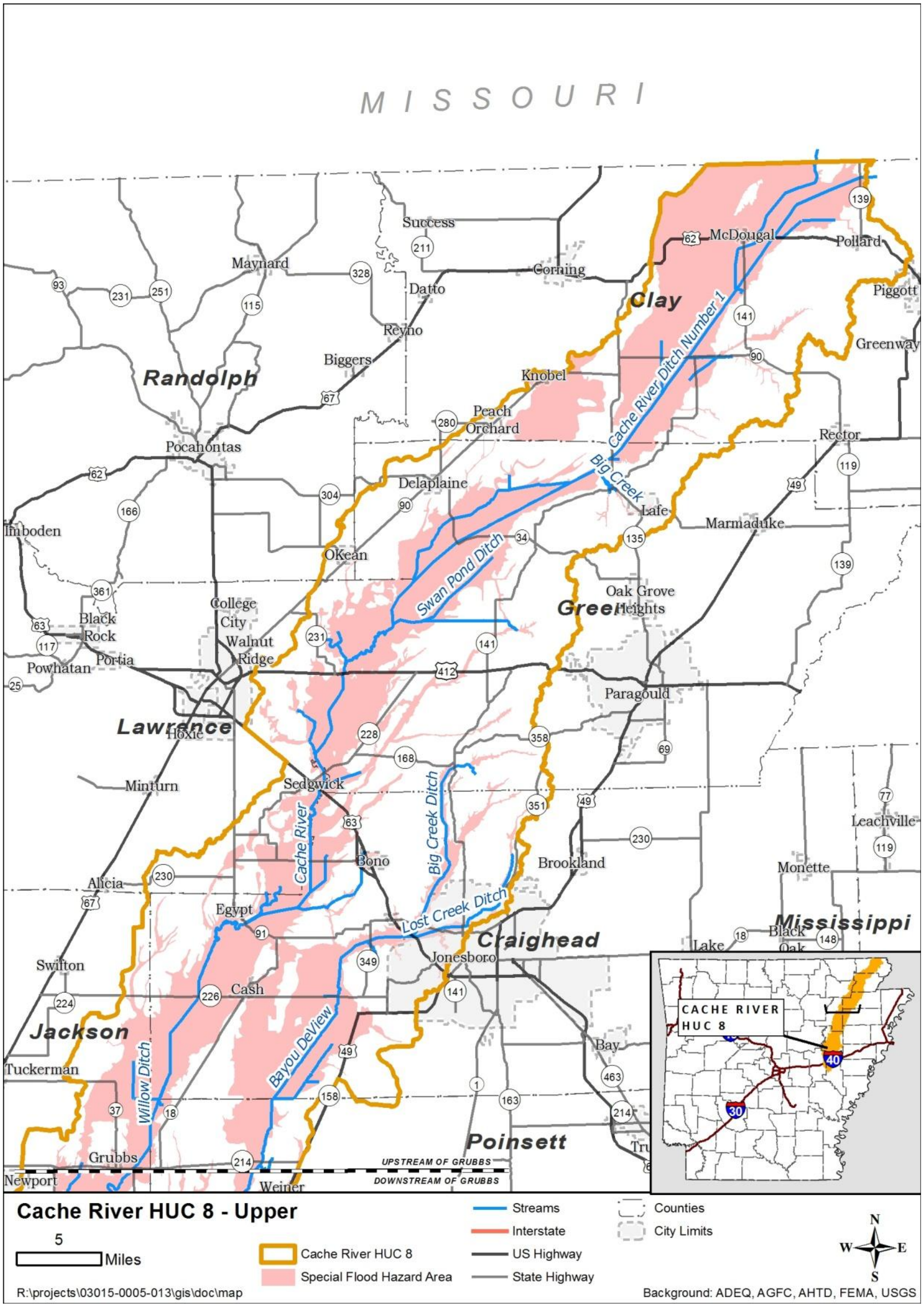


Figure 2.6. Floodplain map for the upper Cache River watershed (FEMA 2015a).

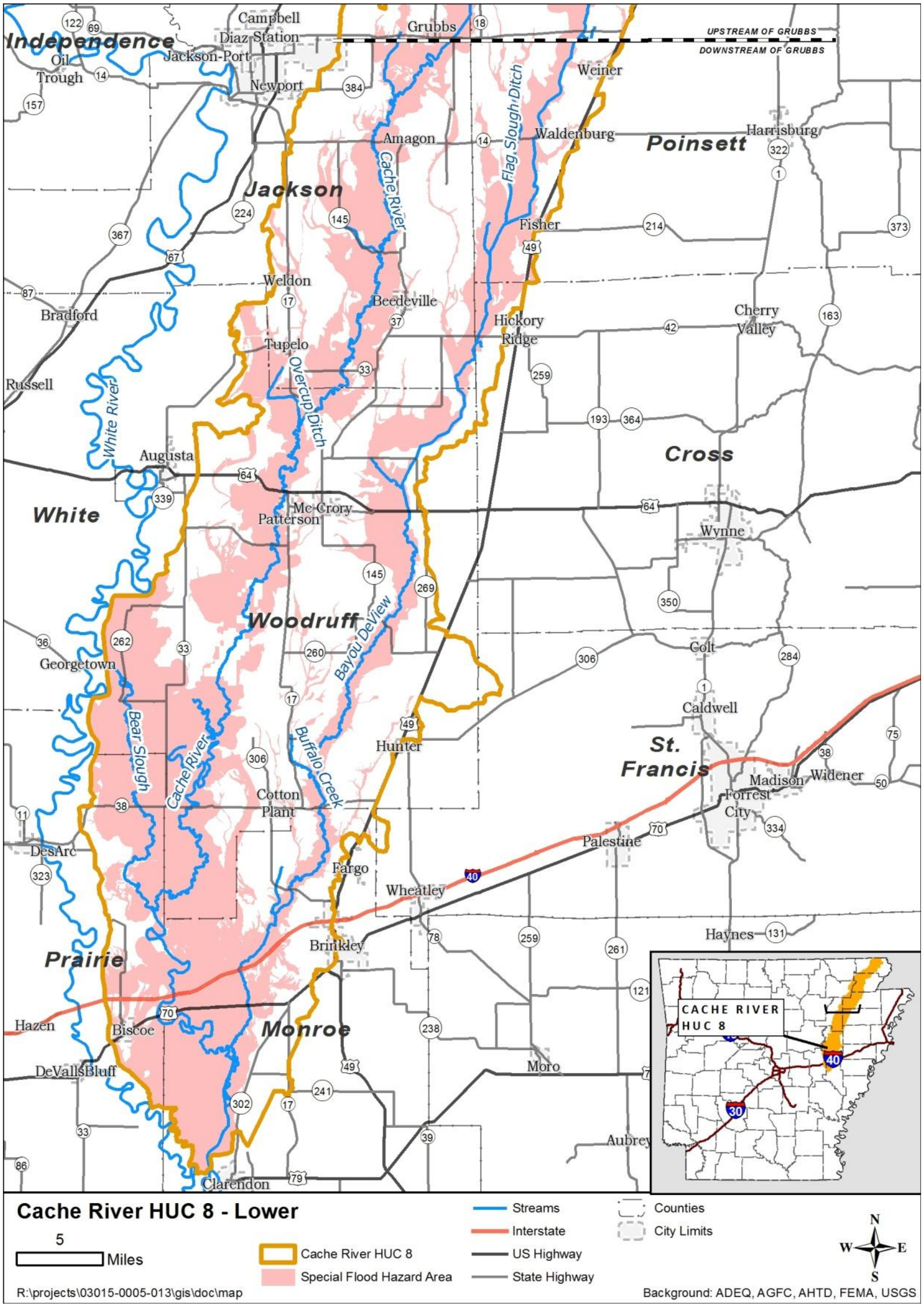


Figure 2.7. Floodplain map for the lower Cache River watershed (FEMA 2015a).

2.1.8 Geology and Soils

Much of the surface geology of the Cache River watershed consists of Pleistocene alluvial terrace deposits (Figures 2.8 and 2.9). Generally, these deposits consist of fine clays with low hydraulic conductivity near the surface, with water-bearing sands and gravels underneath.

Geologic formations underlying the Cache River watershed range in stratigraphic order from the earliest deposited layers of the Tertiary Period to Quaternary terrace deposits, sand dunes, and silt, sand, and gravel formations (Table 2.2). The Mississippi Alluvial Plain province is characterized by largely unconsolidated formations. Geologic formations comprising the Mississippi Alluvial Plain in Arkansas are contained within the Mississippi Embayment which is a low lying basin that is filled with Cretaceous age to recent sediments. The Mississippi Embayment is a geosyncline (trough) formed from downwarping and rifting related to the Ouachita orogeny. This activity resulted in a deep catch basin for sediment deposition. The axis of this syncline plunges southward, with the axis roughly parallel to the Mississippi River (Clark, Hart and Gurdak 2011). The Mississippi Alluvial Plain is a predominantly Quaternary outcrop belt of the Mississippi Embayment (Manger, Zachry, and Garrigan 1988). The Tertiary-age sediments represent marginal marine and alluvial deposits. The Quaternary-age deposits consist of alternating layers of water-washed gravel, sands, silts, and clays (McFarland 2004, Clark, Hart, and Gurdak 2011).

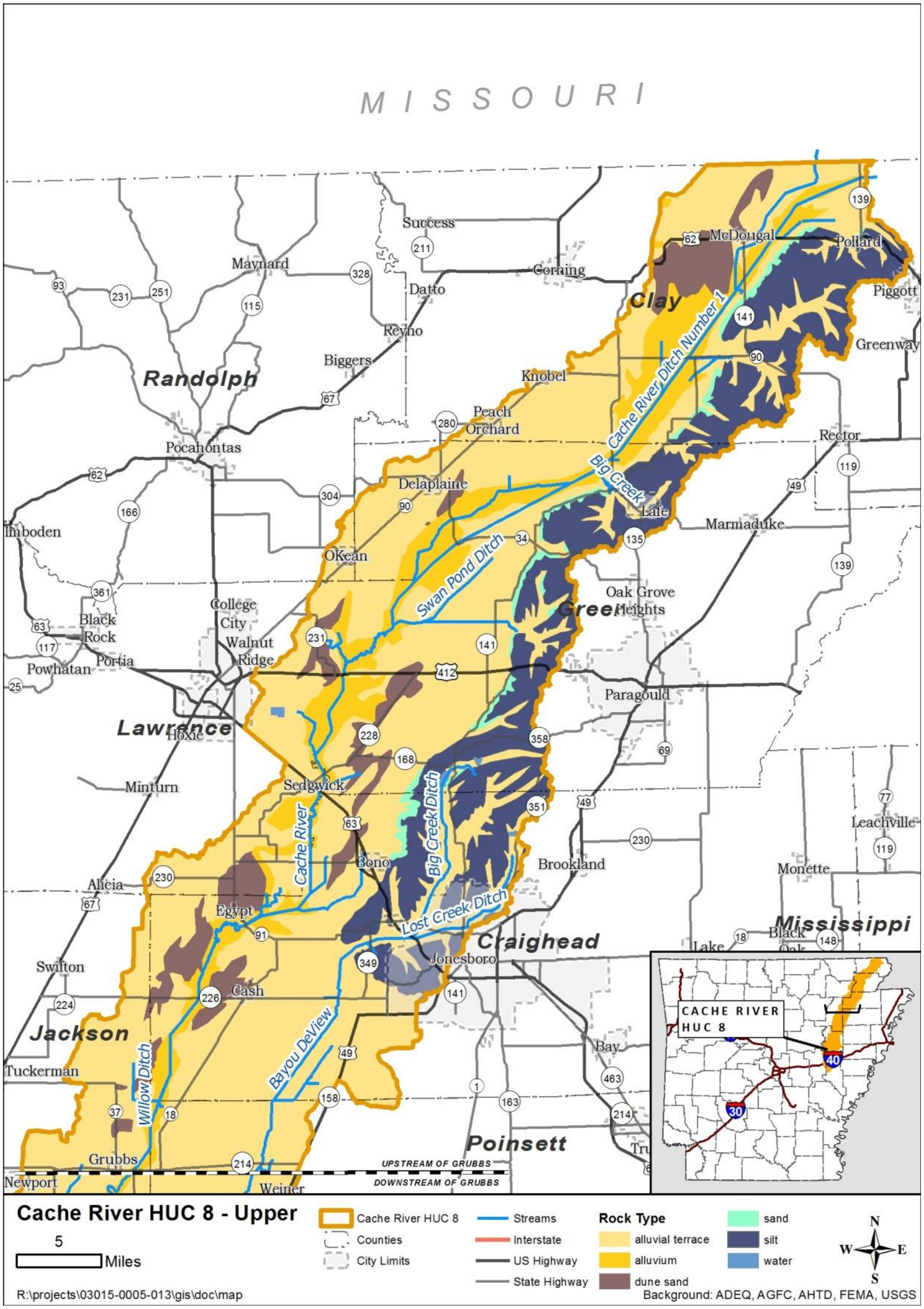


Figure 2.8. Surface geology of the upper Cache River watershed (based on Haley et al. 1993).

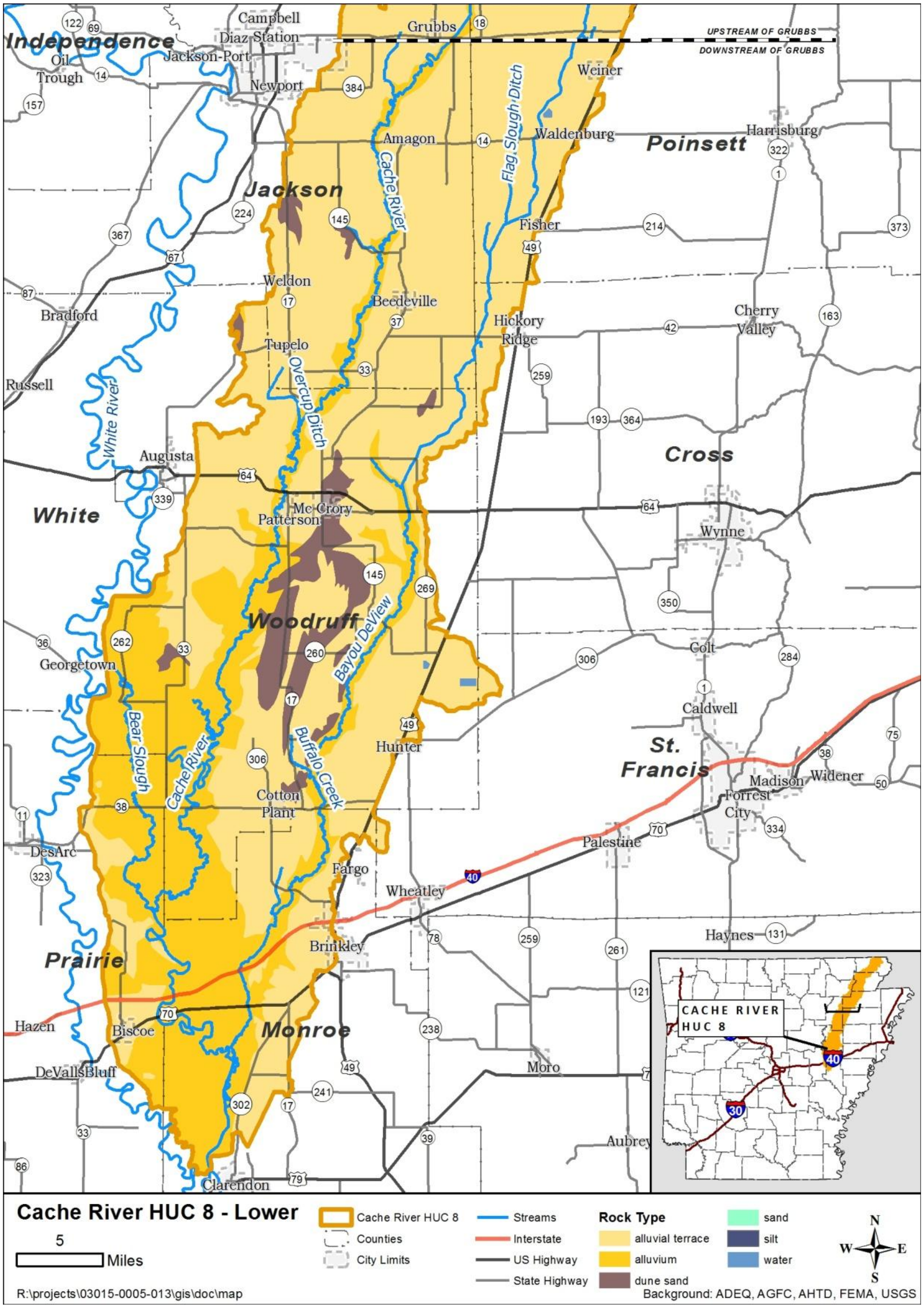


Figure 2.9. Surface geology of the lower Cache River watershed (based on Haley et al. 1993).

Table 2.2 Geology of the Cache River watershed (Arkansas Geological Survey 2015a).

<table>
<tr><th>Period</th><th>Age</th><th colspan="2">Formations</th><th>Location</th></tr>
<tr><td rowspan="4">Quaternary</td><td rowspan="4">Pleistocene</td><td>Terrace deposits</td><td>Dune sand</td><td>Lowlands surface</td></tr>
<tr><td colspan="2">Silt & sand</td><td rowspan="2">Crowley's Ridge</td></tr>
<tr><td colspan="2">Loess</td></tr>
<tr><td colspan="2" rowspan="2">Sand & gravel</td><td rowspan="6">Subsurface lowlands and Crowley's Ridge</td></tr>
<tr><td rowspan="5">Tertiary</td><td>Pliocene</td></tr>
<tr><td rowspan="3">Eocene</td><td colspan="2">Jackson</td></tr>
<tr><td colspan="2">Claiborne</td></tr>
<tr><td colspan="2">Wilcox</td></tr>
<tr><td>Paleocene</td><td colspan="2">Midway</td></tr>
</table>

The majority of the soils in the watershed are poorly drained loamy and clayey soils formed on water-deposited alluvium. Figure 2.10 shows the major soil associations within the watershed. Table 2.3 lists the major soil associations and their characteristics.

Alluvium was deposited in the Cache River watershed by the Mississippi River when it flowed in the channel now occupied by the Cache Rivers. The wide range in textures of the alluvium in the watershed results from the differences in depositional sites. When a river overflows it banks, its velocity immediately diminishes, leaving coarse sediment deposited in strips (low ridges) bordering the channel or natural levees. In the Cache River watershed, Bosket and Dubbs soils formed on these natural levees. Finer sediment, with a higher percentage of silt, is deposited on the floodplains where soils such as the Commerce and Dundee formed. Clay and finer size fractions are deposited in water that is left standing as shallow lakes or swamps once the flood water recedes. The Kobel and Jackport soils formed on these deposits (TNC 2005).

In the upper Cache River watershed, Brandon, Loring, and Memphis soil associations formed on loess deposits on Crowley's Ridge. Saffell soils formed on loamy and gravelly sediments on Crowley's Ridge (USDA Natural Resources Conservation Service [NRCS] 2006).

2.1.9 Vegetation

Historically, the Cache River watershed was heavily forested. Bottomland hardwood forest covered the lowlands, and upland forest covered Crowley's Ridge.

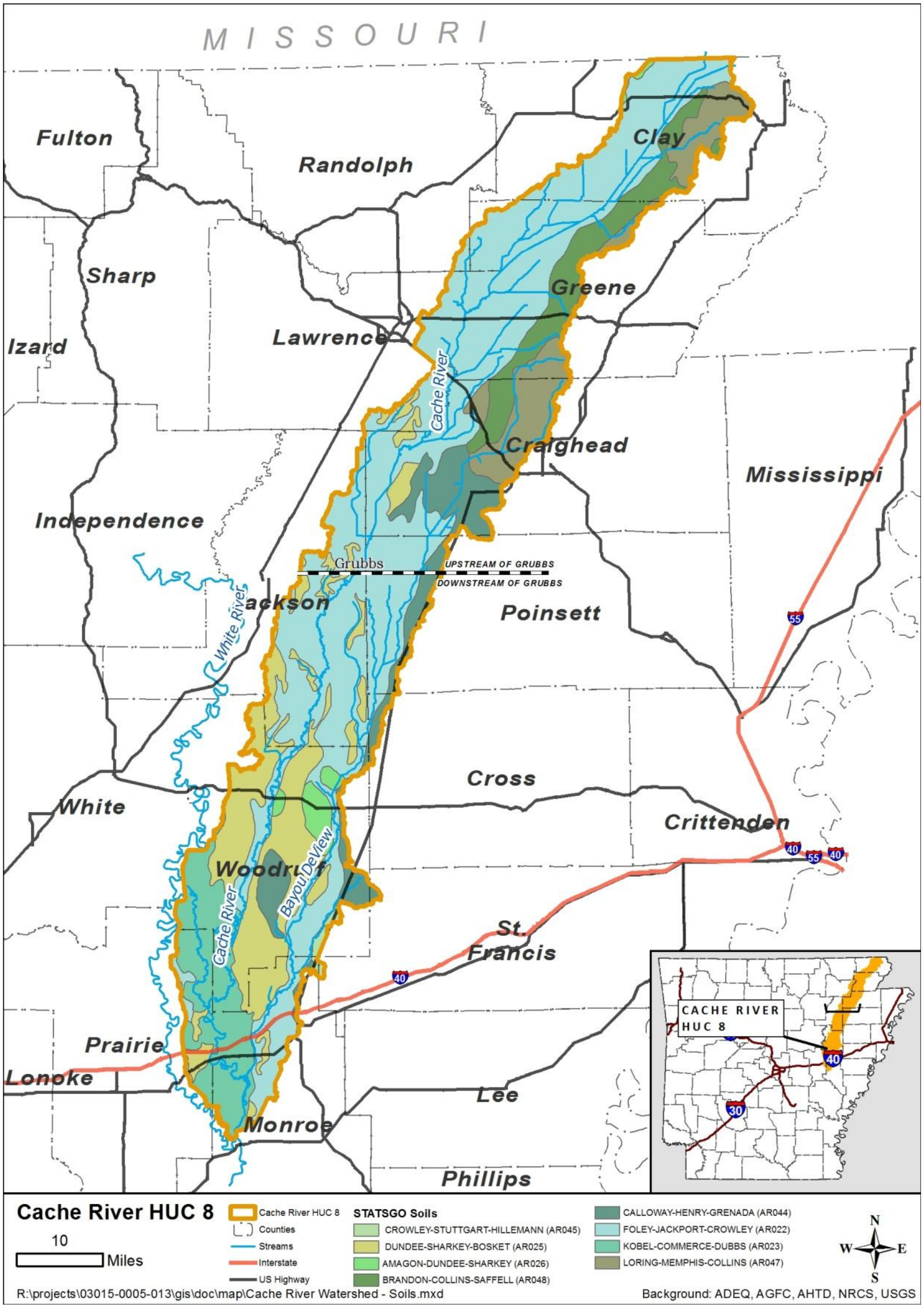


Figure 2.10. Major soil associations of the Cache River watershed (from STATSGO).

Table 2.3 Major soil associations of the Cache River watershed.

Soil Association	Principle landscape where soil association occurs	Soil association characteristics				
		Depth	**drainage**	**permeability**	**slope**	**character**
Amagon-Dundee-Sharkey	Low natural levees within Holocene meander belts	Deep	poorly to somewhat poorly drained	slowly permeable	level to gently undulating	loamy and clayey
Brandon-Collins-Saffell	Loess uplands (Crowley's Ridge)	Very deep	Moderately well to well drained	Moderate	Level to steep	Silty and gravelly loam
Calloway-Henry-Grenada	Pleistocene valley trains and dunefields	Deep	Poorly to moderately well drained	Slowly permeable	Level to moderately sloping	Loamy
Crowley-Stuttgart-Hilleman	Pleistocene terraces	Very deep	Poorly to moderately poorly drained	Very slowly to slowly permeable	Level or nearly level	Silt loam
Dundee-Sharkey-Bosket	Pleistocene valley trains and dunefields	Very deep	Well to very poorly drained	Moderately to very slowly permeable	Level to gently sloping	Clay and silty loam
Foley-Jackport-Crowley	Valley Trains and Pleistocene Alluvial Terraces adjacent to the Cache River.	Deep	Poorly to somewhat poorly drained	Very slowly permeable	Level to nearly level	Clayey and silty loam
Kobel-Commerce-Dubbs	Holocene meander belts	Very deep to deep	Well drained to very poorly drained	Moderately to very slowly permeable	Level to sloping	Silty clay and silt loam
Loring-Memphis-Collins	Pleistocene terraces (Crowley's Ridge)	Moderate (with fragipan) to very deep	Moderately well to well drained	Moderately permeable	Level to strongly sloping	Silt loam

2.1.9.1 Upper Cache River Watershed

Approximately 68% of the land in the upper Cache River watershed is currently cultivated cropland (Homer, et al. 2015). The most commonly cultivated crops in the watershed are soybeans and rice. Corn, cotton, and wheat are also grown. On Crowley's Ridge, crops include hay and fruit (USDA NASS 2014).

The majority of the forest in the upper Cache River watershed occurs on Crowley's Ridge. Forest on the ridge is oak-hickory forest mixed with areas of beech-maple forest similar to those present in the Appalachian Mountains. This is the only region in the state where tulip poplar occurs naturally. Pines occur in sandier soils at the northern part of the ridge plain (Woods, et al. 2004, Foti 2008).

2.1.9.2 Lower Cache River Watershed

Approximately 72% of the land in the lower Cache River watershed is currently cultivated cropland (Homer, et al. 2015). Soybeans and rice are the most common cultivated crops in the watershed. Corn and wheat are also grown (USDA NASS 2014).

The forest in the lower Cache River watershed is bottomland hardwood. Although the lower Cache River watershed has undergone significant conversion from forest to agriculture, it continues to have one of the largest remaining contiguous forested wetlands in the lower Mississippi River Valley (Kress, et al. 1996). In a study of vegetation in the Cache River floodplain, Smith (1996) noted that the species and distribution of vegetation was consistent with alluvial river floodplains found throughout the Coastal Plain. Trees in the river swamp forest, which is subject to nearly continuous flooding or saturation was co-dominated by water tupelo and bald cypress. The next higher zone of vegetation (where flooding or saturation occurs up to 50% of the year) had greater species richness, and was dominated by an overcup/water hickory assemblage (Smith 1996).

2.1.10 Exotic and/or Invasive Species

The USGS Nonindigenous Aquatic Species database lists six nonindigenous species that are found in the Cache River watershed (Table 2.4). All of these have been collected from the upper Cache River watershed, and four have been collected from the lower Cache River watershed (Table 2.4) (USGS 2015a). Of these, two species have been identified as Aquatic Nuisance Species in Arkansas by the Arkansas Game and Fish Commission (AGFC); Silver Carp, and Nutria (Myocastor coypus) (AGFC 2013, USGS 2015a). None of the aquatic nuisance plant species for Arkansas have been reported in the Cache River watershed (University of Georgia Center for Invasive Species and Ecosystem Health 2015, AGFC 2013).

Table 2.4 Aquatic nonindigenous and nuisance species of the upper Cache River watershed (AGFC 2013, USGS 2015a).

Common Name	**Scientific Name**	**Native or Exotic**	**Nuisance**	**Upper Cache**	**Lower Cache**
Jellyfish	*Craspedacusta sowerbyi*	Exotic	No	X	
Grass Carp	*Ctenopharyngodon idella*	Exotic	No	X	X
Common Carp	*Cyprinus carpio*	Exotic	No	X	X
Silver Carp	*Hypophthalmichthys molitrix*	Exotic	Yes	X	X
Tiger Muskellunge	*Esox lucius x E. masquinongy*	Native	No	X	
Nutria	*Myocastor coypus*	Exotic	Yes	X	X

2.1.11 Wildlife

Despite the extensive land cover modification in the Cache River watershed, this is an important area for a wide variety of wildlife.

2.1.11.1 Upper Cache River Watershed

Wildlife common in the upper Cache River watershed include deer, squirrel, rabbit, turkey, quail, skunk, woodchuck, armadillo, and raccoon. Water snakes, including cottonmouth, are common, as are turtles. Fox can be seen on Crowley’s Ridge. A variety of raptors, including bald eagles, hawks, and owls occur here, as well as a variety of songbirds. Waterfowl, including herons, geese, and ducks are also common (Sutton, et al. 2007). State and federal initiatives are in place that encourage keeping cropland flooded in the winter to provide additional habitat for migrating and wintering waterfowl and shorebirds (Arkansas Association of Conservation Districts [AACD] 2015). Fisheries in this watershed tend to consist of generalist species and have little diversity (TNC 2005).

2.1.11.2 Lower Cache River Watershed

The large areas of bottomland hardwood forest, and more natural stream channels, make wildlife communities in the lower Cache River watershed more diverse than those in the upper Cache River watershed. Black bears can often be seen here, and the Ivory-billed woodpecker was recently sighted here after having been thought to be extinct for the past 60 years. Additionally, the river and surrounding lands support 53 species of mammals including deer, raccoons, bobcats, beaver, and river otters; over 200 bird species including ducks, geese, wading birds, and other assorted migratory birds; and nearly 50 species of reptiles and amphibians (McCord 2015). The aquatic community within the lower Cache River ecosystem contains 70% of the fish and mussels known to occur in the Arkansas Mississippi River Alluvial Plain ecoregion (TNC 2001).

2.1.12 Protected Species

There are several state and federally listed threatened and endangered species present in the Cache River watershed, including mussels, plants, and the Ivory-billed Woodpecker (Arkansas Natural Heritage Commission [ANHC] 2014, NatureServe 2015). Table 2.5 lists the state and federally protected species found within the upper and lower Cache River watersheds.

Table 2.5. Protected species found in the Cache River watershed (ANHC 2014, NatureServe 2015, Harris, et al. 2009).

Common Name	**Species name**	**Category**	**State Status**	**Federal Status**	**Upper Cache**	**Lower Cache**
Pink Mucket	*Lampsilis abrupt*	Invertebrate	Endangered	Endangered	X	X
Pondberry	*Lindera melissifolia*	Plant	Endangered	Endangered	X	X
Bigleaf Magnolia	*Magnolia macrophylla*	Plant	Endangered	None	X	--
Purple Fringeless Orchid	*Platanthera peramoena*	Plant	Threatened	None	X	--
Fat pocketbook	*Potamilus capax*	Invertebrate	Endangered	Endangered	X	--
Opaque prairie sedge	*Carex opaca*	Plant	Endangered	None	X	X
Ivory-billed woodpecker	*Campephilus principalis*	Vertebrate	Endangered	Endangered	--	X
Red River fatmucket	*Lampsilis hydiana*	Invertebrate	Threatened	None	X	--

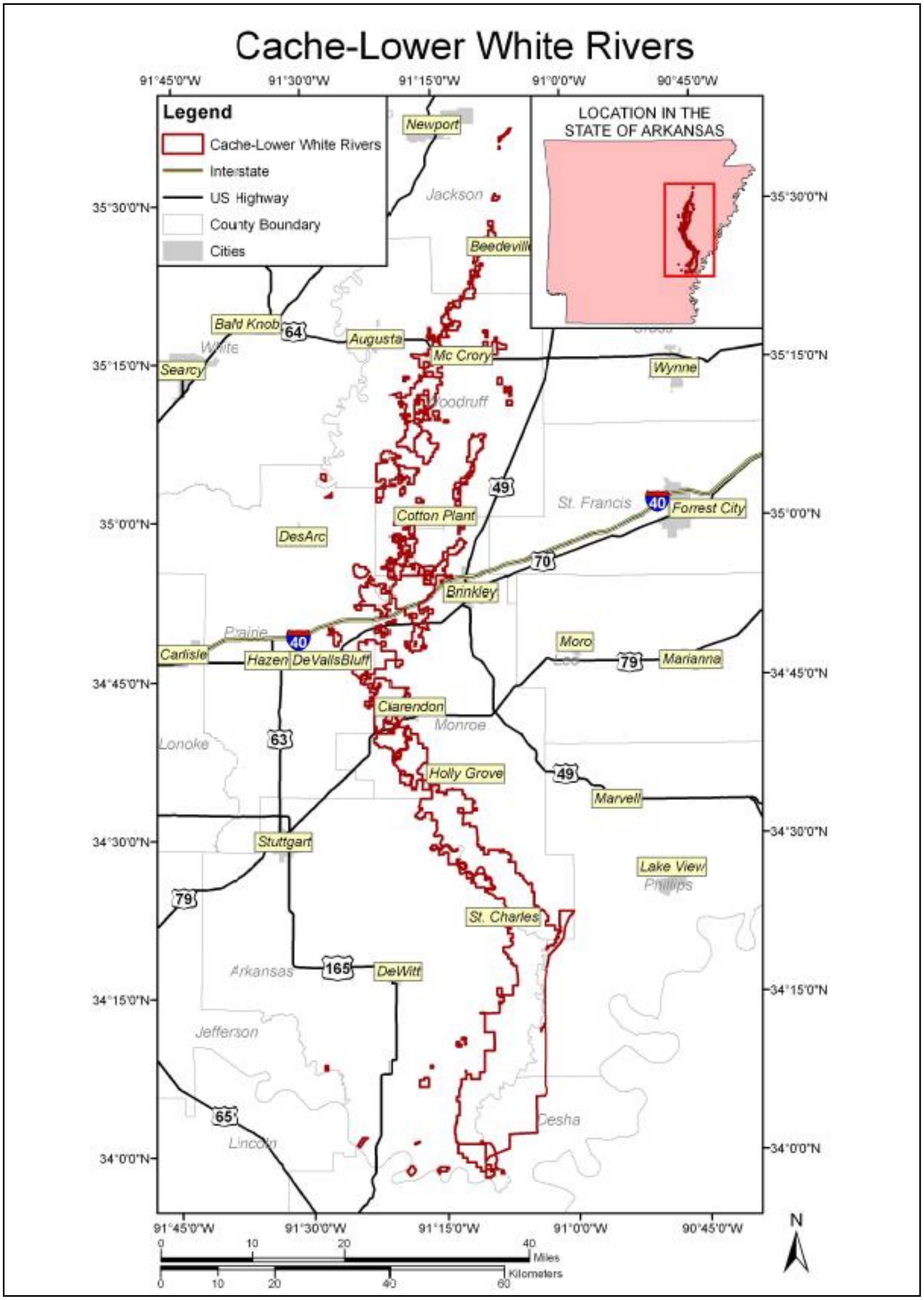
2.1.13 Sensitive Areas

Sensitive areas have been identified in the lower Cache River watershed only. Just over 34,000 hectares of protected wetlands of the Cache River and Bayou DeView in the lower Cache River watershed were named Wetlands of International Importance by the Ramsar Convention in 1998 (Figure 2.11). These wetlands are part of the largest contiguous tract of bottomland hardwood wetlands in the lower Mississippi River basin and are internationally important to the support of migratory waterfowl, raptors, and songbirds.

The lower Cache River has also been declared a “River of Life” by The Nature Conservancy. A short segment of the Cache River between two areas of the Rex Hancock Black Swamp Wildlife Management Area (WMA) has been designated state Extraordinary Resource Waters (Arkansas Pollution Control and Ecology Commission 2014).

2.1.14 Cultural Resources

The Cache River was an important water resource for prehistoric peoples. The internationally known Dalton period graveyard site known as the Sloan Site is located in the upper Cache River watershed in Greene County (Morrow 2013). Important Indian mound sites connected to the Plum Bayou culture are also present in the Cache River watershed. An additional culturally important site in the lower Cache River watershed is the site of the Cotton Plant Battle of the Civil War (Lancaster 2014).



2.11. Map of Ramsar Wetlands of International Importance in the lower Cache River watershed (Ramsar 2014).

2.2 Land Use and Land Cover

The major land covers in the watershed are cropland, forest, and wetlands. Land use in the upper and lower Cache River watersheds is summarized in Figure 2.12, and mapped on Figures 2.13 and 2.14.

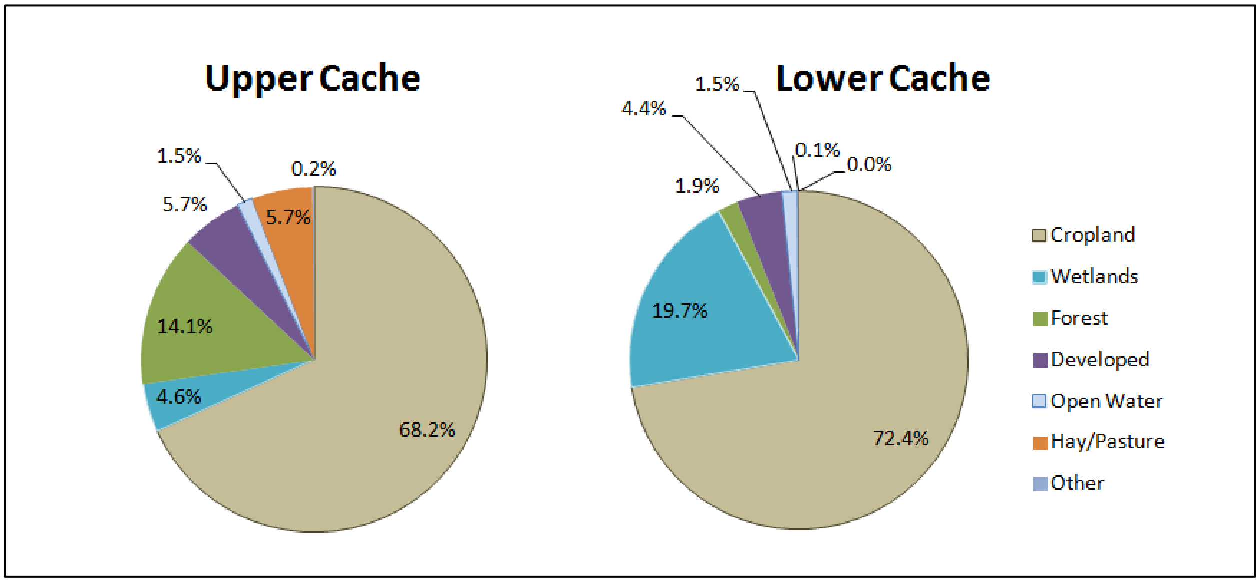


Figure 2.12. Land cover summaries for upper and lower Cache River watersheds (Homer, et al. 2015).

2.2.1 Wetlands

There are 29,192 acres of wetlands in the upper Cache River watershed. The majority, 28,355 acres, is bottomland hardwoods (Homer, et al. 2015).

There are also approximately 130,000 acres of wetlands in the lower Cache River watershed. The majority, 119, 806 acres, are bottomland hardwoods (Homer, et al. 2015). Wetlands in the lower Cache River watershed have been designated Wetlands of International Importance (Ramsar 2014).

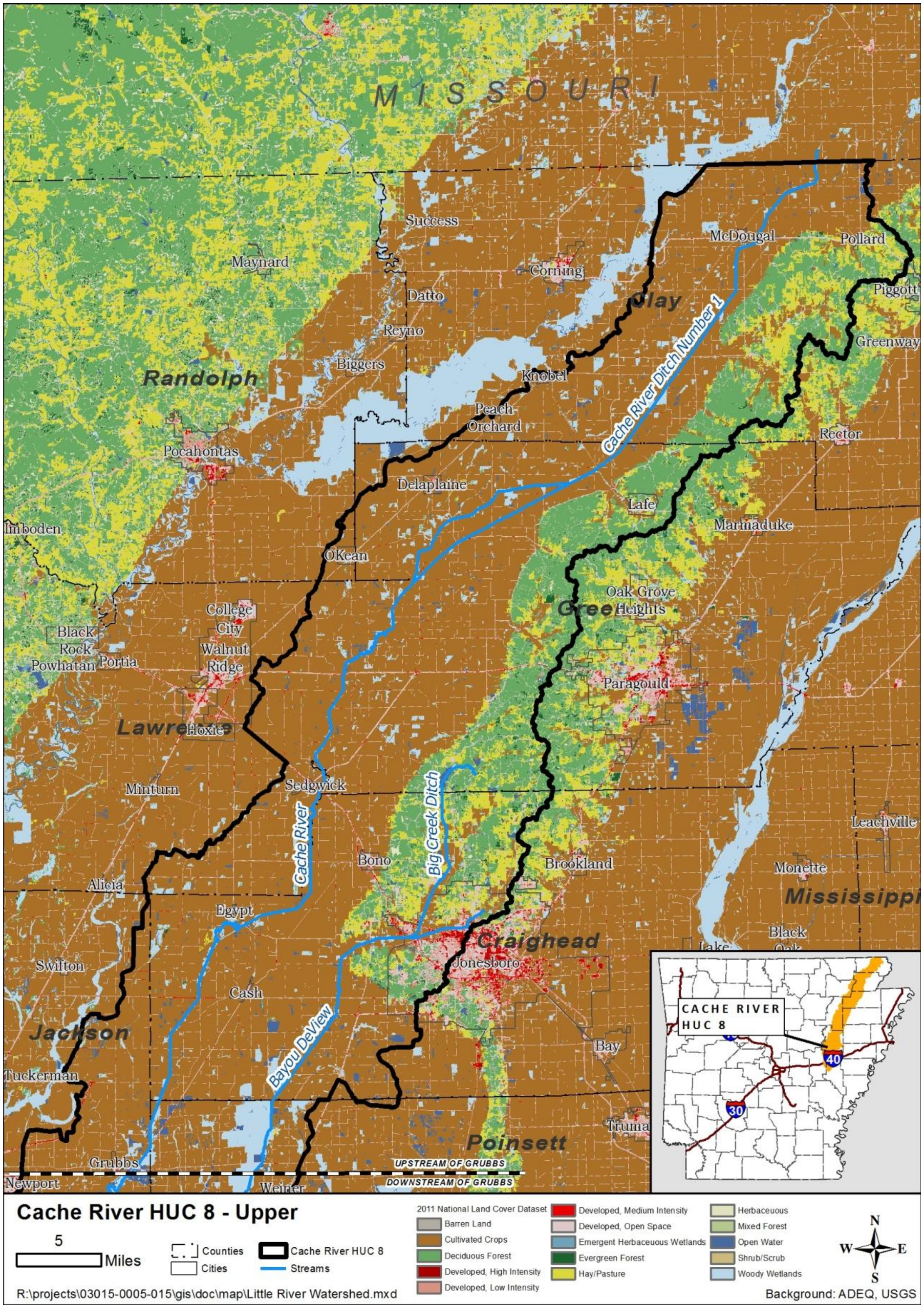


Figure 2.13. Land cover map of upper Cache River watershed (Homer, et al. 2015).

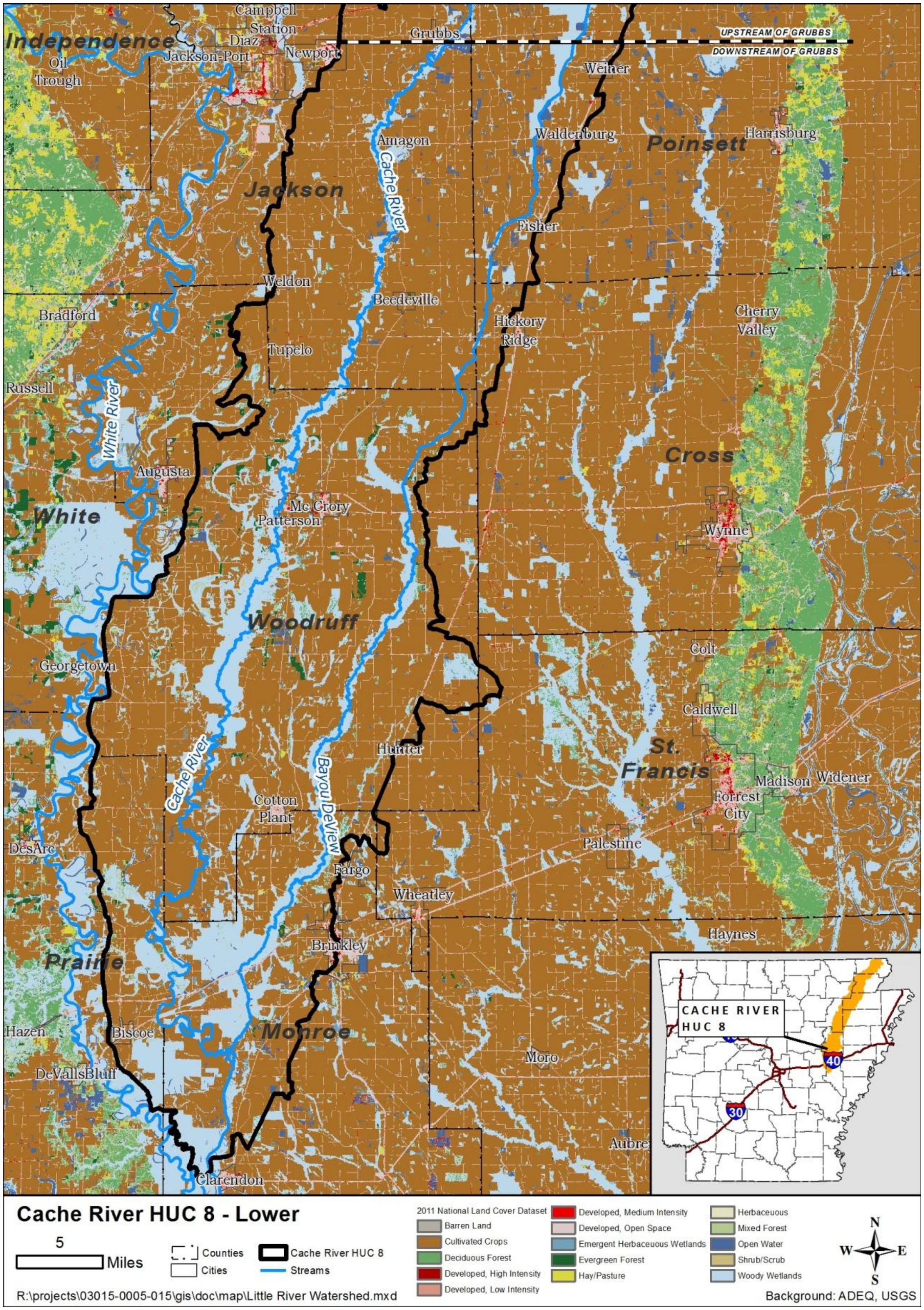


Figure 2.14. Land cover map of lower Cache River watershed (Homer, et al. 2015).

2.2.2 Forest

The majority of the forest in the upper Cache River watershed occurs on Crowley's Ridge. This upland oak-hickory forest is mixed with areas of beech-maple forest similar to those present in the Appalachian Mountains. This is the only region in the state where tulip poplar occurs naturally. Pines occur in sandier soils at the northern part of the ridge plain (Woods, et al. 2004, Foti 2008).

The forest in the lower Cache River watershed is bottomland hardwood, shown as wetlands in Figure 2.13 and 2.14. Although the lower Cache River watershed has undergone significant conversion from forest to agriculture, it continues to have one of the largest remaining contiguous forested wetlands in the lower Mississippi River Valley (Kress, et al. 1996).

2.2.3 Agricultural Lands

Approximately 68% of the land in the upper Cache River watershed is cultivated cropland (Homer, et al. 2015). The most commonly cultivated crops in the watershed are soybeans and rice. Corn, cotton, and wheat are also grown. On Crowley's Ridge, animal and fruit agriculture occurs.

Approximately 72% of the land in the lower Cache River watershed is cultivated cropland (Homer, et al. 2015). Soybeans and rice are the most common cultivated crops in the watershed. Corn and wheat are also grown (USDA NASS 2014).

2.2.4 Mining

Mining in the Cache River watershed consists primarily of sand and gravel mining, with a few locations where clay is mined. The majority of mining in the watershed occurs in the upper Cache River watershed (Clay, Greene, and Craighead Counties), on Crowley's Ridge. Active mines reported by the Arkansas Geological Survey are listed in Table 2.5. There are also a number of active ADEQ permitted mines in the Cache River watershed. It is not always possible to determine when the same mines are reported by both the Arkansas Geological Survey and ADEQ. Where we were reasonably sure the mines are the same, the ADEQ permit number is included in Table 2.6. ADEQ permitted mines that did not directly correspond to a mine listed by the Arkansas Geological Survey are listed in Table 2.7.

Table 2.6. Active mines reported by Arkansas Geological Survey (Arkansas Geological Survey 2015b).

Facility Name	County	Nearest town	Material Mined	ADEQ Permit Number
2 Gravel Pits	Clay	McDougal	Gravel	--
Ridge Road Enterprises	Greene	Lafe	Sand & gravel	--
Knob Pit/Tri-County Pit	Greene	Hopewell	Sand & gravel	--
Gravel Pit	Greene	Paragould	Gravel	--
Gravel Pit	Greene	Paragould	Gravel	--
Branch 18/ Razorback Rock Materials Inc	Greene	Paragould	Sand & gravel	--
Wright Mine	Craighead	Herndon	Sand & gravel	--
Coleman / Acme Brick Co.	Craighead	Bono	Clay	0659-MN-A1
McGowan / Acme Brick Co.	Craighead	Jonesboro	Clay	0659-MN-A1
Lacy / Razorrock Materials Co.	Craighead	Jonesboro	Sand & gravel	0510-MN-A3
Hedger Pit / Hedger Aggregate Inc.	Craighead	Jonesboro	Sand & gravel	0477-MN-A3
Carter Pit / Paul Richardson Trucking Inc	Craighead	Jonesboro	Sand & gravel	--
Mays Pit / Razorrock Materials Co.	Craighead	Jonesboro	Sand & gravel	0439-MN-A4
RazorRock Pit	Craighead	Jonesboro	Sand & gravel	0439-MN-A2
Gravel Pit / Baker Custom Loading and Hauling	Craighead	Jonesboro	Gravel	--
Gravel Pit / Crabtree and Son Mine	Craighead	Jonesboro	Gravel	0574-MN-A2
Parker Pit / Acme Brick Co.	Craighead	Jonesboro	Clay	0659-MN-A1
Sand Pit	Craighead	Jonesboro	Sand	--
2 Sand Pits	Woodruff	Augusta	Sand	--
Sand Pit	Woodruff	DeView	Sand	--

Table 2.7. ADEQ permitted mines in the Cache River watershed (ADEQ 2015a).

Permit No.	Facility Name	County	Nearest town	Material Mined
0572-MN-A3	Paul Tribble	Craighead	Bono	Sand & gravel
0661-MN-A1	Cooksey Gravel Pit	Craighead	Bono	Sand & gravel
0640-MN-A1	R&R Real Estate Investment Mine	Craighead	Jonesboro	Sand & gravel
0687-MN-A1	Thompson Mine	Craighead	Jonesboro	Sand
0731-MN	Darrel Sharp	Craighead	Jonesboro	Sand & gravel
0712-MN-A1	NEA Materials, Inc.	Craighead	Jonesboro	Sand & gravel
0735-MN	Haley Sand & Gravel, LLC	Craighead	Jonesboro	Sand & gravel
0761-MN	Lakeside Contractors, LLC	Craighead	Jonesboro	Sand & gravel
0002-MN-AG2-002	G. Robert Corp	Craighead	Jonesboro	Top soil
0721-MN	B&D Dirt, LLC	Woodruff	Augusta	Top soil
0722-MN	B&D Dirt, LLC	Woodruff	Augusta	Top soil

2.2.5 Commercial Fisheries

Aquaculture is not widespread in the Cache River watershed, but there are aquaculture operations in the watershed. In the 2010 Census of Agriculture, aquaculture sales were reported for all of the counties in the watershed except Craighead County (USDA NASS 2014).

2.2.6 Recreation

Hunting, particularly waterfowl hunting, is an important recreational activity throughout the Cache River watershed. In the upper Cache River watershed, hunting, fishing, camping, hiking, and wildlife watching opportunities are available in WMAs and State Parks on Crowley's Ridge. In the lower Cache River watershed, hunting, fishing, camping, canoeing, kayaking, hiking, and wildlife watching opportunities are available in WMAs and the Cache River National Wildlife Refuge (NWR).

2.2.7 Developed Areas

There are a number of smaller towns and cities in the Cache River watershed. In the upper Cache River watershed, there is 36,317 acres of developed land. Jonesboro, part of which is in the upper Cache River watershed, is the largest city in the watershed. There are 27,142 acres of developed land in the lower Cache River watershed. Brinkley is the largest city in the lower Cache River watershed.

2.2.8 Transportation

There are a number of US highways in the Cache River watershed. In the upper Cache River watershed, US Highways 62,412, and 63 cross the watershed east to west. US Highway 49 enters the upper Cache River watershed at Jonesboro and parallels Bayou DeView as it flows southwest. US Highway 49 follows Bayou DeView through the lower Cache River watershed to Brinkley. In the lower Cache River watershed, US Highways 64 and 70 cross the watershed east to west. Interstate 40 also crosses the lower Cache River watershed.

2.2.9 Political Boundaries and Jurisdictions

2.2.9.1 Federal Lands

The Cache River NWR is managed by the US Fish and Wildlife Service (USFWS). The refuge encompasses 67,500 acres along the Cache River and Bayou DeView. The current acquisition boundary for the refuge encompasses 185,574 acres. The USFWS is proposing to expand the acquisition boundary to encompass an additional 102,000 acres (USFWS 2012).

2.2.9.2 State Lands

Lands managed by state agencies include WMAs, Natural Areas, and State Parks. Table 2.8 provides a summary of state lands in the Cache River watershed. The two State Parks and two of the eight WMAs are in the upper Cache River watershed (Greene and Poinsett Counties). The remaining six WMAs and the two Natural Areas are located in the lower Cache River watershed (Woodruff and Monroe Counties).

Table 2.8. Summary of state owned lands in the Cache River watershed.

Area Designation	Managing Agency	Area, acres	County
Rex Hancock Black Swamp WMA	AGFC	5,967	Woodruff
Cache River Natural Area (within Rex Hancock Black Swamp WMA)	ANHC, AGFC	937	Woodruff
Cattail Marsh WMA	AGFC	78	Greene
Frierson WMA	AGFC		Greene
W.E. Brewer Scatter Creek WMA	AGFC	5,000	Greene
Earl Buss Bayou DeView WMA	AGFC	4,562	Poinsett
Benson Creek Natural Area WMA	AGFC, ANHC	610	Monroe
Sheffield Nelson Dagmar WMA	AGFC	10,137	Monroe
Crowley's Ridge State Park	Arkansas Department of Parks and Tourism (ADPT)	Approx 300	Greene
Lake Frierson State Park	ADPT	114	Greene

2.2.10 Relevant Authorities

Waters of the Cache River watershed are under the jurisdiction of federal and state agencies and regulations. Lands in the watershed are under the jurisdiction of state, county, and local agencies and regulations.

2.2.10.1 Federal Authorities

Federal policy recognizes that states have primary authority for regulation of water usage within their borders. Therefore, the federal laws, regulations, and associated programs that influence water resources management in the Cache River watershed primarily relate to water quality. Federal legislation and programs also deal with other aspects of management of water resources in the region such as conservation and protection of waterbodies, flood control, and navigation. Federal agencies with water resources responsibilities in the Cache River watershed are summarized in Table 2.9.

Table 2.9. Federal agencies with water resources-related responsibilities in the Cache River watershed.

Federal Agency	Responsibility in Arkansas

EPA	• Oversees state agencies in implementation of management and funding programs under
	  ○ Clean Water Act,
	  ○ Safe Drinking Water Act,
	  ○ RCRA,
	  ○ Superfund,
	  ○ Federal Insecticide, Fungicide, and Rodenticide Act, and
	  ○ Surface Mining Control and Reclamation Act
	• Conducts TMDL studies and other water quality studies in the state
	• Implements programs under the Toxic Substances Control Act

Federal Emergency Management Agency (FEMA)	Prepares flood hazard maps for the state and encourages State and local governments to guide development decisions away from defined flood hazard risk areas through participation in the National Flood Insurance Program
US Department of Housing and Urban Development (HUD)	Provides funding for water and wastewater infrastructure improvements
National Oceanic and Atmospheric Administration (NOAA)	Participates in monitoring precipitation and climate in the planning region

NRCS National Water Management Center	• Located in Little Rock
	• Serves as a water resources information exchange
	• Provides support and training related to
	  ○ environmental compliance,
	  ○ hydrology and hydraulics,
	  ○ stream geomorphology and restoration,
	  ○ water quality and quantity,
	  ○ watershed and dam rehabilitation, and
	  ○ technology outreach

Table 2.9. Federal agencies with water resources-related responsibilities in the Cache River watershed (continued).

Federal Agency	Responsibility in Arkansas
USACE	• Involved in flood control and ecosystem restoration projects in the planning region • Implements sections of the Clean Water Act related to impacts to navigable waters and wetlands • Constructs flood control, irrigation, and water supply projects authorized by the Water Resources Development Act • Water level monitoring
USDA	• Conducts the Census of Agriculture • Conducts the Natural Resources Inventory • Manages Conservation Effects Assessment Projects (watershed and regional)
USDA Farm Services Agency (FSA)	Implements the Conservation Reserve Program for erosion control and habitat restoration in the watershed
USDA Forest Service (USFS)	• Forest management incentive programs • Participates in forest inventory • Manages Urban and Community Forestry Program
NRCS	• Implements over 20 Farm Bill erosion control and habitat restoration funding and technical assistance programs • Appraises the status and trends of soil, water, and related resources on non-federal land in the state and assesses their capability to meet present and future demands
USDA Rural Development	• Implements USDA rural utilities financial assistance programs

USFWS	• Implements the Endangered Species Act and programs to
	  ○ Promote management of ecosystems,
	  ○ Promote conservation of migratory birds,
	  ○ Promote preservation of wildlife habitat,
	  ○ Promote restoration of fisheries,
	  ○ Combat invasive species, and
	  ○ Promote international wildlife conservation
	• Manages Cache River National Wildlife Refuge
	• Implements the Partners For Wildlife Program for restoration of bottomland hardwood forests
	• Conducts the National Wetland Inventory
	• Oversees state wildlife planning through the State Wildlife Grant Program

USGS	• Flow and stage monitoring of rivers and streams • Groundwater level monitoring • Water quality monitoring • Groundwater modeling • Water quality modeling • Water data storage and management

2.2.10.2 State Authorities

Arkansas has primary authority for regulation of water usage within the state. Many of the state laws and agency regulations related to water quality implement federal laws. The federal government has delegated authority to the state for a number of the regulatory administrative activities of both the Clean Water Act and the Safe Drinking Water Act. Of particular importance in the Cache River watershed are state water use and groundwater protection regulations and programs. State agencies with water resources responsibilities in the Cache River watershed are summarized in Table 2.10.

2.2.10.3 Federal-State Organizations

There are at least four federal-state organizations involved in water resources management in the Cache River watershed:

- Delta Regional Authority,
- Lower Mississippi River Conservation Committee,
- Lower Mississippi River Joint Venture, and
- Arkansas Conservation Partnership.

The Delta Regional Authority was established in 2000 to enhance economic development and improve quality of life in the Mississippi River delta region of eight states, including the Cache River watershed. These goals are accomplished through improvements to infrastructure, funded by grants from the Delta Regional Authority, to support job creation and retention. Infrastructure improvements include improvement of water supply and wastewater infrastructure. This organization is managed by a board made up the governors from each of the eight states and a federal representative appointed by the US President and confirmed by the US Senate (Delta Regional Authority 2013).

Table 2.10. State agencies with water resources responsibilities in the Cache River watershed.

State Agency	Responsibility
ADEQ	• Implements state water quality policy and the Clean Water Act National Pollutant Discharge Elimination System (NPDES) program • Develops and enforces water quality standards • Investigates citizen complaints regarding water pollution • Oversees solid waste management • Operates the hazardous waste management program • Manages contaminated site clean-up and redevelopment programs • Develops and enforces mining and mine site reclamation regulations • Manages the storage tank regulation program • Permits no-discharge facilities • Water quality monitoring and assessment
ANRC	• Regulates, permits, and tracks water use and dam construction • Monitors climate • Administers federal water resources funding programs • Prepares water resources and nonpoint source pollution management plans • Develops and maintains mitigation banking and restoration incentive programs for aquatic resources • Supports conservation districts • Promotes public health and safety and minimize flood losses through o training, o education, o technical assistance in floodplain management, and o accrediting floodplain administrators
Arkansas Department of Health (ADH)	• Regulates public water supply systems • Implements the Safe Drinking Water Act source water protection programs • Implements state health rules and regulations that apply to water resources • Regulates septic tanks and licenses septic tank cleaners • outdoor bathing and swimming
Arkansas Department of Parks and Tourism (ADPT)	• Manages the two state parks and associated water resources in the watershed • Prepares comprehensive outdoor recreation plan • Manages outdoor recreation grant program
Arkansas Forestry Commission	• Provides guidelines for protection of water resources in forestry operations • Monitors use of forestry BMPs • Participates in forest inventory • Implements forest management incentive programs • Implements Urban and Community Forestry program • Designates and manages state forests for a variety of purposes, including o watershed protection o erosion and flood control

Table 2.10. State agencies with water resources responsibilities in the Cache River watershed (continued).

State Agency	Responsibility

AGFC	• Manages protection, conservation and preservation of fish and wildlife in the planning region through
	  o habitat management,
	  o wildlife management areas,
	  o fish stocking,
	  o hunting and fishing regulations, and
	  o education and outreach programs
	• Prepares state Wildlife Action Plan
	• Implements conservation grant programs

Arkansas Geological Survey	• Participates in research of, and provides information and education about, state water resources • Mapping • Water well construction records
Arkansas Livestock and Poultry Commission	Regulates disposal of livestock carcasses
Arkansas Multi-agency Wetland Planning Team	Developed the State Wetland Strategy and is the lead for developing state numeric nutrient criteria for wetlands
ANHC	• Surveys and conducts research on natural communities in the state • Acquires natural areas for preservation
Arkansas Pollution Control and Ecology Commission	Environmental policy-making body for the state
Arkansas Public Service Commission	Regulates rates and services of private water utilities, as well as utilities water crossings
Arkansas State Board of Health	Promulgates health rules and regulations for the state
Arkansas State Highway and Transportation Department (AHTD)	• Hazardous waste transportation permits • Stormwater management • Develops and implements construction BMPs

Arkansas State Plant Board	Implements
	• Insecticide, Fungicide, and Rodenticide Act programs,
	  o pesticide registration
	  o user and applicator training
	  o dealer licensing
	• state pesticide management plan for groundwater protection,
	• groundwater quality monitoring, and
	• climate/weather monitoring

Arkansas Water Well Construction Commission	• Regulates development of groundwater through licensing water well contractors and registering drillers and pump installers • Regulates specifications for construction of wells • Maintains water well construction records
University of Arkansas (U of A) Cooperative Extension Service	Provides technical assistance to Arkansans related to water conservation, and protection and restoration of water quality
U of A Water Resources Center	Participates in research related to water resources, and in water resources management projects

The Lower Mississippi River Conservation Committee is a coalition of natural resources and environmental quality agencies from the six states that border the lower Mississippi River, supported by the US Fish and Wildlife Service. This committee provides a regional forum for conservation of the natural resources of the Mississippi River floodplain. The committee addresses long-term conservation and restoration planning and implementation, and nature-based economic development in the Mississippi River floodplain (Lower Mississippi River Conservation Committee 2013).

The Lower Mississippi River Joint Venture is a non-regulatory partnership of non-government, state, and federal conservation organizations focused on implementing the National Waterfowl Management Plan (see Section 5.3.1.5). The management board for this joint venture project includes wildlife agencies from eight states, Ducks Unlimited, TNC, The Conservation Fund, NRCS, USFWS, USGS, and USFS (Lower Mississippi River Joint Venture 2013).

The Arkansas Conservation Partnership supports locally-led natural resources conservation through coordination of education, financial, and technical assistance to landowners. Water resources and implementation of Farm Bill programs are two of the six natural resource issues that are the focus of the partnership. Members of the partnership include the NRCS, other federal agencies, ANRC, Arkansas Association of Conservation Districts (AACD), U of A Cooperative Extension, U of A at Pine Bluff, and Arkansas Forestry Commission. This partnership was formed in 1992 (ANRC 2012d, Cooperative Conservation America 2013a).

2.2.10.4 Regional and Local Entities

There are numerous regional and local entities in the Cache River watershed that are involved in activities related to water resources management. Examples of the types of local and regional entities present in this planning region are shown in Table 2.11, along with descriptions of their activities related to water resources management.

Table 2.11. Some of the regional and local government entities involved in water resources management in the Cache River watershed.

Regional or Local Entity	Water Resources Involvement
County Conservation Districts	Work with state and federal agencies to implements measures for the control of erosion and flooding, and conservation of soil and water resources
County Government	Responsible for unincorporated areas, sometimes including floodplain management and zoning
Drainage Districts	Usually created by circuit court order to plan, construct, and maintain a system to drain lands
Irrigation Districts	Created by circuit court order to distribute water resources
Levee Districts	Provide for the construction and maintenance of levees for flood protection
Regional Planning and Economic Development Districts	• Water supply and wastewater infrastructure improvements • Assist Regional Solid Waste Management Districts
Regional Solid Waste Management Districts	Manage collection, disposal, and recycling of solid waste
Universities	Water resources and management research, education, and outreach
Water districts and associations	Water supply planning and management

2.2.10.5 Nonprofit Organizations

There are several nonprofit organizations that have active programs within the Cache River watershed. These include TNC, Ducks Unlimited, the Cache River Non-profit Association, and the Lower Mississippi River Joint Venture.

TNC has designated the Big Woods in Arkansas as a priority area for their activities. The Big Woods includes the bottomland hardwoods that exist along the Cache River and Bayou DeView in the lower Cache River watershed. Activities in the Big Woods include reforestation, reconnecting creeks to their floodplains, purchasing bottomland hardwood wetlands, and assisting with enrolling bottomland hardwood wetlands in reserve programs, such as the NRCS Wetlands Reserve Program (TNC 2013a).

Ducks Unlimited has identified the Mississippi Alluvial Valley from Illinois and Missouri to the Gulf of Mexico as a Level 1 conservation priority area. They have identified this area as the most significant winter habitat area for mallards in North America. The Cache River watershed is part of this conservation priority area. Ducks Unlimited has participated in numerous wetland conservation and restoration projects on private lands and in WMAs within the Cache River watershed, as well as the Cache River NWR (Ducks Unlimited 2013).

The Cache River Non—profit Association includes the county judges for the nine counties of the Cache River watershed. Their purpose is to address water resources issues in the Cache River watershed. This organization led the 2013 project to remove part of the Cache River blockages near Grubbs (USACE 2015a).

The Lower Mississippi Valley Joint Venture has developed a Conservation Delivery Network for the Arkansas Delta region. This network has been used to provide support for projects in the lower Cache River watershed (Lower Mississippi Valley Joint Venture 2014). Projects of the Lower Mississippi Valley Joint Venture implement the North American Waterfowl Management Plan (USACE 2015a).

2.3 Demographic Characteristics

The general socioeconomic condition of the Cache River watershed can be characterized as follows; 1) strongly agriculture oriented, 2) low relative per capita incomes, 3) relatively high rates of unemployment, and 4) relatively low, sparsely distributed, and stable or decreasing population (USFWS 2012). Demographic information from the US Census Bureau for the counties within the Cache River watershed is presented below.

2.3.1 Population

Population information for the counties in the Cache River watershed is presented in Tables 2.12 and 2.13. Numbers of people are presented in Table 2.12. For the most part, the Cache River is predominantly rural. However, the upper Cache River watershed includes a portion of the Jonesboro Metropolitan Statistical Area in Craighead County. The presence of this Metropolitan Statistical Area explains the higher urban population in Craighead County. The Paragould Micropolitan Statistical Area is located in Greene County, outside of the Cache River watershed. The presence of this Micropolitan Statistical Area explains the higher urban population in Greene County. Monroe and Woodruff Counties, in the lower Cache River watershed, have the lowest populations (US Census Bureau 2012).

Table 2.12. Numbers of people in the counties of the Cache River watershed.

County	2000 (a)		2010 (a)		2014 population estimate (a)	2020 projection (b)
	Total population	Percent urban (c)	Total Population	Percent urban(d)		
Clay	18,107	37.7%	16,083	41.1%	15,118	13,919 – 15,048
Craighead	68,956	61.3%	96,443	67.8%	102,518	108,228 – 117,477
Cross	19,225	41.8%	17,870	43.2%	17,227	15,883 – 17,624
Greene	31,804	50.7%	42,090	58.5%	43,694	42,108 – 46,074
Jackson	18,944	42.0%	17,997	34.9%	17,534	15,662 – 18,435
Lawrence	17,774	36.6	17,415	36.4	16,931	16,268 – 17,783
Monroe	11,333	36.1%	8,149	31.0%	7,582	6,217 – 7,058
Poinsett	24,664	37.4%	24,583	28.9%	24,246	22,203 – 24,489
Woodruff	9,520	27.0%	7,260	0%	6,910	6,057 – 6,816

(a) (US Census Bureau 2014)
(b) (UALR Institute for Economic Advancement 2013)
(c) (US Census Bureau 2003)
(d) (US Census Bureau 2012)

In most of the counties, population is declining (Table 2.11). Population has increased in Craighead and Greene Counties, most likely as a result of population increases in the urban areas in those counties. Population projections for Clay, Monroe, and Woodruff Counties anticipate continued population decline. The population projection for Craighead County anticipates continued population increase. For the remainder of the counties, it is not clear whether population will increase or decrease in the future.

Additional demographic information for the counties in the Cache River watershed are listed in Table 2.13. This includes numbers for commuting, household structure, age, gender, race, median income, poverty, workers, and education. The majority of commuters in both the upper and lower Cache River watershed counties drive alone.

The majority of households consist of two-parent families, although percentages are slightly higher in the counties of the upper Cache River watershed than in the counties of the lower Cache River watershed. Percentages of single-parent households are also slightly higher in the counties of the lower Cache River watershed. In all counties, the majority of single-parent households are headed by women.

The average median age in the counties of the upper Cache River watershed is 38.8 years. The average median age in the counties of the lower Cache River watershed is 41.95 years. Percentages of people 65 and older in the counties of the Cache River watershed are less than the percentages of people under 18 years old. Percentages of males and females are fairly similar.

The majority of people in the counties of the Cache River watershed consider themselves white. The percentages of Hispanics are lower than the percentage for the state overall. There are higher percentages of people who classify themselves as black in the counties of the lower Cache River watershed.

Median household incomes in the majority of the counties of the Cache River watershed are less than the state-wide median household income. The median household income in Craighead County (where Jonesboro is located) is higher that the state-wide value. Overall, the counties of the lower Cache River watershed tend to have lower median household incomes than the counties of the upper Cache River watershed.

Unemployment rates in the counties of the Cache River watershed are higher than the state-wide unemployment rate. Overall, the counties of the lower Cache River watershed tend to have slightly higher unemployment rates than the counties of the upper Cache River watershed.

In the counties of the Cache River watershed, higher percentages of jobs are in the management/business/science/arts, sales and office, and production/transportation/materials moving categories. Percentages of self-employed workers are higher than the state-wide percentage, in all of the counties.

In most of the counties of the Cache River watershed, the percentage of people 25 and older who graduated from high school is greater than the state-wide percentage. However, percentages of people with college degrees are lower that the state-wide percentage in all of the counties except Craighead County, where Jonesboro is located.

Table 2.13 Additional demographic information for the Cache River watershed.

	Upper Cache River Watershed				Lower Cache River Watershed				
	Clay County	Craighead County	Greene County	Lawrence County	Jackson County	Monroe County	Poinsett County	Woodruff County	Arkansas
Commuting (b)									
Total Persons Commuting	6,149	42,653	17,135	6,224	5,606	2,743	9,081	2,637	-
Drove alone	81.1%	84.4%	86.6%	79.4%	83.6%	79.0%	81.7%	86.7%	82.2%
Carpooled	12.8%	8.4%	8.3%	11.2%	10.9%	14.2%	13.0%	10.4%	11.1%
Walk or other	3.8%	2.8%	2.2%	3.5%	3.5%	4.0%	2.5%	2.4%	1.8%
Mean travel time (minutes)	22.8	17.5	20.4	25.1	19.1	19.5	23.5	19.3	21.3
Worked at home	2.4%	4.3%	2.8%	6.0%	2.0%	2.9%	3.0%	0.6%	3.2%
Household structure (a)									
Family households	66.3%	66.7%	71.1%	68.6%	65.8%	63.7%	69.7%	63.8%	67.6%
Two parent families	51.3%	48.2%	53.6%	53.3%	46.1%	42.3%	48.8%	43.2%	49.5%
Single parent families	15.1%	18.1%	17.6%	15.3%	19.8%	21.3%	20.9%	20.6%	18.1%
Single person household	29.6%	26.5%	24.2%	27.7%	30.1%	32.8%	26.6%	32.7%	27.1%
Persons in Group Quarters	0.8%	3.7%	1.4%	3.4%	11.1%	1.0%	1.4%	1.5%	5.3%
Age (number of persons) (a)									
Median age	43.2	33.2	37.9	40.9	40.5	44.2	39.8	43.3	37.4
65 and older	20.0%	12.2%	14.3%	18.1%	15.9%	18.9%	15.9%	17.8%	14.4%
Under 18	22.3%	25.0%	25.2%	22.9%	20.7%	22.6%	24.2%	23.0%	24.4%
Gender (number of persons) (a)									
Female	51.1%	51.2%	51.0%	51.4%	50.4%	52.2%	51.4%	52.5%	50.9%
Male	48.9%	48.8%	49.0%	48.6%	49.6%	47.8%	48.6%	47.5%	49.1%
Race (number of persons) (a)									
White non-hispanic	96.9%	79.6%	95.4%	96.7%	78.8%	55.8%	89.0%	69.4%	74.5%
Hispanic	1.3%	4.4%	2.1%	0.9%	2.4%	1.6%	2.2%	1.2%	6.4%
Black non-hispanic	0.3%	13.0%	0.6%	0.8%	16.6%	40.7%	7.2%	27.4%	15.3%
Native American	0.3%	0.4%	0.5%	0.4%	0.5%	0.4%	0.2%	0.2%	0.7%
Asian	0.1%	1.1%	0.3%	0.1%	0.3%	0.4%	0.2%	0.2%	1.2%
Other race	0.5%	2.4%	0.9%	0.2%	1.2%	0.9%	1.1%	0.8%	0.1%
>1 race non-hispanic	1.1%	1.4%	1.1%	1.1%	1.3%	1.0%	1.1%	1.4%	1.6%

Table 2.13 Additional demographic information for the Cache River watershed (continued).

	Upper Cache River Watershed				Lower Cache River Watershed				
	Clay County	Craighead County	Greene County	Lawrence County	Jackson County	Monroe County	Poinsett County	Woodruff County	Arkansas
Income (b)									
Median household income	$31,502	$41,393	$38,413	$32,239	$30,284	$27,263	$32,089	$28,259	$40,768
Families below poverty level	15.2%	16.0%	12.3%	19.3%	22.8%	21.9%	22.7%	20.6%	14.4%
People below poverty level	20.2%	20.6%	17.1%	25.4%	28.4%	28.8%	28.1%	24.3%	19.2%
Employment (b)									
Unemployed	12.5%	9.1%	9.2%	9.5%	11.6%	14.3%	12.8%	10.8%	8.9%
Mgt, business, science, arts	23.7%	33.7%	27.9%	25.2%	23.7%	23.6%	23.1%	29.9%	31.2%
Service	16.5%	16.9%	13.2%	21.4%	18.5%	17.4%	18.4%	18.4%	17.2%
Sales, office	20.9%	23.0%	22.6%	20.9%	22.9%	23.1%	23.1%	18.0%	24.1%
Resources, construction, maintenance	15.4%	10.0%	12.1%	13.0%	13.8%	15.0%	16.0%	18.1%	10.9%
Production, transportation, material moving	23.4%	16.4%	24.1%	19.5%	21.2%	20.9%	19.4%	15.6%	16.6%
Self-employed	8.3%	7.1%	7.9%	10.1%	5.9%	10.1%	8.5%	6.2%	6.4%
Education (population 25 or older) (b)									
High School graduate	43.6%	33.6%	42.8%	77.4%	45.1%	36.8%	42.1%	44.7%	35.1%
Bachelor degree	6.6%	15.8%	9.6%	6.7%	6.1%	8.9%	6.3%	8.0%	13..3%
Graduate degree	3.0%	8.6%	5.1%	3.7%	2.7%	2.4%	2.2%	2.1%	6.8%

(a) (US Census Bureau 2012)

(b) (US Census Bureau 2015)

2.3.2 Economics

2.3.2.1 Upper Cache River Watershed

Agriculture is the largest economic contributor in the upper Cache River watershed. The values of sales of selected agricultural commodities for each of the counties in the upper Cache River watershed are shown in Table 2.14. Dry peas account for the majority of the sales in all of the counties.

Table 2.14. Value of sales in $1,000 of selected agricultural commodities for counties in the upper Cache River watershed (USDA NASS 2014).

Commodity	Clay County	Greene County	Lawrence	Craighead County	Jackson County	Total
All ag products	$246,172	$177,326	$149,140	$261,600	$186,837	$1,021,075
Crops	$242,740	$167,165	$126,179	$258,784	$183,721	$978,589
Dry peas	$211,492	$158,115	$117,994	$195,508	$179,650	$862,759
Soybeans	$75,903	$37,941	$35,790	$77,203	$72,230	$299,067
Rice	$85,657	$82,556	$71,582	$74,841	$83,288	$397,924
Wheat	$2,626	$2,585	$2,246	$3,018	$7,477	$17,952
Corn	$46,343	$33,034	$7,089	$38,688	$15,196	$140,350
Cotton	$30,160	$7,296	$0	$62,010	D*	$99,466

* Data withheld to avoid disclosure of data for individual farms.

Other important economic contributors include light manufacturing (primarily near Jonesboro), and lumber production (in Clay County) (Association of Arkansas Counties 2015a). The value of sales and receipts reported for the counties within the upper Cache River watershed in the 2012 economic census is summarized in Table 2.15 Agriculture and timber are not economic sectors reported in the economic census. However, they contribute value to manufacturing, real estate, wholesale trade, and transportation and warehousing economic sectors (U of A Divison of Agriculture 2012).

Table 2.15. Value of sales and receipts in $1,000 for counties in the upper Cache River watershed (US Census Bureau 2015).

Economic Sector	Clay County	Craighead County	Jackson County	Greene County	Lawrence County	Total
Manufacturing	D*	$2,101,745	$424,960	$1,840,727	$73,224	$4,440,656
Wholesale Trade	$192,920	$1,430,142	$106,857	$1,067,653	$159,148	$2,956,720
Retail Trade	$179,437	$1,680,884	$177,720	$503,474	$196,284	$2,737,799
Transportation & Warehousing	$12,748	$155,778	$14,972	$11,146	$10,751	$205,395
Real Estate	D*	$79,219	$3,193	$8,076	$3,045	$93,533
Accommodation & Food Service	D*	D*	$14,919	$49,084	$9,212	$73,215
Total	$385,105	$5,447,768	$742,621	$3,480,160	$451,664	$10,507,318

* Data withheld to avoid disclosure of data for individual businesses.

In Craighead and Greene Counties, manufacturing accounts for around half of the value of sales and receipts. Bricks, chemicals, clothing and shoes, concrete products, dairy products, feed and fertilizer, electric motors, furniture, lumber, wood products and food products are manufactured in Craighead County (Association of Arkansas Counties 2015b). Wholesale trade and retail trade account for significant portions of the values of sales and receipts in all of the counties.

Tourism is the second largest industry in Arkansas. Tourism economic impacts for 2014 are summarized by county in Table 2.16.

Table 2.16. Preliminary 2014 tourism economic impacts for counties in the upper Cache River watershed (ADPT 2015).

	Clay County	Craighead County	Greene County	Jackson County	Lawrence County
Travel expenditures	$17,163,843	$106,094,190	$27,214,985	$16,163,250	$16,214,972
Travel-generated payroll	$2,643,500	$20,115,633	$4,935,082	$2,556,069	$2,432,513
Travel-generated employment	137 jobs	1,155 jobs	281 jobs	141 jobs	133 jobs
Travel-generated local tax	$423,021	$1,732,354	$ 576,833	$ 291,907	$361,770

2.3.2.2 Lower Cache River Watershed

Agriculture is one of the largest economic contributors in the lower Cache River watershed. Part of the lower Cache River watershed is in the major rice-growing area of the state (Association of Arkansas Counties 2015a). The values of sales of selected agricultural commodities for each of the counties in the lower Cache River watershed are shown in Table 2.17. Dry peas account for the majority of the sales in all of the counties.

Table 2.17. Value of sales in $1,000 of selected agricultural commodities for counties in the lower Cache River watershed (USDA NASS 2014).

Commodity	Cross County	Jackson County	Monroe County	Poinsett County	Woodruff County	Total
All ag products	$188,778	$186,837	$845,102	$287,420	$167,588	$1,675,725
Crops	$188,405	$183,721	D*	$286,746	D*	$658,872+
Dry peas	$174,256	$179,650	$185,997	$256,769	$159,993	$956,665
Soybeans	$86,340	$72,230	$71,183	$113,767	$67,389	$410,909
Rice	$65,913	$83,288	$57,497	$108,382	$58,833	$373,913
Wheat	$7,194	$7,477	$10,858	$6,836	$6,973	$39,338
Corn	$10,815	$15,196	$42,522	$24,563	$23,201	$116,297

* Data withheld to avoid disclosure of data for individual farms.

Light industry and small manufacturing facilities are located within the lower Cache River watershed. This includes aluminum, wood products, and food processing. The value of sales and receipts reported for the counties within the lower Cache River watershed in the 2012 economic census is summarized in Table 2.18. Agriculture is not reported in the economic census as an economic sector. However, it contributes value to manufacturing, real estate, wholesale trade, and transportation and warehousing economic sectors (U of A Divison of Agriculture 2012).

Table 2.18. Value of sales and receipts in $1,000 for counties in the lower Cache River watershed (US Census Bureau 2015).

Economic Sector	Cross County	Jackson County	Monroe County	Poinsett County	Woodruff County	Total
Manufacturing	$238,845	$424,960	$48,478	$223,965	D*	$936,248+
Wholesale Trade	$265,744	$106,857	$126,222	$424,629	$118,087	$1,041,539
Retail Trade	$180,768	$177,720	$90,632	$177,995	$74,228	$701,343
Transportation & Warehousing	$29,486	$14,972	$9,593	$20,158	$25,291	$99,500
Real Estate	$9,476	$3,193	$811	$4,027	$762	$18,269
Accommodation & Food Service	$14,269	$14,919	$9,894	D*	D*	$39,082+
Total	$738,588	$742,621	$285,630	$850,774+	$218,368+	$2,835,981+

* Data withheld to avoid disclosure of data for individual businesses.

Tourism is the second largest industry in Arkansas. Tourism economic impacts for 2014 are summarized by county in Table 2.19. Much of the tourism in these counties is based on usage of WMAs, State Parks, and Cache River NWR (Association of Arkansas Counties 2015a). Hunting and other wildlife-dependent recreation is second only to agriculture in its economic impact on the rural economies of eastern Arkansas (National Wildlife Refuge Association 2014, Association of Arkansas Counties 2015a). The Cache River NWR brings in approximately 150,000 visitors annually, and the value of land surrounding the refuge has more than doubled (USFWS 2010).

Table 2.19. Preliminary 2014 tourism economic impacts for counties in the lower Cache River watershed (ADPT 2015).

	Cross County	Jackson County	Monroe County	Poinsett County	Woodruff County
Travel expenditures	$15,032,034	$16,163,250	$35,145,746	$15,751,207	$7,108,271
Travel-generated payroll	$2,570,541	$2,556,069	$6,191,441	$1,699,131	$942,810
Travel-generated employment	141 jobs	141 jobs	334 jobs	90 jobs	51 jobs
Travel-generated local tax	$284,127	$ 291,907	$635,714	$283,136	$193,367

3.0 WATERSHED CONDITION

3.1 Water Quality Standards

3.1.1 Designated Uses

Designated uses of the streams in the Cache River watershed are primary contact recreation (streams with watersheds of >10 square miles), secondary contact recreation, Domestic, Industrial and Agricultural Water Supply, Perennial Delta aquatic life support (streams with watersheds of >10 square miles and discharge ≥ 1 cubic foot per second [cfs]), and Seasonal Delta aquatic life support (streams with watersheds <10square miles). Designated uses of lakes and reservoirs in the Cache River watershed are primary contact recreation; secondary contact recreation; domestic, industrial and agricultural water supply; and aquatic life support. There are no use variations granted in the watershed (Arkansas Pollution Control and Ecology Commission 2014).

Arkansas water quality regulations designate Cache River and Bayou DeView as Channel-altered Delta Ecoregion Streams, and a stretch of the Cache River in Woodruff County that runs between two areas of the Rex Hancock Black Swamp WMA as Extraordinary Resource Waters (Arkansas Pollution Control and Ecology Commission 2014).

3.1.2 Numeric and Narrative Criteria

Numeric water quality criteria for selected parameters are listed in Table 3.1. Numeric water quality criteria for toxic substances and other metals can be found in Regulation 2 of the Arkansas Pollution Control and Ecology Commission (Arkansas Pollution Control and Ecology Commission 2014). In addition to numeric water quality criteria, state narrative criteria have been developed for the following: nuisance species; color; taste and odor; solids, floating material, and deposits; toxic substances; oil and grease; temperature; turbidity; and nutrients. Site specific numeric water quality criteria for nutrients have not yet been developed for the Cache River watershed.

Table 3.1. Numeric water quality criteria for the Cache River watershed.

Parameter	Conditions			Criteria
Temperature	Least-altered Delta streams			30 deg C
	Channel-altered Delta streams (Cache River & Bayou DeView)			32 deg C
	Lakes and reservoirs			32 deg C
Turbidity	Base flow	Least-altered Delta streams		45 NTU
		Channel-altered Delta streams		75 NTU
		Lakes and reservoirs		25 NTU
	All flows	Least-altered Delta streams		84 NTU
		Channel-altered delta streams		250 NTU
		Lakes and reservoirs		45 NTU
Dissolved Oxygen (DO)	Primary season			5 mg/L
	Critical season	< 10 sq mi		2 mg/L
		10 – 100 sq mi		3 mg/L
		> 100 sq mi		5 mg/L
pH	--			6.0 – 9.0 su
Escherichia coli (E. coli)	Primary Contact	Extraordinary Resource Waters, lakes, reservoirs	Individual sample	298 col/100mL
			Geometric mean	126 col/100mL
		All other waters	Individual sample	410 col/100mL
	Secondary Contact	Extraordinary Resource Waters, lakes, reservoirs	Individual sample	1490 col/100mL
			Geometric mean	630 col/100mL
		All other waters	Individual sample	2050 col/100mL
Fecal coliform	Primary Contact	All waters	Individual sample	400 col/100mL
			Geometric mean	200 col/100mL
	Secondary Contact	All waters	Individual sample	2000 col/100mL
			Geometric mean	1000 col/100mL
Chloride	Cache River, Lost Creek Ditch			20 mg/L
	Unnamed tributary to Big Creek			71 mg/L
	Big Creek from Whistle Ditch to unnamed tributary			58 mg/L
	Bayou DeView from mouth to Whistle Ditch			48 mg/L
Sulfate	Cache River, Lost Creek Ditch			30 mg/L
	Unnamed tributary to Big Creek			60 mg/L
	Big Creek from Whistle Ditch to unnamed tributary			49 mg/L
	Bayou DeView from AR Hwy 14 to Whistle Ditch			38 mg/L
	Bayou DeView from mouth to AR Hwy 14			37.3 mg/L
Total Dissolved Solids (TDS)	Cache River, Lost Creek Ditch			270 mg/L
	Unnamed tributary to Big Creek			453 mg/L
	Bayou DeView from mouth to Whistle Ditch			411.3 mg/L
Lead	Acute			$e^{[1.273(lnhardness)]-1.460}$ * {1.46203 - [(ln hardness)(0.145712)]}
	Chronic			e[$^{1.273(lnhardness)]-4.705}$ * {1.46203 - [(ln hardness)(0.145712)]}
Copper	Acute			0.960* $e^{[0..9422(lnhardness)]-1.464}$
	Chronic			0.960* $e^{[0.8545(lnhardness)]-1.465}$

Turbidity criteria that apply in the Cache River watershed are listed in Table 3.1. Separate turbidity criteria are specified for base flow conditions. The base flow criteria should not be exceeded in more that 20% of samples collected June to October. The all flow criteria should not be exceeded in more than 25% of all samples collected over an entire year (Arkansas Pollution Control and Ecology Commission 2014).

Bacteria water quality criteria that apply in the Cache River watershed are summarized in Table 3.1. These criteria are considered to be met if less than 25% of no less than 8 samples collected during each season are below the criteria.

3.1.3 Antidegradation Policy

The antidegredation policy of the Arkansas water quality standards is summarized below:

- Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
- Water quality that exceeds standards shall be maintained and protected unless allowing lower water quality is necessary to accommodate important economic or social development, although water quality must still be adequate to fully protect existing uses.
- For outstanding state or national resource waters, those uses and water quality for which the outstanding waterbody was designated shall be protected.
- For potential water quality impairments associated with a thermal discharge, the antidegradation policy and implementing method shall be consistent with Section 316 of the Clean Water Act.

3.2 Available Resource Monitoring Data

This section describes available data for water quality, flow, groundwater level, and biological parameters in the Cache River watershed.

3.2.1 Surface Water Quality

This section describes and discusses available surface water quality data in the Cache River watershed. This includes water quality monitoring and modeling, surface water impairments, and water quality characteristics.

3.2.1.1 Monitoring in Upper Cache River Watershed

Over the last 10 years, surface water quality data have been collected in the Arkansas portion of the upper Cache River watershed by ADEQ, TNC, and Arkansas State University (ASU). ADEQ monitors surface water quality in the upper Cache River watershed through several programs. There are three ADEQ ambient water quality monitoring network sites in the watershed (on Bayou DeView headwaters) that are sampled monthly for chemical analysis. There are also two roving water quality monitoring network sites in the watershed, on the Cache River. All roving sites across the state are divided into four regional groups. Each group of roving sites is sampled for chemical and bacterial analysis on a rotating basis, bimonthly over a 2-year period, every 6 years (ADEQ 2014a). Roving network sites in the upper Cache River watershed were last sampled in 2012 – 2013.

Through its nonpoint source management program, ANRC has overseen several projects that included collection of surface water quality samples in the upper Cache River watershed; two conducted by TNC (ANRC project numbers 01-610, 06-400), and one by the ASU Ecotoxicology Research Facility (ANRC project number 13-500). TNC collected water quality samples from 14 sites in the upper Cache River watershed in 2004 and 2005 as part of an intensive water quality assessment of the Cache River watershed (TNC 2005). In March 2006, TNC collected total suspended solid (TSS) samples during a storm to characterize spatial distribution of sediment loading in the Cache River watershed (TNC 2006). As part of a project to prioritize subbasins of the Cache River watershed with regard to sediment load, TNC collected TSS measurements from fall 2007 to spring 2009 in five tributaries of the Cache River (two in the upper Cache River watershed) and two tributaries of Bayou DeView (TNC 2009). Although some of the data collected by TNC is over 10 years old, it is included in this summary as a record of historic water quality in the upper Cache River watershed.

ASU began collecting water quality data at a number of sites in the middle and upper Cache River watershed in 2013. This data being collected by ASU is to document water quality before, during, and after implementation of Best Management Practices (BMPs) through the NRCS Mississippi River Basin Initiative (MRBI) (A. Brown, ANRC, personal communication March 2015).

The locations where surface water quality monitoring has occurred in the upper Cache River watershed within the last 10 years are shown on Figure 3.1. The periods of record for water quality data from these monitoring sites are summarized in Table 3.2. A detailed water quality data inventory that includes older water quality data is available in Appendix B.

Table 3.2. Periods of record for active and recent surface water quality monitoring stations in the upper Cache River watershed.

Station ID	Monitoring Agency/ Organization	Waterbody	Date of first sample	Date of most recent sample	Program/ Project number
WHI0196	ADEQ	Big Creek Ditch	7/8/2008	1/6/2015	Ambient
WHI0172	ADEQ	Lost Creek Ditch	8/27/2002	1/6/2015	Ambient
WHI0026	ADEQ	Bayou DeView	9/11/1990	1/6/2015	Ambient
UWCHR04	ADEQ	Cache River	6/13/1994	3/4/2013	Roving
UWCHR03	ADEQ	Cache River	6/13/1994	3/4/2013	Roving
[14 stations]	TNC	Cache River & Bayou DeView	4/27/2004	6/6/2005	01-610 intensive
[31 stations]	TNC	Cache River & Bayou DeView and tributaries	3/20/2006	3/21/2006	01-610 storm
Swan Pond Ditch	TNC	Swan Pond Ditch	10/5/2007	3/3/2009	06-400
Willow Ditch	TNC	Willow Ditch	9/28/2007	3/3/2009	06-400
[17 stations]	ASU	Primarily tributaries of Cache River and Bayou DeView	8/6/2013	1/14/2014	13-500
Lake Frierson	FTN Associates	Lake Frierson	9/11/2006	10/5/2006	TMDL
Lake Frierson	USGS	Lake Frierson	8/24/2004	6/8/2005	Study

3.2.1.2 Monitoring in the Lower Cache River Watershed

Over the last 10 years, surface water quality data have been collected in the lower Cache River watershed by ADEQ, EPA, USGS, TNC, and ASU. ADEQ monitors surface water quality in the lower Cache River watershed through several programs. There are four ADEQ roving water quality monitoring network sites in the watershed. All roving sites across the state are divided into four regional groups. Each region is sampled for chemical and bacterial analysis every 6 years on a rotating basis. During each rotation, roving sites are sampled bi-monthly over a 2-year period . Roving stations in the lower Cache River watershed were last sampled in 2012 – 2013(ADEQ 2014a).

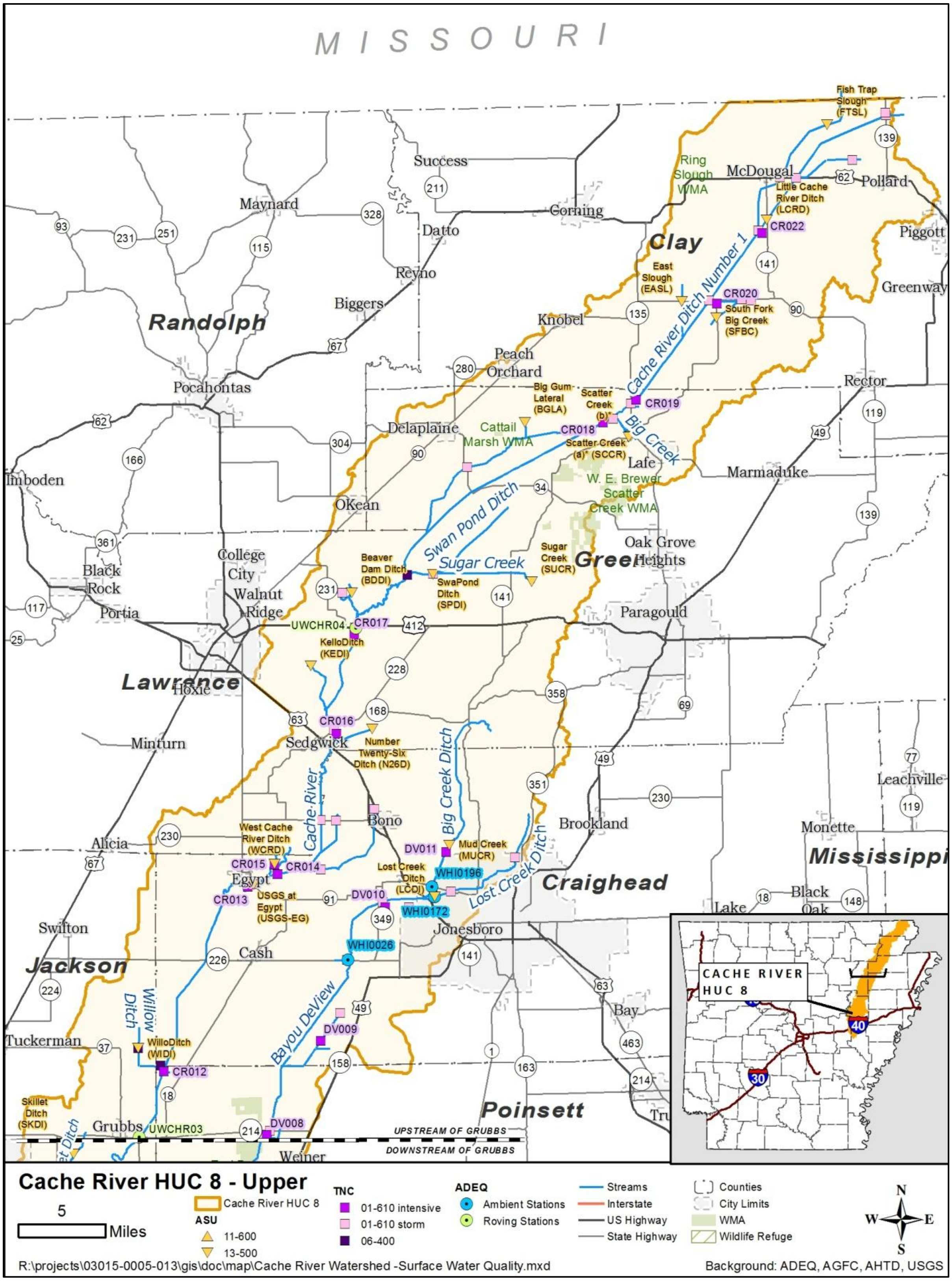


Figure 3.1. Active and recent surface water quality monitoring locations in the upper Cache River watershed.

There are two active USGS water quality monitoring stations in the lower Cache River watershed. These stations are at the same locations as two of the ADEQ water quality stations (UWCHR02 and UWBDV02). Since 2008, the USGS has collected water samples at these stations quarterly. Prior to 2008, samples were collected bi-monthly or monthly (USGS 2015b). These sites are included in the USGS National Water Quality Assessment Program Mississippi Embayment Study Unit. The USGS conducted an intensive study of water quality in this study unit during the period from 1995 through 1998 (Kleiss, et al. 2000).

Through its nonpoint source management program, ANRC has overseen several projects that included collection of surface water quality samples in the lower Cache River watershed; two conducted by TNC (ANRC Project Numbers 01-610 and 06-400), and two by the ASU Ecotoxicology Research Facility (ANRC project numbers 13-500 and 11-6000). TNC collected water quality samples from 14 sites in the lower Cache River watershed in 2004 and 2005 as part of an intensive water quality assessment of the Cache River watershed (TNC 2005). In March 2006, TNC collected TSS samples during a storm to characterize spatial distribution of sediment loading in the Cache River watershed (TNC 2006). As part of a project to prioritize subbasins of the Cache River watershed with regard to sediment load, TNC collected TSS measurements from fall 2007 to spring 2009 in five tributaries of the Cache River (three in the lower Cache River watershed) and two tributaries of Bayou DeView in the lower Cache River watershed (TNC 2009). Although some of the data collected by TNC is over 10 years old, it is included in this summary as a record of historic water quality in the lower Cache River watershed.

TNC also collected water quality data from seven sites on the Cache River downstream of Bayou DeView associated with the lower Cache River Restoration Project (T. Wentz, ADEQ personal communication December 1, 2015).

ASU has conducted two water quality sampling projects in the lower Cache River watershed to document water quality before, during, and after implementation of BMPs through the NRCS MRBI. ASU collected water quality samples from six locations on Bayou DeView and one location on the Cache River from 2011 through 2014. As part of a separate project, ASU began collecting water quality data at a number of locations in the middle Cache River watershed in 2013 (A. Brown, ANRC, personal communication March 2015).

In 2006, EPA began a program to conduct probability-based surveys of the condition of the nation's water resources. Water quality sampling was conducted at a site on Bayou DeView in Poinsett County as part of the survey (EPA 2013a).

The locations where surface water quality monitoring has occurred in the lower Cache River watershed within the last 10 years are shown on Figure 3.2. The periods of record for water quality data from active monitoring sites are listed in Table 3.3. A detailed water quality data inventory that includes older water quality data is available in Appendix B.

Table 3.3. Periods of record for active and recent surface water quality monitoring stations in the lower Cache River watershed (ADEQ 2015b, EPA 2015a, USGS 2015b).

Station ID	Monitoring Agency/ Organization	Waterbody	Date of first sample	Date of most recent sample	Program/ Project
WHI0033	ADEQ	Bayou DeView	6/7/1994	6/20/2012	Roving
UWBDV02	ADEQ	Bayou DeView	6/13/1994	3/5/2013	Roving
WHI0032	ADEQ	Cache River	6/7/1994	6/20/2012	Roving
UWCHR02	ADEQ	Cache River	6/13/1994	3/5/2013	Roving
7077700	USGS	Bayou DeView	1/16/1951	11/6/2014	Routine
7077500	USGS	Cache River	1/16/1951	11/5/2014	Routine
[7 stations]	ASU	Cache River and Bayou DeView and tributaries	8/2/2011	8/2/2014	11-6000
[6 stations]	ASU	Cache River and Bayou DeView and tributaries	8/6/2013	1/14/2014	13-500
[18 stations]	TNC	Cache River and Bayou DeView	4/27/2004	6/6/2005	01-610 intensive
[13 stations]	TNC	Cache River and Bayou DeView tributaries	3/20/2006	3/21/2006	01-610 storm
[7 stations]	TNC	Cache River	2011	2014	Special study
[5 stations]	TNC	Selected tributaries	7/16/2007	3/31/2009	06-400
NLA06608-0208	EPA	Bayou DeView	9/6/2007	9/6/2007	National Aquatic Resources Survey

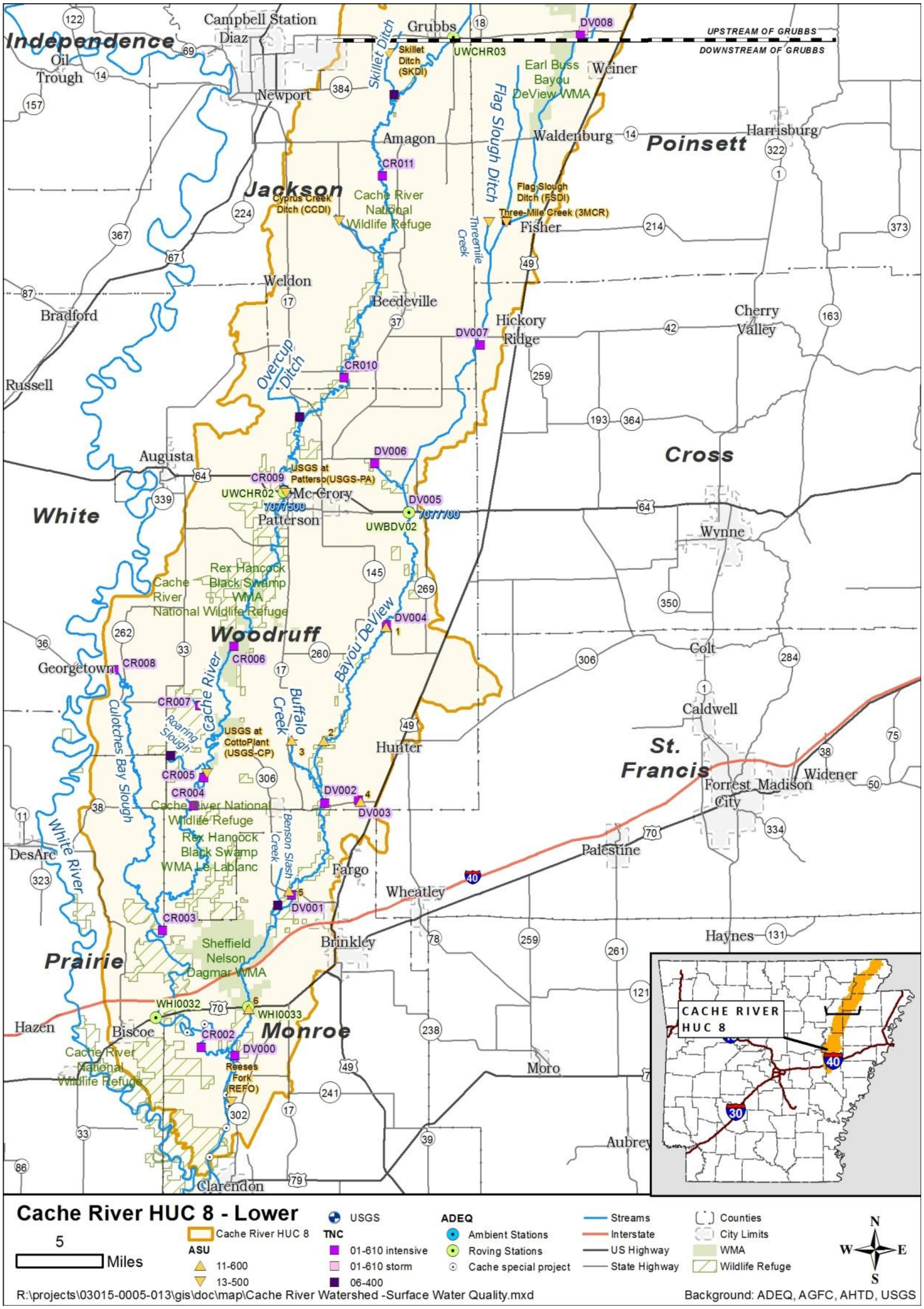


Figure 3.2. Active and recent surface water quality monitoring locations in the lower Cache River watershed.

3.2.1.3 Impaired Uses and Water Quality Threats

3.2.1.3.1. Pollutants of Concern

Stakeholders attending the Cache Watershed Water Quality Forum identified sedimentation as the highest priority surface water quality issue in the entire Cache River watershed (U of A Cooperative Extension Service 2015). In their 2005 report, TNC identified sediment and nitrogen as the surface water pollutants of concern in the Cache River watershed (TNC 2005). The USFWS has identified oil and gas extraction as a potential threat to the Cache River NWR in the lower Cache River watershed (USFWS 2012).

3.2.1.3.2. Impaired Surface Waters in the Upper Cache River Watershed

The last EPA approved state impaired waters list (i.e., 303(d) list) for Arkansas was from 2008. Impaired waters in the upper Cache River watershed from the 2008 list are given in Table 3.4 and shown on Figure 3.3. On the 2008 303(d) list, 115.9 miles of streams in the upper Cache River watershed were classified as impaired (ADEQ 2008).

Table 3.4. Impaired waters of the upper Cache River watershed, 2008 303(d) list.

Stream name	Segment(s)	Impaired use	Pollutant(s)	Pollutant source	Category	Stream miles
Bayou DeView	007*	Aquatic life	Lead	Agriculture	5d[a]	18.2
Bayou DeView	009	Agriculture & Industry water supply	TDS, Chloride	Agriculture	5a[b]	20.3
			Aluminum	Municipal point source		
Cache River	027*, 028, 029*, 031*, 032*	Aquatic life	Siltation/ turbidity	Agriculture	4a[c]	28.5
		Agriculture & Industry water supply	TDS	Agriculture	5d[a]	
Cache River	020, 021*, 027*, 028, 029*, 031*, 032*	Aquatic life	Lead	Agriculture	5d[a]	69.5
Cache River	028	Primary contact	Pathogens	Unknown	5d[a]	5.9
Lake Frierson	NA	Aquatic life	Siltation/ turbidity	Unknown	4a[c]	NA
			Copper	Unknown	5a[b]	
Lost Creek Ditch	909	Aquatic life, drinking water	Beryllium	Unknown	5d[a]	7.9
		Agriculture & Industry water supply, drinking water	Chloride	Industrial point source		

[*] Evaluated impairment, no water quality monitoring station on this stream segment
[a] additional data needed to confirm impairment prior to Total Maximum Daily Load (TMDL) study; [b] impaired, TMDL required; [c] impaired, TMDL complete

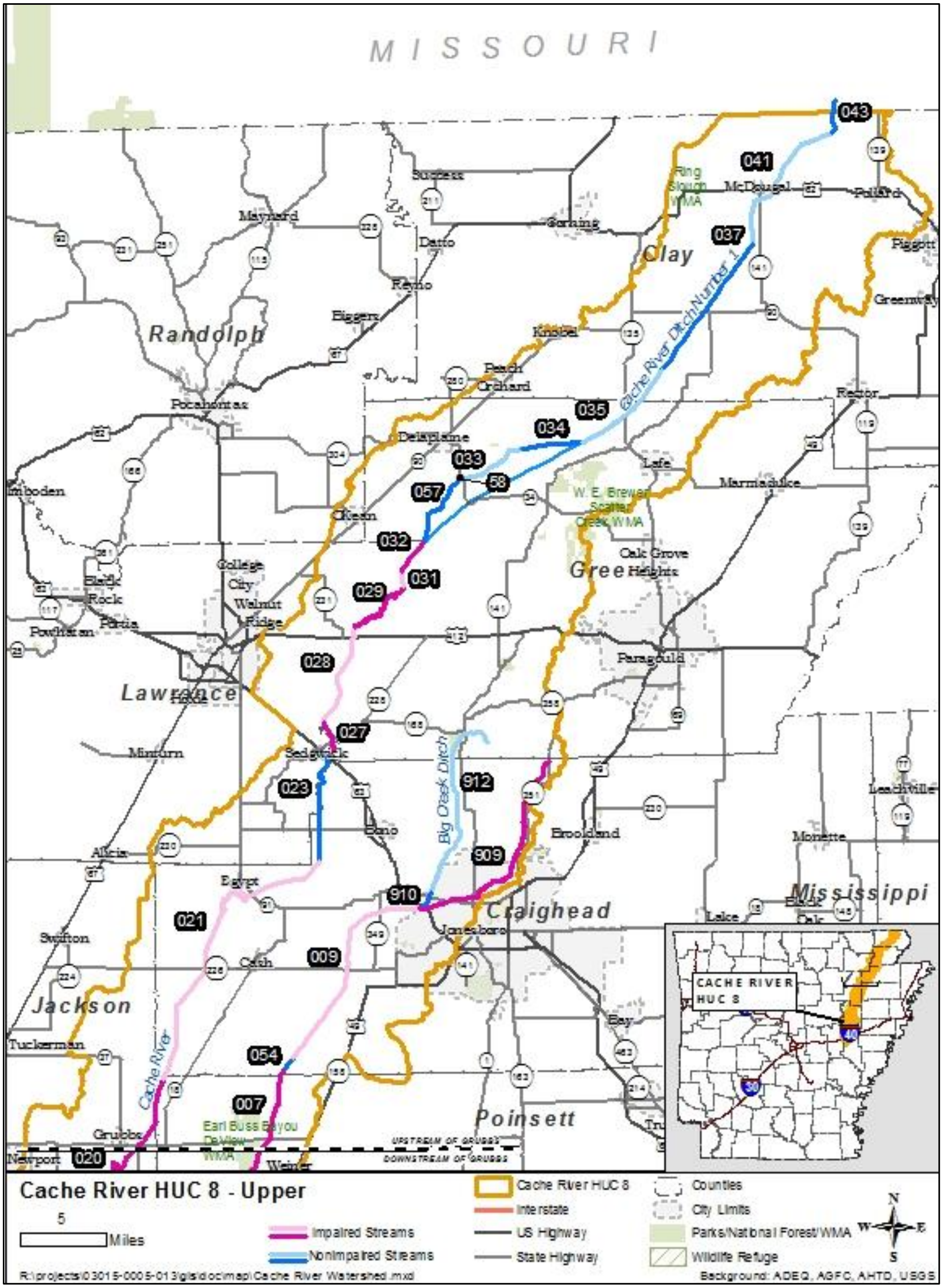


Figure 3.3. Impaired waters of the upper Cache River watershed from the 2008 303(d) list.

The most recent state biennial assessment of water quality was conducted in 2014. Waterbodies in the upper Cache River watershed included on the draft 2014 impaired waters list resulting from that assessment are given in Table 3.5. A total of 128.9 miles of streams in the upper Cache River watershed were classified as impaired in 2014 (ADEQ 2014b).

Table 3.5. Impaired waters of the upper Cache River watershed, draft 2014 303(d) list (ADEQ 2014a,b).

Stream name	Segment(s)	Impaired use	Pollutant(s)	Pollutant source	Category	Stream miles
Bayou DeView	007*	Fishery	Sulfate	Agriculture	5[a]	18.2
Bayou DeView	006*, 007*	Fishery	Turbidity	Surface erosion	4a[b]	28.4
			Lead	Agriculture	5	
Bayou DeView	009	Fishery	Copper	Industrial point source	5[a]	20.3
			Turbidity	Muncipal point source	4a[b]	38.5
Big Creek Ditch	910	Fishery	Copper	Unknown	5[a]	13.0
Cache River	027*, 028, 029*, 031*	Fishery	Sulfate	Agriculture	5[a]	17.1
			Turbidity	Agriculture	4a[b]	
Cache River	020,021*	Fishery	Turbidity	Surface erosion	4a[b]	41.0
			Lead	Agriculture	5[a]	
Cache River Ditch	032*	Fishery	Sulfate	Agriculture	5[a]	11.4
			Turbidity	Agriculture	4a[b]	
Lake Frierson	NA[+]	Fishery	Copper	unknown	5[a]	NA[+]
			Siltation/turbidity	Unknown	4a[b]	
Lost Creek Ditch	909	Fishery	DO, Chloride, Copper	Municipal point source, industrial point source	5[a]	7.9
			DO, Copper	Unknown	5[a]	

[a] impaired
[b] impaired, TMDL complete
[*] evaluated impairment, no water quality monitoring station on stream segment
[+] not applicable

There have been several changes to the impaired waterbodies list since 2008. The beryllium impairment on the 2008 list was removed in 2010, as a result of a change in the beryllium water quality criterion. The aluminum and pathogen impairments on the 2008 list were also removed in 2010, but no information on the reason is available. Since ADEQ named municipal point source as the source of aluminum, this impairment was dealt with through the NPDES program. All of the TDS impairments and most of the lead impairments on the 2008 list were removed in 2014 because new data showed the TDS and lead water quality standards were being met (ADEQ 2014c).

3.2.1.3.3. Impaired Surface Waters in the Lower Cache River Watershed

The last EPA approved state impaired waters list (i.e., 303(d) list) for Arkansas is from 2008. Impaired waters in the lower Cache River watershed from the 2008 list are given in Table 3.6 and mapped on Figure 3.4. A total of 157.1 miles of streams in the lower Cache River watershed were classified as impaired on the 2008 303(d) list (ADEQ 2008).

Table 3.6. Impaired waters of the lower Cache River watershed, 2008 303(d) list.

Stream Name	Segment(s)	Impaired Use	Pollutant(s)	Pollutant Source	Category	Stream Miles
Cache River	016, 017*, 018, 019*, 020	Aquatic life	Lead	Agriculture	5d+	98.9
Bayou DeView	004, 005*, 006*, 007*	Aquatic life	Lead	Agriculture	5d+	58.2

* Evaluated impairment, no water quality monitoring station on stream segment

\+ Additional data needed to confirm impairment prior to TMDL

The most recent state biennial assessment of water quality was conducted in 2014 (ADEQ 2014a). Waterbodies in the lower Cache River watershed included on the draft 2014 impaired waters list resulting from that assessment are given in Table 3.7. A total of 175.6 miles of streams in the lower Cache River watershed were classified as impaired in 2014 (ADEQ 2014b). Note that in draft 2014 impaired waters list, ADEQ is proposing to remove the 2008 lead impairment from Bayou DeView segments 004 through 007, as new data indicates lead concentrations are below the water quality criterion (ADEQ 2014c).

Table 3.7. Impaired waters of the lower Cache River watershed, draft 2014 303(d) list (ADEQ 2014a,b).

Stream name	Segment(s)	Impaired Use	Pollutant(s)	Pollutant Source	Category	Stream Miles
Cache River	016, 017*, 018, 019*, 020	Fishery	Lead	Agriculture	5[a]	98.9
			Turbidity	Surface erosion	4a[b]	
Bayou DeView	002	Not given	DO	Agriculture	5[a]	13.7
Cache River	016	Fishery	DO	Agriculture	5[a]	21.8
Caney Creek	903	Not given	DO	Agriculture	5[a]	16.8
Bayou DeView	004	Fishery	DO	Agriculture	5[a]	21.2
Buffalo Creek	014	Not given	DO	Agriculture	5[a]	13.1
Unnamed Trib to Turkey Creek	915	Not given	DO	Agriculture	5[a]	2.3
Bayou DeView	004, 005*, 006*, 007*	Not given	Turbidity	Surface erosion	4a[b]	58.2
		Fishery	Sulfate	Agriculture	5[a]	

[a] Impaired
[b] impaired, TMDL complete
* evaluated impairment, no water quality monitoring station on stream segment

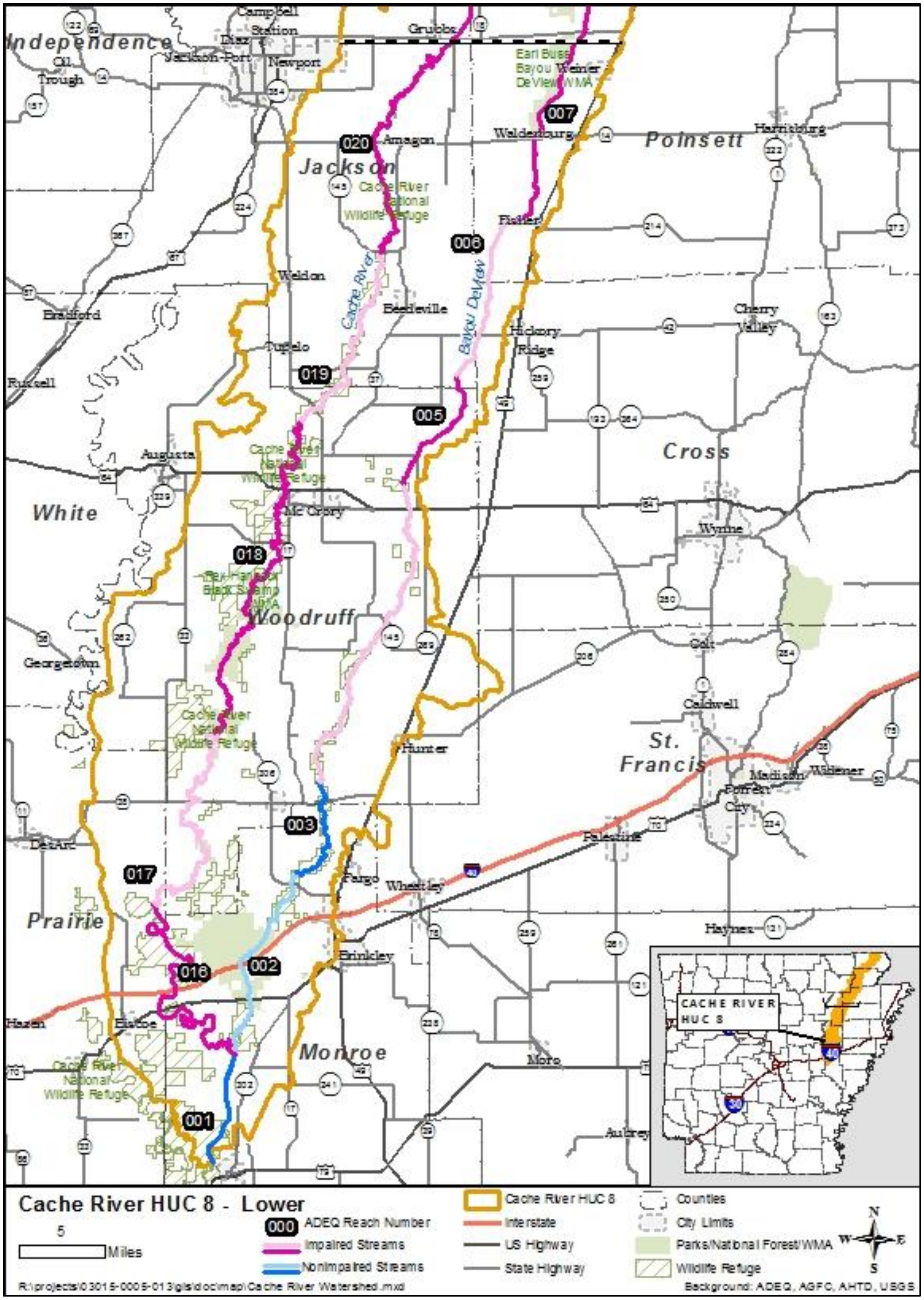


Figure 3.4. Impaired waters of the lower Cache River watershed from the 2008 303(d) list.

3.2.1.4 Sediment Water Quality

All stakeholders identify sediment as a priority pollutant in the Cache River watershed. TSS and turbidity are typically monitored as indicators of sediment water quality issues. Only the USGS measured suspended sediment concentrations in the Cache River watershed. The analytical method used to measure suspended sediment concentration is different from the method used to measure TSS. As a result, TSS and suspended sediment concentration are not interchangeable (Gray et al. 2000). All monitoring and studies of the Cache River watershed have addressed TSS and/or turbidity. It is well documented and accepted that erosion and sediment are issues of concern in the watershed.

This section evaluates sediment water quality data in two ways. First, recent data, from 2010 through 2014, from monitoring sites throughout the upper and lower Cache River watersheds are examined, to identify spatial differences in water quality. Second, entire periods of record of sediment water quality data collected at locations in the Cache River watershed with data records longer than 15 years are examined for evidence of water quality trends over time. Finally, data gaps are discussed.

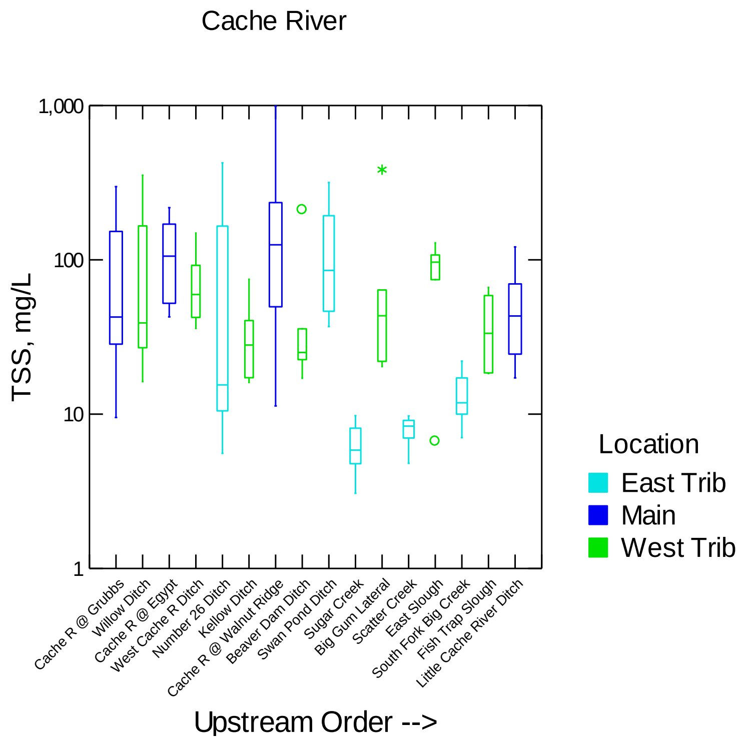
3.2.1.4.1. TSS and Turbidity Around the Upper Cache River Watershed

TSS and turbidity data have been collected by ADEQ, ASU, and TNC at 18 locations in the upper Cache River watershed within the time period from 2010 through 2014 (Figure 3.1). Summary plots of these data by location are shown on Figures 3.5 and 3.6. Data collected by different entities at the same location are combined. In both the Cache River and Bayou DeView, TSS concentrations and turbidity appear to be higher at downstream stations than at upstream stations. None of the tributaries to either the Cache River, or Bayou DeView, stand out as having particularly high TSS concentrations or turbidity. Therefore, this data gives no evidence of a specific location in the upper Cache River watershed that contributes more TSS or turbidity than any other.

However, the eastern tributaries to the Cache River upstream of Swan Pond Ditch have significantly lower TSS concentrations than the Cache River and the other Cache River tributaries. This may be because these tributaries have smaller watersheds that are primarily forested. One of the TNC sediment studies in the watershed found a strong relationship between watershed size and estimated TSS loads during a storm event (TNC 2009). Bayou DeView and its tributaries within the upper Cache River watershed also tend to have lower TSS concentrations than the Cache River and most of its tributaries, and have smaller watersheds that are primarily forested. Similar relationships are evident in the turbidity values, however, the differences among the streams do not appear as pronounced. Statistical comparisons (i.e., analysis of variance) of TSS concentrations and turbidity measurements from the Cache River and its tributaries to those from Bayou DeView and its tributaries show that the difference in TSS concentrations and turbidity measurements from the two streams is statistically significant. This suggests that there are areas in the upper Cache River watershed that contribute less TSS and turbidity to the system.

3.2.1.4.2. TSS and Turbidity Around the Lower Cache River Watershed

TSS and turbidity data have been collected by ADEQ, ASU, and TNC at 32 locations in the lower Cache River watershed within the time period from 2010 through 2014 (see Figure 3.2). The USGS has collected suspended sediment data at two locations in the lower Cache River watershed within the same time period. Summary plots of these data by location are shown on Figures 3.7 and 3.8. Data from the TNC special study of the lower Cache River is not yet publicly available, so it is not included in the graphs. Note that data collected by different entities at the same location have been combined.



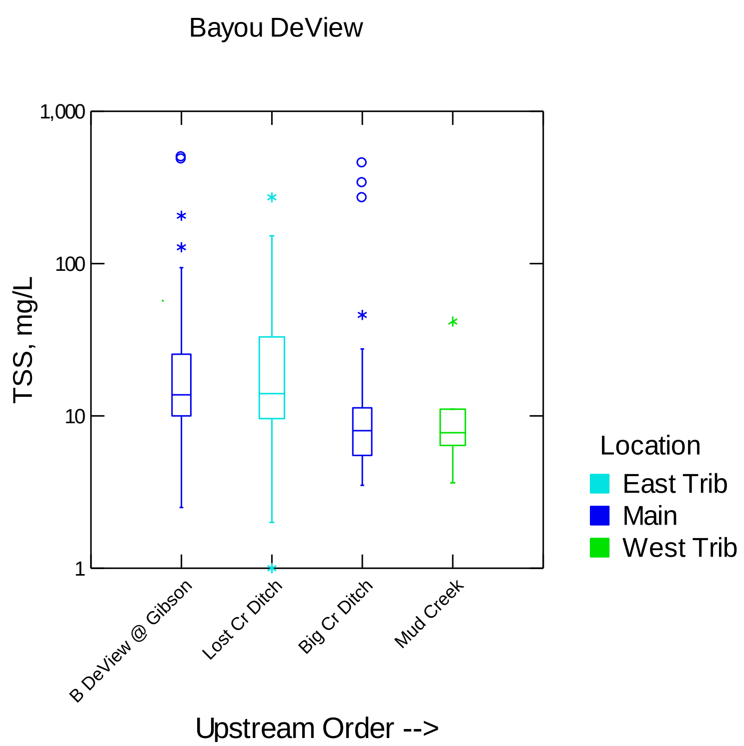
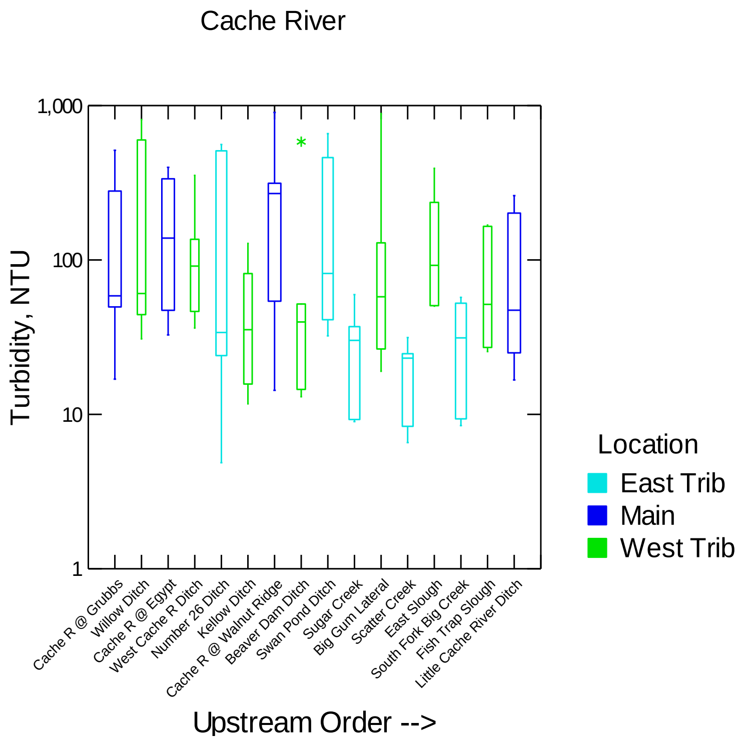


Figure 3.5. Recent TSS data collected from 2010 through 2014 in the upper Cache River watershed.



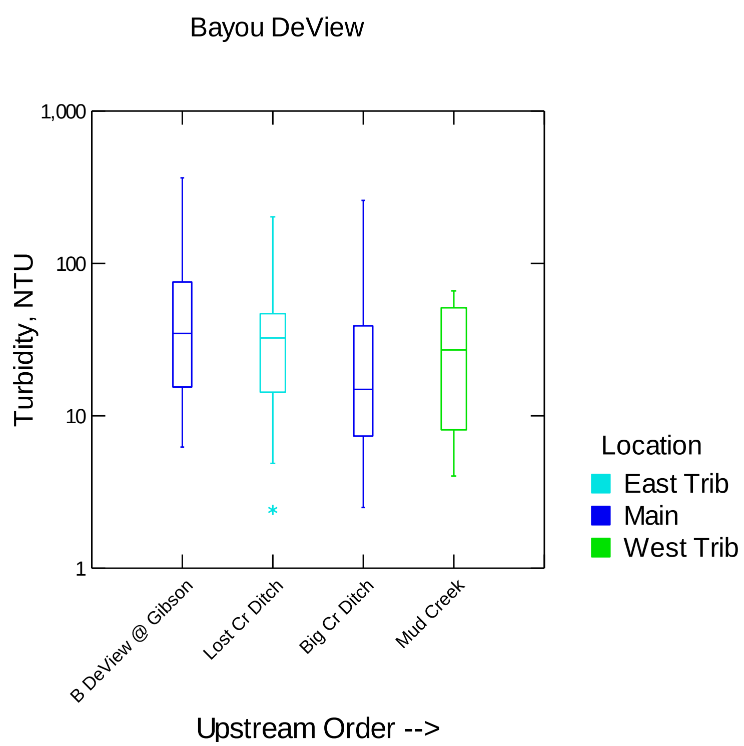


Figure 3.6. Turbidity data collected from 2010 through 2014 in the upper Cache River watershed.

TSS measurements collected in the lower Cache River watershed from 2010 through 2014 are summarized on Figure 3.7. It is apparent that TSS concentrations are higher in Bayou DeView and its monitored tributaries upstream of Highway 260, than in the rest of Bayou DeView and its monitored tributaries. Analysis of variance of these data indicates that the mean TSS concentrations at Three-mile Creek and Bayou DeView at Highway 64 are statistically significantly higher than the mean TSS concentrations at other monitoring locations in the lower Cache River watershed.

Overall, TSS measurements from the lower Cache River and its tributaries are relatively similar, regardless of location. Analysis of variance indicates a statistically significant difference between the mean TSS values in the Cache River at Patterson and the Cache River near Brasfield. However, mean TSS values at both of these locations are not statistically different from the mean TSS values at the Cache River near Cotton Plant, nor the tributaries.

Analysis of variance indicates that the mean of the TSS measurements from all of the Bayou DeView and its tributary stations in the lower Cache River watershed is statistically significantly lower than the mean of the TSS measurement from all of the Cache River and its tributary stations. Overall, the highest mean TSS concentrations were measured, in descending order, at Three-mile Creek, Cache River at Patterson, and Bayou DeView at Highway 64. Based on analysis of variance, the mean TSS values at these three locations were statistically significantly greater than the mean TSS values at the majority of the other locations in the lower Cache River watershed.

T urbidity measurements collected in the lower Cache River watershed from 2010 through 2014 are summarized in Figure 3.8. Turbidity levels measured at the upstream tributaries (Three-mile Creek and Flag Slough) and Bayou DeView monitoring location (at Highway 64) were the highest in the Bayou DeView system. The highest mean and median turbidity levels were from Three-mile Creek. The lowest mean and median turbidity levels in the Bayou DeView system were from Buffalo Creek.

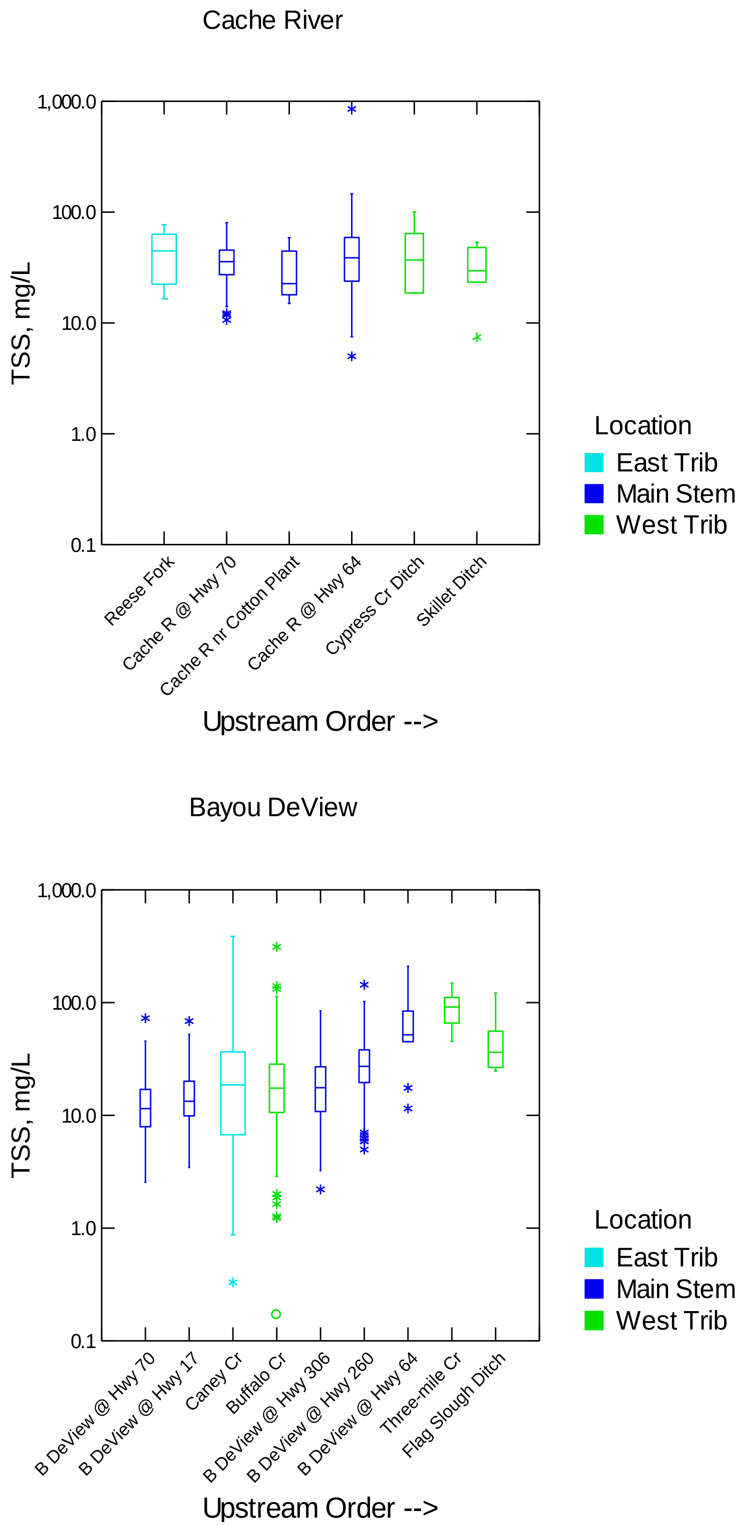


Figure 3.7. TSS measurements from the lower Cache River watershed from 2010 through 2014.

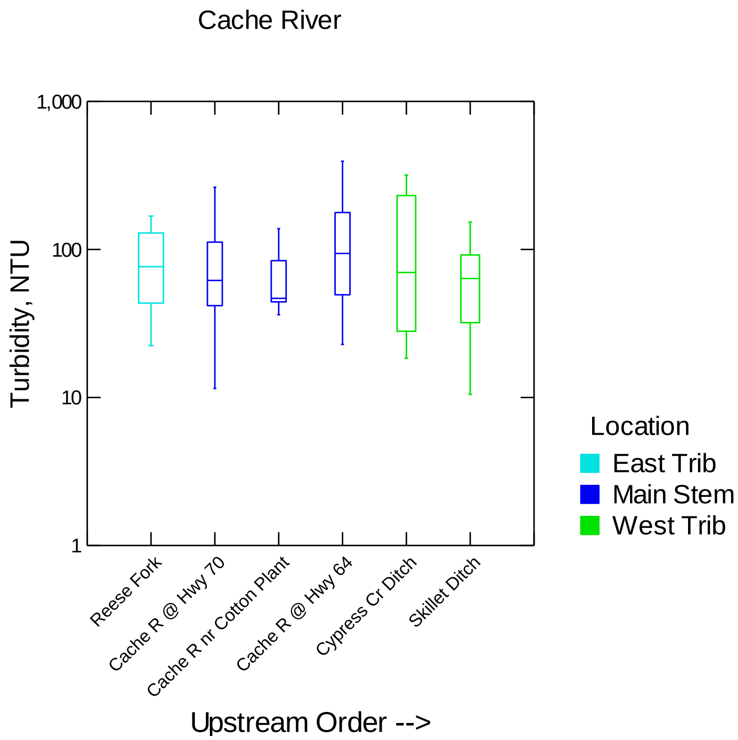
In the Cache River system, the highest mean and median turbidity levels were from the Cache River at Patterson, in the upper watershed. Turbidity levels were lower at locations in the lower Cache River system. Analysis of variance indicates that the mean turbidity level in the Cache River at Patterson is statistically significantly higher than the mean turbidity level in the Cache River near Brasfield (the downstream-most station).

Analysis of variance indicates that the mean turbidity level from all of the Bayou DeView and its tributary stations is statistically significantly lower than the mean turbidity level from all of the Cache River and its tributary stations. However, the highest mean turbidity level in the entire lower Cache River watershed is from Three-mile Creek, a tributary of Bayou DeView. On the other hand, the lowest mean turbidity levels in the entire lower Cache River watershed are from Bayou DeView and its tributary Buffalo Creek.

Suspended sediment concentrations measured by the USGS in the lower Cache River watershed from 2010 through 2014 are summarized in Figure 3.9. While mean and median suspended sediment concentrations at the Cache River station are higher than at the Bayou DeView station, they are not statistically significantly different.

3.2.1.4.1. Sediment Water Quality Over Time in the Upper Cache River Watershed

Most of the water quality stations in the upper Cache River watershed do not have a lot of data, or a long record. For the most part, there is not enough TSS data from the upper Cache River tributaries to determine if there have been changes over time. Many of these stations do not have multiple years of turbidity data. Figures 3.10 and 3.11 show graphs of TSS and turbidity measurements from the six water quality monitoring stations in the upper Cache River watershed with multiple years of data (TSS data are not available from one of these stations). Data from ADEQ, USGS, ASU, and TNC are included on these graphs. Data collected by different entities at the same location have been combined. TSS and turbidity records from the Bayou DeView station and those on the Cache River have the longest data records.



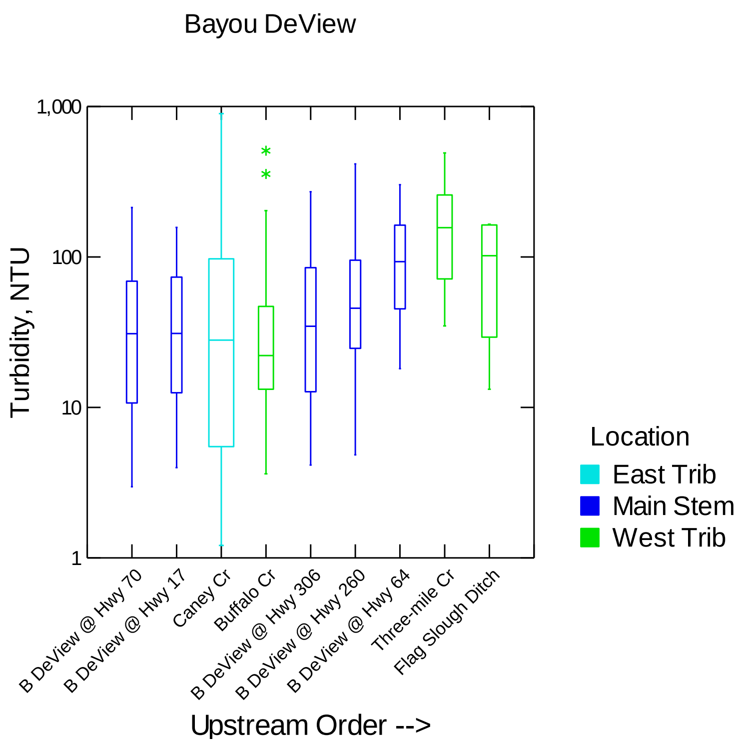


Figure 3.8. Turbidity measurements from the lower Cache River watershed from 2010 through 2014.

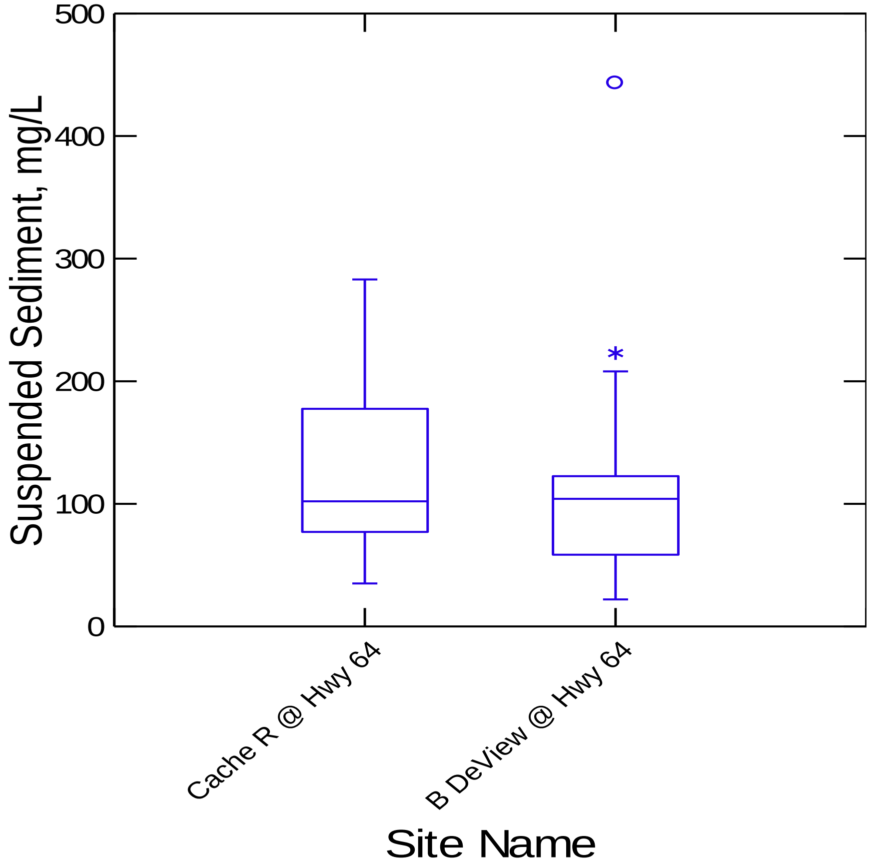


Figure 3.9. Suspended sediment measurements from the lower Cache River watershed from 2010 through 2014.

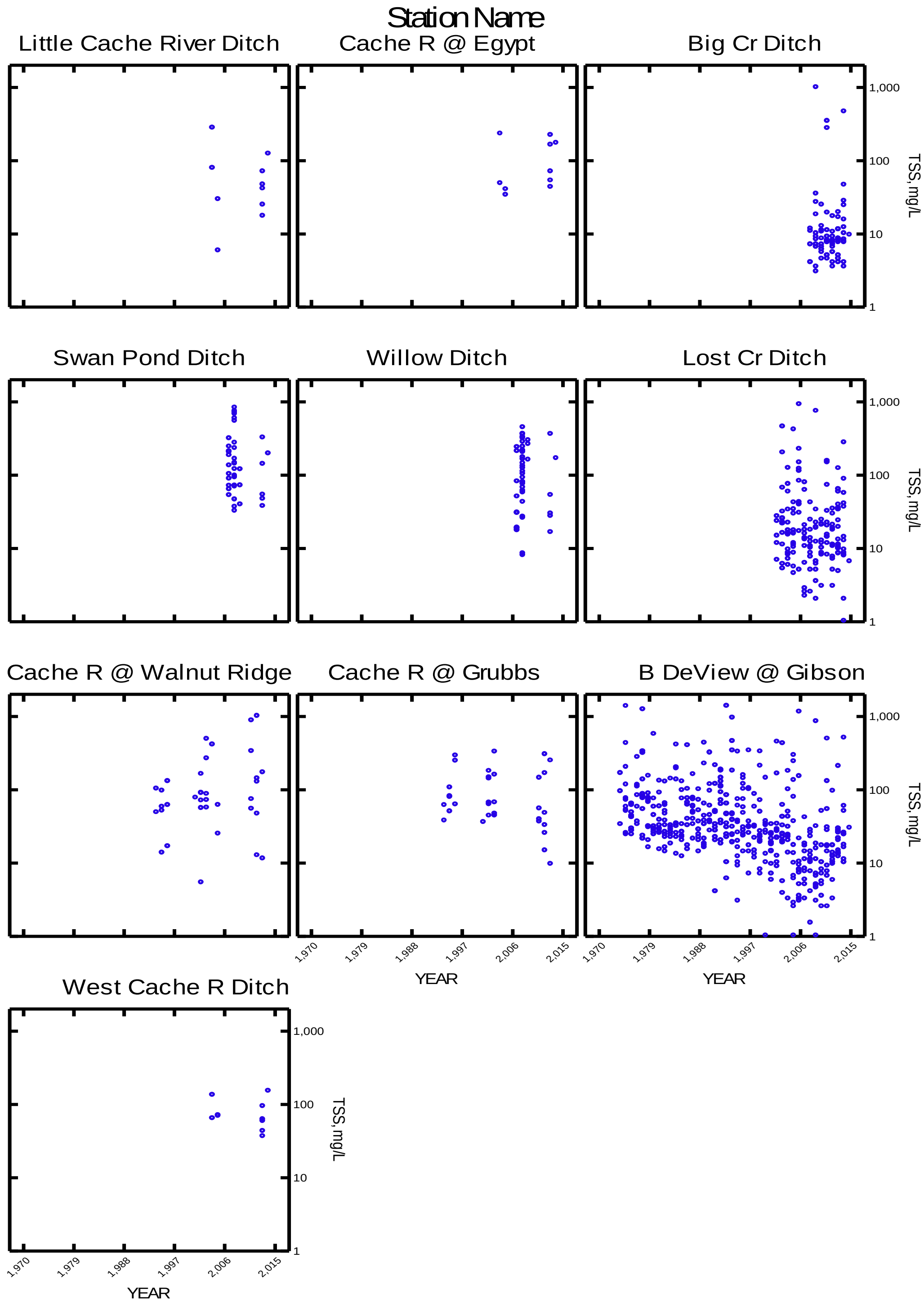


Figure 3.10. TSS time series for upper Cache River water quality stations (ADEQ 2015a, EPA 2015a, USGS 2015a).

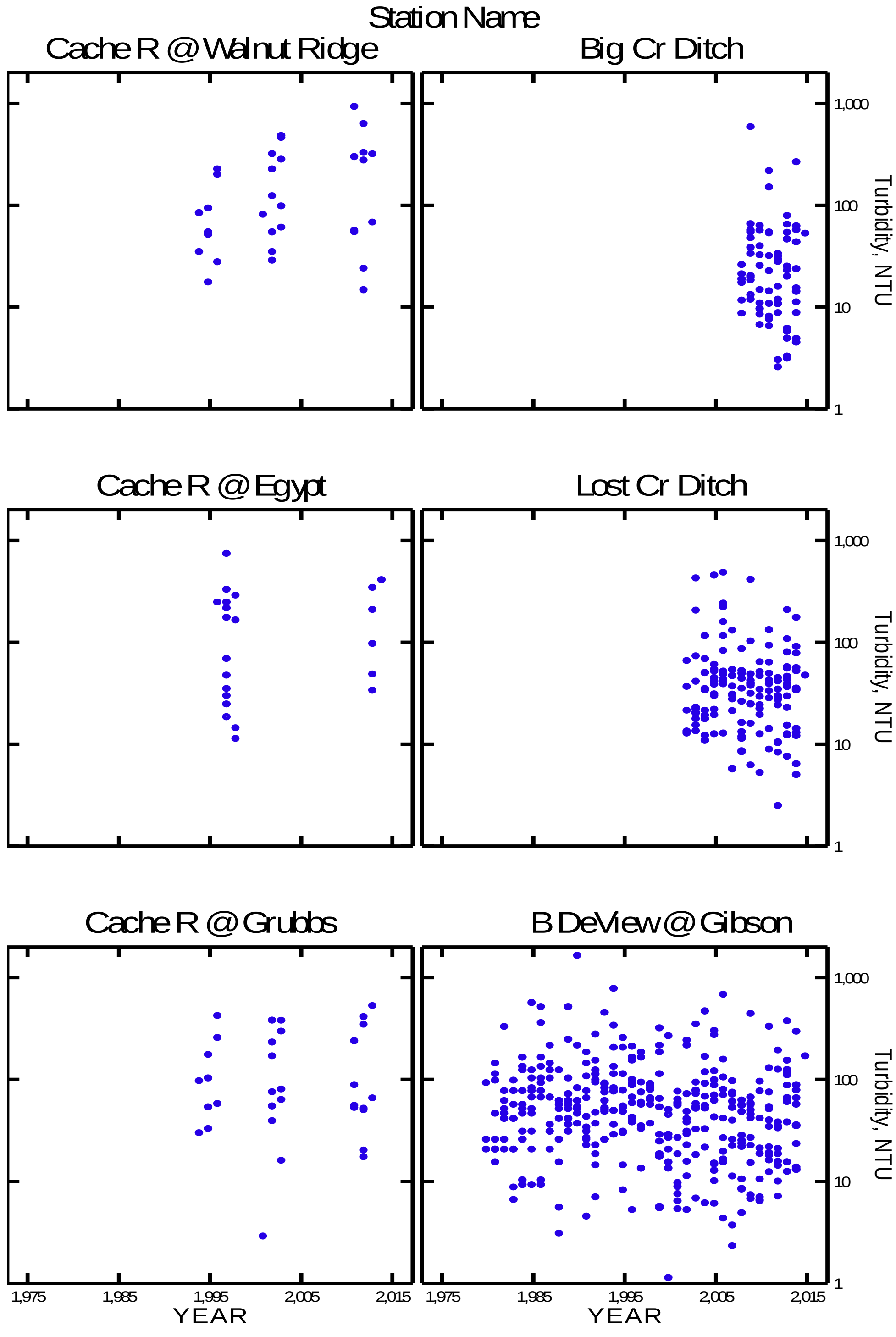


Figure 3.11. Turbidity time series for upper Cache River watershed stations.

The longest TSS and turbidity data records in the upper Cache River watershed are from Bayou DeView (at Gibson). These data appear to indicate that TSS concentrations have declined over time. The TSS data record from Lost Creek Ditch is shorter, but the pattern of the data also suggests that TSS concentrations may be declining. The TSS data record from Big Creek Ditch is shortest and does not exhibit any obvious trend. Turbidity measurements from these three stations also exhibit apparent declines over time (Figure 3.11). Linear regression analysis indicates a statistically significant linear decreasing trend in TSS concentrations from the Bayou DeView station only.

The water quality monitoring stations on the upper Cache River with the longest TSS data records are located near Walnut Ridge and Grubbs. TSS data from the upstream station (near Walnut Ridge) show an apparent increase in concentrations between 1995 and 2002. Both minimum and maximum concentrations have increased. TSS data from the station at Grubbs (downstream) do not indicate a change (Figure 3.10). Linear regression analysis does not indicate a statistically significant linear trend in the TSS data from any of the Cache River stations.

Multiple years of turbidity data are available from three Cache River stations. Turbidity measurements from the Cache River near Egypt and Grubbs do not appear to exhibit changes over time. However, turbidity measurements from the Cache River near Walnut Ridge appear to have increased over time (Figure 3.11). Linear regression analysis indicates a statistically significant increasing trend in the turbidity data from the Cache River station near Walnut Ridge.

In 2005, TNC performed an intensive evaluation of ADEQ TSS data collected prior to 2004 at several long term water quality monitoring stations in the upper Cache River watershed as part of one of their 319 projects involving the Cache River (Project Number 01-610) (TNC 2005). Medians and interquartile ranges from the historical ADEQ TSS data record (2003 and before) and TSS data collected since 2003 from the long-term monitoring stations within the upper Cache River watershed are illustrated in Figure 3.6. The purpose of this comparison is to evaluate whether water quality conditions in the upper Cache River watershed have changed since the TNC evaluation.

Comparing the medians (medians are represented as the narrowest part of the boxes in Figure 3.12) of data collected prior to 2004 (blue) to the medians of the more recent data (purple), we can see that there are statistically significant (at the 95% confidence) differences between the median TSS values (i.e., the notches around the median values do not overlap) at the stations in the Bayou DeView headwaters (WHI0026 and WHI0172). The median TSS values at both of these stations have declined since 2003. In the TNC evaluation of water quality in the Cache River watershed, they found the highest TSS loads at the Bayou DeView water quality stations (TNC 2005). Since TSS concentrations have declined at these stations, they may no longer have the highest loads.

It appears there may also have been a decline in the median TSS value in the Cache River at Grubbs (UWCHR03). However, there is significant variability in the more recent TSS measurements. As a result, the medians are not statistically significantly different. For the same reason, the apparent increase in the median TSS value in the Cache River at Walnut Ridge (UWCHR04) does not represent a statistically significant change. In the TNC evaluation of water quality, they found the highest Cache River TSS loads at stations between ADEQ stations UWCHR03 and UWCHR04 (TNC 2005). Given that there has not been a statistically significant change in the median TSS concentrations at these stations, it may be that this area of the Cache River still exhibits the highest TSS loads.

Figure 3.13 shows a similar comparison of turbidity data. TNC did not evaluate turbidity in their study. For the most part, the turbidity comparison exhibits relationships similar to those for TSS, but there are differences. As with the TSS data, the median turbidity value at the Bayou DeView station (WHI0026) has declined. However, the median turbidity values are not statistically significantly different, where the TSS medians were. Also, as was seen in the TSS data, the median turbidity at the upstream Cache River station (UWCHR04) has increased. However, it appears the median turbidity values may be statistically significantly different, when the median TSS values were not. The greatest difference between TSS and turbidity relationships is at the Lost Creek Ditch station (WHI0172). Here, the median turbidity of the post-2003 data is statistically significantly greater than the median of the pre-2004 data, when the median TSS concentration of the post-2003 data is statistically significantly lower than the median of the pre-2004 data.

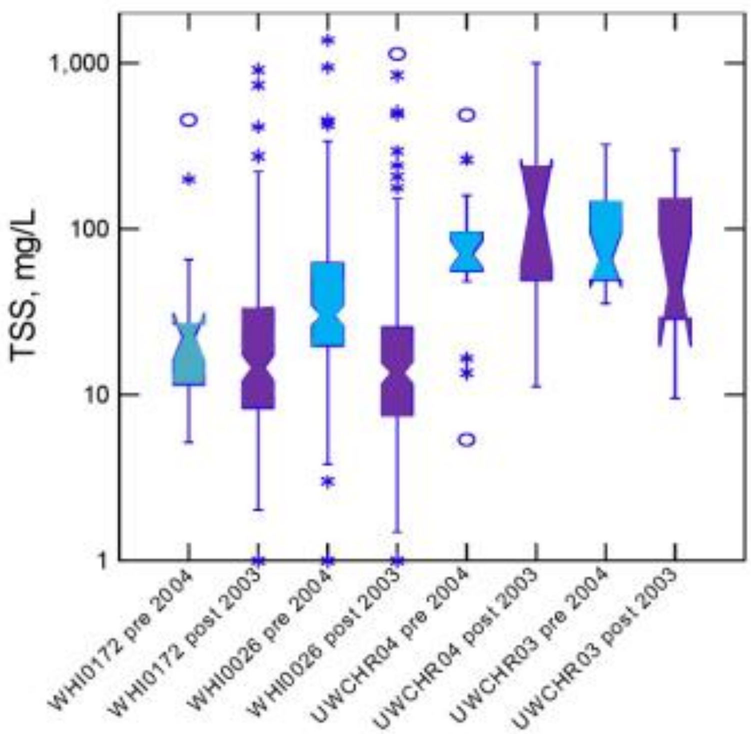


Figure 3.12. Comparison of upper Cache River TSS data from two time periods.

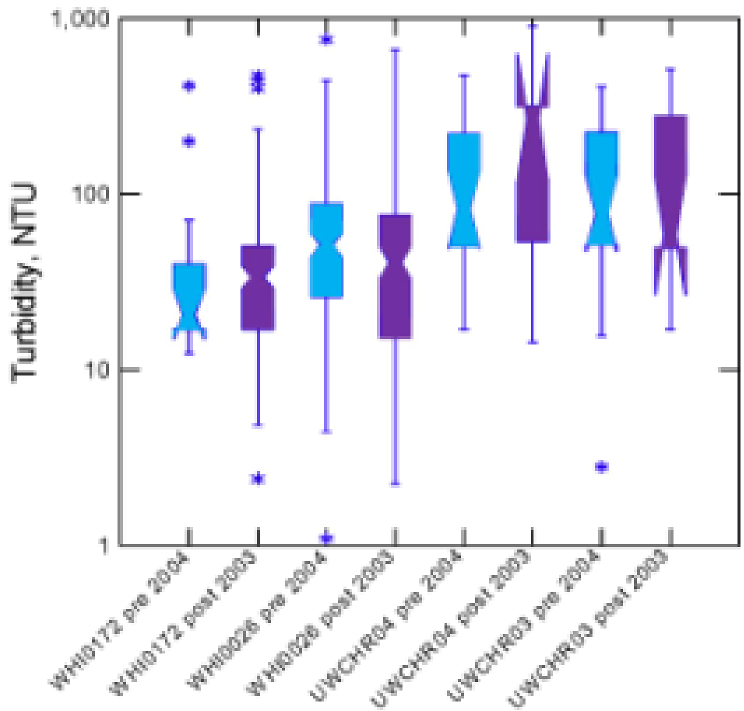


Figure 3.13. Comparison of upper Cache River turbidity data from two time periods.

3.2.1.4.2. Sediment Water Quality Over Time in the Lower Cache River Watershed

Figure 3.14 shows the entire period of record of TSS measurements from long term stations in the lower Cache River watershed. Data collected by different agencies at the same location are all shown on a single graph. At the upstream Bayou DeView and Cache River locations, TSS concentrations measured in the 1990s and later appear lower than those measured in the 1970s. In the Cache River (at Patterson), TSS concentrations appear to have declined from the 1970s through the 2000s sampling event, but may have increased between the 2000s sampling and the 2010s sampling event. A similar pattern occurs at the Bayou DeView station at Highway 70, where TSS concentrations appear to decline from the 1990s to the 2000s, and increase between the 2000s and the 2010s. At the Cache River near Brasfield, TSS concentrations appear to have remained fairly constant over the monitoring record. Linear regression analysis identified statistically significant linear trends at three of these monitoring locations. The results are summarized in Table 3.8.

Table 3.8. Results of linear regression analysis on TSS measurements at long-term monitoring locations in the lower Cache River watershed.

Location	P value	R^2 value	Direction
Bayou DeView at Hwy 64	0.000	0.23	Decrease
Bayou DeView at Hwy 70	0.010	0.03	Increase
Cache River near Brasfield	0.000	0.08	Increase

Figure 3.15 shows the entire period of record of turbidity values measured at long-term monitoring locations in the lower Cache River watershed. At the Cache River at Patterson, in the upper watershed, turbidity levels appear to have remained relatively constant over time. At the Cache River near Brasfield, in the lower part of the watershed, turbidity levels may be declining over time. At the Bayou DeView stations, turbidity levels may be increasing, at least since the 1990s. At Bayou DeView at Highway 64, turbidity levels appear to have declined from the 1970s to the 1990s, and may have increased since the 1990s. Simple linear regression of the data did not identify any statistically significant linear trends.

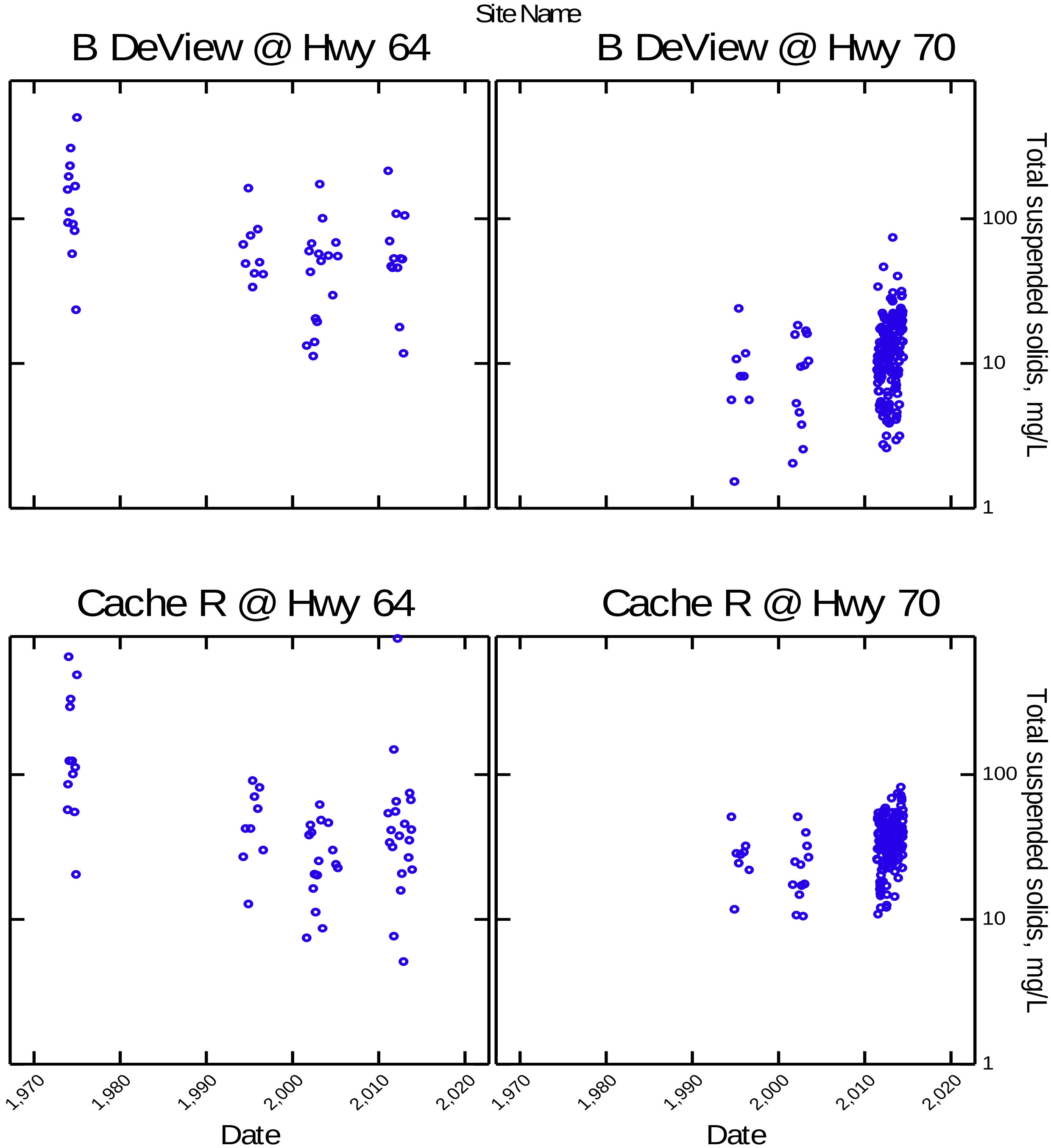


Figure 3.14. TSS data collected from long-term monitoring locations in the lower Cache River watershed.

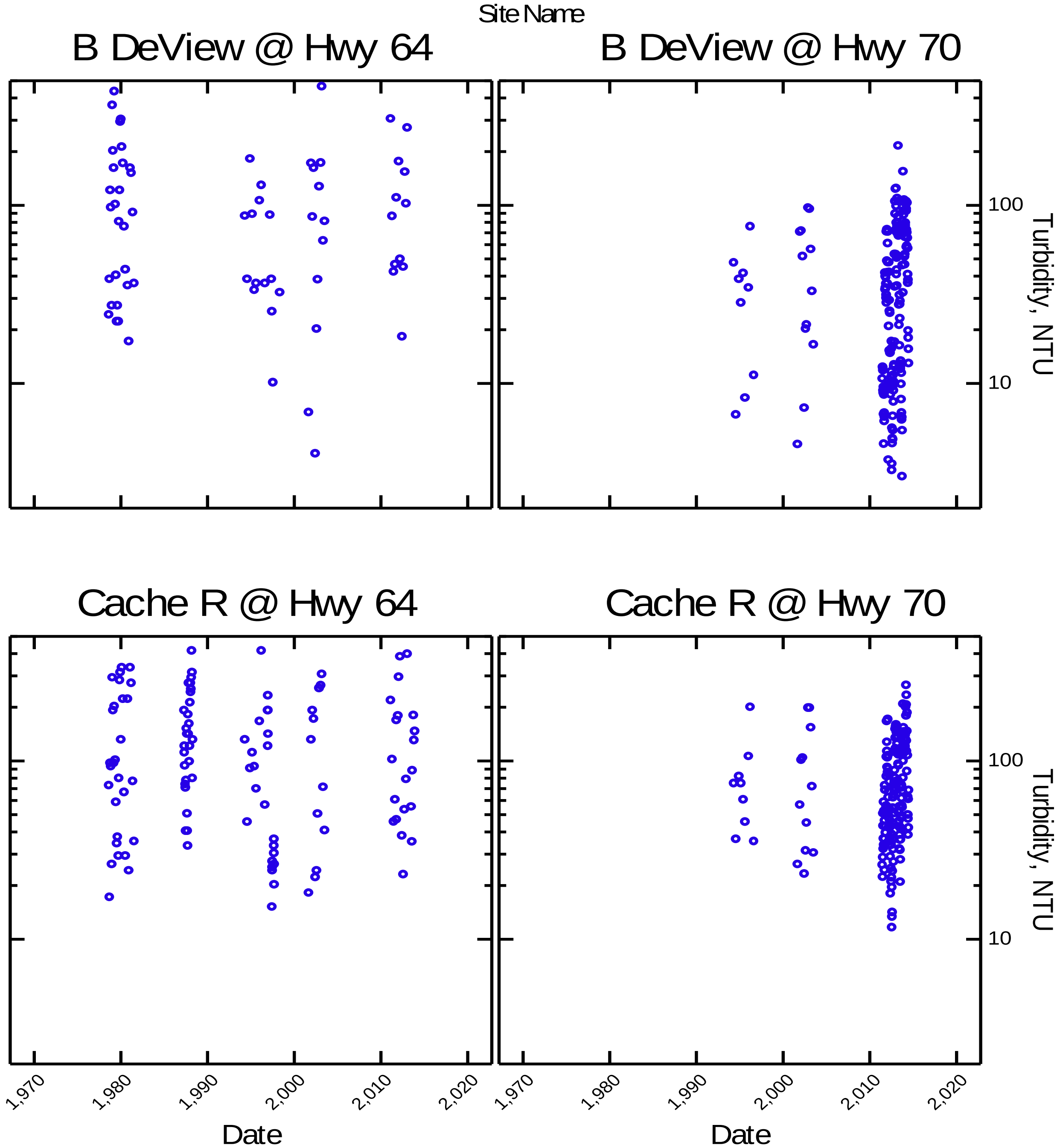


Figure 3.15. Turbidity data collected from long-term monitoring locations in the lower Cache River watershed.

Figure 3.16 shows the entire period of record of suspended sediment data from USGS long-term monitoring stations in the lower Cache River watershed. These data do not exhibit large changes over time. Simple linear regression analysis did not identify any statistically significant linear trends in the data over time.

3.2.1.4.3. Sediment Data Gaps

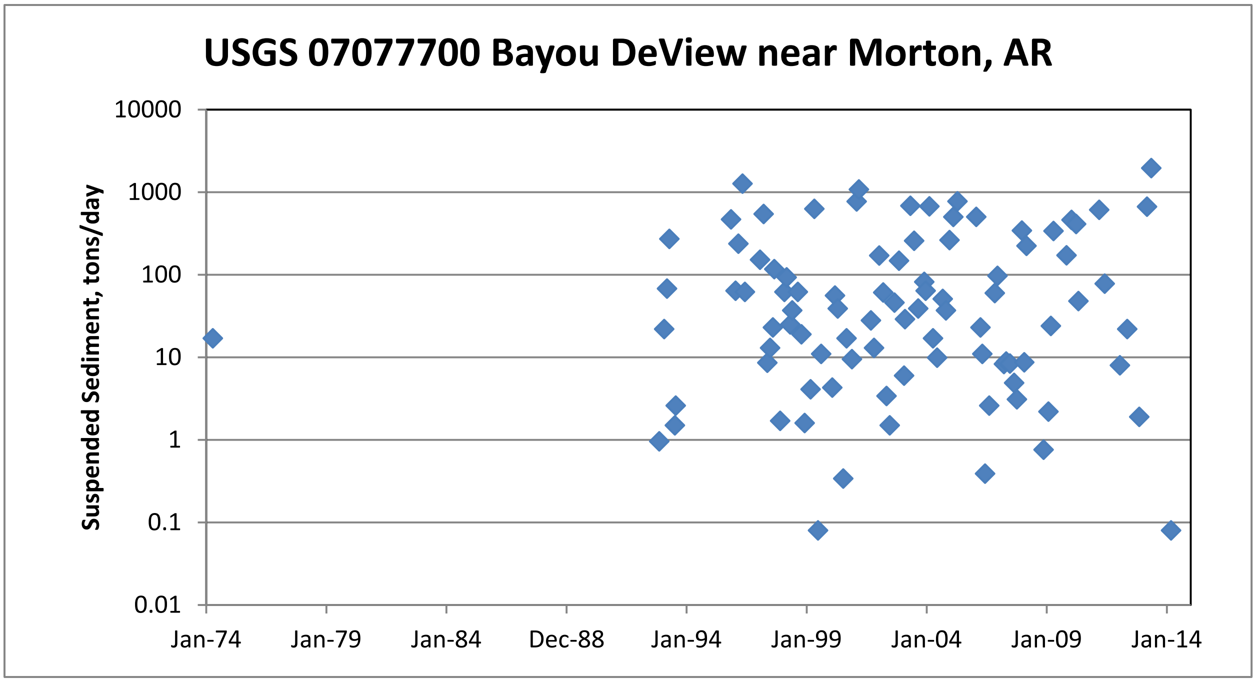
There is not widespread measurement of suspended sediment in the Cache River watershed. There is no routine monitoring of sediment parameters in the priority tributaries identified by TNC. A longer period of record may be needed at the ASU monitoring sites to see changes in sediment parameters resulting from the installation of BMPs in the Cache River watershed.

3.2.1.5 Sulfate Water Quality

Sulfate impairments are present only in the upper Cache River watershed, so this discussion addresses only data from the upper Cache River watershed. ADEQ collects sulfate data at their monitoring locations in the upper Cache River watershed (ADEQ 2015b). No other entities have collected sulfate data in the watershed within the last 5 years. The USGS collected sulfate data in the past, but there are no other entities that have collected sulfate data in the watershed (USGS 2015b). Sulfate levels in some stream segments of Bayou DeView and the Cache River in the upper Cache River watershed have exceeded Arkansas water quality standards.

3.2.1.5.1. Sulfate Around the Upper Cache River Watershed

Sulfate data collected by ADEQ over the last 5 years (2010 – 2014) in the upper Cache River watershed are shown on Figure 3.17. Sulfate concentrations appear to be relatively similar at all five of the stations. Analysis of variance indicates that the average sulfate concentration at the Lost Creek Ditch station is statistically significantly lower than the average concentration at Grubbs on the Cache River, but not statistically different from average sulfate concentrations at any other water quality stations.



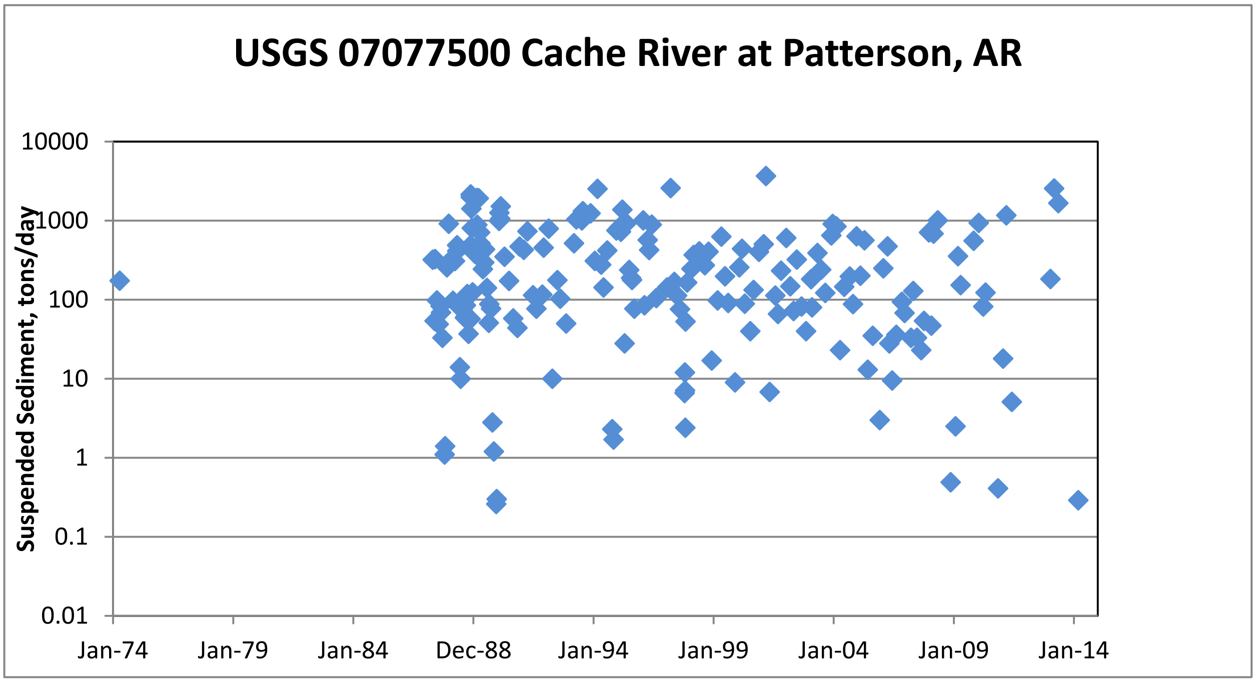


Figure 3.16. Suspended sediment measurements from USGS long-term monitoring stations in the lower Cache River watershed.

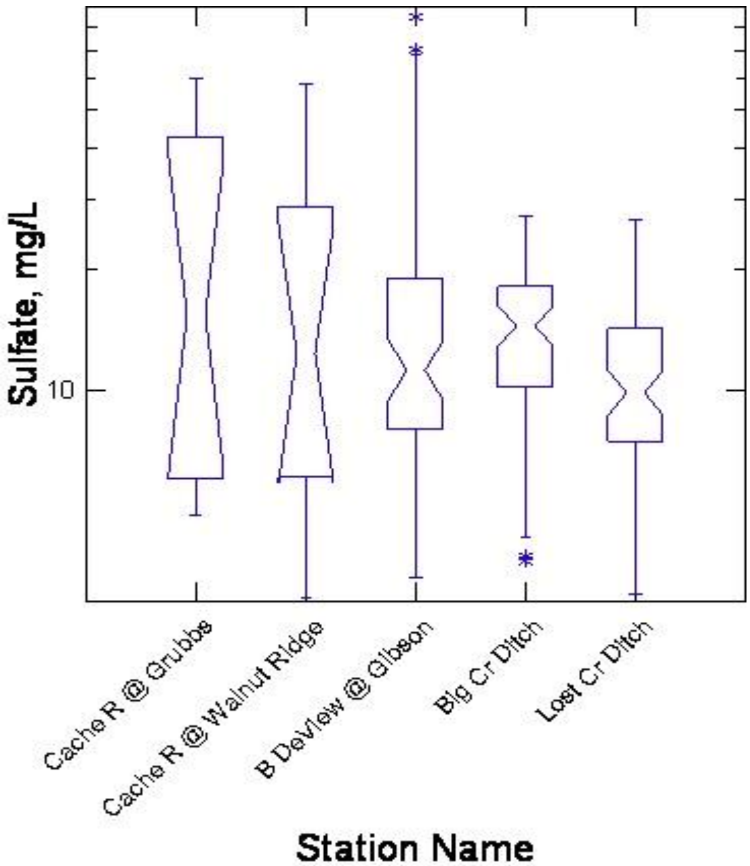


Figure 3.17. Recent sulfate data from the upper Cache River watershed.

3.2.1.5.2. Sulfate Over Time

Sulfate data collected by ADEQ and USGS over the entire period of record are shown on Figure 3.18. Sulfate concentrations at the Lost Creek Ditch and Bayou DeView stations appear to exhibit declining trends. Although the period record for the Big Creek Ditch station is relatively short, it appears to be exhibiting a slight increasing trend (i.e., the minimum measurements have been increasing over the period of record). Linear regression analysis indicates a statistically significant decline in the sulfate concentrations at both the Lost Creek Ditch and Bayou DeView stations. Sulfate concentrations at the Cache River stations have been becoming more variable, exhibiting both declining minimum measurements and increasing maximum measurements. Linear regression analysis indicates a statistically significant increasing trend at the Grubbs Cache River station.

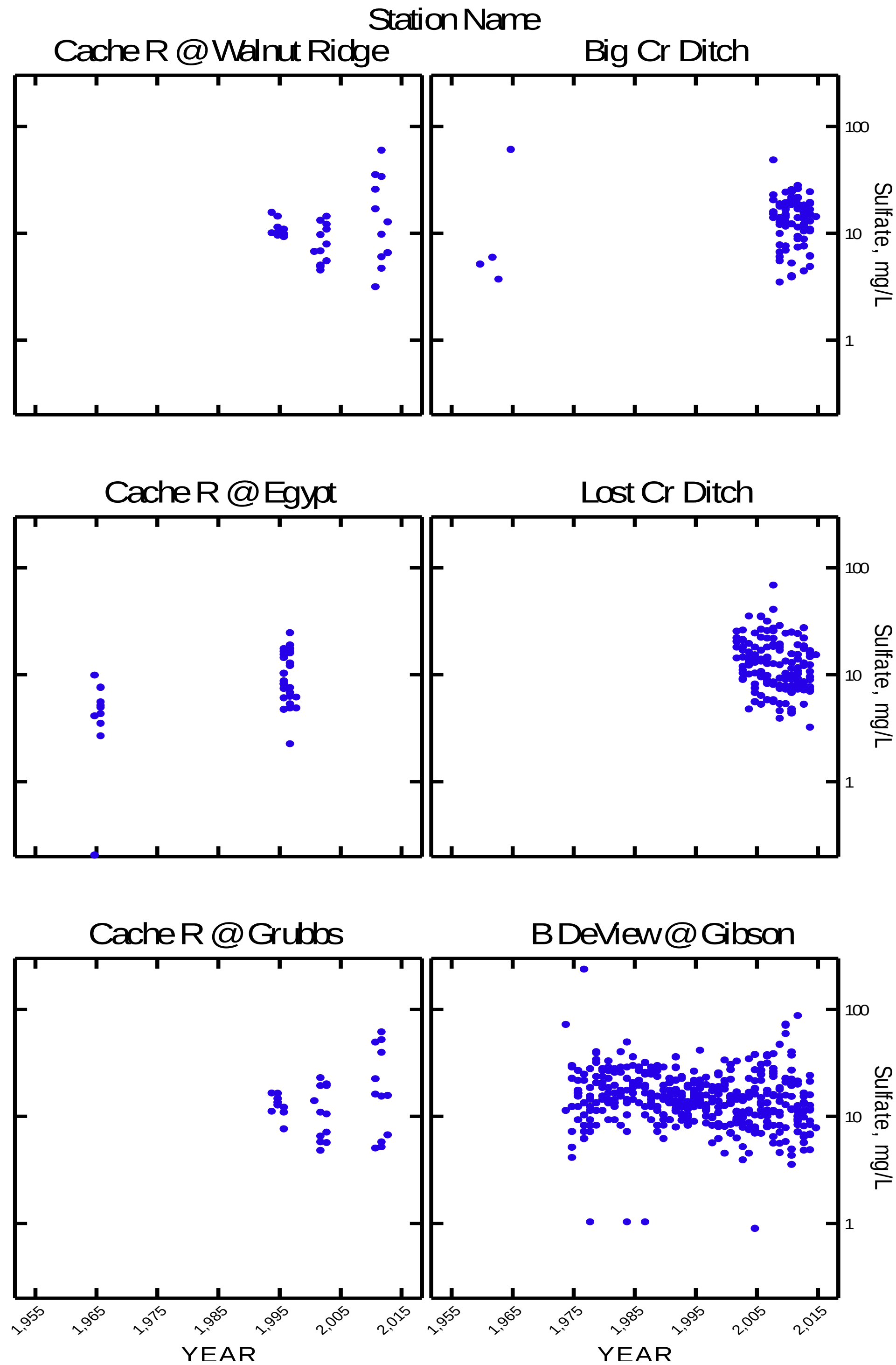


Figure 3.18. Time series graphs of available sulfate data from the upper Cache River watershed.

3.2.1.5.3. Sulfate Data Gaps

There has not been widespread collection of sulfate data in the upper Cache River watershed. Additional data collection in the watershed may be useful for determining the source of sulfate that is causing high concentrations impairing monitored stream segments. Additional data collection would also be needed to more accurately characterize sulfate loads in the watershed.

3.2.1.6 Dissolved Lead Water Quality

ADEQ collects dissolved lead data at their monitoring locations in the Cache River watershed (ADEQ 2015b). No other entities have collected lead data in the watershed within the last 5 years. The USGS collected dissolved lead data in the past, but there are no other entities that have collected lead data in the watershed (USGS 2015b). Dissolved lead levels in several stream segments of the Cache River have exceeded the Arkansas chronic numeric water quality criterion for the Delta, 2.4 µg/L (calculated using the equation found in ADEQ Regulation 2 (ADEQ 2014b) and the mean hardness for the Delta ecoregion, 81 mg/L, per the State of Arkansas Continuing Planning Process (ADEQ 2000).

3.2.1.6.1. Dissolved Lead Around the Upper Cache River Watershed

Dissolved lead concentrations measured over the last 5 years (2010 – 2014) at the ADEQ water quality monitoring stations are shown on Figure 3.19. The majority of the dissolved lead measurements from this time period are less than the detection limit. The largest number of measurements above the detection limit occurred at the Lost Creek Ditch station.

3.2.1.6.2. Dissolved Lead Around the Lower Cache River Watershed

Dissolved lead has been measured during the last 5 years (2010 – 2014) at only two of the ADEQ water quality monitoring stations in the lower Cache River watershed, those at Highway 64. The majority of the dissolved lead measurements from this time period are less than the detection limit. The two values measured above the detection limit at the Bayou DeView station are higher than the one value measured above the detection limit at the Cache River station (Figure 3.20).

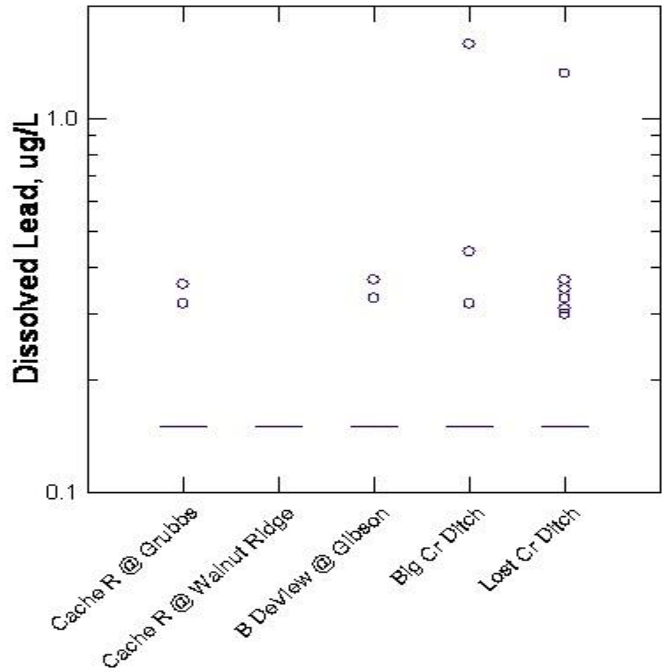


Figure 3.19. Dissolved lead measurements from 2010 – 2014 from the upper Cache River watershed.

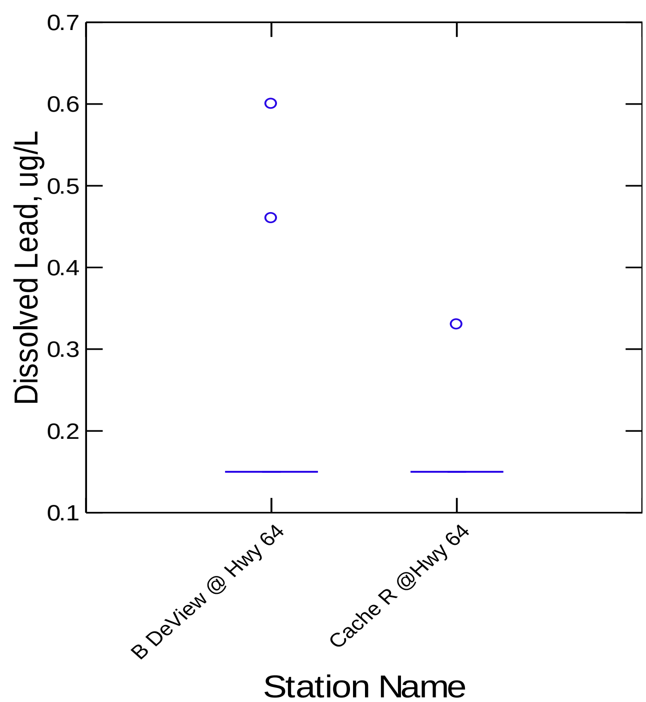


Figure 3.20. Dissolved lead measurements from 2010 through 2014 from the lower Cache River watershed.

3.2.1.6.3. Upper cache River Water shed Dissolved Lead Concentrations Over Time

Entire periods of record of dissolved lead data collected by ADEQ and USGS are shown on Figure 3.21. Dissolved lead concentrations at most of the water quality monitoring stations appear to have declined over time. At least part of the decline in dissolved lead concentrations at the Cache River stations is the result of the lowering of detection limits for dissolved lead over time.

3.2.1.6.4. Lower Cache River Watershed Dissolved Lead Concentrations Over Time

Entire periods of record of dissolved lead data collected by ADEQ and USGS are shown on Figure 3.22. The longest periods of record are at the two stations at Highway 64. Dissolved lead concentrations at the water quality monitoring stations have declined over time. At least part of the decline in dissolved lead concentrations appears to be the result of the lowering of detection limits for dissolved lead over time.

3.2.1.6.5. Dissolved Lead Data Gaps

There has not been widespread collection of dissolved lead data in the Cache River watershed. It may be important to continue monitoring dissolved lead levels in the watershed, to make sure they continue to stay below the water quality criterion. On the lower Cache River, additional data collection in the watershed may be useful for determining the source of lead that is causing high concentrations in the monitored stream segments.

3.2.1.7 Dissolved Copper Water Quality?

3.2.2 Groundwater Quality

This section describes and discusses available groundwater quality data in the Cache River watershed. This includes water quality monitoring, water quality characteristics, and water quality threats.

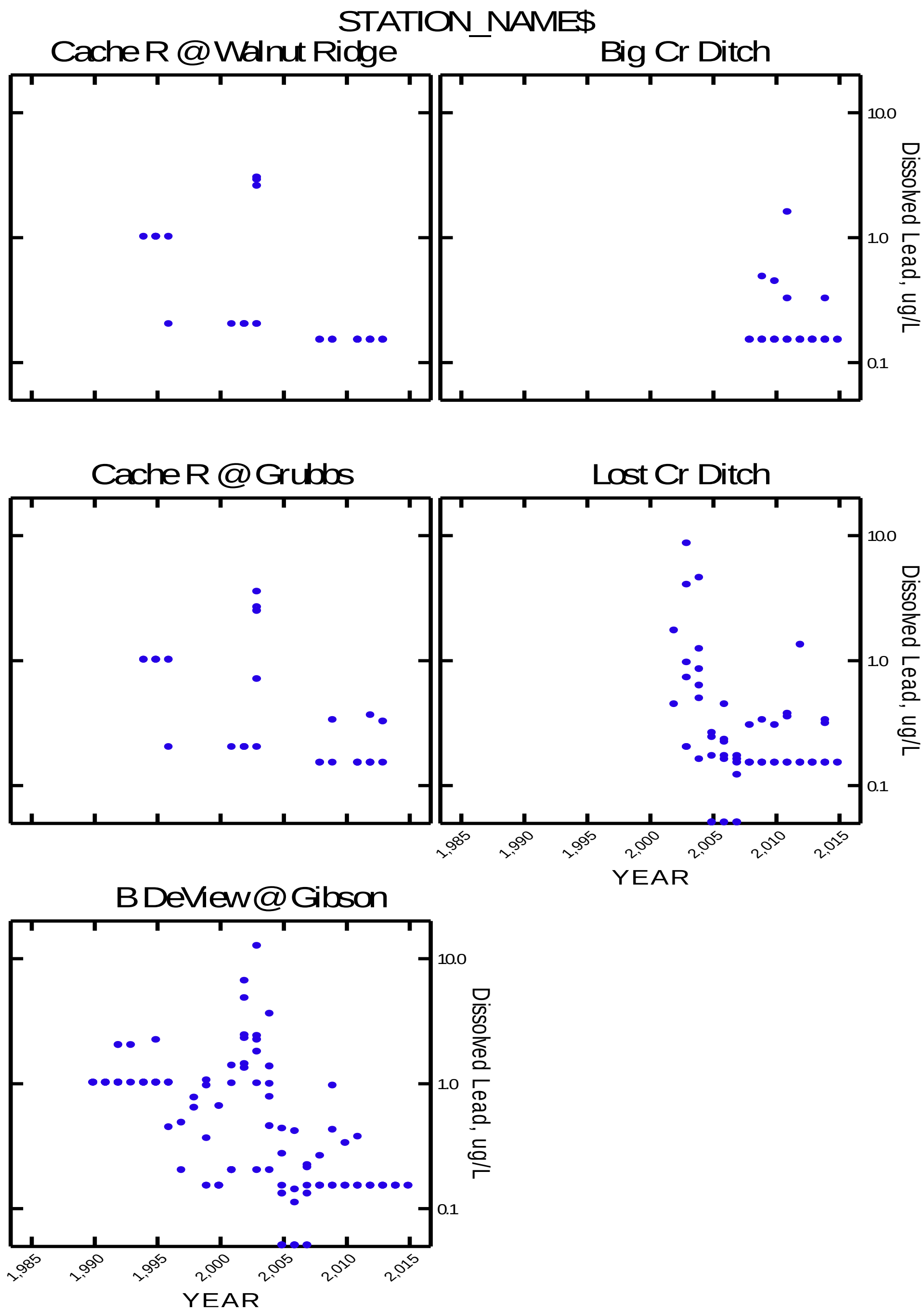


Figure 3.21. Time series graphs of long term dissolved lead data collected in the upper Cache River watershed.

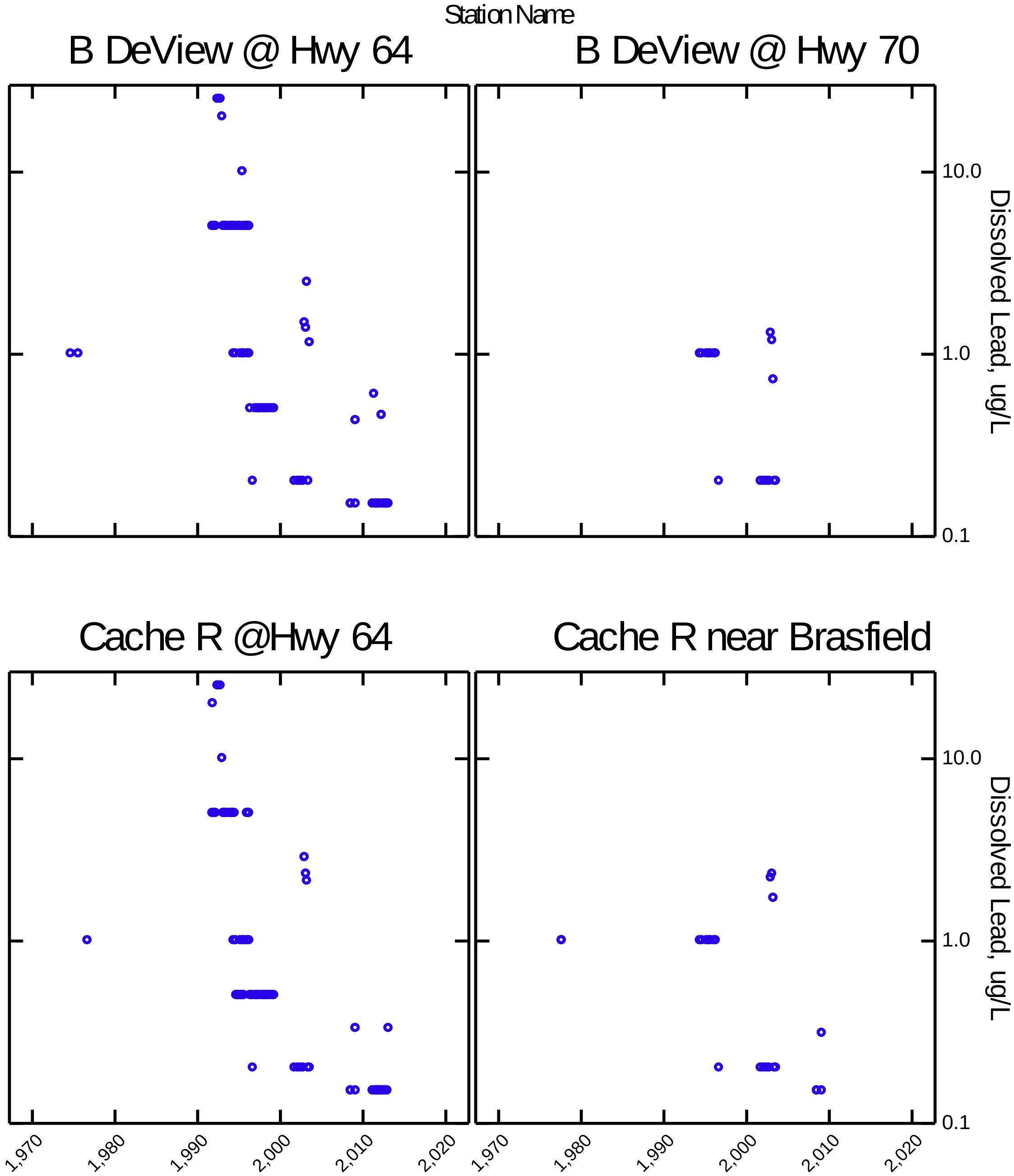


Figure 3.22. Long term dissolved lead measurements from the lower Cache River watershed.

3.2.2.1 Monitoring

Groundwater quality data have been collected in the Cache River watershed by ADEQ, ANRC, USGS, and the Arkansas State Plant Board. ADEQ administers mandated groundwater monitoring programs at various sites that are regulated by state and federal programs. The purpose of this monitoring is to evaluate potential and actual impacts to groundwater resulting from human activities, e.g., solid waste landfills and underground storage tanks, and natural phenomenon (ADEQ 2009).

ADEQ developed the Arkansas Ambient Ground Water Monitoring Program in 1986, which currently consists of 12 monitoring areas and approximately 250 wells and springs throughout the state (ADEQ 2014a, Kresse et al. 2014). A portion of the Jonesboro groundwater quality monitoring area is within the upper Cache River watershed. Monitoring in the Jonesboro area was initiated in 1989 to track the potential for contamination of the water supply aquifers utilized in the area. Samples are collected from wells completed in the Mississippi River Valley alluvial aquifer (MRV) (ADEQ 2014a). A portion of the Brinkley groundwater quality monitoring area is within the lower Cache River watershed. Monitoring in the Brinkley area was initiated in 1989 to characterize chloride levels and determine if pesticides were present in the MRV aquifer (ADEQ 2014a).

The USGS collects groundwater quality data at a number of wells in the Cache River watershed. There are 20 USGS groundwater quality sites in the upper Cache River watershed that have been sampled since 2010 (USGS 2015b). One of the 25 USGS master wells is located in the upper Cache River watershed (completed in terrace deposits). There are 15 USGS groundwater quality sites in the watershed that have been sampled since 2010 (USGS 2014a). One of the 25 USGS master wells is located in this watershed (Memphis Sand aquifer). Master wells are sampled for water quality every 5 years (ADEQ 2014a).

In 2000, ANRC began the Section 319 Core Program Monitoring Enhancement Wells program to establish long-term water quality trends and assist with the development of water quality standards for groundwater (ANRC 2009). In 2010, ANRC initiated sampling at seven wells in the upper Cache River watershed as part of this project. In the lower Cache River watershed, ANRC collected water quality measurements of MRV groundwater at two wells in 2004 (USGS 2014a).

The Arkansas State Plant Board has tested irrigation wells within the upper Cache River watershed in Clay County for the presence of pesticides. The Arkansas State Plant Board also has tested irrigation wells within the lower Cache River watershed in Jackson, Prairie, and Woodruff Counties for the presence of pesticides. However, these wells are not currently actively monitored (Arkansas State Plant Board 2015).

The periods of record for water quality data from the 30 monitoring wells within the upper Cache River watershed that have been sampled within the last 5 years (2010 – 2014) are listed in Table 3.9. The periods of record for water quality data from the 37 wells that have been sampled in the lower Cache River watershed since 2009 are listed in Table 3.10. ANRC and the Arkansas State Plant Board have not collected groundwater samples in the lower Cache River watershed since 2009. A detailed water quality data inventory that includes older data is available in Appendix B.

Table 3.9. Periods of record for active groundwater quality monitoring wells in the upper Cache River watershed (ADEQ 2015b (USGS 2014a).

Well ID	Monitoring Agency/ Organization	Aquifer	Date of first sample	Date of most recent sample
CRA038	ADEQ	MRV	7/27/1989	8/27/2013
CRA045	ADEQ	MRV	6/14/1995	8/20/2013
CRA900	ADEQ	MRV	7/17/2006	8/27/2013
13N03E21CB2	ANRC	MRV	6/24/2010	6/24/2010
13N03E22CA1	ANRC	MRV	6/24/2010	6/24/2010
13N03E28AB1	ANRC	MRV	6/24/2010	6/24/2010
13N03E29BA1	ANRC	Sparta/Memphis Sand	6/24/2010	6/24/2010
13N03E30AA1	ANRC	MRV	6/24/2010	6/24/2010
14N01E34DC1	ANRC	MRV	6/24/2010	6/24/2010
14N02E27DD2	ANRC	no information	6/24/2010	6/24/2010
13N01E01CC1	USGS	MRV	7/17/2012	7/17/2012
13N01E02AB1	USGS	MRV	8/17/2001	7/31/2014
13N01E03AAA1	USGS	MRV	8/14/2007	7/17/2012
13N01E11AA1	USGS	no information	7/17/2012	7/17/2012
13N02E06BB2	USGS	MRV	6/24/2010	7/31/2014
13N02E32AAA1	USGS	MRV	6/24/2010	6/24/2010
13N02E35DDB1	USGS	MRV	8/12/2009	6/24/2010
13N03E21CC2	USGS	MRV	7/17/2012	7/17/2012
13N03E29AAA1	USGS	Terrace Deposits	8/3/1973	7/31/2014
13N03E29DDC1	USGS	MRV	6/24/2010	7/17/2012
13N03E31BB1	USGS	MRV	7/8/2004	7/17/2012
14N02E32DDC1	USGS	MRV	6/24/2010	6/24/2010

Table 3.9. Periods of record for active groundwater quality monitoring wells in the upper Cache River watershed (continued).

Well ID	Monitoring Agency/ Organization	Aquifer	Date of first sample	Date of most recent sample
15N01E26DDA1	USGS	MRV	7/15/1999	7/29/2014
15N03E12ABB1	USGS	Sparta/Memphis Sand	8/5/2014	8/5/2014
16N02E34BDA1	USGS	Pleistocene Valley Trains	7/1/1998	6/29/2010
16N04E23CAC1	USGS	MRV	7/28/2014	7/28/2014
17N02E35AB1	USGS	MRV	7/19/2012	7/19/2012
17N04E30CDC1	USGS	Terrace Deposits	8/7/1967	7/29/2014
19N03E36AD1	USGS	MRV	7/29/2014	7/29/2014
20N05E34BD1	USGS	MRV	7/28/2014	7/28/2014

Table 3.10. Periods of record for recently sampled groundwater quality monitoring wells in the lower Cache River watershed (EPA 2015a, USGS 2014a).

Well ID	Monitoring Agency/ Organization	Aquifer	Date of first sample	Date of most recent sample
MON103	ADEQ	no information	8/25/1989	6/28/2011
MON116	ADEQ	no information	8/25/1989	7/25/2011
MON182	ADEQ	no information	8/24/1989	6/27/2011
MON183	ADEQ	no information	8/24/1989	6/27/2011
MON315	ADEQ	no information	8/24/1989	6/27/2011
MON318	ADEQ	no information	8/24/1989	6/27/2011
MON325	ADEQ	no information	8/25/1989	7/5/2011
MON326	ADEQ	no information	8/25/1989	7/12/2011
MON327	ADEQ	no information	8/25/1989	7/25/2011
MON900	ADEQ	no information	7/7/2003	6/28/2011
MON902	ADEQ	no information	7/7/2003	7/5/2011
MON903	ADEQ	no information	7/7/2003	7/12/2011
MON905	ADEQ	no information	7/8/2003	6/27/2011
MON906	ADEQ	no information	7/8/2003	6/27/2011
02N02W06AAD1	USGS	MRV	9/10/1982	7/6/2012
02N02W20BBC1	USGS	MRV	8/7/1974	7/10/2014
02N02W20BCB1	USGS	MRV	6/30/2010	6/30/2010
03N02W32BBC1	USGS	MRV	9/9/1982	6/30/2010
04N02W30BAC1	USGS	Sparta/Memphis Sand	9/7/1983	7/2/2013
04N04W01BAA1	USGS	MRV	7/12/2012	7/12/2012
05N02W31DCB3	USGS	Sparta/Memphis Sand	4/18/1997	8/20/2014
05N02W35DBB1	USGS	MRV	7/12/2012	7/12/2012
05N04W02AD1	USGS	MRV	7/13/2012	7/13/2012
05N04W25DDA1	USGS	MRV	8/1/2014	8/1/2014
06N01W10AB1	USGS	MRV	6/18/1998	8/1/2014

Table 3.10. Periods of record for recently sampled groundwater quality monitoring wells in the lower Cache River watershed (continued).

Well ID	Monitoring Agency/ Organization	Aquifer	Date of first sample	Date of most recent sample
06N03W05CBB1	USGS	MRV	7/13/2012	7/13/2012
06N04W22DCB1	USGS	MRV	7/13/2012	7/13/2012
07N01W27CD1	USGS	No information	7/12/2012	7/12/2012
07N01W32CCD1	USGS	MRV	8/19/1998	8/1/2014
07N02W12BB1	USGS	MRV	7/12/2012	7/12/2012
08N02W11DD1	USGS	MRV	8/1/2014	8/1/2014
09N01E16CAC1	USGS	Sparta/Memphis Sand	6/20/1995	7/11/2013
09N02W32CBB1	USGS	Terrace deposits	7/14/1999	6/29/2010
10N01E15DBB1	USGS	Sparta/Memphis Sand	6/3/1970	7/31/2013
10N01W32DDC1	USGS	MRV	8/1/2014	8/1/2014
10N02W29ABB1	USGS	Terrace deposits	7/14/1999	6/29/2010
11N01W26AAD1	USGS	MRV, terrace deposits	8/20/1998	8/1/2014

3.2.2.2 Groundwater Quality Characteristics

3.2.2.2.1. ADEQ

The character of the groundwater in the ADEQ Jonesboro groundwater monitoring area gradually changes from calcium-bicarbonate in the shallow MRV aquifer to strongly sodium-bicarbonate water in the deeper Memphis Sand aquifer. Parameters measured in the monitoring wells include TDS, sulfate, chloride, iron, manganese, and inorganic nitrogen (ADEQ 2014a). In the wells within the upper Cache River watershed, TDS concentrations range from 100 mg/L up to 1,100 mg/L. Sulfate concentrations range from 6.5 mg/L up to 332 mg/L. The maximum sulfate concentration exceeds the secondary maximum contaminant level (SMCL) of 250 mg/L. Sulfate measurements from two wells exceed 200 mg/L. Chloride levels measured in most of the monitoring wells within the watershed are less than 40 mg/L. Chloride concentrations around 200 mg/L have been measured at one of the wells in the watershed, but these measurements are below the SMCL of 250 mg/L. Dissolved iron concentrations tend to be high, and dissolved iron concentrations that exceed the SMCL of 300 µg/L have been measured in four of the seven wells in the watershed. Manganese occurs in all of the wells, with two of the wells consistently having manganese levels above the 50 µg/L SMCL. Inorganic nitrogen has been measured in all of the wells in the watershed at concentrations up to 3 mg/L. High arsenic levels occur in some areas of the MRV.

Arsenic levels in the Jonesboro monitoring area wells within the upper Cache River watershed are below the drinking water MCL (ADEQ 2015b (Kresse, et al. 2014).

Parameters measured in the monitoring wells within ADEQ Brinkley Monitoring Area include TDS, sulfate, chloride, iron, manganese, and inorganic nitrogen (ADEQ 2014a). In the wells within the lower Cache River watershed, TDS concentrations range from 132 mg/L up to 1,332 mg/L. TDS concentrations above the SMCL occur in 10 of the 14 wells. Sulfate concentrations range from 7.5 mg/L to 103 mg/L. Chloride concentrations range from 4 mg/L to 1,000 mg/L. Chloride concentrations above the SMCL of 250 mg/L were measured at four of the study area wells within the lower Cache River watershed. Dissolved iron concentrations tend to be high, almost all measured dissolved iron concentrations exceed the SMCL of 300 µg/L. Manganese occurs in all 14 wells where it was measured, and almost all dissolved manganese measurements exceed the 50 µg/L SMCL. Inorganic nitrogen has been measured in all of the wells in the watershed. The majority of inorganic nitrogen concentrations in these wells are below the detection level. The maximum inorganic nitrogen concentration measured in the wells within the lower Cache River watershed is 1 mg/L, well below the drinking water standard of 10 mg/L. High arsenic levels occur in some areas of the MRV. Arsenic concentrations measured in the Brinkley monitoring area wells within the lower Cache River watershed range from below detection to 6.4 µg/L. All arsenic measurements are below the drinking water maximum contaminant level of 10 µg/L (EPA 2015a, Kresse, et al. 2014).

3.2.2.2.2. State Plant Board

In 2009, the Arkansas State Plant Board tested three irrigation wells in Clay County within the upper Cache River watershed for the presence of pesticides. No pesticides were detected in these wells. The Arkansas State Plant Board has also tested irrigation wells within the lower Cache River watershed in Jackson, Woodruff, and Prairie Counties. Pesticides were detected in three of the seven irrigation wells within the lower Cache River that were tested. Pesticides detected included 2,4-D and Bentazon (Arkansas State Plant Board 2015).

3.2.2.2.3. USGS

Temperature, specific conductivity, and chloride are the water quality parameters most often measured by USGS in wells. Specific conductivity measurements collected from wells in the upper Cache River watershed over the last 5 years ranged from110 microsiemens/cm to 1,310 microsiemens/cm. Chloride concentrations measured were all less than 30 mg/L. The majority of water quality parameters were measured once in two wells. Both nitrate concentrations measured were less than 2 mg/L. Concentrations of iron measured were 4 µg/L and 5,830 µg/L (SMCL for iron is 300 µg/L). Concentrations of manganese measured were <0.4 µg/L and 484 µg/L (SMCL for manganese is 50 µg/L). Arsenic was measured in only one well and was 0.2 µg/L, below the 10 µg/L MCL. Organic compounds measured, including pesticides and pesticide byproducts, were not detected in the samples from these two wells (USGS 2015b).

Specific conductivity measurements collected from wells in the lower Cache River watershed over the last 5 years ranged from 87 microsiemens/cm to 1,380 microsiemens/cm. Measured chloride concentrations ranged from 2.0 mg/L to 36.5 mg/L. Only one well in the lower Cache River watershed has been sampled once for analysis of the full range of water quality parameters within the last 5 years (USGS 2015b).

3.2.2.2.4. ANRC

Temperature, specific conductance, and pH have been measured at the ANRC monitoring wells in the upper Cache River watershed. The specific conductance measurements at these wells ranged from 745 microsiemens/cm to 1,540 microsiemens/cm (USGS 2014a). Specific conductance levels above 1,000 microsiemens/cm, which occurred in four of the seven wells, indicate high concentrations of dissolved solids. High levels of dissolved solids may be the result of the movement of groundwater up into the MRV from a deeper aquifer (Schrader 2010).

3.2.2.2.5. Groundwater Quality Summary

- Available data indicate that chloride, pesticides, and arsenic are not present at harmful levels in the MRV groundwater of the upper Cache River watershed.
- High levels of minerals, iron, and manganese do occur in the MRV in the upper Cache River watershed.
- Iron and manganese concentrations in the MRV groundwater of the lower Cache River watershed usually exceed SMCLs.

- Chloride concentrations above the SMCL do occur in the Brinkley area, but are not widespread. Chloride concentrations measured in USGS wells were all below the SMCL.
- TDS concentrations above the SMCL occur in the majority of the wells in the Brinkley area.
- Levels of inorganic nitrogen and arsenic in the groundwater in the Brinkley area are less than the drinking water standards.
- Pesticides 2,4-D and Bentazon have been detected in irrigation wells within the lower Cache River watershed.

3.2.2.3 Groundwater Quality Threats

ADEQ has identified the following potential threats to groundwater quality in the Jonesboro groundwater monitoring area in the upper Cache River watershed; pesticides, industrial solvents, landfill leachate, and septic systems. A number of leaking groundwater storage tanks have been identified at gas stations in the Jonesboro area (Section 4.1.3.2). These leaking tanks have the potential to impact local groundwater quality. Water quality data from the monitoring wells within the upper Cache River watershed does not indicate current contamination from any of these sources.

ADEQ has identified saltwater intrusion (chloride) and pesticides as potential threats to groundwater quality in the Brinkley groundwater monitoring area in the lower Cache River watershed. Pesticides have been detected in irrigation wells in the lower Cache River watershed. A number of leaking underground storage tanks have been identified by ADEQ in the lower Cache River watershed. These leaking tanks have the potential to impact local groundwater quality. Chloride levels in the monitoring wells within the lower Cache River watershed do not indicate existing saltwater intrusion.

3.2.3 Hydrologic Data

This section describes available surface water flow and groundwater level data from the Cache River watershed.

3.2.3.1 Upper Cache River Watershed Surface Water Flow Data

The USGS is the primary agency that monitors stream flow in the upper Cache River watershed. Table 3.11 lists active and historical USGS flow gages located in the upper Cache River watershed. There is one active USGS gage station within the upper Cache River watershed, 07077380 on the Cache River at Egypt, AR. This gage is a continuous monitoring site (USGS 2015c).

Table 3.11. Active and historical USGS flow gages located within the upper Cache River watershed.

Gage ID Number	Stream	Continuous dates	Daily dates	Peak dates	Measurement Dates
07077080	Little Cache Ditch 1	NA*	NA	NA	2/17/01 – 5/22/03
07077100	Big Creek	NA	NA	9/14/62 – 7/4/04	2/26/62 – 12/17/02
07077200	Big Creek Tributary	NA	NA	4/30/62 – 7/4/04	2/26/62 – 3/26/02
07077300	Cache River	NA	NA	NA	11/12/58 – 10/22/87
07077340	Sugar Creek Tributary	NA	NA	3/4/63 – 11/27/85	3/4/63 – 12/4/73
07077380	Cache River	10/1/07 – 1/13/15	10/1/64 – 1/12/15	2/22/38 – 5/8/13	10/24/64 – 10/7/14
07077430	Willow Ditch	NA	NA	5/27/63 – 4/22/04	8/16/95 – 12/17/01
07077650	Big Creek	NA	NA	11/19/88 – 4/24/04	9/18/57 – 10/23/02
07077655	Christian Creek	NA	NA	6/15/94 – 4/24/04	2/15/02 – 2/16/02
07077660	Bayou DeView	NA	NA	NA	7/1/74 – 12/14/09

* not available

USGS StreamStats is an online utility that can be used to estimate flows at ungaged sites along streams. Using StreamStats, it was possible to estimate flows at the two ADEQ water quality sites on the upper Cache River using nearby gages. However, StreamStats was not able to estimate flows for the ADEQ stations on upper Bayou DeView, due to the lack of nearby stream gages, and because regional regression equations for estimating flow were not available for the area (USGS 2014b).

The TNC conducted an analysis of surface water flow recorded at USGS gages in the Cache River watershed. The only USGS gage in the upper Cache River watershed is on the Cache River (at Egypt), so there was no discussion of flow characteristics in the headwaters of Bayou DeView.

The hydrograph for the Cache River gage at Egypt exhibits rapid changes in flow in response to rainfall. This characteristic is typical in both headwaters and in channelized systems (TNC 2005). Since the portion of Bayou DeView in the upper Cache River watershed shares these characteristics, it is likely that flows in Bayou DeView and its tributaries also exhibit rapid changes in response to rainfall.

TNC's analysis found that there is more variability and higher flows in the Cache River at Egypt during the months from November through May, and less variability and lower flows during the months June through December. They also found that periods of very low flow, or stagnant conditions, occur in the Cache River at Egypt (TNC 2005). The 7Q10 flow for this gage is 14 cfs (USGS 2014b).

The TNC analysis also found an increasing trend in the number of high flow events per year at the Cache River gage at Egypt, as well as increasing trends in the number of low flow events, and the number of zero flow days per year. The durations of both high flow events and low flow events appeared to be decreasing over time. These changes were characterized as responses to man-made changes to the hydrology of the watershed, e.g., channelization, addition of drainage ditches, and irrigation (TNC 2005). A recent study by the USGS found a statistically significant increasing trend in fall and winter rainfall within the Arkansas Delta region (Wagner, Krieger and Merriman 2014).

3.2.3.2 Lower Cache River Watershed Surface Water Flow Data

The USGS and USACE Memphis District monitor stream flow in the lower Cache River watershed. Table 3.12 lists active and historical USGS flow gages located in the lower Cache River watershed. There are three active USGS gage stations in the lower Cache River watershed. All three are continuous monitoring gages (Table 2.3) (USGS 2015c). The USACE monitors river stage in the Cache River and Bayou DeView at four real-time gages (Table 3.13). Three of the USACE gages are at the same locations as USGS gages (USACE 2015b).

Table 3.12. Active and historical USGS flow gages located within the lower Cache River watershed.

Gage No.	Stream	Location	Continuous dates	Daily dates	Peak dates	Measurement Dates
07077555	Cache River	Cotton Plant	10/1/2007 – 5/26/2015	4/3/1987 – 5/25/2015	7/13/1987 – 12/28/2013	4/22/1987 – 4/24/2015
07077500	Cache River	Patterson	10/1/2007 – 5/26/2015	NA*	4/18/1921 - 2014	4/22/1987 – 11/5/2014
07077730	Bayou DeView	Brinkley	11/24/2013 – 5/26/2015	NA	2014	10/20/1987
07077700	Bayou DeView	Morton	NA	NA	4/5/1933 – 5/10/2009	8/2/1997 – 11/6/2014
07077680	Three-mile Creek	Amagon	NA	NA	5/6/1961 – 7/22/1980	3/9/1961 – 11/7/1972
07077560	Cache River	Little Dixie	NA	NA	NA	10/20/1987
07077675	Bayou DeView	Waldenburg	NA	NA	NA	6/23/1966 – 10/19/1987
07077682	Bayou DeView	Hickory Ridge	NA	NA	NA	10/27/1965 – 7/25/1966

*not available

Table 3.13. USACE gages located within the lower Cache River watershed (USACE 2015b).

Gage No.	Stream	Location	Measurement	Start Year
CR113	Cache River	Patterson	Stage	1911
CR115	Cache River	Little Dixie	Stage, Precipitation	2012
CR114	Cache River	Brasfield	Stage, Precipitation	1911
BD111	Bayou DeView	Morton	Stage	1911

The TNC conducted an analysis of surface water flow recorded at USGS gages in the Cache River watershed. TNC's analysis found that the highest variability and highest flows at the Cache River USGS gages (07077500 at Patterson and 07077555 at Cotton Plant) and Bayou DeView gage (07077700 at Morton) occur during the months from December through May, and there is less variability and lower flows during the months June through November. They also found that periods of very low flow, or stagnant conditions, occur in the Cache River at Patterson and Bayou DeView at Morton, but not in the Cache River at Cotton Plant (TNC 2005). Values for 7Q10 flow determined by TNC are listed in Table 3.14.

Table 3.14. 7Q10 flows for USGS gages in the lower Cache River watershed (TNC 2005).

Station ID	Location	7Q10 Flow (cfs)
07077500	Cache R at Patterson	5
07077555	Cache R at Cotton Plant	27
07077700	Bayou DeView at Morton	0

TNC also analyzed long term flow records at two of the USGS gages in the lower Cache River watershed (07077500 Cache R at Patterson, and 07077700 Bayou DeView at Morton) to identify changes in the hydrology. The overall conclusion of the analysis was that the flow regime in the lower Cache River watershed had become more “spiky”, i.e., exhibiting more rapid variability, over time (TNC 2005).

3.2.3.3 Flood Data

Flood events in the Cache River watershed are tracked by the USGS, Farm Bureau, and FEMA. The USGS tracks flood events using their flow gages (Perry 2000). FEMA and the Farm Bureau track flood events through requests for assistance and determination of levels of damage (FEMA 2015b). The National Weather Service also compiles information on flood damage (National Weather Service 2015). FEMA flood declarations over the last 10 years for each of the counties in the Cache River watershed are summarized in Table 3.15. Cross County has the lowest number of flood declarations over the last 10 years, and Jackson County has the highest number. Note that these flood declarations do not necessarily involve the Cache River.

Table 3.15 FEMA flood declarations in counties of the Cache River watershed.

Year	Clay	Craighead	Cross	Greene	Jackson	Monroe	Prairie	Poinsett	Woodruff
2004	0	0	0	0	1	0	0	0	1
2005	0	0	0	0	0	0	0	0	0
2006	0	0	0	1	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0
2008	2	2	1	2	1	1	2	1	1
2009	1	2	1	3	4	3	3	4	2
2010	0	0	0	0	0	0	0	0	0
2011	1	1	1	1	1	1	1	1	1
2012	0	0	0	0	0	0	0	0	0
2013	0	0	1	0	0	0	0	1	1
2014	1	0	0	0	1	0	0	0	0
Total	5	5	4	7	8	5	6	7	6

3.2.3.4 Groundwater Level in the Upper Cache River Watershed

The upper Cache River watershed is within the Cache Groundwater Study Area. Groundwater level measurements are collected at least once a year from 41 wells within the upper Cache River watershed in a cooperative effort involving ANRC, USGS, and NRCS. In addition, the USGS has operated a continuous groundwater level monitoring well in Craighead County within the watershed since December 2009 (USGS 2015d). In addition to water level monitoring, the USGS Mississippi Embayment Regional Aquifer Study model encompasses the upper Cache River watershed (Clark and Hart 2009, Clark, Hart and Gurdak 2011).

Over the last 10 years, water levels in the MRV alluvial aquifer within the upper Cache River watershed have declined. Average water level declines in the upper Cache River watershed over the last 10 years range from 4.45 ft in Clay County to 9.21 ft in Craighead County. The upper Cache River watershed west of Crowley's Ridge in Clay, Craighead, and Greene Counties is designated as a critical groundwater area. The remainder of the watershed west of Crowley's Ridge is designated as a groundwater study area. In the spring of 2014, depths to water in the MRV under the upper Cache River watershed ranged from less than 17 ft to over 94 ft (ANRC 2015).

3.2.3.5 Groundwater Levels in the Lower Cache River Watershed

The lower Cache River watershed is within the Cache groundwater Study Area. Groundwater level measurements are collected at least once a year from 37 wells in the lower Cache River watershed in a cooperative effort involving ANRC, USGS, and NRCS (ANRC 2014, USGS 2015d). In addition to water level monitoring, the USGS Mississippi Embayment Regional Aquifer Study model encompasses the lower Cache River watershed (Clark and Hart 2009, Clark, Hart and Gurdak 2011).

Over the last 10 years, water levels in the MRV alluvial aquifer within the lower Cache River watershed have declined. Average water level declines in the lower Cache River watershed over the last 10 years range from 2.32 ft in Monroe County to 11.1 ft in Poinsett County. The lower Cache River watershed west of Crowley's Ridge in Cross, Poinsett, and Prairie Counties is designated as a critical groundwater area. The remainder of the watershed west of Crowley's Ridge is designated as a groundwater study area. In the spring of 2014, depths to water in the

MRV under the lower Cache River watershed ranged from less than 17 ft to over 94 ft (ANRC 2015).

3.2.3.6 Interaction between Groundwater and Surface Water

The interaction between groundwater and surface water varies throughout the Delta region of Arkansas. In the lower Cache River watershed, the Cache River channel is known to be deeper than the silt and clay layer that covers the MRV in much of the Delta, and thus is hydraulically connected to the MRV (Gonthier and Kleiss 1996). The USGS Mississippi Embayment Regional Aquifer Study model includes a portion the upper Cache River, indicating that there is a hydraulic connection between at least part of the upper Cache River and the MRV (Clark and Hart 2009). Therefore, it is possible that declining water levels in the MRV may be influencing flow in the upper Cache River, and may account for some of the changes observed in the flow characteristics at the USGS gage on the Cache River at Egypt (Section 3.2.3.1). No information was found to suggest that Bayou DeView is considered to be hydraulically connected to the MRV (Czarneki, Clark and Reed 2003, Clark and Hart 2009).

3.2.4 Biological Data

This section describes available biological data from the Cache River watershed, including information on aquatic nuisance species, species of concern, and migratory patterns.

3.2.4.1 Upper Cache River Watershed Biological Sampling

ADEQ has sampled macroinvertebrates and fish in the upper Cache River watershed. Macroinvertebrate and fish sampling occurred at locations on upper Bayou DeView, Big Creek Ditch, and Lost Creek Ditch in the mid 1980s and late 1990s. The most recent data are from 1996 (ADEQ 2015c), (ADEQ 2015d).

During the TNC water quality survey of the Cache River watershed, macroinvertebrate and fish community data were collected at the 14 monitoring locations in the upper Cache River watershed (see Figure 3.1). The objectives of the biological sampling was “to describe fishes and macroinvertebrates of the Cache River watershed in 2004 and 2005 that (1) can be used for comparative purposes, and (2) will serve as a biological baseline.” Several of the Cache River monitoring locations were dry during one or more of the biological sampling dates (Table 3.16). As a result, less than four biological samples were collected at these sites (TNC 2005).

Table 3.16. TNC sites in the upper Cache River watershed where biological data were not collected (TNC 2005).

Station	Quarter 1 May 2004	Quarter 2 October 2004	Quarter 3 March 2005	Quarter 4 May 2005
CR012	Sampled	Sampled	Sampled	**Dry – no sample**
CR014	**Dry – no sample**	**Dry – no sample**	Sampled	Sampled
CR015	Sampled	**Dry – no sample**	Sampled	Sampled
CR016	Sampled	**Dry – no sample**	**Dry – no sample**	Sampled
CR018	Sampled	**Dry – no sample**	Sampled	Sampled
CR019	Sampled	**Dry – no sample**	Sampled	Sampled
CR020	Sampled	**Dry – no sample**	Sampled	Sampled

As part of the National Aquatic Resources Survey, EPA collected data in June of 2009 and developed indices of biological condition at a site on Caney Slough in the upper Cache River watershed (EPA 2015b).

3.2.4.2 Lower Cache River Watershed Biological Sampling

During the TNC water quality survey of the Cache River watershed, macroinvertebrate and fish community data were collected at 11 of the 16 monitoring locations in the lower Cache River watershed (see Figure 3.2). The objective of the biological sampling was “to describe fishes and macroinvertebrates of the Cache River watershed in 2004 and 2005 that (1) can be used for comparative purposes, and (2) will serve as a biological baseline.” (TNC 2005).

ADEQ has conducted macroinvertebrate sampling at one location on lower Bayou DeView. These data were collected in 2003 (ADEQ 2015c). ADEQ, with TNC and AGFC, conducted fish and macroinvertebrate surveys in the Cache River below Bayou DeView. These surveys were part of the projects to restore meanders cut off by channelization. Pre-restoration surveys were completed in 2012, and post-restoration surveys were completed in 2014 (T. Wentz, ADEQ, personal communication 12/1/2015).

In 2006, EPA began a program to conduct probability-based surveys of the condition of the nation's water resources. Biological sampling was conducted at Lake Hogue in the lower Cache River watershed in 2007 and 2009 as part of this program (EPA 2013a).

Arkansas Game and Fish Commission is proposing a fish community survey in the Cache River downstream of Highway 33. This survey would take place in 2017 (AGFC 2015a).

3.2.4.3 Upper Cache River Biological Condition

Because the biological data available from ADEQ is 20 years old, it will not be discussed here. The information in this section is from the TNC intensive study of the Cache River watershed, and the EPA National Aquatic Resources Survey.

The character of the biological communities observed in the upper Cache River watershed during the TNC study tended to vary depending whether sites were located on stream reaches that had recently been channelized or maintained (CR012, CR015, CR016, CR019, CR020, CR021, CR022, DV008), or had been channelized in the past but not maintained within the last 15 years (CR014, CR017, CR018, DV009, DV010, DV011) (TNC 2005).

3.2.4.3.1. Benthic Macroinvertebrates

A total of 1,481 benthic macroinvertebrates were identified in the 2004 and 2005 samples collected from 14 study sites for the TNC study, representing14 families and 39 orders. There was a great deal of variability in all of the macroinvertebrate indices presented in the TNC intensive water quality survey: taxa richness, relative abundance, diversity, community evenness, EPT percentage, and Chironomidae percentage. Such differences were expected, given the variation in watershed size and anthropogenic disturbance among sites. Sites located in stream reaches that had recently been channelized or maintained generally had benthic macroinvertebrate communities characteristic of impaired watersheds, i.e. exhibiting low taxa richness, diversity, and percent EPT; and relatively high percent Chironomidae. Sites located in stream reaches that had historically been channelized but not recently maintained tended to have macroinvertebrate communities indicative of healthy ecosystems (TNC 2005).

EPA classified the 2009 condition of Caney Creek as poor based on the benthic MMI score (EPA 2015b).

3.2.4.3.2. Fish

A total of 2,444 fishes representing 41 species were collected from 14 study sites within the upper Cache River watershed during the TNC study. There tended to be greater variability in fish community indices among sites on the Cache River than those in the Bayou DeView headwaters. The fish populations within the recently channelized streams in the upper Cache River watershed (e.g., CR022) were characterized by having few specialist and gamefish species, and an abundance of generalist species able to tolerate extremes of temperature, turbidity, and DO. Fish populations at historically channelized sites varied widely. Some sites (e.g., CR017, CR018, and DV011) supported diverse fish assemblages, although they lack the specialist lowland species characteristic of the Mississippi River Alluvial Plain. While fish populations at other sites, such as CR014, CR015, DV009 and DV011, were more similar to those found at recently channelized sites (TNC 2005).

EPA classified the condition of the fish assemblage observed in Caney Creek in 2009 as fair (EPA 2015a).

3.2.4.3.3. Periphyton

EPA collected periphyton data from Caney Creek in 2009 as part of the National Aquatic Resources Survey. Based on this data, EPA classified the condition of the periphyton assemblage in Caney Creek in 2009 as good (EPA 2015b).

3.2.4.4 Lower Cache River Watershed Biological Condition

This section discusses the results of biological sampling conducted in the lower Cache River watershed within the last 15 years. This includes biological sampling by ADEQ, TNC, and EPA.

3.2.4.4.1. Benthic Macroinvertebrates

Benthic macroinvertebrate sampling has been conducted by ADEQ and TNC in the lower Cache River watershed. Results of these sampling efforts are summarized below.

At Bayou DeView at Highway 145, ADEQ collected and identified 82 macroinvertebrates representing 22 species from 10 families (ADEQ 2015c).

A total of 1,121 benthic macroinvertebrates were identified from the TNC study sites, representing 13 families and 28 orders. There was a great deal of variability in all of the macroinvertebrate indices presented by TNC; taxa richness, relative abundance, diversity, community evenness, EPT percentage, and Chironomidae percentage. Such differences were expected, given the variation in watershed size and anthropogenic disturbance among sites. The data collected for the TNC survey were not intended for making comparisons among sites in the watershed, nor for characterizing the environmental quality within the watershed. The character of the biological communities observed in the lower Cache River watershed tended to vary depending whether sites were located on unaltered stream reaches (CR003, CR007, CR008, DV003, DV004), had been channelized in the past but not maintained within the last 15 years (CR010, DV005, DV006, DV007), or had been recently channelized or maintained (CR004, CR011) (TNC 2005).

The TNC sampling site DV004 is on Bayou DeView at Highway 145, the same location ADEQ sampled in 2003. TNC and ADEQ indices for taxa richness were similar. However, the ADEQ sample had EPT and Chironomidae percentages that were two to four times higher than the TNC samples.

3.2.4.4.2. Fish

Fish sampling has been conducted by ADEQ and TNC in the lower Cache River watershed. A total of 1,222 fishes representing 47 species were collected from the 11 TNC study sites within the lower Cache River watershed in 2004 and 2005. There tended to be greater variability in fish community indices among sites on the Cache River than Bayou DeView sites. Fish communities at sites where channels were unaltered (CR003, CR007, CR008, DV003, DV004) were characteristic of healthy Delta ecosystems, with diverse populations that included many specialist species. The fish populations within the recently channelized streams in the lower Cache River watershed (CR004, CR011) were characterized by having few specialist and gamefish species, and an abundance of generalist species able to tolerate extremes of temperature, turbidity, and DO. Fish communities at historically channelized sites in the lower Cache River watershed (not maintained in 15 years or more) tended to be very similar to those at sites on unaltered channels. The fisheries data collected during this survey were not intended for making comparisons among sites in the watershed, nor for characterizing the environmental quality within the watershed (TNC 2005).

ADEQ collected fish from Bayou DeView near the location of the TNC sampling site DV004, in 1985 (ADEQ 2015d). The number of species identified from the 1985 sample, 23, is almost identical to the number of species identified by TNC in their four samples, 24. Four species identified by ADEQ were not reported by TNC. In addition, ADEQ did not report any individuals of *Lepomis cyanellus* (green sunfish), while TNC did.

3.2.4.4.3. Periphyton

EPA collected periphyton from Lake Hogue in Poinsett County during 2007 and 2009 as part of the National Aquatic Resources Survey National Lakes Assessment. Based on these periphyton data, EPA classified the condition of Lake Hogue as similar to least disturbed conditions (EPA 2013b).

3.2.4.5 Aquatic Nuisance Species

Two aquatic species that have been designated by AGFC as nuisance species are found in the Cache River watershed; Silver Carp, (*Hypophthalmichthys molitrix*), and Nutria (Myocastor coypus). See Section 2.1.10 for additional information.

3.2.4.6 Species of Concern

Several protected species occur in the Cache River watershed (see Section 2.1.12). AGFC has identified additional non-plant species of greatest conservation need (SGCN) in the state, and ANHC has identified rare plant and animal species for the state. These species of concern that are known to occur in the Cache River watershed are listed in Tables 3.17 and 3.18.

Table 3.17. Species of Concern from the upper Cache River watershed.

Common name	Scientific name	Category	AGFC	State Rank	Counties
Cooper’s Hawk	*Accipiter cooperii*	Vertebrate	None	Extremely rare to uncommon	Craighead
Mole Salamander	*Ambystoma talpoideum*	Vertebrate	None	Rare to uncommon	Clay, Greene, Jackson
Western Sand Darter	*Ammocrypta clara*	Vertebrate	SGCN	Very rare	Clay, Jackson, Lawrence
Woolly Three-Awn	*Aristida lanosa*	Plant	None	Very rare	Greene
Brome Sedge	*Carex bromoides spp bromoides*	Plant	None	Very rare	Greene
Palm Sedge	*Carex muskingumensis*	Plant	None	Extremely rare	Jackson, Lawrence
Spreading Oval Sedge	*Carex normalis*	Plant	None	Extremely rare	Craighead, Greene
Opaque Prairie Sedge	*Carex opaca*	Plant	None	Very rare to uncommon	Clay
Woolly Sedge	*Carex pellita*	Plant	None	Extremely to very rare	Lawrence
Tussock Sedge	*Carex stricta*	Plant	None	Rare to uncommon	Greene
Northern Scarletsnake	*Cemophora coccinea copei*	Vertebrate	None	Rare to uncommon	Greene
White Turtlehead	*Chelone glabra*	Plant	None	Extremely rare	Greene
Southern Painted Turtle	*Chrysemys dorsalis*	Vertebrate	None	Rare to uncommon	Craighead, Greene, Jackson, Lawrence
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*	Vertebrate	None	Rare to uncommon	Clay, Craighead, Greene, Jackson, Lawrence
Hazel Dodder	*Cuscuta coryli*	Plant	None	Status uncertain	Greene
Blue Sucker	*Cycleptus elongates*	Vertebrate	SGCN	Very rare	Clay
Western Chicken Turtle	*Deirochelys reticularia miaria*	Vertebrate	None	Rare to uncommon	Craighead, Jackson
Goldstripe Darter	*Etheostoma parvipinne*	Vertebrate	SGCN	Very rare	Greene
Bald Eagle	*Haliaeetus leucocephalus*	Vertebrate	None	Very rare	Craighead, Greene, Jackson, Lawrence
Butternut	*Juglans cinerea*	Plant	None	Rare to uncommon	Clay, Greene
Corkwood	*Leitneria floridana*	Plant	None	Rare to uncommon	Clay, Craighead, Greene, Jackson, Lawrenece
Northern Crawfish Frog	*Lithobates areolatus circulosus*	Vertebrate	None	Very rare	Craighead
Big-Leaf Magnolia	*Magnolia macrophylla*	Plant	None	Extremely rare	Clay
Pealip Redhorse	*Moxostoma pisolabrum*	Vertebrate	SGCN	Very rare	Clay, Greene, Lawrence
Long-Tailed Weasel	*Mustela frenata primulina*	Vertebrate	None	Rare to uncommon	Craighead, Jackson
Southeastern Myotis	*Myotis austroriparius*	Vertebrate	None	Rare to uncommon	Clay

Table 3.17. Species of Concern from the upper Cache River watershed (continued).

Common name	Scientific name	Category	AGFC	State Rank	Counties
Mississippi Green Watersnake	*Nerodia cyclopion*	Vertebrate	None	Rare to uncommon	Craighead, Greene, Jackson
Taillight Shiner	*Notropis maculates*	Vertebrate	None	Rare to uncommon	Craighead, Greene, Jackson, Lawrence
Sabine Shiner	*Notropis sabinae*	Vertebrate	SGCN	Very rare	Clay, Jackson, Lawrence
Southern Hickorynut	*Obovaria jacksoniana*	Invertebrate	None	Very rare	Lawrence
Brand's Scorpion-Weed	*Phacelia gilioides*	Plant	None	Very rare to uncommon	Lawrence
Purple Fringeless Orchid	*Platanthera peramoena*	plant	None	Very rare	Clay, Craighead, Lawrence
Fat Pocketbook	*Potamilus capax*	invertebrate	SGCN	Extremely rare	Craighead
Graham's Crayfish Snake	*Regina grahamii*	vertebrate	None	Very rare	Craighead, Greene
Leafy Bulrush	*Scirpus polyphyllus*	plant	None	Very rare	Greene
Hardhack	*Spiraea tomentosa*	Plant	None	Very rare	Greene
Bewick's Wren	*Thryomanes bewickii*	vertebrate	None	Extremely rare	Clay, Craighead
Purple Lilliput	*Toxolasma lividum*	Invertebrate	SGCN	Very rare	Craighead, Greene, Jackson, Lawrence
Central Mudminnow	*Umbra limi*	vertebrate	None	Historically present, not found recently	Clay
Brown Bullhead	*Ameiurus nebulosus*	vertebrate	SGCN	Very rare	Craighead

Table 3.18. Species of concern from lower Cache River watershed.

Common name	Scientific name	Category	AGFC	State Rank	Counties
Western Sand Darter	*Ammocrypta clara*	Vertebrate	SGCN	Very rare	Jackson
Opaque Prairie Sedge	*Carex opaca*	Plant	None	Very rare to uncommon	Monroe, Poinsett
Southern Painted Turtle	*Chrysemys dorsalis*	Vertebrate	None	Rare to uncommon	Cross, Jackson, Poinsett, Woodruff
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*	Vertebrate	None	Rare to uncommon	Cross, Jackson, Monroe, Poinsett, Woodruff
Blue Sucker	*Cycleptus elongates*	Vertebrate	SGCN	Very rare	Jackson
Western Chicken Turtle	*Deirochelys reticularia miaria*	Vertebrate	None	Rare to uncommon	Jackson, Poinsett
Bald Eagle	*Haliaeetus leucocephalus*	Vertebrate	None	Very rare	Cross, Jackson, Monroe, Poinsett, Woodruff
Corkwood	*Leitneria floridana*	Plant	None	Rare to uncommon	Jackson, Woodruff
Pealip Redhorse	*Moxostoma pisolabrum*	Vertebrate	SGCN	Very rare	Monroe
Long-Tailed Weasel	*Mustela frenata primulina*	Vertebrate	None	Rare to uncommon	Cross, Jackson, Woodruff
Mississippi Green Watersnake	*Nerodia cyclopion*	Vertebrate	None	Rare to uncommon	Jackson, Poinsett
Southeastern Myotis	*Myotis austroriparius*	Vertebrate	None	Rare to uncommon	Jackson, Monroe, Poinsett, Woodruff
Taillight Shiner	*Notropis maculates*	Vertebrate	None	Rare to uncommon	Jackson, Monroe, Poinsett
Sabine Shiner	*Notropis sabinae*	Vertebrate	SGCN	Very rare	Jackson, Monroe
Paddlefish	*Polyodon spathula*	Vertebrate	SGCN	Very rare?	Jackson, Monroe, Woodruff
Graham's Crayfish Snake	*Regina grahamii*	Vertebrate	None	Very rare	Monroe, Poinsett, Woodruff

3.2.4.7 Migratory Patterns

The Cache River watershed is located in the Mississippi Flyway and the Lower Mississippi River Ecosystem. The Lower Mississippi River Ecosystem is the primary wintering habitat for mid-continent waterfowl populations, as well as breeding and migrating habitat for songbirds returning from Central and South America (USFWS 2012). The wetlands and wooded areas in the lower Cache River watershed provide important winter habitat for waterfowl from the northern prairies and Great Lakes. Most years, more Mallard ducks overwinter in Arkansas than anywhere else in North America (Ducks Unlimited 2014). Large numbers of raptors also winter in this area, including Bald Eagles, and Red-tailed Hawks (Audubon Arkansas 2015).

These wetlands and wooded areas are also important for the support of migrating birds that use the Mississippi Flyway. These include waterfowl, shorebirds, songbirds, and raptors. A number of migratory songbirds breed in these areas, including Acadian Flycatcher, Wood Thrush, and several species of warblers (Audubon Arkansas 2015).

3.2.4.8 Data Gaps

The only recent collection and evaluation of macroinvertebrates or fish identified is from a relatively short segment of the Cache River downstream of Bayou DeView. It could be useful to ascertain whether there have been any changes in the biological communities of the streams studied during the TNC water quality intensive. Evaluation of biotic integrity through sampling macroinvertebrates and/or fish is a proven approach for reliably assessing and tracking the effects of human activities on streams and watersheds. No information on an index of biotic integrity for Delta region streams was found.

3.2.4.9 Biological Condition Summary

- The character of the macroinvertebrate and fish communities in the upper Cache River watershed vary as a result of watershed size and the presence/absence and frequency of channelization and channel clearing.
- Two Arkansas Aquatic Nuisance Species are present in the upper Cache River watershed; nutria and silver carp.
- The character of the macroinvertebrate and fish communities in the lower Cache River watershed vary as a result of watershed size and the presence or absence, and frequency, of channelization and channel clearing.
- Two Arkansas Aquatic Nuisance Species are present in the lower Cache River watershed; nutria and silver carp.

3.2.5 Stream Habitat Survey Data

Stream habitat survey data includes aspect, channel type, bedload, substrate, streambank stability, slump potential, large woody debris, and riparian vegetation. This data can be used to create maps of areas of concern such as slumping, wetlands, and erosion, as well as to establish trends within the watershed. Stream habitat surveys within the Cache River watershed are described below.

3.2.5.1 ADEQ

ADEQ collects data on stream habitat when sampling macroinvertebrates and fish. See information on ADEQ macroinvertebrate and fish sampling in the Cache River watershed in Section 3.2.4. Information collected includes condition of stream banks, riparian vegetation, stream sinuousity, substrate, stream alteration, and index of habitat integrity (ADEQ 2015c,d).

3.2.5.2 TNC

During the 2003 TNC water quality assessment of the Cache River watershed, a survey of channel geomorphology and sediment flux was conducted. Channel cross sections were surveyed at 13 locations within the upper Cache River watershed, and 16 locations within the lower Cache River watershed. Bedload and suspended sediment fluxes for the Cache River and the Bayou DeView were determined for four sample events throughout the project period. (TNC 2005).

No significant changes in channel morphology were observed during the time frame of the TNC project. TNC found that sediment fluxes were an order of magnitude greater than bedload fluxes throughout the watershed during low flow conditions (the data collected during the project was considered representative of low flow conditions only). The highest sediment fluxes occurred in the upper Cache River watershed, and were believed to be the result of the channelized and degraded stream channel conditions prevalent in that area of the watershed (TNC 2005).

TNC also collected stream survey data as part of the project to restore stream meanders in the Cache River downstream of Bayou DeView (T. Wentz, ADEQ, personal communication, December 1, 2005).

3.2.5.3 EPA

As part of the National Aquatic Resources Survey, EPA collected information on the condition of riparian vegetation, streambed stability, bed sediment condition, and instream cover in Caney Slough in Greene County. At this site, bed sediment condition was classified as good, riparian condition was classified as poor, riparian disturbance was classified as medium, and instream cover was classified as fair (EPA 2015b).

4.0 POLLUTANT SOURCE ASSESSMENT

This section summarizes available information on pollutant sources that are present in the Cache River watershed. This includes both nonpoint sources and point sources. The information presented in this section will be used to link the pollutants or problems discovered in the monitored data with possible sources of the pollutants or problems. Once the sources have been identified, then management strategies can be developed to control the sources. Information for the upper and lower Cache River watersheds are presented separately.

4.1 Upper Cache River Watershed

4.1.1 Nonpoint Sources

Nonpoint source pollution generally results from precipitation, land runoff, infiltration, drainage, seepage, hydrologic modification, or atmospheric deposition. As runoff from rainfall or snowmelt moves, it picks up and transports pollutants resulting from human activity, ultimately depositing them into rivers, lakes, wetlands, coastal waters, and ground water. Nonpoint sources that have been identified for the upper Cache River watershed include cropland and streambank erosion. One study in the Cache River watershed found a strong relationship between drainage area and TSS load (USGS 2015a). Septic systems and wildlife are other potential nonpoint sources in this watershed.

4.1.1.1 Cropland

Erosion from row crop agriculture is suspected as the nonpoint source of pollutants causing impairments within the upper Cache River watershed (ADEQ 2009, ADEQ 2014a, TNC 2005, ANRC 2012a). Almost 70% of the land in the upper Cache River watershed is cultivated cropland. Table 4.1 summarizes information on cropland for the counties that are part of the upper Cache River watershed, from the most recent Census of Agriculture.

Table 4.1. Agricultural statistics for counties in the upper Cache River watershed (USDA NASS 2014).

2012 Census	Clay County	Greene	Craighead	Lawrence	Poinsett
Cropland, ac	297,992	216,574	314,247	179,193	369,758
Soybeans, ac	123,078	68,510	120,617	68,171	181,181
Rice, ac	81,814	79,760	72,470	74,009	107,016
Corn, ac	39,327	31,644	32,238	6,430	21,834
Cotton, ac	32,586	10,054	73,547	0	36,326
Wheat, ac	7,810	7,633	7,831	6,523	18,769

Row crop agriculture is identified by ADEQ as the nonpoint source of pollutants impairing water quality in the upper Cache River watershed, including sediment, TDS, chloride, sulfate, and metals. ADEQ suspects that elevated metals in the watershed are associated with winter and spring storms that carry large amounts of clay particles into waterbodies, and that reduction in lead concentrations in the Cache River is the result of BMPs installed in the watershed to reduce erosion (ADEQ 2009, ADEQ 2014a).

In their phase I project assessing water quality in the Cache River watershed, TNC concluded that multiple sources contribute sediment to the system, including wet season agricultural runoff and headcutting in fields. The conclusion was that no one nonpoint source was the primary contributor (TNC 2005). At least one stakeholder at the 2015 watershed stakeholder meetings felt that producers had done as much as possible to reduce erosion and sediment in field runoff, i.e., widespread application of BMPs. He felt that erosion from row crops was no longer the primary nonpoint source of pollutants in the upper Cache River watershed. His conclusion was that streambank and channel erosion are now the primary nonpoint source of pollutants in the watershed.

Every 5 years the NRCS conducts state and national resource assessments to assess major impacts of agricultural practices on the environment. There are nine major resource concerns, including soil erosion and soil quality degradation, water quality degradation and inadequate habitat for fish and wildlife, and air quality degradation. The latest resource assessment for Arkansas was conducted in 2011. NRCS is currently planning for the 2016 resource assessment.

The state resource assessments are conducted at the 12-digit HUC scale. The resource assessment considers a variety of factors. For erosion impacts the factors considered include soil rainfall runoff erosivity factor (R), soil erodibility factor (K), slope length and steepness factor (LS), and a transport factor (T), a soil erodibility class obtained from the state SURGO soils database, soil vulnerability class, and the presence of streams on the state 303(d) list of impaired waterbodies. Figure 4.1 is a map of the NRCS relative ranking of the upper Cache River 12-digit HUC subwatersheds in terms of the potential for sheet/rill/wind erosion to impact surface water quality. Figure 4.2 is a map of the NRCS relative ranking of the upper Cache River subwatersheds in terms of the potential for concentrated flow (i.e., gully) erosion to impact surface water quality. On these maps, green indicates little or no impact, and red indicates a high potential for impact.

Irrigation runoff is a possible source of minerals impairing stream reaches in the upper Cache River watershed. Irrigation runoff can transport a variety of pollutants from fields into surface waters. In addition, mineral concentrations in the groundwater used for irrigation may not meet surface water quality standards. Three of the seven groundwater sulfate measurements in the upper Cache River watershed were above the Cache River sulfate numeric criterion (30 mg/L) and the numeric criterion for Bayou DeView, 38 mg/L. Three of the seven Groundwater TDS measurements in the upper Cache River watershed exceed the numeric TDS criterion for the Cache River (270 mg/L).

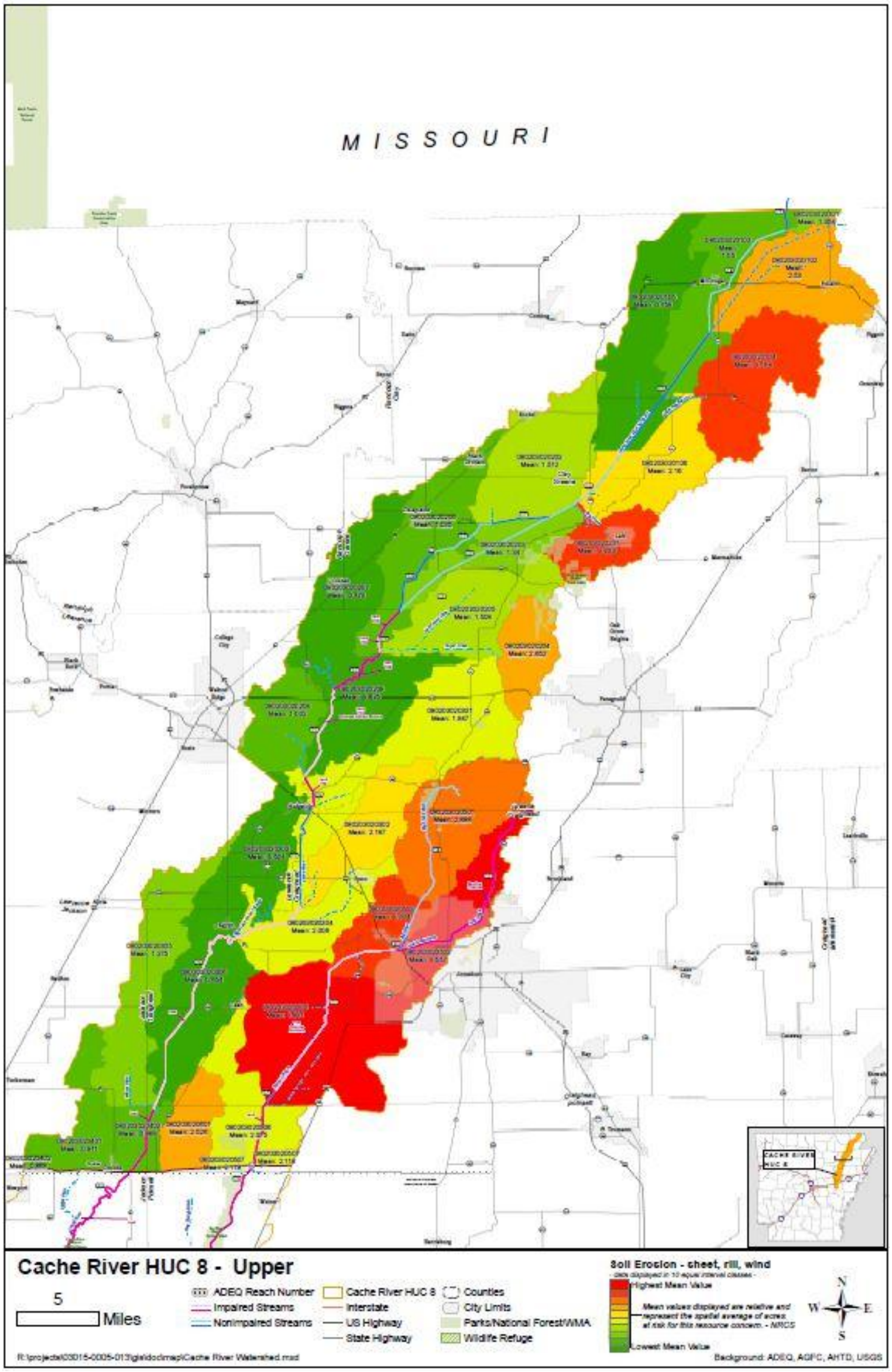


Figure 4.1. NRCS resource concern ranking of upper Cache River 12-digit HUC subwatersheds for sheet/rill/wind erosion.

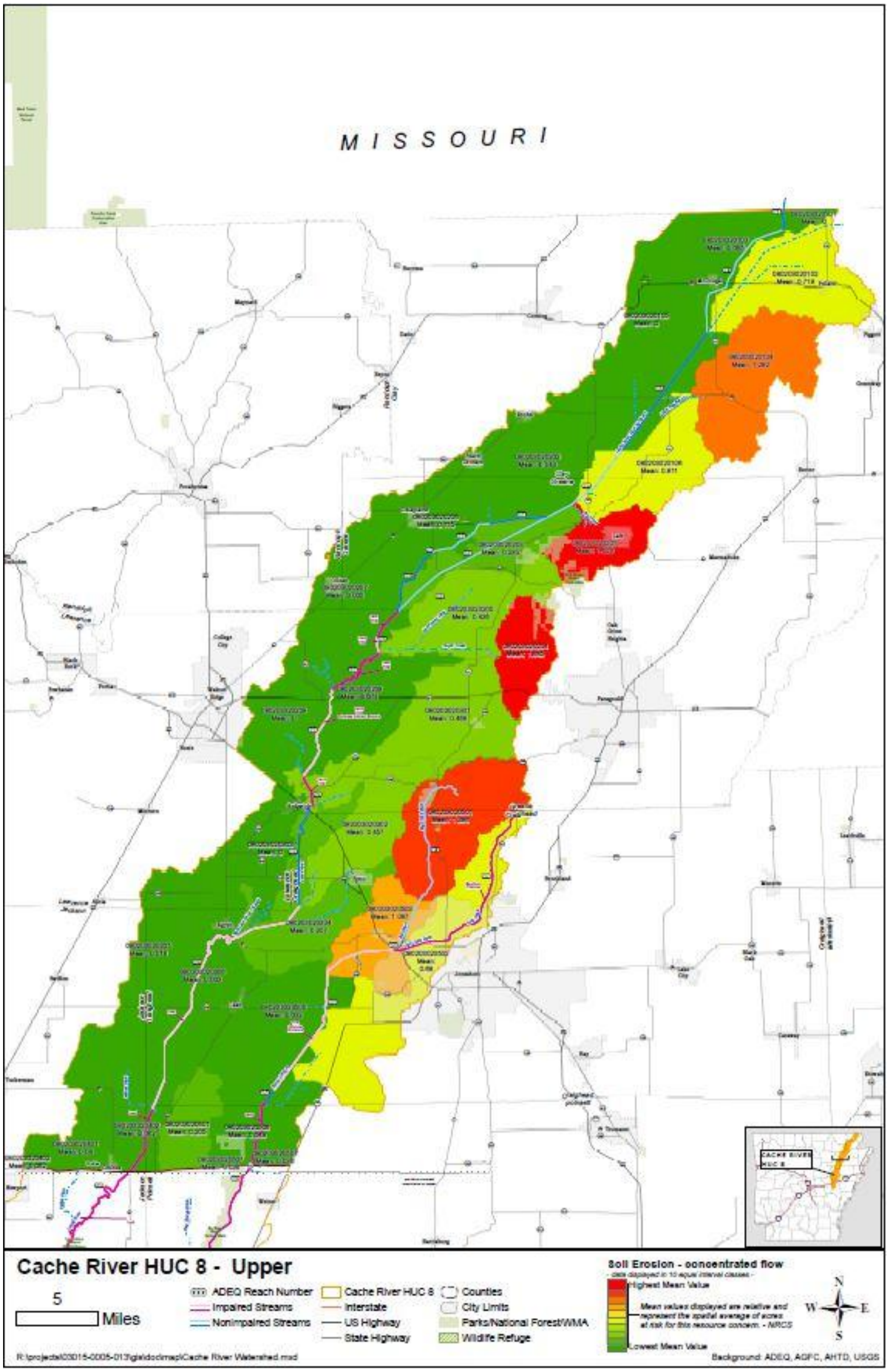


Figure 4.2. NRCS resource concern ranking of upper Cache River 12-digit HUC subwatersheds for concentrated flow (i.e., gully) erosion.

Table 4.2 summarizes the results of the streambank erosion potential analysis, reported as a Bank Erosion Hazard Index (BEHI), for the stream reaches in the upper Cache River watershed (TNC 2009). Swan Pond Ditch originates on Crowley's Ridge. The 9.4 miles of Swan Pond Ditch evaluated for streambank erosion potential is downstream of Crowley's Ridge. Given the characteristics of the soils on Crowley's Ridge, the erosion potential for the portions of Swan Pond Ditch on Crowley's Ridge is likely to be higher. Just over 13 miles of Willow Creek Ditch was evaluated for streambank erosion potential. The 9.4 miles of Skillet Ditch that were evaluated exhibited the highest BEHI values of any of the subwatersheds evaluated. The portion of Flag Slough Ditch evaluated for streambank erosion potential is downstream of the upper Cache River watershed. Therefore, results for Flag Slough Ditch are not included in Table 4.2.

Table 4.2. BEHI ranks for selected reaches of priority sub-watersheds in the upper Cache River watershed (TNC 2009).

Sub-watershed	Extreme	Very High	High	Moderate	Low	Very Low
Swan Pond Ditch	0	0	50%	28%	22%	0
Willow Ditch	0	0	10%	88%	2%	0
Skillet Ditch	9%	36%	8%	15%	24%	8%

In the National Aquatic Resources Survey, EPA found the riparian areas at the Caney Creek site to be moderately disturbed and the riparian vegetation to be in poor condition (EPA 2015b).

Streambank erosion is another resource concern assessed by NRCS every 5 yeras. Figure 4.3 is a map of the NRCS relative ranking of the upper Cache River 12-digit HUC subwatersheds in terms of the potential for streambank erosion to impact surface water quality. On this map, green indicates little or no impact, and red indicates a high potential for impact.

4.1.1.2 Channel Erosion

Streams in the upper Cache River watershed are extensively channelized and altered as a result of dredging and other channel maintenance activities. These channels are deeply incised, to the point that the floodprone elevation is below the top of the channel banks. Channel bankfull cross sectional areas measured at the beginning and the end of the TNC project period (2004 - 2005) showed no significant change in channel size during this period (TNC 2005). However, head cutting of stream channels has increased in the upper Cache River watershed, and is believed to be a major source of sediment entering the Cache River system (Binger, Wilcox and Gaines 2010).

TNC estimated bedload for the Cache River and Bayou DeView using quarterly samples collected during late 2004 and early 2005.The results of the bedload calculations indicate that the highest bedloads occurred in the Cache River downstream of CR019. The bedloads calculated by TNC represent low flow conditions (TNC 2005).

The USGS measured metals in a bed sediment sample from the Cache River near Egypt in September 1995. The copper concentration in the bed sediment less than 62.5 microns was 14 mg/kg, and lead was 17 mg/kg (USGS 2015b).

4.1.1.3 Gullies and Land Clearing on Crowley's Ridge

Soils on Crowley's Ridge are highly erodible. Gullies on Crowley's Ridge are a major source of sediment entering the upper Cache River and Bayou DeView (Binger, Wilcox and Gaines 2010, Heitmeyer 2010). The Big Creek subwatershed (i.e., Ditches No. 8 and No. 10) has been identified as a potentially significant contributor of sediment loading to the Cache River (Carmen 2008). The NRCS natural resources concern ranking map for concentrated flow (i.e., gully) erosion (Figure 4.2), shows a high potential for water quality impacts from gully erosion in 12-digit HUC subwatersheds on Crowley's Ridge. One study, using the Agricultural Non-Point Source Pollution Model, estimated that nearly 60% of the annual sediment load of the Cache River comes from only 10% of the basin area, the majority of which is on Crowley's Ridge (Binger, Wilcox and Gaines 2010). Land clearing activities, e.g. construction, industrial, and mining sites, and pasture conditions on Crowley's Ridge can contribute to gulley formation and sediment loading to the Cache River and Bayou DeView (USACE 2015a). Active mining operations in the upper Cache River watershed are listed in Tables 2.6 and 2.7. Construction and industrial sites are listed in Section 4.1.2.2.

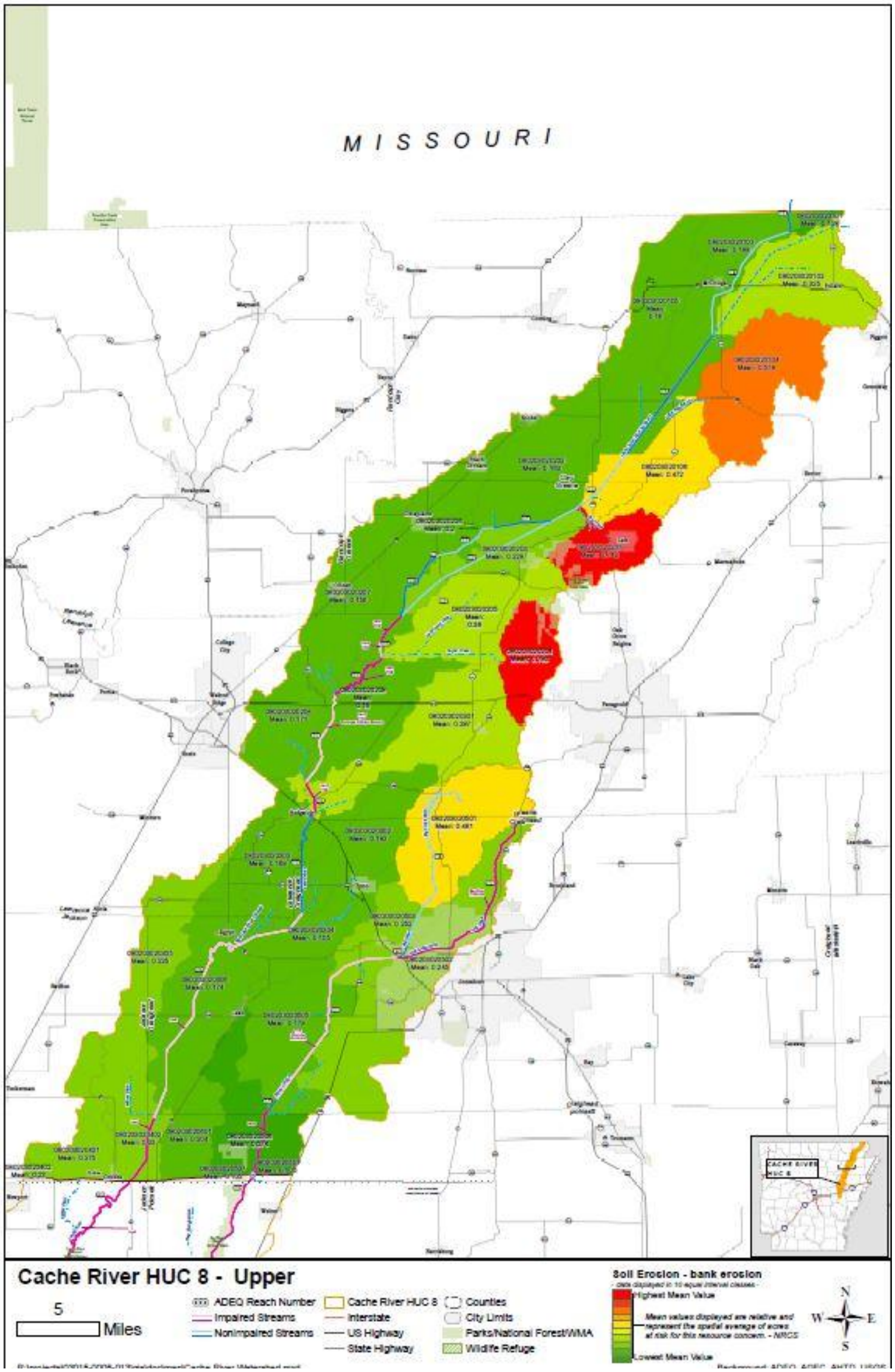


Figure 4.3. NRCS resource concern ranking of upper Cache River 12-digit HUC subwatersheds for streambank erosion.

4.1.1.4 Urban Area

A portion of the City of Jonesboro is located in the upper Bayou DeView watershed on Crowley's Ridge. Impervious areas in cities tend to increase the amount of runoff in the area during storm events. Higher flows during storm events lead to increased erosion in ditches and streambeds, which can contribute to high turbidity. In addition, runoff from cities can carry a wide range of pollutants, including metals such as lead and copper.

4.1.1.5 Turbidity in Frierson Lake

High turbidity levels in Frierson Lake are due to clay particles (Justus 2006). Soils within the lake watershed, and sediments in the lake, are easily eroded and dominated by fine clay particles. These particles take a long time to settle out of the water column, and are easily resuspended within the lake.

4.1.1.6 Septic Systems

Given the rural character of the upper Cache River watershed, it is likely that septic systems are used by many residents. However, there are currently no indications that septic systems are contributing to water quality issues in the watershed.

4.1.1.7 Wildlife

The large numbers of waterfowl and shorebirds that overwinter in the area and utilize the area during migration, could have the potential to impact water quality. However, there are currently no indications that migrating and overwintering waterfowl and shorebirds are impacting water quality in the upper Cache River watershed.

4.1.1.8 Nonpoint Source Summary

There is overall general agreement that erosion is the primary nonpoint source of pollutants in the upper Cache River watershed. However, there is disagreement about the current relative contributions of field erosion (row crop runoff) and bank and channel erosion, although runoff from Crowley's Ridge has been identified as a major sediment source.

4.1.2 Point Sources

This section identifies National Pollutant Discharge Elimination System (NPDES) permitted point sources discharging in the upper Cache River watershed, as well as locations with Phase I or Phase II stormwater permits, Resource Conservation and Recovery Act (RCRA) sites, and underground storage tanks. No permitted landfills, permitted underground injection sites, active brownfields sites, confined animal feeding operation (CAFO) permits, hazardous waste treatment/storage/disposal facilities, nor state priority, nor Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) superfund sites were identified within the upper Cache River watershed. ADEQ has identified point sources as the source of pollutants impairing water quality in Lost Creek, and upper Bayou DeView (see tables 3.1 and 3.2).

4.1.2.1 NPDES Permits

NPDES point source discharges have been identified by ADEQ as contributing to water quality impairments in the upper Cache River watershed (see Tables 3.4 and 3.5). There are 19 NPDES permitted point sources discharging in the upper Cache River watershed (Table 4.3). The majority of these are individual permits for municipal wastewater treatment plants. Several of these permitted facilities have discharged effluent that did not meet one or more of their permit limits (ADEQ 2015a).

Both the 2008 and 2014 ADEQ water quality assessments have identified point sources as the source of chloride, copper, and pollutants causing low DO levels that have led to Lost Creek Ditch being classified as impaired. The only permitted point source that currently discharges to Lost Creek Ditch is the Holy Angels Convent (Table 4.3). Chloride and copper are not monitored in this effluent, and there have been no recorded violations of the DO, biological oxygen demand, nor ammonia nitrogen permit limits over the period from 1999 through 2014 (EPA 2015c).

Table 4.3. NPDES permitted point sources discharging in the upper Cache River watershed.

Permit No.	Facility Name	Receiving Reach	Receiving Stream	Reported Permit violations?
AR0020699	City of Bono	21	Whaley Slough Ditch	Yes
AR0035947	Crowley's Ridge State Park	26	Main Lateral Ditch	No
AR0037907	Jonesboro Westside WWTP	912	Big Creek Ditch	Yes
AR0042781	McDougal Municipal Water and Sewer	41	Cache River Ditch #1	No
AR0043290	City of Knobel	44	Big Gum Lateral	Yes
AR0043443	City of Sedgwick	27	West Cache River Ditch	Yes
AR0043486	Tri-city Utilities, Inc.	45	Beaver Dam Ditch	Yes
AR0043524	Egypt Sewer System	21	West Cache River Ditch	No
AR0044211	Holy Angels Convent	909	Lost Creek Ditch	Yes
AR0045284	City of Cash	21	Cache River	Yes
AR0046981	Hedger Aggregate, Inc.	912	Mud Creek	No
AR0048402	LMJ Trailer Park	912	Big Creek Ditch	Yes
AR0048909	Town of Lafe	36	Big Creek	No
AR0045489	City of Pollard	39	Horse Creek	Yes
ARR150202	Alvin Crabtree & Son Pit	NA*	NA	No
ARR152717	Bono Lake	NA	NA	No
ARR153737	Arkansas Hwy Dept. job #100677	NA	NA	No
ARR154001	Arkansas Hwy Dept. job #100677	NA	NA	No
ARR154035	Arkansas Hwy Dept. job #100643	NA	NA	No

* information not available

4.1.2.2 Phase I and II Stormwater Permits

Stormwater runoff from developed areas is a potential source of a variety of pollutants that can impact water quality. There is only one city with a Municipal Separate Storm Sewer System (MS4) stormwater permit that discharges to the upper Cache River watershed. The City of Jonesboro (ARR040033) discharges stormwater to the Cache River (ADEQ 2015a). There are also a number of active construction and industrial stormwater, permits for locations within the watershed (Tables 4.4 and 4.5). Note the construction permits for poultry producers, suggesting expansion of poultry production within the watershed on Crowley's Ridge (ADEQ 2015d).

Table 4.4. Active NPDES construction stormwater permits for locations within the upper Cache River watershed (Arkansas Geological Survey 2015, ADEQ 2015e).

Permit No.	Permitee	Project Name	Receiving Stream	City	County
ARR150202	Crabtree	Alvin Crabtree & Son	Cache R	Bono	Craighead
ARR152717	Craighead County	Bono Lake	Cache River	Bono	Craighead
ARR152058	Kensington Development Corp.	Barrington Park Subdivision	Whistle Creek Ditch	Jonesboro	Craighead
ARR153570	AHTD	Job No. 100675, Cache River & Relief Strs. & Apprs.			Clay
ARR153737	AHTD	Job No. 100667 Hwy 226-49	Cache R	Cash	Craighead
ARR153953	AHTD	Job No. 100679, Hwy 49 Connection-West	Cache R	Cash	Craighead
ARR153961	Merrell Estates Development, LLC	Merrell Estates Subdivision	Whistle Creek Ditch	Jonesboro	Craighead
ARR154001	AHTD	Job No. 100667, Cash Bypass – East	Cache R	Cash	Craighead
ARR154072	Craftsbury Village, LLC	Craftsbury Village, Phase IV	Whaley Slough Ditch	Bono	Craighead
ARR154117	City Water and Light Plant	East Side Wastewater Treatment Sludge Irrigation Phase II	Lost Cr	Jonesboro	Craighead
ARR154131	Saint Bernards Village, Inc.	Saint Bernards Village II	Lost Cr	Jonesboro	Craighead
ARR154137	Morris Real Estate Holdings, LLC	Buckhead South Subdivision	Whistle Cr Ditch	Jonesboro	Craighead
ARR154232	Love's Travel Stops and Country Stores, Inc.	Love's Travel Stop	Lost Cr	Jonesboro	Craighead
ARR154335	AHTD	Job No. 100678, Hwy. 226-Hwy. 49	Whistle Cr Ditch	Jonesboro	Craighead
ARR154438	T. Abraham & Sons Construction LLC	Oaktree Manor	Lost Cr	Jonesboro	Craighead
ARR154448	Phillips Investments & Construction, Inc.	Gateway Square	Lost Cr	Jonesboro	Craighead
ARR154449	Kent Arnold Construction	Kent Arnold Woods	Whistle Cr Ditch	Jonesboro	Craighead
ARR154456	PX2, LLC	PX2 Residential Development	Whistle Cr Ditch	Jonesboro	Craighead
ARR154506	AHTD	Job No. 100676, Cash Bypass	Cache R	Cash	Craighead
ARR154527	Nix Development, LLC	Jamestown PH IV	Whistle Cr. Ditch	Jonesboro	Craighead

Table 4.4. Active NPDES construction stormwater permits for locations within the upper Cache River watershed (continued).

Permit No.	Permitee	Project Name	Receiving Stream	City	County
ARR154564	Murphy Oil USA, Inc.	Murphy Oil USA Fueling Station	Whistle Cr. Ditch	Jonesboro	Craighead
ARR154662	AHTD	Job No. 100764, Bayou DeView Str. & Apprs.	Bayou DeView	Weiner	Poinsett
ARR154663	Huff	Huff Planned Unit Development	Whistle Cr Ditch	Jonesboro	Craighead
ARR154688	Ronald Bounds	Ronald Bounds Broiler Houses	Ditch No. 10	Boydsville	Clay
ARR154783	W. Woodard	Woodard broiler house	Cache River	Rector	Clay
ARR154822	C. Jenkins	C&C egg farm	Big Creek/Ditch No. 10	Crockett	Clay
ARR154832	Wilcox Custom Homes, LLC	Mallard Pointe Subdivision	Big Creek?	Jonesboro	Craighead
ARR154870	W. Terrell	Warren Terrell poultry farm	Big Creek	Boydsville	Clay
ARR154874	T. Stokes	Stokes poultry farm	Big Creek	Boydsville	Clay
ARR154900	Boydsville Broilers LLC	Boydsville Broiler House #1	Unknown	Boydesville	Clay
ARR154901	Boydsville Broilers LLC	Boydsville Broiler House #2	Unknown	Boydsville	Clay
ARR154916	Bishop	Bishop Farms	Big Cr Ditch	Bono	Craighead
ARR154945	M. Branson	Michael Branson	Big Creek	Crockett	Clay
ARR154981	Wood	The Woodlands at Terra Hills	Lost Cr?	Jonesboro	Craighead
ARR155010	Sanders	Friendly Hope Rd.	Whistle Cr Ditch?	Jonesboro	Craighead
ARR155023	Winters, LLC	The Villas at Sage Meadows Phase 3	Lost Cr?	Jonesboro	Craighead

Table 4.5. Active NPDES industrial stormwater permits for locations within the upper Cache River watershed (ADEQ 2015d, ADEQ 2015f).

Permit No.	Facility Name	Receiving Stream
ARR00C444	MARCK Recycling & Waste Services of NEA, LLC	Big Cr
ARR00C437	Razorback Concrete Company - Plant 113	Big Cr
ARR00C170	Sunrise Auto Sales & Parts	Big Cr
ARR00C137	Pruitt's Auto, Inc.	Big Cr
ARR00B913	Hedger Aggregate Inc.	Big Cr
ARR00B724	Carco Rentals, Inc.	Lost Cr. Ditch
ARR00B453	Economy Auto Parts, Inc.	Big Cr
ARR00B376	Acme Brick Company	Big Cr
ARR00B290	TRG Jonesboro	Lost Cr. Ditch
ARR00A966	Majestic Metals, Inc.	Lost Cr. Ditch
ARR00A488	Ingels' Inc	Lost Creek Ditch
ARR00A433	Hedger Brothers	Lost Creek Ditch
ARR00A199	Riceland Foods	Lost Creek Ditch
ARR000776	Hedger Aggregate, Inc. Thompson Mine	Lost Creek Ditch
ARR000771	Hedger Aggregate, Inc. Rock Hill Site	Lost Creek Ditch
ARR000687	NEA Materials, Inc.	Lost Creek Ditch
ARR000629	West Side Wastewater Treatment Plant	Big Creek Ditch
ARR000591	Hedger Brothers Inc.	Lost Creek Ditch
ARR000555	Jimmy Sanders, Inc.	Whistle Creek Ditch
ARR000412	RazorRock Materials Company-Mays Pit	Big Creek
ARR000410	RazorRock Materials Company-Wright Pit	Big Creek
ARR000386	RazorRock Materials-Philadelphia Pit	Lost Creek Ditch
ARR000116	Cooksey Gravel Pit	Lost Creek Ditch
ARR00B388	UPS	Whistle Creek Ditch
ARR00A845	RazorRock Materials Co. Plant 675	Big Creek Ditch

4.1.2.3 Point Source Summary

Several of the permitted point source discharges in the upper Cache River watershed have discharged effluent that did not meet their permit requirements, potentially impacting surface water quality.

4.1.3 Hazardous Waste

4.1.3.1 RCRA Facilities

There are 13 RCRA facilities within the upper Cache River watershed identified by EPA (Table 4.6). ADEQ has identified 14 hazardous waste generators in the upper Cache River watershed (ADEQ 2015g). The 13 facilities still generating hazardous waste are listed in Table 4.7. The majority of these facilities have been classified as conditionally exempt small quantity generators, meaning that they generate 100 kilograms or less per month of hazardous waste, or 1 kilogram or less per month of acutely hazardous waste.

Table 4.6. RCRA facilities in the upper Cache River watershed identified by EPA (EPA 2015c).

ID	Facility Name	County
ARD982283871	Enterprise TE Products Pipeline Company LLC - Egypt Pump Station	Lawrence
110003398314	Martins Cleaners	Craighead
110003404174	Sykes Truck & Equipment Co	Craighead
110003407769	Collision Repair of Jonesboro	Craighead
110003408054	Best Manufacturing Co.	Craighead
110003408660	Former Tri-State Custom Baths	Craighead
110006035717	TETLP-Walnut Ridge	Lawrence
110007411087	Ingels Inc.	Craighead
110012213611	Wal-Mart Supercenter #128	Craighead
110012228160	Nucor Steel	Poinsett
110015708037	Guthries Auto Repair	Jackson
110024833420	Craft Propane	Craighead
110037070166	Plant Diesel	Craighead

Table 4.7. Hazardous waste generators in the upper Cache River watershed identified by ADEQ (ADEQ 2015e).

ID	Facility Name	Generator Type	County
AR0000384891	Jimco Lamp Company	Conditionally exempt small quantity	Craighead
ARD093797124	Best Diversified Products Inc.	Conditionally exempt small quantity	Craighead
ARD980629992	Ingels Inc.	Conditionally exempt small quantity	Craighead
ARD980630206	TETLP - Walnut Ridge, AR	Conditionally exempt small quantity	Lawrence
ARD982283871	Enterprise TE Products Pipeline Company LLC - Egypt Pump Station	Conditionally exempt small quantity	Lawrence
ARD982283889	Enterprise Products Operating LLC - Fagus Pump Station	Conditionally exempt small quantity	Clay
ARD982552010	Arkansas Glass Container Corp.	Conditionally exempt small quantity	Craighead
ARD982552606	TETLP - Pollard, AR	Conditionally exempt small quantity	Clay
ARR000009092	Walmart Supercenter #128	Small quantity	Craighead
ARR000011544	Star Petroleum	No information	Craighead
ARR000012369	Gutheries Auto Repair	No information	Jackson
ARR000015594	Craft Propane	No information	Craighead
ARR000022525	Scott Burk Construction Inc. @ Wal-Mart Supercenter 0128	Conditionally exempt small quantity	Craighead

4.1.3.2 Underground Storage Tanks

ADEQ has identified 28 underground storage tanks within the upper Cache River watershed (Table 4.8). Eight of these tanks have been confirmed to be leaking. All of the leaking tanks are located at gas stations. Three of the leaking tanks are temporarily not in use (ADEQ 2015f). Leaking underground storage tanks have the potential to contaminate groundwater.

Table 4.8. Underground storage tanks identified in the upper Cache River watershed (ADEQ 2015f).

County	Number of Underground Tanks	Temporarily out of Service	Leaking
Clay	3	1	1
Craighead	23	4	7
Greene	2	1	0
Jackson	0	0	0
Lawrence	0	0	0
Total	28	6	8

4.1.3.3 Hazardous Waste Summary

There are a number of underground storage tanks at gas stations in the upper Cache River watershed known to be leaking. These tanks have the potential to affect local groundwater quality. RCRA facilities and hazardous waste generators are present in the upper Cache River watershed. However, there have been no reports of releases from these facilities that would affect water quality.

4.2 Lower Cache River Watershed

4.2.1 Nonpoint Sources

Nonpoint source pollution generally results from precipitation, land runoff, infiltration, drainage, seepage, hydrologic modification, or atmospheric deposition. As runoff from rainfall moves, it picks up and transports pollutants resulting mainly from human activity, ultimately depositing them into rivers, lakes, wetlands, coastal waters, and ground water. Nonpoint sources that have been identified for the lower Cache River watershed include cropland and streambank erosion. One study in the Cache River watershed found a strong relationship between drainage area and TSS load (TNC 2009). Septic systems and wildlife are other potential nonpoint sources in this watershed.

4.2.1.1 Cropland

Erosion from row crop agriculture is suspected as the nonpoint source of many of the pollutants causing impairments within the upper Cache River watershed (ADEQ 2009, ADEQ 2014a, ANRC 2011a, TNC 2005). Cropland typically has greater soil erosion than most other land uses. Cultivated cropland covers 72% of the land in the lower Cache River watershed. Table 4.9 summarizes information on cropland for the counties that are part of the lower Cache River watershed, from the most recent Census of Agriculture.

Table 4.9. Agricultural statistics for counties in the lower Cache River watershed (USDA NASS 2014).

2012 Census	Cross County	Jackson County	Monroe County	Woodruff County
Cropland, ac	255,241	271,738	248,852	245,952
Soybeans, ac	141,706	139,270	125,498	131,644
Rice, ac	66,724	87,612	57,430	59,697
Corn, ac	9,961	13,917	37,251	20,409
Wheat, ac	18,254	21,181	26,735	17,294

Figure 4.4 shows the NRCS relative ranking of the lower Cache River 12-digit HUC subwatersheds in terms of the potential for sheet/rill/wind erosion to impact surface water quality. Figure 4.5 shows the NRCS relative ranking of the lower Cache River subwatersheds in terms of the potential for concentrated flow (i.e., gully) erosion to impact surface water quality. On these maps, green indicates little or no impact, and red indicates a high potential for impact.

4.2.1.2 Streambank Erosion

In their phase I project assessing water quality in the Cache River watershed, TNC concluded that multiple sources contribute sediment, including streambank erosion (TNC 2005). Streambank instability occurs as a result of channelization of streams. In addition, the higher sediment load from channelized streams can destabilize natural channels downstream (Rosgen 1995, Shankman and Smith 2004). As part of phase II of the project, TNC evaluated streambank erosion potential in seven 12-DIGIT HUC sub-watersheds of the Cache River watershed that were identified as having the highest sediment loads in phase I of the project (TNC 2006). All or part of four of these sub-watersheds are part of the lower Cache River watershed. All of the Swan Pond Ditch and Willow Ditch sub-watersheds are within the lower Cache River watershed. Lower portions of Skillet Ditch and Flag Slough Ditch sub-watersheds are also part of the lower Cache River watershed.

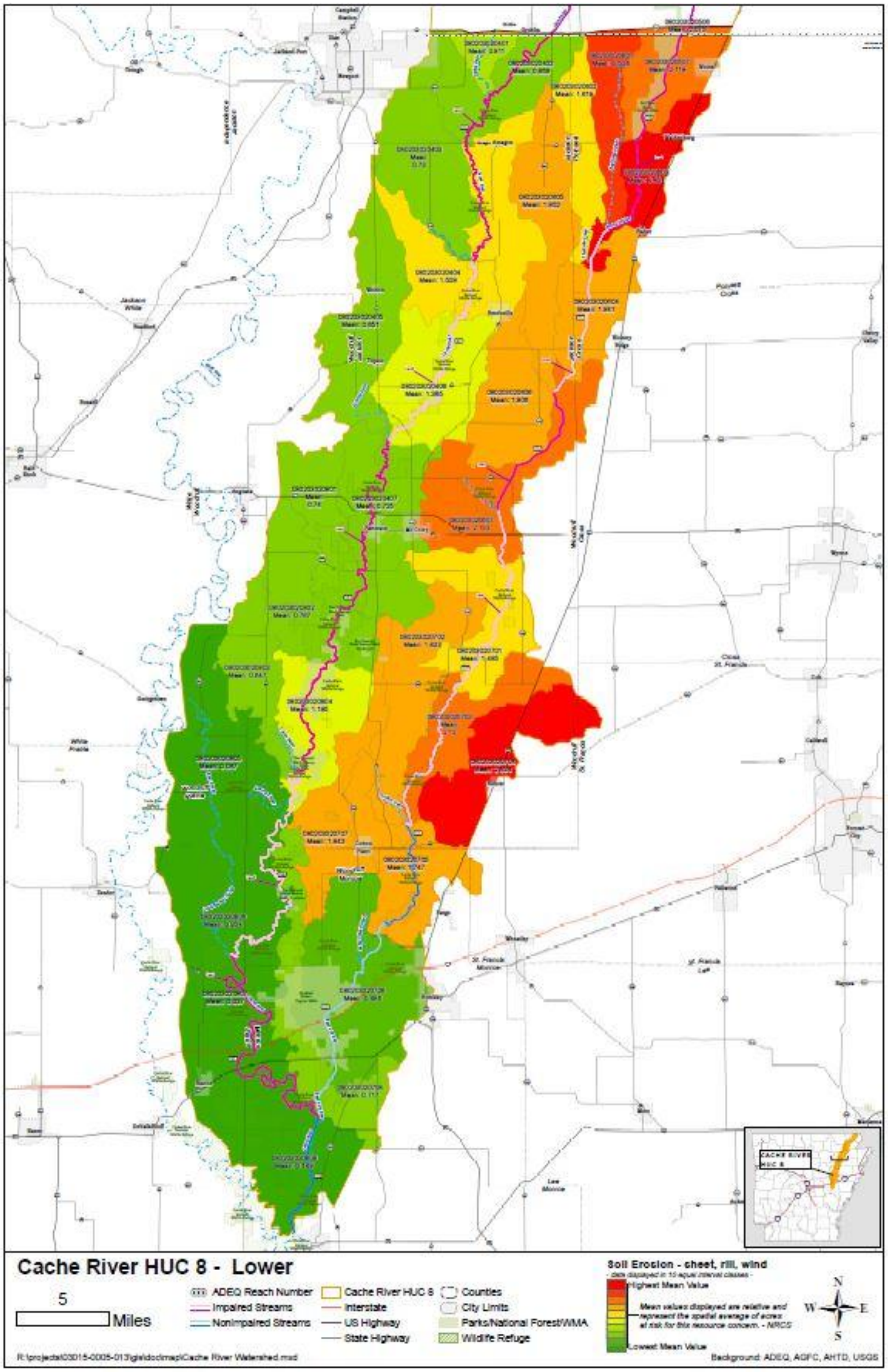


Figure 4.4. NRCS resource concern ranking of lower Cache River 12-digit HUC subwatersheds for sheet/rill/wind erosion.

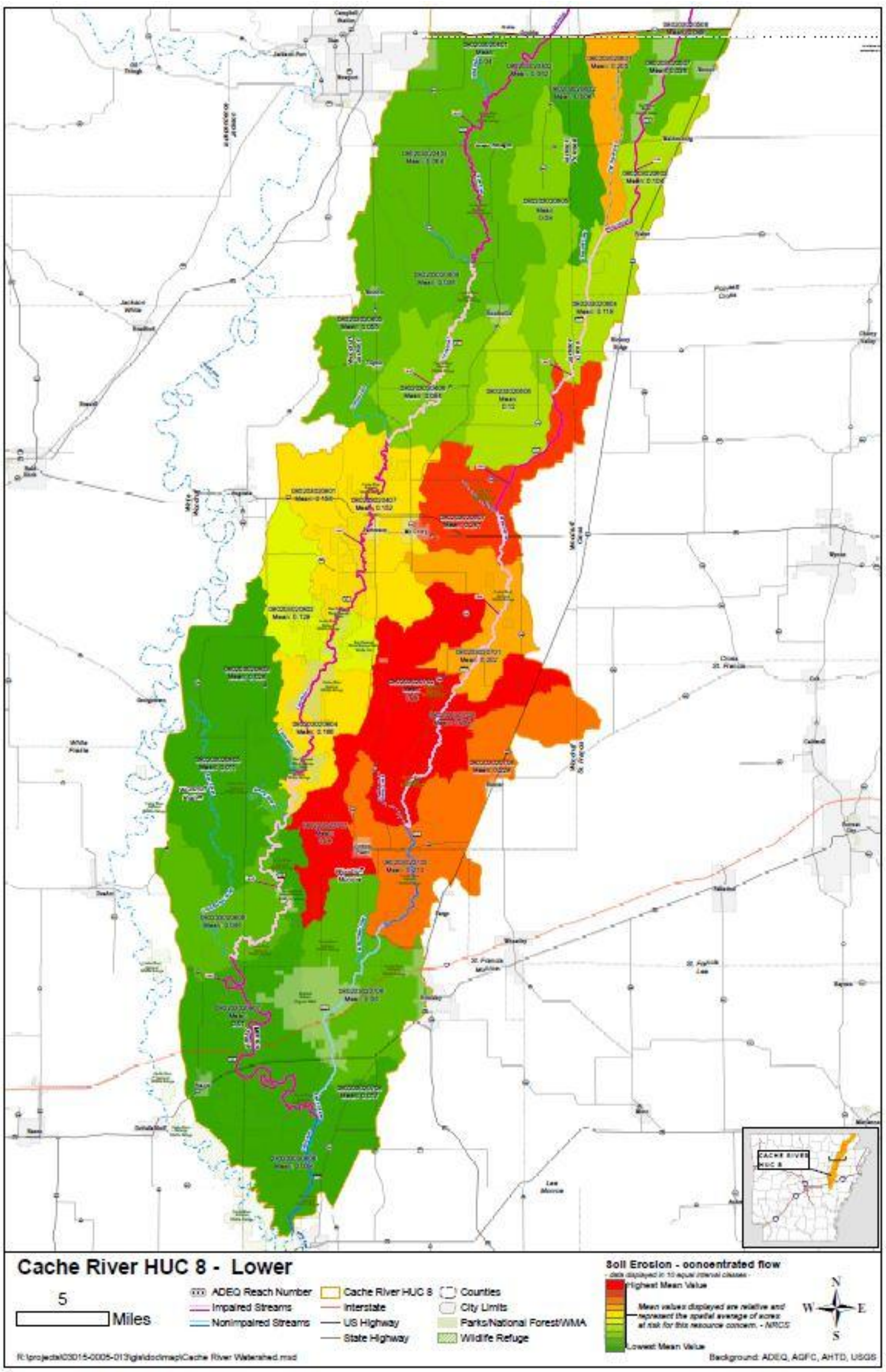


Figure 4.5. NRCS resource concern ranking of lower Cache River 12-digit HUC subwatersheds for concentrated flow.

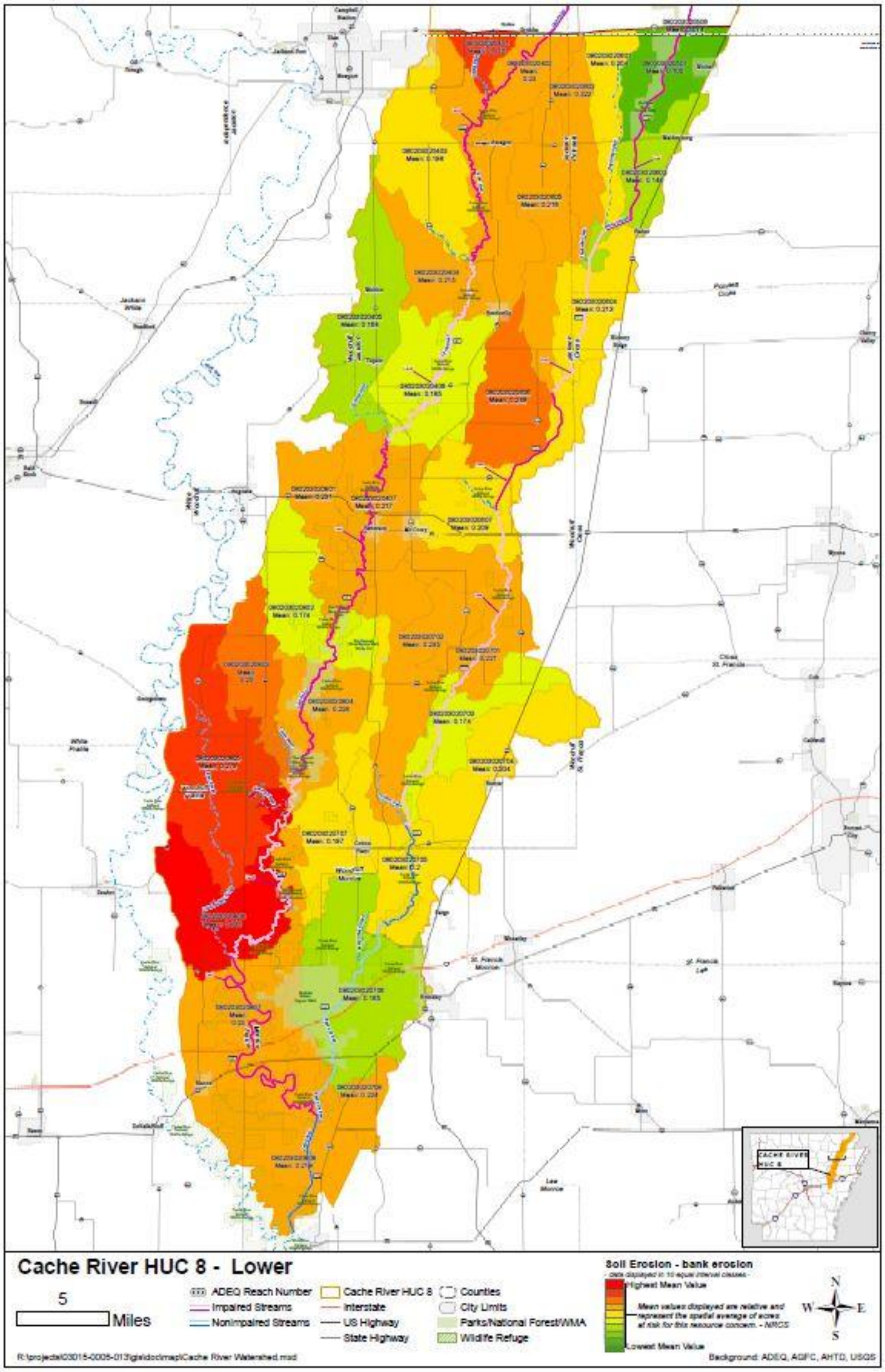


Figure 4.6. NRCS resource concern ranking of lower Cache River 12-digit HUC subwatersheds for streambank erosion.

Table 4.10 summarizes the results of the streambank erosion potential analysis, reported as BEHI, for the stream reaches in the lower Cache River watershed. Evaluated streambanks along Culotches Bay Slough, which had the largest observed TSS load during the TNC phase II project, were classified as having primarily low or very low BEHI values. Similarly, streambanks along Benson Slash Creek, which has the largest observed per unit TSS load during the TNC phase II project, had only moderate or low BEHI values. This may indicate that streambank erosion is not contributing significantly to the TSS loads in these watersheds. Conversely, the two streams with the greatest percentages of streambank assigned high to extreme BEHI values, did not have particularly large observed TSS loads during the TNC phase II project.

Table 4.10. BEHI ranks for selected reaches of priority sub-watersheds in the lower Cache River watershed (TNC 2009).

Sub-watershed	Extreme	Very High	High	Moderate	Low	Very Low
Benson Slash Creek	0	0	0	60%	40%	0
Culotches Bay Slough	0	0	8%	19%	58%	15%
Overcup Ditch	0	0	82%	9%	7%	0
Flag Slough Ditch	0	0	3%	44%	53%	0
Skillet Ditch	9%	36%	8%	15%	24%	8%

4.2.1.3 Channel Erosion

During the TNC intensive study of the Cache River watershed, channel bankfull cross sectional area was measured near the sampling locations at the beginning and the end of the project period (2004 – 2005). No significant changes in channel morphology were observed (TNC 2005).

TNC estimated bedload for the Cache River and Bayou DeView using quarterly samples collected during late 2004 and early 2005 (TNC 2005). Results are summarized in Table 4.11. In both the Cache River and Bayou DeView, the highest maximum estimated bedloads occurred at the downstream-most stations. The estimated maximum bedloads at the remining Bayou DeView stations were relatively similar, and all less than 1 ton/day. Estimated maximum bedloads for the remaining Cache River stations varied, though most were less than 2 tons/day. Overall, bedloads at the Bayou DeView stations were slightly lower than those at the Cache River stations.

Table 4.11. Estimated bedload flux (TNC 2005).

Station	Waterbody	Location	Estimated Bedload Range, tons/day
DV007	Bayou DeView	Hickory Ridge	0 – 0.66
DV006	May Branch Lateral	Highway 269	0
DV004	Bayou DeView	Tip	0 – 0.80
DV003	Caney Creek	Cotton Plant	0 – 0.12
DV002	Bayou DeView	Cotton Plant	0
DV001	Bayou DeView	Brinkley	0 – 0.27
DV000	Bayou DeView	Mouth	0 – 15.42
CR011	Cache River	South of Amagon	0 – 0.24
CR010	Cache River	Highway 33	0 – 1.08
CR008	Culotches Bay Slough	McClelland	0
CR007	Cache Bayou	Dixie	0
CR006	Cache River	Gregory	0 – 1.64
CR004	Cache River	Cotton Plant	0 – 14.49
CR003	Cache River	Williams Lake	0 – 1.29
CR002	Cache River	South of Highway 70	0 – 20.56

In the 1970s, the USGS measured lead in a few bed sediment samples collected from Bayou DeView at Highway 64 (07077700). The measurements ranged between 10 and 20 mg/kg (USGS 2015b).

4.2.1.4 Septic Systems

Given the rural character of the lower Cache River watershed, it is likely that septic systems are used by many residents. However, there are currently no indications that septic systems are contributing to water quality issues in the watershed.

4.2.1.5 Wildlife

The large numbers of waterfowl and shorebirds that overwinter in the lower Cache River watershed, and utilize the area during migration, could have the potential to impact water quality. However, there are currently no indications that migrating and overwintering waterfowl and shorebirds are impacting water quality in the lower Cache River watershed.

4.2.1.6 Resource Extraction

The USFWS has identified oil and gas extraction as a potential threat to the Cache River NWR in the lower Cache River watershed. USFWS has identified threats from exploration and development of oil and natural gas resources in the area, as well as from construction and use of pipelines that pass through the NWR (USFWS 2012).

4.2.1.7 Nonpoint Source Data Gaps

There is disagreement about the relative contributions of field erosion (row crop runoff) and bank and channel erosion to the pollutant loads in the lower Cache River watershed. Additional study of this question would help to ensure that the correct management practices are used to reduce nonpoint source pollution in the watershed.

4.2.1.8 Nonpoint Source Summary

There is overall general agreement that erosion is the primary nonpoint source of pollutants in the lower Cache River watershed. However, there is disagreement about the current relative contributions of field erosion (row crop runoff) and bank and channel erosion.

4.2.2 Point Sources

This section identifies NPDES permitted point sources discharging in the lower Cache River watershed, as well as RCRA sites, and underground storage tanks. No active Phase I or Phase II stormwater permits, CAFO permits, hazardous waste treatment/storage/disposal facilities, brownfield sites, nor state priority, nor CERCLA superfund sites were identified within the lower Cache River watershed. ADEQ has not specifically identified point sources as potential sources of pollutants impairing water quality in the lower Cache River watershed (see Tables 3.6 and 3.7).

4.2.2.1 NPDES Permits

There are 19 NPDES permitted point sources discharging in the lower Cache River watershed (Table 4.12). The majority of these are individual permits for municipal wastewater treatment plants (ADEQ 2015a, EPA 2015c).

Table 4.12. NPDES permitted point sources discharging in the lower Cache River watershed.

Permit No.	Type	Facility Name	Receiving Reach	Receiving Stream	Reported Permit Violations?
AR0020354	Municipal	City of Weiner	007	Bayou DeView Tributary	Yes
AR0021890	Municipal	City of Brinkley	013	Benson Slash Creek	Yes
AR0033391	Municipal	City of Cotton Plant	002	Turkey Creek	Yes
AR0034720	Municipal	City of Hickory Ridge	006	Bayou DeView	No
AR0037834	Industrial Stormwater	Riceland – Waldenburg Rice Division	007	Bayou DeView	Yes
AR0039837	Municipal	City of Patterson	018	Cache River	No
AR0044954	Municipal	City of McCrory	018	Cache River	Yes
AR0046604	Municipal	City of Amagon	020	Cache River Tributary	Yes
AR0049603	Municipal	City of Beedeville	019	Cache River	No
AR0034614	Municipal	City of Grubbs	020	Cache River	No
ARR00A953	Industrial Stormwater	Bowman Manufacturing	019	Locust Creek	No
ARG640049	Filter Backwash	Cross County Rural Water Pulliam Station	006	Cow Lake Ditch	No
ARG640021	Filter Backwash	Breckenridge-Union Water Treatment Facility	019	Overcup Ditch	No
ARG550441	Domestic	John A. Ball	005	Bayou DeView	Yes
ARR000774	Industrial Stormwater	B&D Dirt, LLC	018	Maple Creek	NA*
ARR00A562	Industrial Stormwater	Thompson & Son, M.D.	018	Miller Branch Ditch	NA
ARR000423	Stormwater	Worldwide Label & Packaging	018	Cache River Tributary	NA
ARG640034	Filter Backwash	City of Patterson	018	Cache River	Yes
ARR000950	Industrial Stormwater	Woodruff County Transfer Station	018	Loshita Branch	NA
ARR001307	Industrial Stormwater	Koss #89 Biscoe Plant Site	016	Cache River Tributary	NA

*Enforcement reports not available

4.2.2.1 Phase I and II Stormwater Permits

Stormwater runoff from developed areas is a potential source of a variety of pollutants that can impact water quality. There are no Municipal Separate Storm Sewer System (MS4) stormwater permits that discharge in the lower Cache River watershed (ADEQ 2015a). However, there are several active construction and industrial stormwater, permits for locations within the watershed (Tables 4.13 and 4.14).

Table 4.13. Active NPDES industrial stormwater permits for locations within the lower Cache River watershed (ADEQ 2015d, ADEQ 2015f).

Permit No.	Facility Name	Receiving Stream
ARR00B265	Fair Oaks Manufacturing Co.	Bayou DeView?
ARR000426	Worldwide Label and Packaging, LLC	Bayou DeView?

Table 4.14. Active NPDES construction stormwater permits for locations within the lower Cache River watershed (Arkansas Geological Survey 2015, ADEQ 2015e).

Permit No.	Permitee	Project Name	Receiving Stream	City	County
ARR155037	Pinnacle Agriculture Holdings	Sanders	Cache River	McCrory	Woodruff
ARR154112	J. Broadaway	API Brinkley Portable Plant	Bayou DeView	Brinkley	Monroe
ARR154452	AHTD	Job No. BB0101, Cache River-Bayou DeView	Cache River, Bayou DeView	Brinkley	Monroe
ARR154619	AHTD	Job No. 110544 Hwy 17-St. Francis Co. Line Strs.	Bayou DeView	Brinkley	Monroe

4.2.2.2 Point Source Summary

Several of the permitted point source discharges in the lower Cache River watershed have discharged effluent that did not meet their permit requirements, potentially impacting surface water quality.

4.2.3 Hazardous Waste

4.2.3.1 RCRA Facilities

There are three RCRA facilities within the lower Cache River watershed, identified by EPA (EPA 2015e). However, ADEQ has classified these facilities as not generating hazardous waste, two because they are out of business (ADEQ 2015e).

4.2.3.2 Underground Storage Tanks

Based on information from the ADEQ Storage Tank Facility database, there are 81 underground storage tanks within the lower Cache River watershed (Table 4.12). Seven of these tanks have been confirmed to be leaking. The majority of the leaking tanks are located at gas stations. Two of the leaking tanks are temporarily not in use (ADEQ 2015f).

Table 4.15. Underground storage tanks identified in the lower Cache River watershed (ADEQ 2015f).

County	Number of Underground Tanks	Temporarily Out of Service	Leaking
Cross	6	0	0
Jackson	3	0	0
Monroe	19	2	4
Poinsett	36	0	2
Woodruff	17	0	1
Total	**81**	**2**	**7**

4.2.3.3 Hazardous Waste Summary

There are a number of underground storage tanks in the lower Cache River watershed known to be leaking. These tanks have the potential to affect local groundwater quality. RCRA facilities identified by EPA in the lower Cache River watershed, have been determined by ADEQ to not be generating hazardous waste.

5.0 POLLUTANT LOADS

This section includes a discussion of pollutant loads for the upper and lower Cache River watersheds, along with identification of critical areas for nonpoint source management activities. The pollutant loads discussion addresses only pollutants of concern, and includes a summary of previous pollutant load estimation work, along with estimates of current pollutant loads.

5.1 Estimation of Pollutant Loads for the Upper Cache River Watershed

This section discusses past pollutant load estimation work, along with estimates of current pollutant loads to the upper Cache River watershed. The primary pollutants of concern for the upper Cache River watershed (based on the draft 2014 303(d) list in Table 3.5) are turbidity/sediment, lead, and sulfate.

5.1.1 Turbidity

There have been several studies that address sediment loads in the upper Cache River watershed. It is not possible to calculate turbidity loads, so TSS load is used as a surrogate. TSS loads in the upper Cache River watershed have been estimated as part of TMDL studies, studies conducted by TNC, measurements collected by USGS, and computer modeling using SWAT.

5.1.1.1 TMDLs

TMDLs have been completed addressing turbidity in the upper Cache River watershed. Existing pollutant loads were calculated as part of these TMDL studies. In these TMDLs, observed TSS loads were estimated at monitoring stations using measured TSS concentrations and estimated flows. The range of these calculated values are shown in Table 5.1, along with the percent reductions needed to meet the applicable water quality criteria in the impaired reaches (FTN 2006, 2007).

Table 5.1 Estimated existing TSS loads at water quality stations in the upper Cache River watershed from TMDLs.

Waterbody	Station	Time period of data used	Estimated existing load range	Load units	Required load reduction	
					Base flow	Storm flow
Lake Frierson	various	1994 - 2006	46.27 - 4,321	Lbs/day	55%	82%
Cache River	UWCHR04	1994 - 2003	1 – 4,598	Lbs/day/sq mi	13%	0%
Cache River	UWCHR03	1994 – 2003	4.57 – 5,670	Lbs/day/sq mi	0%	17%
Bayou DeView	WHI0026	1990 – 2005	0.02 - 14,401	Lbs/day/sq mi	0%	0%

Note that the maximum estimated TSS load per square mile for the Bayou DeView station is about 3 times greater than the maximum estimated load for the Cache River stations. This may be a reflection of the erodibility of the soils on Crowley's Ridge, where the majority of the drainage for upper Bayou DeView is located. However, given the smaller size of the drainage area for the Bayou DeView station, the TSS load per day would be smaller than at the Cache River stations. Thus, it appears that smaller watershed size is the primary reason that TSS concentrations are lower in Bayou DeView than in the Cache River.

5.1.1.2 Studies

TNC has conducted studies in the Cache River watershed that involved characterizing sediment loads. In the water quality intensive study TNC conducted (319 project 01-610), TSS loads were calculated using TSS and flow data collected four times from July 2004 through July 2005. Note that at the majority of the stations, a TSS sample was not collected at least once during the study period (see Table 5.2) (TNC 2005). The calculated loads from this study are shown in Table 5.3.

Table 5.2. Availability of TSS loads for the upper Cache River watershed during Study 01-610.

Station	Quarter 1 May 2004	Quarter 2 October 2004	Quarter 3 March 2005	Quarter 4 May 2005
CR012	Load	No TSS	No TSS	No flow
CR014	Load	No flow	No flow	No flow
CR015	Load	No TSS	Load	Load
CR016	No TSS	No TSS	Load	Load
CR017	No TSS	No TSS	Load	Load
CR018	Load	No TSS	Load	Load
CR019	Load	No TSS	Load	Load
CR020	No TSS	No TSS	No flow	No TSS
CR021	Load	No TSS	Load	Load
CR022	Load	No TSS	Load	Load
DV008	Load	No TSS	Load	Load
DV009	Load	No TSS	Load	No TSS
DV010	Load	Load	Load	Load
DV011	Load	Load	Load	Load

Table 5.3 Summary of TNC estimated TSS loads at locations in the upper Cache River watershed.

Waterbody	Station	Estimated existing load range, tons/day
Cache River	CR012	10.29 *
East Cache R Ditch	CR014	7.09 *
West Cache R Ditch	CR015	0.56 – 874.8
Cache River	CR016	5.14 – 61.44
Cache River	CR017	16.30 – 1,084
Big Creek	CR018	6.03 – 99.07
Unnamed Tributary to Cache River	CR019	1.98 – 252.2
Little Cache River Ditch	CR021	0.08 – 23.78
Cache River Ditch No. 1	CR022	0.50 – 59.83
Bayou DeView	DV008	0.06 – 7.87
Whistle Creek	DV009	0.96 – 1.40
Bayou DeView	DV010	0.17 – 209.3
Big Creek Ditch	DV011	0.05 – 8.84

* Only one sample collected at this station, so only one load calculated

In March 2006, TNC conducted an intensive turbidity data collection at over 30 stations in the upper Cache River watershed during a storm event (see Figure 3.1). These data were used to estimate peak sediment loads at each location. The eight tributaries with the highest estimated peak sediment loads were identified as priorities for further investigation. Three of these tributaries are located in the upper Cache River watershed; Swan Pond Ditch, Main Lateral, and Willow Ditch (TNC 2006).

In a later study (319 project 06-400), TSS samples were collected daily and flow was continuously monitored on the priority tributaries identified from the March 2006 storm sampling. These data were then used to calculate TSS loads. Due to problems with some of the equipment, adequate data for estimating TSS loads was obtained from only one of the target tributaries in the upper Cache River watershed; Swan Pond Ditch. The average annual TSS load from Swan Pond Ditch estimated in this study was about 440 tons/sq mi. This load was estimated from data collected from October 2007 through February 2009, and was the second highest load calculated in the study (TNC 2009).

5.1.1.3 USGS

The USGS measured sediment loads at the Cache River at Egypt gage station for a 2 year period beginning in 1996 and ending in 1998. During this time 27 measurements were collected. Measured loads ranged from 7.3 tons/day to 4,140 tons/day, with an average of 791 tons/day (USGS 2015b).

5.1.1.4 SWAT Model

Researchers from the University of Arkansas Dale Bumpers College of Agricultural, Food, and Life Sciences developed and calibrated a model of the Cache River watershed using the SWAT model. This model incorporates information on land cover, topography, soil characteristics, rainfall, and land management. The Cache River SWAT model was used to estimate sediment and nutrient loads for each of the 12-digit HUC subwatersheds of the Cache River. However, the project final report did not include the estimated loads (Saraswat et al. 2016).

5.1.1.5 Comparison of TSS Loads

There are a few sampling locations in the upper Cache River watershed where existing TSS loads were calculated more than once. These loads are compared in Table 5.4.

Table 5.4 Comparison of TSS loads estimated for the upper Cache River watershed from two sources.

Reach Number	TMDL Load, tons/day	TNC station	TNC Load, tons/day
021	1.8 – 2,193	CR012	10.29
027	0.3 – 1,337	CR016	5.14 – 61.44
029	0.2 – 1,046	CR017	16.30 – 1,084

5.1.2 Lead Loads

A TMDL study has been completed addressing dissolved lead in the upper Cache River watershed. Existing nonpoint source pollutant loads were calculated as part of this TMDL study. Observed lead loads were estimated at the upper Cache River monitoring stations using measured dissolved lead concentrations and flows. The range of these calculated values are shown in Table 5.5. The TMDL determined that there was no need to reduce loads to meet the dissolved lead water quality standard (FTN 2012). The lead impairment has been removed from these stream reaches in the draft 2014 303(d) list (Table 3.5).

Table 5.5. Estimated existing lead loads from TMDL study (FTN 2012).

Waterbody	Station ID	Date Range of Data Used	Estimated Existing Load, (lbs/day)
Cache River	UWCHR04	1994 – 2009	<0.1 – 16.8
Cache River	UWCHR03	1994 – 2009	<0.1 – 27.8

Estimates of current existing lead loads in the upper Cache River watershed were calculated using the average of the dissolved lead data collected by ADEQ over the last 5 years (Table 5.6). Average daily flows estimated by StreamStats at the upper Cache River ADEQ water quality stations were used to estimate loads at those locations (USGS 2014b). Average daily flows at the upper Bayou DeView ADEQ water quality stations were estimated from the average daily flow at the USGS Cache River gage at Egypt, adjusted based on the drainage areas at the gage and at the water quality stations.

Table 5.6. Estimated lead loads for the upper Cache River water quality monitoring stations.

Station name (ID)	Estimated average daily flow, (cfs)	Average dissolved lead (2010 – 2014), (µg/L)	Estimated average dissolved lead load, (lbs/day)
Cache R @ Walnut Ridge (UWCHR04)	491	0.15	0.4
Cache R @ Grubbs (UWCHR03)	968	0.18	1.0
Lost Creek Ditch (WHI0172)	34.3	0.22	<0.1
Big Creek Ditch (WHI0196)	62.8	0.22	<0.1
Bayou DeView (WHI0026)	128	0.16	0.1

5.1.3 Sulfate Loads

No estimates of sulfate loads in the upper Cache River watershed were identified. Estimates of existing average daily sulfate loads for the upper Cache River watershed were calculated using the average of the sulfate data collected by ADEQ over the last 5 years (Table 5.7). Average daily flows estimated by StreamStats at the upper Cache River ADEQ water quality stations were used to estimate loads at those locations (USGS 2014b). Average daily flows at the upper Bayou DeView ADEQ water quality stations were estimated from the average daily flow at the USGS Cache River gage at Egypt, adjusted based on the drainage areas at the gage and at the water quality stations.

Average sulfate concentrations are greater at downstream stations, appearing to increase with drainage area. As a result, the estimated sulfate loads also increase with drainage area. Since all of the average sulfate concentrations are below the applicable sulfate water quality criteria, it is not possible to estimate a required load reduction using these estimated loads. A more detailed loading estimate will be necessary to determine if sulfate load reductions might be necessary.

Table 5.7. Estimated sulfate loads for the upper Cache River water quality monitoring stations.

Station name (ID)	Estimated average daily flow, (cfs)	Average sulfate (2010 – 2014), (mg/L)	Estimated average sulfate load, (tons/day)
Cache R @ Walnut Ridge (UWCHR04)	491	18.9	25.1
Cache R @ Grubbs (UWCHR03)	968	23.9	62.3
Lost Creek Ditch (WHI0172)	34.3	11.0	1.0
Big Creek Ditch (WHI0196)	62.8	14.3	2.4
Bayou DeView (WHI0026)	128	16.9	5.9

5.2 Estimation of Pollutant Loads for the Lower Cache River Watershed

This section discusses past pollutant load estimation work, along with estimates of current pollutant loads to the lower Cache River watershed. The primary pollutants of concern for the lower Cache River watershed (based on the draft 2014 303(d) list in Table 3.7) are turbidity/sediment, lead, and low DO.

5.2.1 Turbidity

There have been several studies that address TSS loads in the lower Cache River watershed. It is not possible to calculate turbidity loads, so TSS load is used as a surrogate. TSS loads in the lower Cache River watershed have been estimated as part of TMDL studies, studies conducted by TNC, measurements collected by USGS, and computer modeling using SWAT.

5.2.1.1 TMDLs

A TMDL has been completed addressing turbidity in the lower Cache River watershed. Since it is not possible to calculate turbidity load, for the turbidity TMDL observed TSS loads were estimated at each of the ADEQ monitoring locations using measured TSS concentrations and observed flow per unit area from USGS flow gages. The range of these calculated values are shown in Table 5.8 (FTN 2006).

Table 5.8 Estimated existing TSS loads to stream reaches in the lower Cache River watershed from TMDLs (FTN 2006, 2007).

Waterbody	Station	Estimated Existing Load Range, lbs/day/sq mi	Percent Load Reduction Needed
Bayou DeView	UWBDV02	16.5 – 1,020	35% baseflow only
Cache River	WHI0032	3.5 – 389	NA*
Cache River	UWCHR02	9.1 – 707	35% baseflow only
Cache River	UWCHR03	4.6 – 1,730	17% stormflow only
Lake Frierson	Various	46.3 – 4,728 lbs/day	55% baseblow 82% stormflow

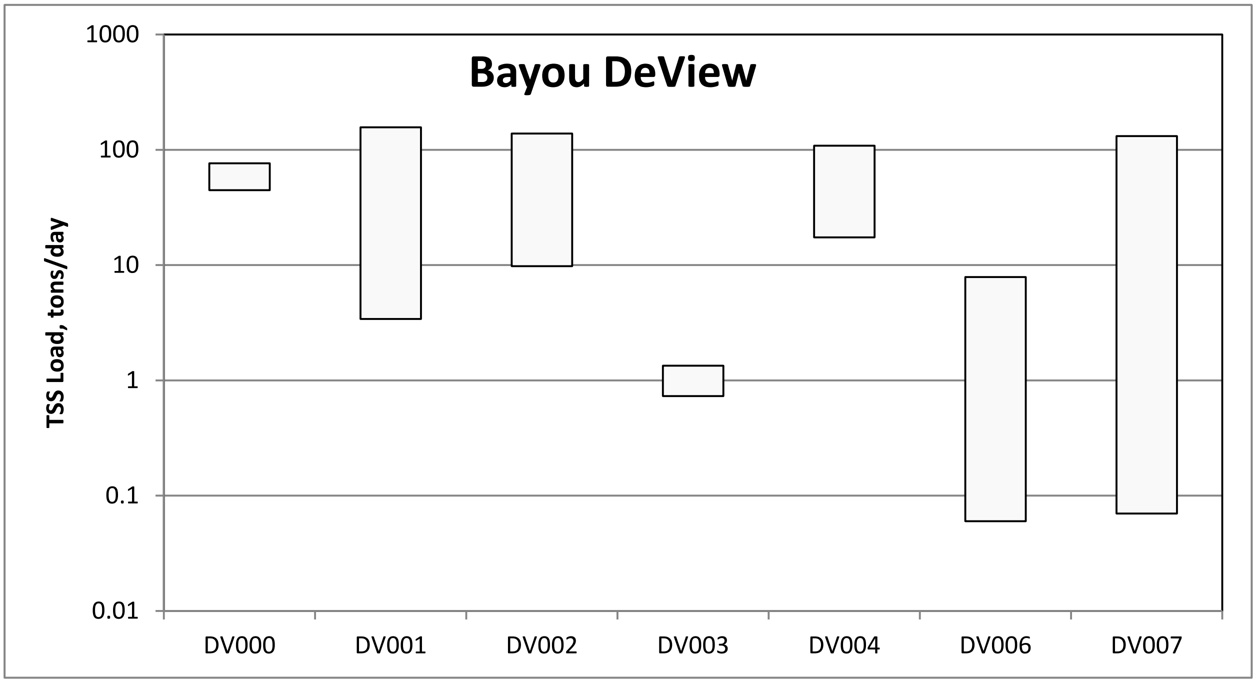
*This stream segment was not listed as impaired, so load reduction was not calculated for the TMDL.

5.2.1.2 TNC Studies

TNC has conducted studies in the Cache River watershed that involved characterizing sediment loads. For the TNC intensive study of the Cache River watershed, TSS loads were calculated using measurements collected on four sampling dates during 2004 and 2005. These loads are summarized in Table 5.9 and Figure 5.1. For the most part, these data show lower TSS loads in tributaries than in Bayou DeView or the Cache River.

Table 5.9. Summary of TNC estimated TSS loads at locations in the lower Cache River watershed (TNC 2005).

Station	Waterbody	Location	Estimated Existing Load Range, tons/day
DV007	Bayou DeView	Hickory Ridge	0.07 – 131.6
DV006	Bayou DeView	State Rd 269	0.06 – 7.87
DV004	Bayou DeView	Tip	17.4 – 108.6
DV003	Caney Creek	Hunter	0.73 – 1.34
DV002	Bayou DeView	Cotton Plant	9.78 – 138.5
DV001	Bayou DeView	Brinkley	3.41 – 156.7
DV000	Bayou DeView	Mouth	44.7 – 76.3
CR011	Cache River	South of Amagon	2.85 – 271.9
CR010	Cache River	Highway 33	6.29 – 343.2
CR008	Culotches Bay Slough	McClelland	0.07 – 0.71
CR007	Cache Bayou	Dixie	0.28 – 1.60
CR006	Cache River	Gregory	10.6 – 16.0
CR004	Cache River	Cotton Plant	57.0 – 76.4
CR002	Cache River	South of Highway 70	49.3 – 82.2



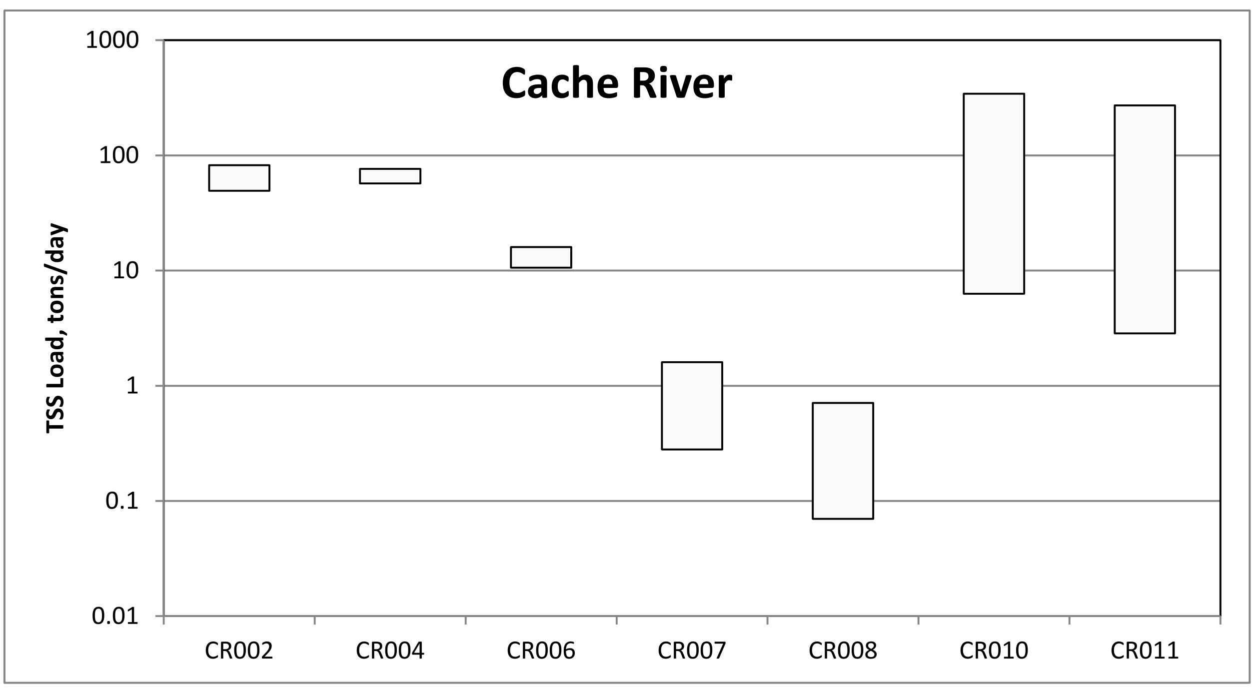


Figure 5.1. TNC estimated TSS loads for lower Cache River 2004 – 2005.

From 2007 through 2009, TNC conducted continuous monitoring of flow and TSS concentrations on four tributaries in the lower Cache River watershed. These data were used to calculate weekly TSS loads for each of the tributaries. The loads estimated from this study are summarized in Table 5.10. Although Skillet Ditch is also within the lower Cache River watershed, an equipment failure resulted in the collection of insufficient data to for estimating the TSS load for the study period (TNC 2009). Therefore, a load for Skillet Ditch is not included in Table 5.10.

Table 5.10. Summary of TNC estimated TSS loads at locations in the lower Cache River watershed (TNC 2009).

Station	Waterbody	Estimated Existing Load Range, tons/week	Average Load, tons/sq mi	Estimated Existing Load Range, tons/day
Overcup Ditch	Overcup Ditch	0.58 – 289.2	68.35	<0.1 – 41.3
Flag Slough	Flag Slough Ditch	1.34 – 612.6	112.49	0.19 – 87.5
Culotches Bay	Culotches Bay Slough	2.29 – 2,463	190.64	0.33 – 351.8
Benson Slash Creek	Benson Slash Creek	0.08 – 228.7	539.77	<0.1 – 32.7

In this study, Benson Slash Creek watershed was determined to have the highest sediment yield per square mile. However, Culotches Bay Slough received the highest rank of the lower Cache River tributaries evaluated in terms of priority for addressing sediment issues. As shown in Table 5.10, Culotches Bay Slough had the highest TSS load of the tributaries evaluated in the lower Cache River watershed (TNC 2009).

5.2.1.3 USGS Studies

The USGS has measured sediment loads at several locations in the lower Cache River watershed (USGS 2015b). The results from these measurements are summarized in Table 5.11. The highest average and maximum suspended sediment loads measured are on the Cache River, at Patterson and near Cotton Plant. Suspended sediment loads measured in Bayou DeView are lower than the loads measured at the nearby Cache River location (USGS station 07077500). These are the two stations with the most suspended sediment load measurements and the longest period of record.

Table 5.11. Measured sediment loads at USGS monitoring locations in the lower Cache River watershed (USGS 2015b).

USGS station ID	Stream	Location	Period of Record (years with data)	Suspended Sediment Load, (tons/day)			
				N	Min	Max	Avg
07077500	Cache River	Patterson (Hwy 64)	1974– 2014 (28)	194	0	3,680	404
07077510	Miller Branch	Grays	1987 – 1989 (3)	36	0.01	1,320	127
07077520	Moore Creek	Grays	1987 – 1988 (2)	8	0.01	1.6	0.2
07077530	Cache Bayou	Gregory	1987 – 1988 (2)	3	0.57	1.8	1.3
07077545	Roaring Slough	Dixie	1987 – 1988 (2)	8	0.02	53	7.7
07077555	Cache River	Cotton Plant	1987 – 1998 (9)	100	2	3,380	411
07077700	Bayou DeView	Morton (Hwy 64)	1974 – 2014 (23)	99	0	1,960	165

5.2.2 Lead Loads

A TMDL has been completed addressing lead pollution in the Cache River watershed. Existing pollutant loads to stream segments in the lower Cache River watershed were calculated as part of the TMDL study. In the TMDL, these loads were calculated by multiplying the average measured dissolved lead concentrations from ADEQ water quality monitoring stations by the estimated flow at the downstream end of the stream segment. The flow at the downstream end of each stream segment was estimated by multiplying flows at a nearby USGS flow gage by the ratio of gage drainage area to the stream segment drainage area. Loads were calculated for a range of flow conditions (FTN 2012).

These estimated loads are summarized in Table 5.12. Loads for the Cache River stream segments tend to be greater than those for the Bayou DeView stream segments. At least part of this is likely due to the fact that drainage areas and flows for the Cache River stream segments are greater than those for the Bayou DeView stream segments. Lead loads in Bayou DeView increase downstream, while the loads in the Cache River remain fairly constant throughout its length.

The TMDL determined that there was no need to reduce loads to meet the dissolved lead water quality standard(FTN 2012). The lead impairment has been removed from Bayou DeView stream segments of the lower Cache River watershed in the draft 2014 303(d) list (Table 3.7).

Table 5.12. Estimated existing lead loads to stream reaches in the lower Cache River watershed from TMDLs(FTN 2012).

Waterbody	ADEQ Stream Reach	Estimated Existing Load Range (lbs/day)	ADEQ Station Used
Cache River	020	<0.01 – 27.8	UWCHR03
Cache River	019	0.06 – 23.7	UWCHR02
Cache River	018	0.08 – 27.5	UWCHR02
Cache River	017	0.11 – 24.5	WHI0032
Cache River	016	0.11 – 25.2	WHI0032
Bayou DeView	007	<0.01 – 6.1	UWBDV02
Bayou DeView	006	<0.01 – 8.2	UWBDV02
Bayou DeView	005	<0.01 – 9.2	UWBDV02
Bayou DeView	004	<0.01 – 11.9	UWBDV02

5.3 Future Conditions and Pollutant Loads

Recent and planned activities in the lower Cache River watershed have the potential to reduce pollutant loads to the Cache River and Bayou DeView. These activities include the restoration of two historic meanders in the channelized section of the lower Cache River, and planned expansion of the Cache River NWR.

Poultry production may be expanding in the upper Cache River watershed (see construction stormwater permits in Table 4.4). Construction and operation of poultry houses has the potential to increase sediment, nutrient, and pathogen loads in the upper Cache River watershed.

5.4 Identification of Critical Areas

There have been studies and projects in the Cache River watershed that evaluated and/or prioritized subwatersheds based on water quality. The water quality parameter most frequently addressed in these studies and projects is sediment. These studies and projects each used different approaches to evaluate and prioritize. Information from these studies and projects was used to develop an overall ranking of 12-digit HUCs for this plan to identify critical areas for erosion and sediment sources. Critical areas for the upper and lower Cache River were determined separately. The following information was used to identify critical areas (i.e., 12-digit HUCs) for this plan in both the upper and lower Cache River watersheds: 1) stream segments with water quality impairments; 2) TNC prioritization of subwatersheds for sediment reduction; 3) stream segments that drain to impaired stream segments; and 4) NRCS 2011 Resource Assessment of 12-digit HUCs; and 5) results from SWAT modeling of nonpoint source pollution in the Cache River watershed. The approaches used to assign ranks to this information are discussed below. Note that in all of the rankings, the highest rank is 1, and the lowest rank is 5.

5.4.1 Impaired Stream Segments

The highest rank (1) was given to 12-digit HUC subwatersheds that contain stream segments listed as impaired on the Arkansas 303(d) list. There are 10 stream segments in the upper Cache River watershed on the final 2008 303(d) list, and 11 stream segments on the draft 2014 303(d) (see Tables 3.4 and 3.5). There are nine stream segments in the lower Cache River watershed on the final 2008 303(d) list, and 14 stream segments on the draft 2014 303(d) list (see Tables 3.6 and 3.7). Twelve-digit HUC subwatersheds that contain impaired stream segments are assigned the highest rank, 1. Those without impaired stream segments are assigned the lowest rank, 5. Because the focus of this plan is nonpoint source pollution, stream segments where the suspected pollutant source is point sources are also assigned the lowest rank, 5.

5.4.2 TNC 12-Digit HUC Subwatershed Prioritization

TNC conducted a two phase study to identify and prioritize 12-digit subwatersheds in the Cache River watershed for sediment abatement. Of the seven TNC priority subwatersheds identified for sediment abatement, two were located entirely in the upper Cache River watershed-Swan Pond Ditch (HUC 80203020205), and Willow Ditch (080203020305); and five were lower Cache River subwatersheds - Skillet Ditch (HUC 80203020401), Flag Slough (HUC 80203020601), Overcup Ditch (HUC 80203020405), Culotches Bay Slough (HUC 80203020806), and Benson Slash Creek (HUC 80203020706). TNC used the ESAT model, which uses elevation, soil types, land use, and annual precipitation to estimate erosion potential, as part of the prioritization methodology. Output from this model indicated that Swan Pond Ditch had the highest erosion potential of the seven TNC priority subwatersheds.

For this category, six of the seven TNC priority subwatersheds are assigned the highest rank, 1. Benson Slash Creek is a very small watershed (2.6 square miles) where about 2 stream miles were restored in 2008. There have been significant TSS reductions following restoration. Therefore, this subwatershed was assigned a low rank, 5. All other Cache River subwatersheds were assigned the lowest rank, 5, in this category.

5.4.3 Confluence with Impaired Stream Segment

Because the ADEQ ambient monitoring program primarily collects data on the mainstem Cache and Bayou DeView Rivers, the streams of the TNC priority subwatersheds cannot be listed as impaired. However, each of the TNC priority streams drains to an impaired mainstem stream segment. Therefore, 12-digit HUC subwatersheds that drain directly to an impaired stream segment were assigned the highest rank, 1, for this category. All other subwatersheds were assigned the lowest rank, 5.

5.4.4 NRCS Resource Assessment

Every 5 years the NRCS conducts state and national resource assessments to assess major impacts of agricultural practices on the environment. There are nine major resource concerns, including soil erosion and soil quality degradation, water quality degradation and inadequate habitat for fish and wildlife, and air quality degradation. The latest resource assessment for Arkansas was conducted in 2011. NRCS is currently planning for the 2016 resource assessment. The state resource assessments are conducted at the 12-digit HUC scale. The resource assessment considers a variety of factors.

The resource concern considered in ranking 12-digit HUCs of the upper and lower Cache River watersheds is ‘excess sediment’. For this concern, relative ranks ranging from 1 (highest impact) to 5 (lowest impact) are assigned to the subwatersheds based on the reported average value of the resource concern index for the subwatershed.

5.4.5 SWAT Model Prioritization

Researchers at the U of A prepared and calibrated a SWAT model of the Cache River watershed to aid in prioritizing subwatersheds for implementation of nonpoint source best management practices (BMPs). The parameters sediment, total phosphorus, and total nitrogen were modeled for the period 1992 through 2012. Model results for the period 2010 through 2012 were used by the researchers to prioritize the 12-digit HUCs of the Cache River watershed based on flow-weighted concentrations for each of the three modeled parameters (Saraswat et al. 2016). Relative ranks were assigned to the 12-digit HUCs ranging from 1 for the highest flow-weighted sediment concentrations, to 5 for the lowest flow-weighted sediment concentrations.

5.4.6 Upper Cache River Watershed

Table 5.13 summarizes and compares results from the evaluation and prioritization approaches described above for the upper Cache River watershed. Additional information was also considered in ranking the 12-digit HUCs of the upper Cache River watershed and is included in Table 5.13, drainage from Crowley's Ridge. This information is described below.

Table 5.13. Overall rankings for 12-digit HUC subwatersheds of the upper Cache River watershed.

HUC name (12-digit HUC number)	2014 nonpoint source impairment	Drains to impaired stream segment	TNC Phase II sediment assessment	NRCS excess sediment	Crowley's Ridge drainage	SWAT sediment	Number of high ranks (1 and 2)	Overall rank
Fish Trap Slough (80203020101)	5	5	5	4	5	5	0	Low
Little Cache River Ditch (80203020102)	5	5	5	1	1	4	2	Medium
North Big Creek-Cache River Ditch Number One (80203020103)	5	5	5	4	5	5	0	Low
South Fork Big Creek-Big Creek (80203020104)	5	5	5	1	1	5	2	Medium
East Slough-Cache River Ditch Number One (80203020105)	5	5	5	4	5	5	0	Low
Cache River Ditch Number One-Big Creek (80203020106)	5	5	5	1	1	5	2	Medium
Scatter Creek-Big Creek (80203020201)	5	5	5	1	1	5	2	Medium
Big Gum Lateral-Cache River (80203020202)	5	5	5	4	5	5	0	Low
Town of Evening Star-Cache River Ditch (80203020203)	1	5	5	1	5	5	2	Medium
Sugar Creek-Cache River (80203020204)	5	5	5	1	1	5	2	Medium
Swan Pond Ditch-Cache River (80203020205)	5	1	1	1	1	5	4	High
Petersburg Ditch-Cache River (80203020206)	1	5	5	3	5	4	1	Low
Beaver Dam Ditch (80203020207)	1	5	5	5	5	5	1	Low
Kellow Ditch (80203020208)	5	1	5	5	5	5	1	Low
Buffalo Head Slough-Cache River (80203020209)	1	5	5	2	5	4	2	Medium
Number Twenty Six Ditch-Cache River (80203020301)	1	5	5	1	1	4	3	High
Gum Slough Ditch (80203020302)	5	1	5	2	5	5	2	Medium
West Cache River Ditch (80203020303)	5	5	5	4	5	5	0	Low
Whaley Slough Ditch-Cache River (80203020304)	1	5	5	3	5	3	1	Low
Willow Ditch (80203020305)	5	1	1	4	5	5	2	Medium
Podo Creek-Cache River (80203020306)	1	5	5	3	5	3	1	Low
Skillet Ditch (80203020401)	5	1	1	3	5	5	2	Medium
Browns Creek-Cache River (80203020402)	1	5	5	5	5	3	1	Low
Mud Creek-Big Creek Ditch (80203020501)	1	5	5	1	1	5	3	High
Lost Creek Ditch (80203020502)	1	5	5	2	1	5	3	High
Rogers Bayou-Big Creek Ditch (80203020503)	1	5	5	2	1	5	3	High
Whistle Ditch-Big Creek Ditch (80203020505)	1	5	5	2	5	5	2	Medium
OK Lake-Bayou DeView (80203020506)	1	5	5	5	5	5	1	Low

5.4.6.1 Crowley's Ridge Drainage

Because runoff from Crowley's Ridge has been identified as a significant source of sediment to the Cache River system, 12-digit HUC subwatersheds of the upper Cache River were also ranked based on whether or not they included drainage from Crowley's Ridge. Those subwatersheds that include drainage from Crowley's Ridge were ranked high, i.e., 1. Those subwatersheds that do not include drainage from Crowley's Ridge were ranked low, i.e., 5.

5.4.6.2 Recommended Subwatersheds of the Upper Cache River for this Plan

The overall ranking of the upper Cache River 12-digit HUC subwatershes is based on the number of high ranks (i.e., ranks of 1 or 2) assigned to the subwatersheds. The 12-digit HUC subwatersheds with three or more high ranks are assigned a high overall rank. Subwatersheds with two high ranks are assigned a medium overall rank, and those with one or zero high ranks have a low overall rank. Overall rankings assigned to the 12-digit HUC subwatersheds of the upper Cache River are shown on Figure 5.2.

This ranking method resulted in five subwatersheds being assigned a high overall rank (see Table 5.13). These five subwatersheds are recommended for management through this plan in the upper Cache River watershed. Table 5.14 displays the individual rankings for the recommended 12-digit HUC subwatersheds from each of the prioritization approaches discussed above.

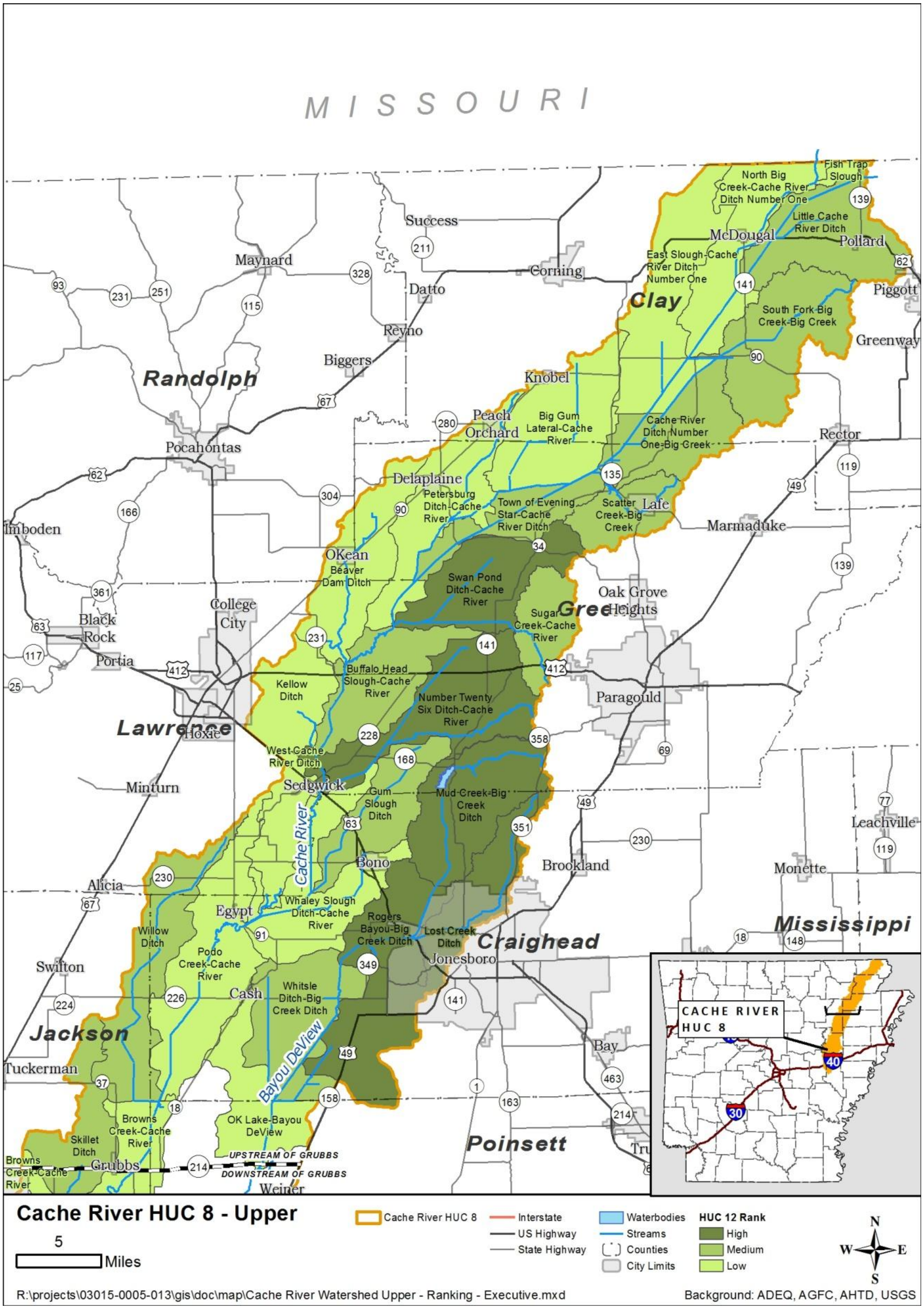


Figure 5.2. Overall ranking of the 12-digit HUC subwatersheds of the upper Cache River.

Table 5.14. Rankings from multiple approaches for recommended 12-digit HUC subwatersheds of the upper Cache River watershed.

HUC name (12-digit HUC number)	2014 nonpoint source impairment	Drains to impaired stream segment	TNC Phase II sediment assessment	NRCS excess sediment	Crowley's Ridge drainage	SWAT sediment priority			
Swan Pond Ditch-Cache River (80203020205)	5	1	1	1	1	5			
Number Twenty Six Ditch-Cache River (80203020301)	1	5	5	1	1	4			
Mud Creek-Big Creek Ditch (80203020501)	1	5	5	1	1	5			
Lost Creek Ditch (80203020502)	1	5	5	2	1	5			
Rogers Bayou-Big Creek Ditch (80203020503)	1	5	5	2	1	5			

5.4.6.1 Nonpoint Pollutant Sources in the Recommended 12-digit HUC subwatersheds of the upper Cache River

Based on the draft 2014 state impaired waters list (Table 3.4), the priority pollutants in the recommended subwatersheds of the upper Cache River are turbidity, dissolved copper, and sulfate. Table 5.15 summarizes priority nonpoint pollutants and sources that are present in each of the recommended subwatersheds of the upper Cache River.

Table 5.15. Priority pollutants and nonpoint sources for recommended subwatersheds of the upper Cache River.

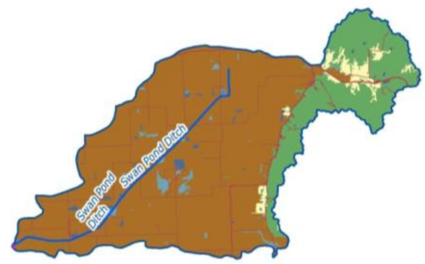
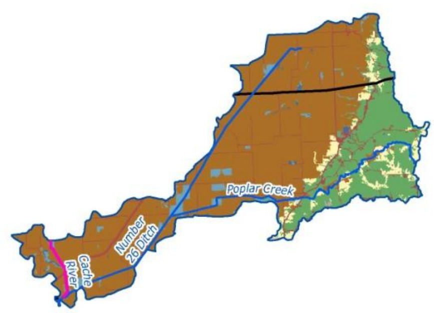
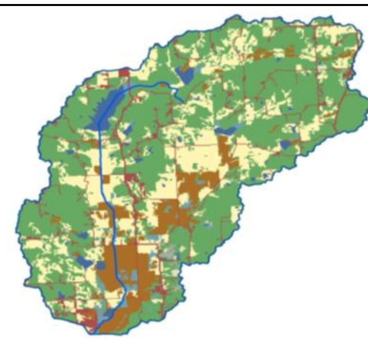
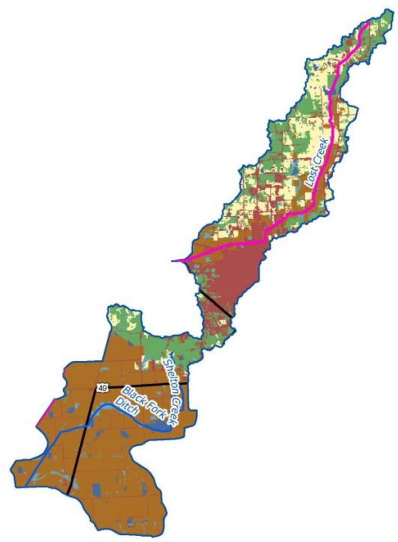
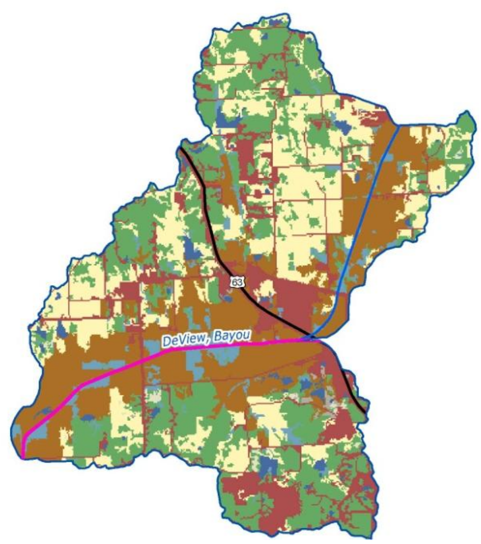
Land use	**% area**	**Priority Nonpoint Pollutants**	**Priority Nonpoint Sources**	**Land Use Map**
Swan Pond Ditch-Cache River - 80203020205				
Developed	4.2	None	None	
Cropland	72.6	Turbidity	Agriculture, streambank erosion, gully erosion	
		Sulfate	Agriculture, runoff	
Hay/Pasture	2.5	Turbidity	Agriculture, streambank erosion, gully erosion	
Forest	17.9	None	None	
Number Twenty Six Ditch-Cache River – 80203020301				
Developed	5.6	None	None	
Cropland	66.8	Turbidity	Agriculture, streambank erosion, sheet/rill/wind erosion, gully erosion	
		Sulfate	Agriculture, runoff	
Hay/Pasture	4.8	Turbidity	Agriculture, streambank erosion, gully erosion	
Forest	18.7	None	None	
Mud Creek-Big Creek Ditch – 80203020501				
Developed	6.9	Copper	Runoff	
Cropland	10.1	Copper, turbidity	Streambank erosion, sheet/rill/wind erosion, gully erosion, runoff	
Hay/Pasture	24.0	Copper, turbidity	Streambank erosion, sheet/rill/wind erosion, gully erosion, runoff	

Table 5.15. Priority pollutants and nonpoint sources for recommended subwatersheds of the upper Cache River (continued).

Land use	% area	Priority Nonpoint Pollutants	Priority Nonpoint Sources	Land Use Map
Mud Creek-Big Creek Ditch – 80203020501				
Forest	53.4	Copper, turbidity	Streambank erosion, gully erosion, runoff	
Lost Creek Ditch – 80203020502				
Developed	17.8	Copper	Runoff	
Cropland	47.0	Copper	Streambank erosion, sheet/rill erosion, gully erosion	
Hay/Pasture	12.6	Copper	Streambank erosion, sheet/rill/wind erosion, gully erosion	
Forest	17.3	Copper	Streambank erosion, gully erosion	
Rogers Bayou-Big Creek Ditch - 80203020503				
Developed	16.8	Copper	Runoff	
Cropland	24.2	Copper	Streambank erosion, sheet/rill/wind erosion, gully erosion	
Hay/Pasture	23.0	Copper	Streambank erosion, sheet/rill/wind erosion, gully erosion	
Forest	28.0	Copper	Streambank erosion, gully erosion	

5.4.6.1.1. Turbidity

Erosion is the priority nonpoint source of turbidity in the recommended subwatersheds associated with turbidity impaired waterbodies. The Number Twenty-six Ditch subwatershed includes a Cache River stream segment listed as impaired due to high turbidity levels. Lake Frierson in the Mud Bayou subwatershed is also listed as impaired due to high turbidity levels. There are no impaired stream segments within the Swan Pond Ditch subwatershed, however, it contributes flow, and thus turbidity, to turbidity impaired stream segments of the Cache River.

ADEQ has identified agriculture as the source of turbidity in the impaired stream segment in the Number Twenty-six Ditch subwatershed, and in the Cache River impaired stream segments that receive flow from the Swan Pond Ditch subwatershed. Therefore, erosion from agricultural land is the priority nonpoint source of turbidity in the Number Twenty-six Ditch and Swan Pond Ditch subwatersheds. The most prevalent agricultural land use in these subwatersheds is cropland. Both subwatersheds also include areas of hay/pasture land in the portion of their watersheds on Crowley’s Ridge, where soils are highly erodible.

ADEQ has determined that high levels of turbidity in Lake Frierson are the result of both in-lake processes, e.g., wind action stirring up sediment from the bottom, and external inputs (ADEQ 2005).

NRCS resource concern rankings of the recommended subwatersheds for erosion sources are listed in Table 5.16. Streambank erosion and concentrated flow erosion (i.e., gullies) are ranked high as resource concerns in all of the recommended subwatersheds. TNC determined that 50% of the evaluated streambanks along Swan Pond Ditch had a high erosion potential (TNC 2009). As a result, these types of erosion are priority nonpoint sources of turbidity in all of the recommended subwatersheds of the upper Cache River. Figure 5.3 shows areas of Swan Pond Ditch streambank to be restored or managed to reduce erosion. Sheet/rill/wind erosion is ranked high as a resource concern in all of the recommended subwatersheds except Swan Pond Ditch. Therefore, sheet/rill/wind erosion is a priority nonpoint source of turbidity in four of the five recommended subwatersheds of the upper Cache River.

Table 5.16. NRCS resource concern ranks for erosion sources in the recommended subwatersheds of the upper Cache River.

HUC name (12-digit HUC number)	Streambank Erosion*	Sheet/rill/wind Erosion*	Concentrated Flow Erosion*
Swan Pond Ditch-Cache River (80203020205)	1	3	1
Number Twenty Six Ditch-Cache River (80203020301)	1	2	1
Mud Creek-Big Creek Ditch (80203020501)	1	1	1
Lost Creek Ditch (80203020502)	2	1	1
Rogers Bayou-Big Creek Ditch (80203020503)	1	1	1

* ranks range from 1 to 5 with 1 being highest concern and 5 being lowest concern

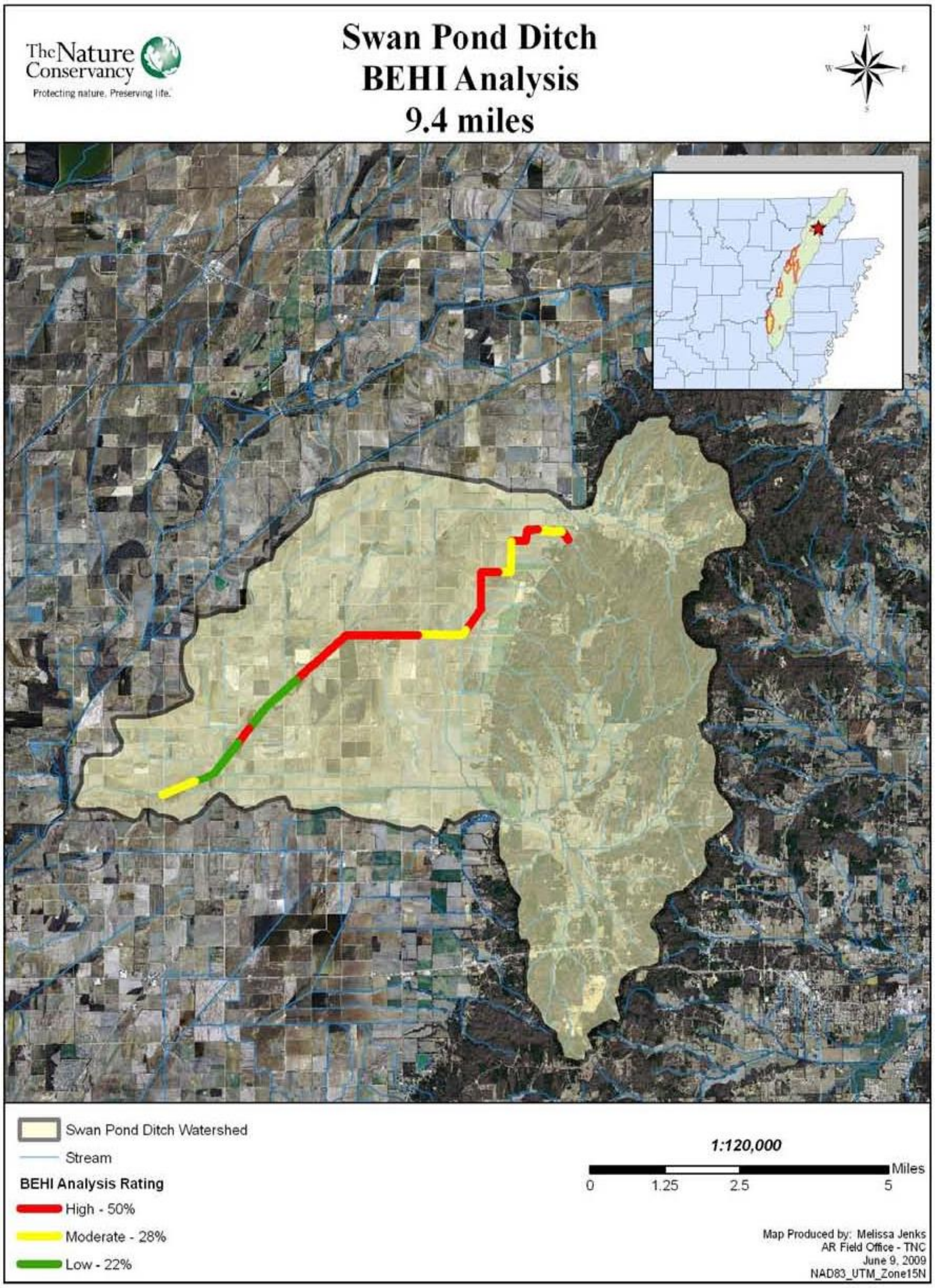


Figure 5.3 Bank erosion hazard index results for Swan Pond Ditch (TNC 2009).

5.4.6.1.2. Sulfate

Sulfate impaired stream segments are associated with the Swan Pond Ditch and Number Twenty-six Ditch subwatersheds. ADEQ has identified agriculture as the source of sulfate in the impaired stream reaches associated with these recommended subwatersheds, and cropland is the most prevalent agricultural land use in these subwatersheds. Therefore, runoff from cropland is the priority nonpoint source of sulfate in the Swan Pond Ditch and Number Twenty-six Ditch recommended subwatersheds.

5.4.6.1.3. Copper

Waterbodies that do not meet dissolved copper water quality criteria are associated with the recommended subwatersheds of Bayou deView, which are located primarily on Crowley's Ridge (Mud Creek, Lost Creek Ditch, and Rogers Bayou). ADEQ has not identified sources of the copper impairing the waterbodies associated with these recommended subwatersheds. However, based on available information, priority nonpoint sources have been identified for this pollutant that will be addressed in this plan.

Copper source identification studies in other states have identified runoff from cities and areas where pesticides and/or herbicides that contain copper are used, as contributing copper loads to surface waters. They have also determined that copper in eroded soils can contribute copper to surface waters (TDC Environmental 2004). The three recommended subwatersheds where copper is a priority pollutant, encompass developed areas that are part of the City of Jonesboro. As noted previously, NRCS has identified erosion as a resource concern in these subwatersheds. Based on this information, the priority nonpoint sources of copper that will be addressed in this plan are runoff from developed areas, and erosion.

5.4.7 Lower Cache River Watershed

Table 5.15 summarizes and compares results from the evaluation and prioritization approaches described above for the lower Cache River watershed. Additional information was also considered in ranking the 12-digit HUCs of the lower Cache River watershed and is included in Table 5.17, the presence of protected land (e.g., Cache River NWR, WMAs) along impaired stream segments. This information is described below. Figure 5.4 illustrates the overall ranking of the lower Cache River 12-digit HUCs for this plan.

5.4.7.1 Protected Land

An additional consideration in determining overall ranks for subwatersheds for the lower Cache River, was whether or not impaired stream segments in the subwatersheds are within the Cache River NWR, or a state WMA or Natural Area, i.e., protected land. Because of the extensive forest cover and lack of soil disturbing activities on protected lands in the watershed, impaired stream segments on protected lands are not expected to be receiving significant nonpoint source pollution inputs from those lands. Therefore, the overall rank of those subwatersheds where the entire impaired stream segment is within protected lands is reduced one level.

5.4.7.2 Recommended Subwatersheds of the Lower Cache River for this Plan

The overall ranks for the 12-digit HUC subwatersheds of the lower Cache River are based on the total number of high ranks (i.e., ranks of 1 or 2) assigned to the subwatersheds, as shown in Table 5.17. Subwatersheds with three or more high ranks are assigned a high overall rank. Subwatersheds with two high ranks are assigned a medium overall rank, and those with one or zero high ranks have a low overall rank. Overall rankings assigned to the 12-digit HUC subwatersheds of the lower Cache River are shown on Figure 5.4.

This ranking method resulted in three subwatersheds being assigned a high overall rank. For this plan, these are the subwatersheds in the lower Cache River watershed recommended for implementing nonpoint source management practices. Table 5.18 displays individual rankings for the recommended 12-digit HUC subwatersheds from each of the prioritization and evaluation approaches discussed above.

Table 5.17. Overall rankings for 12-digit HUC subwatersheds of the lower Cache River watershed.

HUC name (12-digit HUC number)	2014 nonpoint source impairment	Drains directly to turbidity impaired stream segment	TNC Phase II sediment assessment (TNC rank)	NRCS excess sediment	SWAT Rank	Number of high ranks (1 and 2)	Protected riparian land*	Overall rank
Skillet Ditch (80203020401)	5	1	1	3	5	2		Medium
Browns Creek-Cache River (80203020402)	1	5	5	5	5	1		Low
Cyprus Creek Ditch (80203020403)	5	1	5	3	5	1		Low
Overcup Slough-Cache River (80203020404)	1	5	5	5	3	1	X	Low
Overcup Ditch (80203020405)	5	1	1	2	5	3		High
Town of Gourd Neck-Cache River (80203020406)	1	5	5	4	3	1	X	Low
Town of Patterson-Cache River (80203020407)	1	5	5	4	5	1	X	Low
Lake Hogue – Bayou DeView (80203020507)	1	5	5	5	5	1	X	Low
Flag Slough Ditch (80203020601)	5	1	1	3	5	2		Medium
Threemile Creek (80203020602)	5	1	5	2	5	2		Medium
Town of Waldenburg-Bayou DeView (80203020603)	1	5	5	3	5	1		Low
Town of Pittinger-Bayou DeView (80203020604)	1	5	5	3	5	1		Low
Cow Lake Ditch (80203020605)	5	1	5	2	5	2		Medium
May Branch Lateral (80203020606)	1	5	5	3	5	1		Low
Old Channel Bayou DeView-Bayou DeView (80203020607)	1	5	5	2	5	2		Medium
Possom Creek-Bayou DeView (80203020701)	1	5	5	2	5	2		Medium
Buffalo Creek (80203020702)	1	5	5	2	5	2		Medium
Morrison Lake-Bayou DeView (80203020703)	1	5	5	4	5	1	X	Low
Caney Creek-Buffalo Creek (80203020704)	1	5	5	4	5	1		Low

Table 5.17. Overall rankings for 12-digit HUC subwatersheds of the lower Cache River watershed (continued).

HUC name (12-digit HUC number)	2014 nonpoint source impairment	Drains directly to turbidity impaired stream segment	TNC Phase II sediment assessment (TNC rank)	NRCS excess sediment	SWAT Rank	Number of high ranks (1 and 2)	Protected riparian land*	Overall rank
Turkey Creek-Bayou DeView (80203020705)	1	5	5	4	5	1		Low
Channey Slough-Bayou DeView (80203020706)	1	5	5	5	4	1		Low
Gum Flat Bayou (80203020707)	5	5	5	2	5	1		Low
Robe Bayou-Bayou DeView (80203020708)	1	5	5	2	4	2		Medium
Miller Branch-Cache River (80203020801)	1	5	5	4	2	2	X	Low
Beard Lake-Cache River (80203020802)	1	5	5	5	2	2	X	Low
Cache Bayou (80203020803)	1	5	5	1	5	2		Medium
James Ferry-Cache River (80203020804)	1	5	5	4	2	2	P	Medium
Bear Slough-Culotches Bay Slough (80203020805)	5	5	1	1	5	2		Medium
Culotches Bay Slough-Cache River (80203020806)	1	5	1	1	1	4		High
Maloy Bayou-Cache River (80203020807)	1	5	5	1	1	3	P	High
Reeses Fork-Cache River (80203020808)	5	5	5	3	1	1		Low

*X = the impaired stream segment(s) within the subwatershed are surrounded by protected lands, i.e., NWR or WMA; P = a portion of the impaired stream segment(s) within the subwatershed are surrounded by protected land.

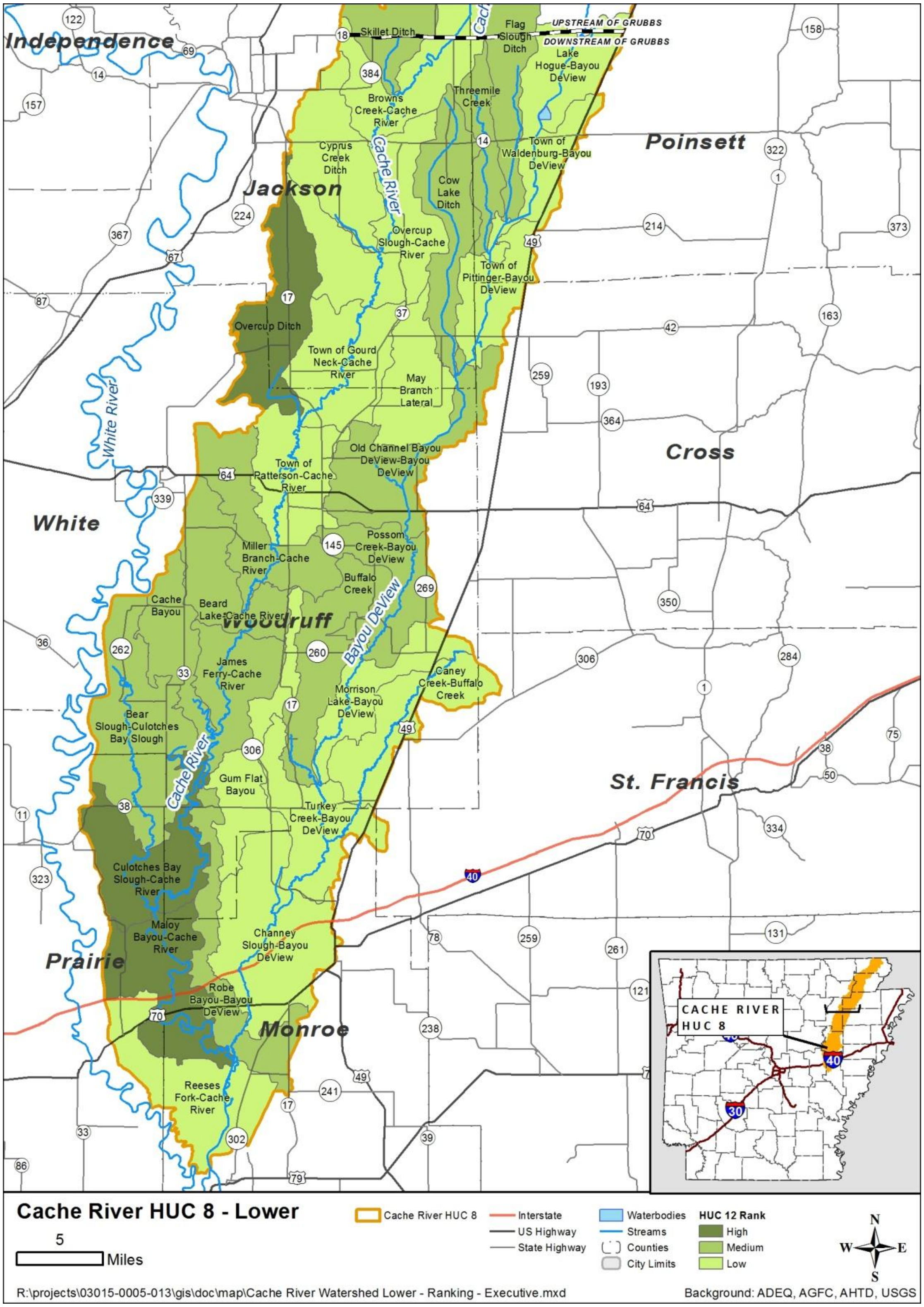


Figure 5.4. Overall ranks for 12-digit HUC subwatersheds of the lower Cache River.

Table 5.18. Rankings from multiple approaches for recommended 12-digit HUC subwatersheds of the lower Cache River watershed.

HUC name (12-digit HUC number)	2014 nonpoint source impairment	Drains directly to impaired stream	TNC Phase II sediment assessment (TNC rank)	NRCS excess sediment	SWAT sediment priority			
Overcup Ditch (80203020405)	5	1	1	2	5			
Culotches Bay Slough-Cache River (80203020806)	1	5	1	1	1			
Maloy Bayou-Cache River (80203020807)	1	5	5	1	1			

5.4.7.1 Nonpoint Pollutant Sources in the Recommended 12-digit HUC subwatersheds of the lower Cache River

Based on the draft 2014 state impaired waters list (Table 3.7), the priority pollutants in the recommended subwatersheds of the lower Cache River are turbidity and lead. Table 5.19 summarizes priority nonpoint pollutants and sources that are present in each of the recommended subwatersheds of the lower Cache River.

Table 5.19. Priority pollutants and nonpoint sources for recommended subwatersheds of the lower Cache River.

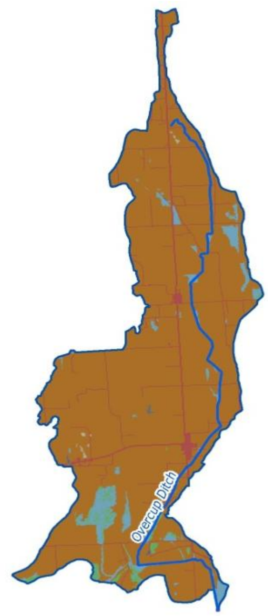
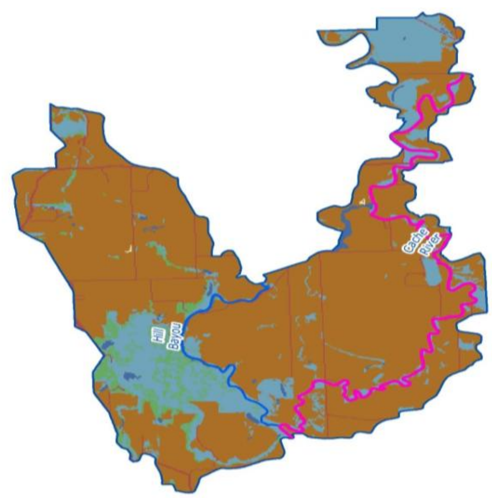
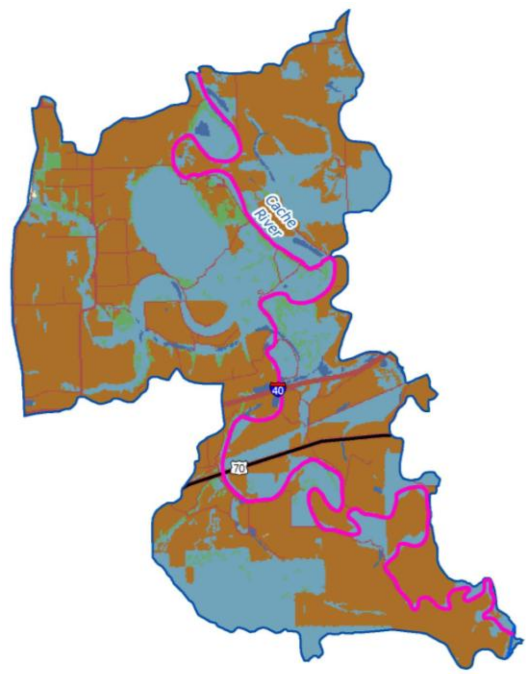
Land use	% area	Priority Pollutants	Priority Nonpoint Sources	Land Use Map
Overcup Ditch - 80203020405				
Developed	4.8	None	None	
Cropland	88.8	Turbidity	Surface erosion, Streambank erosion	
		Lead	Agriculture runoff, streambank erosion	
Forest	1.4	None	None	
Culotches Bay Slough-Cache River - 80203020806				
Developed	2.7	None	None	
Cropland	73.1	Turbidity	Surface erosion, Streambank erosion	
		Lead	Agriculture runoff, streambank erosion	
Forest	3.7	None	None	

Table 5.19. Priority pollutants and nonpoint sources for recommended subwatersheds of the lower Cache River (continued).

Land use	% area	Priority Pollutants	Priority Nonpoint Sources	Land Use Map
Maloy Bayou-Cache River - 80203020807				
Developed	4.5	Npne	None	
Cropland	53.7	Turbidity	Surface erosion, Streambank erosion	
		Lead	Agriculture runoff, streambank erosion	
Forest	3.5	None	None	

5.4.7.1.1. Turbidity

Erosion is the priority nonpoint source of turbidity in the recommended subwatersheds associated with turbidity impaired waterbodies. The Culotches Bay Slough, and Maloy Bayou subwatersheds include stream segments that are listed as impaired due to high turbidity levels. There are no impaired stream segments within the Overcup Ditch subwatershed, however, it contributes flow, and thus turbidity, to a turbidity impaired stream segment (018).

ADEQ has identified surface erosion as the source of turbidity causing turbidity impairment in the stream reaches associated with the recommended subwatersheds. NRCS resource concern rankings of the recommended subwatersheds for erosion sources are listed in Table 5.20. Streambank erosion is ranked high as a resource concern two of the three recommended subwatersheds of the lower Cache River. Although NRCS has assigned the lowest rank for streambank erosion to the Overcup Ditch subwatershed, a TNC 2009 bank hazard analysis of approximately 10 miles of this ditch classified 84% of the evaluated streambanks as having a high or very high erosion potential (TNC 2009). Since the predominant land use in the recommended subwatersheds is cropland, streambank erosion associated with cropland is the priority nonpoint source of turbidity in all three of the recommended subwatersheds of the lower Cache River. Figures 5.5 and 5.6 show areas of streambank to be restored or managed to reduce streambank erosion along Overcup Ditch and Culotches Bay Slough. None of the subwatersheds have high ranks for concentrated flow erosion (i.e., gully erosion), nor sheet/rill/wind erosion, suggesting that these are not significant sources of turbidity in these subwatersheds.

Table 5.20. NRCS resource concern ranks for erosion sources in the recommended subwatersheds of the lower Cache River.

HUC name (12-digit HUC number)	Streambank Erosion*	Sheet/rill/wind Erosion	Concentrated Flow Erosion
Overcup Ditch (80203020405)	5	5	4
Culotches Bay Slough-Cache River (80203020806)	1	5	4
Maloy Bayou-Cache River (80203020807)	2	5	5

* ranks range from 1 to 5 with 1 being highest concern and 5 being lowest concern

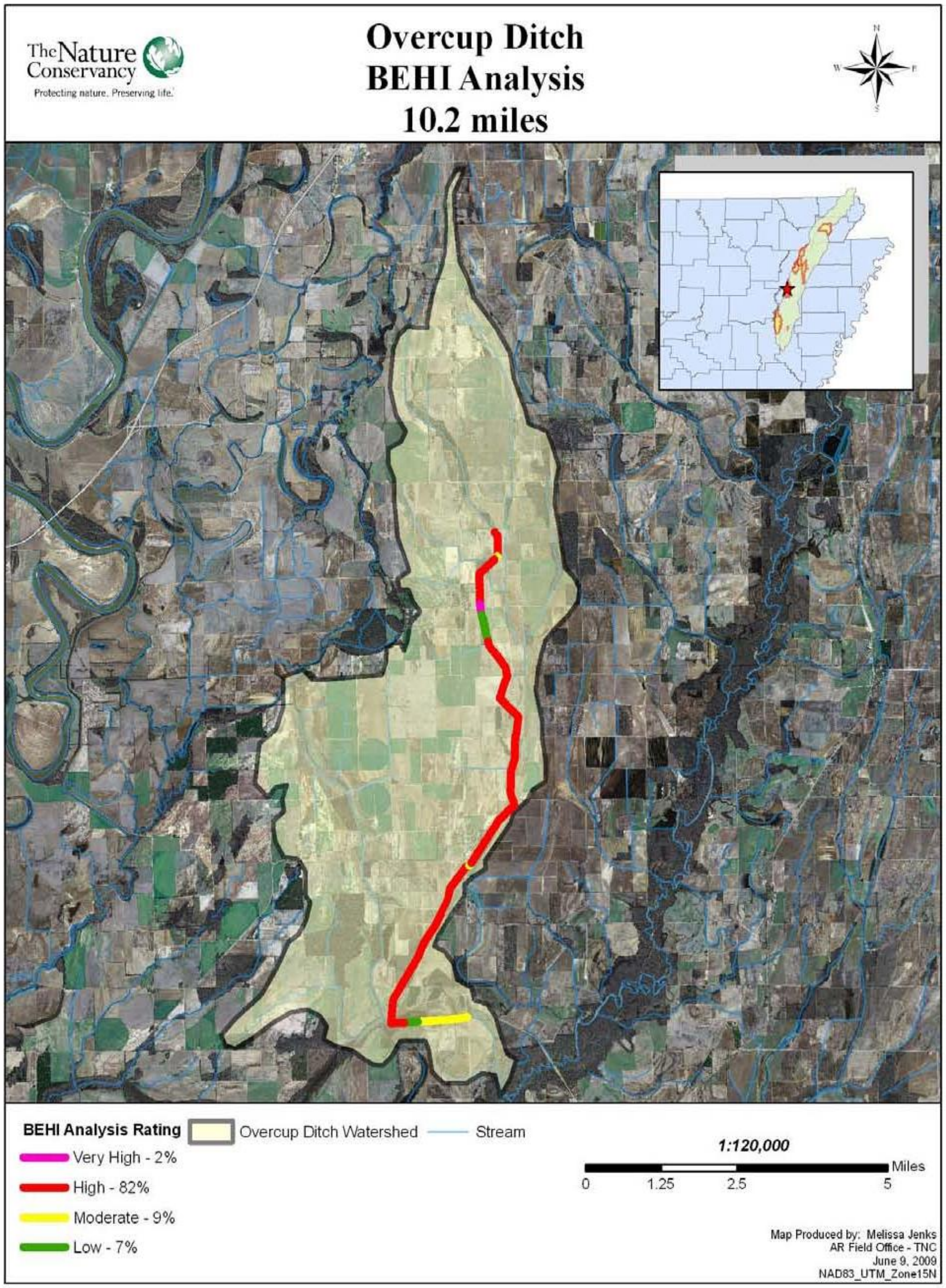


Figure 5.5. Bank erosion hazard index results for Overcup Ditch (TNC 2009).

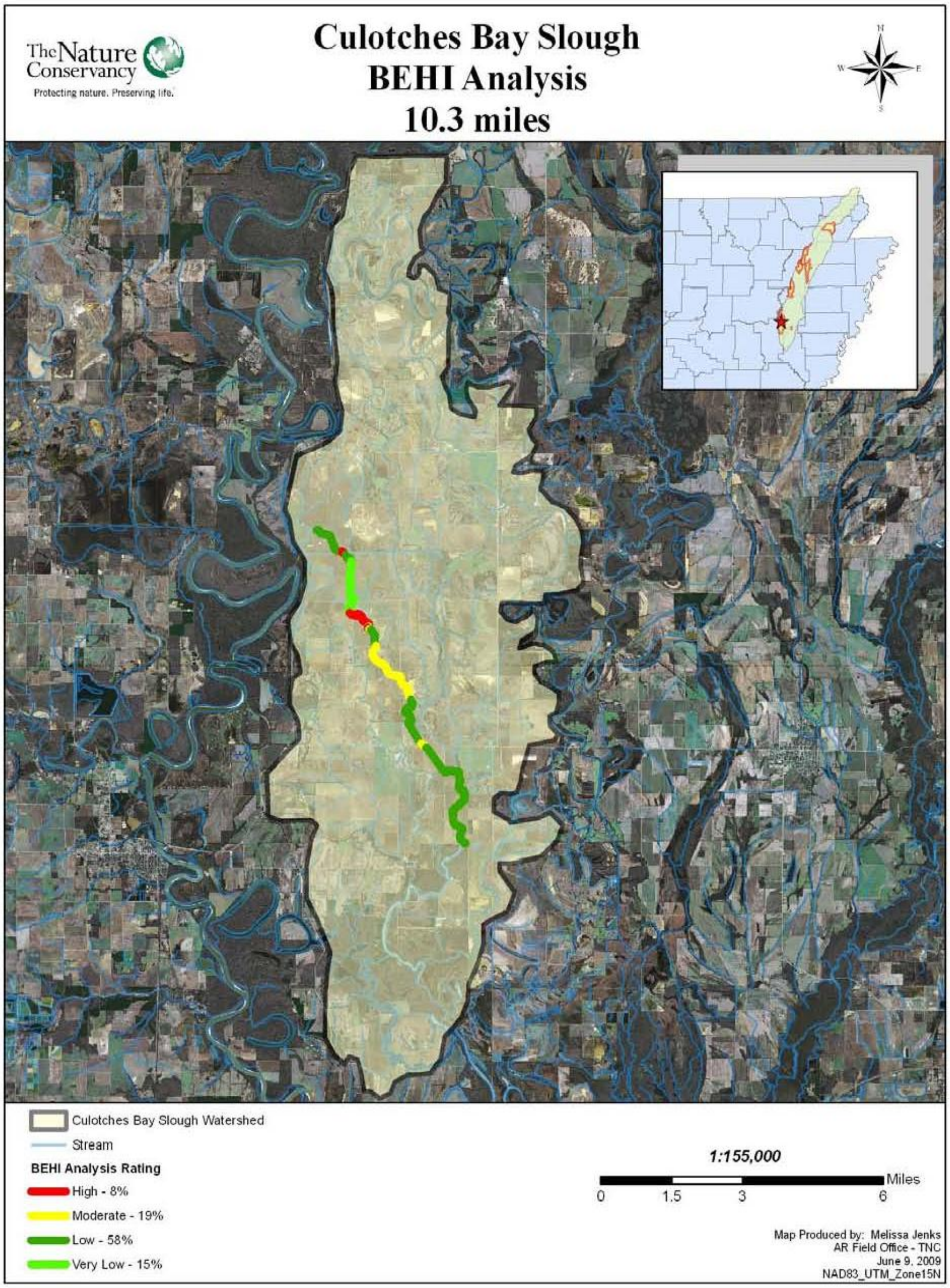


Figure 5.6. Bank erosion hazard index results for Culotches Bay Slough (TNC 2009).

5.4.7.1.2. Lead

The Culotches Bay Slough, and Maloy Bayou subwatersheds include stream segments that are listed as impaired due to high lead levels. There are no impaired stream segments within the Overcup Ditch subwatershed, however, it contributes flow, and thus lead, to a lead impaired stream segment of the Cache River. ADEQ has identified agriculture as the source of lead for the lead impaired stream reaches associated with the recommended subwatersheds. Lead levels in Bayou DeView stream segments were reduced enough to remove these segments from the state impaired waters list after wide-spread implementation of erosion control practices on cropland (EPA 2014). This suggests that lead in the Cache River watershed is associated with erosion. Based on this information, the priority nonpoint sources of lead in the recommended subwatersheds that will be addressed in this plan are runoff and erosion from cropland.

6.0 WATERSHED GOALS AND OBJECTIVES

The overall objective of this watershed-based management plan is to restore and sustain the natural resources of the Cache River watershed so that the vision of its citizens can be achieved. The vision for the Cache River for this plan is: Stream, lake, and wetland uses are attained and sustained within a mosaic of local communities and economically-viable agriculture to improve the natural and social amenities of rural life within the Cache River basin.

The primary focus of this plan is to address surface water quality. However, the intention is to manage the Cache River watershed holistically, so that addressing surface water quality does not adversely affect other management efforts (e.g., groundwater and wildlife habitat management), or give rise to, or exacerbate, other issues. To this end, the visions and goals of other organizations for the Cache River watershed are discussed.

6.1 Visions and Goals of Organizations Working in the Cache River Watershed

There are a number of agencies and other organizations that work within the Cache River watershed to manage natural resources. Several of them have developed plans that address their visions and goals in the watershed. These are discussed by organization below.

6.1.1 America's Great Outdoors Initiative

The Cache/Lower White River (which includes the lower Cache River watershed) is a Rivers Demonstration Project of the America's Great Outdoors Initiative. An inter-organizational work groups has identified a vision and goals for this area. The vision is to: "Maintain and enhance the globally significant Cache - White Rivers' bottomland hardwood ecosystem within a sustainable agriculture-based landscape to balance ecological, economic, and social interests." To achieve this vision, the work group has identified the following goals:

- Improve ecological health of the Cache and Lower White Rivers' system (habitat);
- Promote voluntary, sustainable agricultural and forestry practices that improve water quality and enhance wildlife habitat (agriculture);

- Effectively manage surface and groundwater resources to support all users. (hydrology);
- Increase outdoor recreational opportunities and access (recreation); and
- Increase public awareness of the link between economic benefits and conservation goals (outreach) (USGS 2015b).

6.1.2 USFWS

USFWS activities in the Cache River watershed, particularly the lower Cache River watershed, are guided by a number of management plans. These include the North American Waterfowl Management Plan, the Partners in Flight Bird Conservation Plan, and the Central Arkansas Comprehensive NWR Complex Comprehensive Plan.

6.1.3 Lower Mississippi Valley Join Venture

The Cache River watershed is part of the Mississippi Alluvial Valley Conservation Delivery Network of the Lower Mississippi Valley Join Venture. The Conservation Delivery Network group has identified a vision and goals for this region. This group includes USFWS, AGFC, NRCS, Ducks Unlimited, TNC, Audubon, ANHC, National Wild Turkey Federation, and Arkansas Forestry Commission. The vision is: “The [Conservation Delivery Network] will implement on-the-ground delivery projects to link with the biological goals and objectives of the [Lower Mississippi Valley Joint Venture]. This will improve the ecological function of forested wetlands, including water quantity and quality which supports these complex wetland systems. A functional landscape will support priority bird populations that are key to [Lower Mississippi Valley Joint Venture] objectives, as well as other wildlife and fisheries resources. A functional landscape will result in healthy natural resources that can be used and enjoyed by people.” (Lower Mississippi Valley Joint Venture 2014). The three overall goals for achieving this vision are:

- Implement on-the-ground projects within the Conservation Delivery Network-defined priority areas,
- Coordinate the independent efforts of Conservation Delivery Network members, and

- Leverage human resources and funding of Conservation Delivery Network member organizations to implement on-the-ground projects that further the natural resource objectives of each independent entity and link those projects to the biological goals of the Lower Mississippi Valley Joint Venture (Lower Mississippi Valley Joint Venture 2014).

6.1.4 USACE

In 2014, the USACE prepared a Cache River Basin Watershed Management Plan in coordination with the federal, state, and local authorities involved in water resources management in the watershed. The purpose of the plan was to "assess the problems, needs, and opportunities" association with water resources in the Cache River watershed and "to inform Congress, management agencies, and local groups of methods to address problems … and the necessity for a study to determine the best federal course of action to implement improvements." The vision and specific goals for this plan were the same as those cited in Section 6.1.1. The general goal for this plan was to "promote access, recreation and investment in the water, wildlife, and culture" of the Cache River watershed (USACE 2015a).

6.1.5 TNC

The lower Cache River watershed is part of The Big Woods focus area for TNC. The TNC vision for the Big Woods is "a healthy, functioning floodplain ecosystem within the context of sustainable human use." To accomplish this vision, TNC has developed four goals:

- conserve the remaining forests and wetlands;
- reforest degraded sites to reconnect forest fragments;
- restore sustainable form and function to major rivers; and
- reduce river sedimentation and pollution to preserve water quality (TNC 2015a).

6.2 Management Objectives

The overall management objective of this plan is to implement management practices so the designated uses of the waterbodies within the Cache River watershed highly recommended subwatersheds are attained. Stream segments in the highly subwatersheds of the upper Cache River are not meeting numeric water quality criteria for turbidity, sulfate, and copper. Stream segments in the highly recommended subwatersheds of the lower Cache River watershed are not meeting numeric water quality criteria for turbidity and lead. Management practices can reduce the pollutants identified on the 303(d) list as the causes of impairment of the designated uses, so that Arkansas water quality criteria are met and the designated uses of the streams are attained.

The surface water pollutant that will be the primary target for reduction in the recommended 12-digit HUC subwatersheds, in both the upper and lower Cache River watersheds, through implementation of management measures, is turbidity (TSS). Secondary pollutant targets will be lead and sulfate. Lead impairments in Bayou DeView have been removed as a result of implementation of erosion control management strategies (EPA 2014a). Therefore, it is reasonable to assume that management strategies that address sediment and erosion can reduce lead in the Cache River. It is possible that management strategies to reduce runoff from cropland may also reduce sulfate levels. The source of copper in the upper Cache River watershed is unknown, so it is not possible to address this pollutant at this time.

6.3 Load Reduction Targets

The primary load reduction targets to be addressed by this plan are for TSS (as a surrogate for turbidity), copper, lead, and sulfate. ADEQ has identified point sources as the source of chloride and DO reducing pollutants causing impairment of Lost Creek. Therefore, the 2014 chloride and DO impairments of Lost Creek will be dealt with through the state NPDES program. ADEQ has identified agriculture as the source of pollution causing low DO concentrations in impaired stream reaches of the lower Cache River watershed. A TMDL addressing this water quality issue in these stream reaches has not been completed. As a result, there are no reduction targets available for these stream reaches to meet the DO water quality standard. Therefore, this impairment will not be addressed directly in this plan. After reduction targets to meet the DO standard have been determined, this impairment will be addressed in updates of this plan. In the meantime, however, practices that reduce turbidity through reducing erosion and TSS loads, will also reduce loads of pollutants, such as nutrients and organic material, that cause low DO conditions.

6.3.1 Turbidity

TMDLs addressing turbidity in the Cache River watershed have been completed. In these TMDLs, TSS is used as a surrogate for turbidity, because turbidity cannot be expressed as a load. Table 6.1 summarizes the total and nonpoint source target TSS loads to meet turbidity criteria in the recommended subwatersheds. Percent TSS load reduction targets to achieve turbidity water quality criteria were specified the turbidity TMDLs. The percent TSS load reduction targets from the turbidity TMDLs that apply to the recommended 12-digit HUC subwatersheds are summarized in Table 6.2. The turbidity TMDL for Lake Frierson identifies TSS load reductions for both base flow and storm flow conditions. For this plan, the percent TSS load reduction target for Lake Frierson will be the lower of the two TMDL TSS load reduction targets, 55%. Once this reduction is achieved, if further TSS load reductions are needed, they will be addressed in updates to this watershed-based plan.

Table 6.1. TMDL TSS target loads for recommended 12-digit HUC subwaterseds of the Cache River.

HUC name (12-digit HUC ID number)	ADEQ stream reaches turbidity impaired	Turbidity criterion	TSS target load, lbs/day
Number Twenty Six Ditch-Cache River (80203020301)	027	Base flow	10.5
		Storm flow	304
Swan Pond Ditch-Cache River (80203020205)	029*	Base flow	8.22
		Storm flow	238
Mud Creek-Big Creek Ditch (80203020501)	Lake Frierson	Base flow	82.5
		Storm flow	939
Overcup Ditch (80203020405)	019*	Base flow	16.7
		Storm flow	177
Culotches Bay Slough-Cache River (80203020806)	017	Base flow	19.4
		Storm flow	205
Maloy Bayou-Cache River (80203020807)	016	Base flow	21.3
		Storm flow	225

Table 6.2. TMDL TSS load reductions for recommended 12-digit HUC subwatersheds of the Cache River.

HUC name (12-digit HUC ID number)	ADEQ stream reaches turbidity impaired	TSS load reduction targets	
		Base flow	Storm flow
Number Twenty Six Ditch-Cache River (80203020301)	027	13%	0
Swan Pond Ditch-Cache River (80203020205)	029*	13%	0
Mud Creek-Big Creek Ditch (80203020501)	Lake Frierson	55%	82%
Overcup Ditch (80203020405)	019*	35%	0
Culotches Bay Slough-Cache River (80203020806)	017	35%	0
Maloy Bayou-Cache River (80203020807)	016	35%	0

* Swan Pond Ditch drains to stream segments 031 and 029, Overcup Ditch drains to ADEQ stream segment 019.

The interim target for turbidity reduction is that the percentage of measurements from the impaired stream reaches in the recommended subwatersheds that exceed the water quality criteria, declines from the 2008 percentage (shown in Table 6.3).

Table 6.3 Percentage of measurements exceeding turbidity criteria during the 2008 water quality assessment period (7/1/2002 – 6/30/2007).

HUC name (12-digit HUC no.)	ADEQ water quality station	Turbidity criterion assessed	Percent exceedences
Number Twenty Six Ditch-Cache River (80203020301) Swan Pond Ditch-Cache River (80203020205)	UWCHR04	Channel altered base flow	25%
		Channel altered all flow	37.5%
Overcup Ditch (80203020405)	UWCHR02	Channel altered all flow	37.5%
Maloy Bayou-Cache River (80203020807)	WHI0032	Channel altered base flow	25%
Culotches Bay Slough-Cache River (80203020806)		Channel altered all flow	37.5%

6.3.2 Lead

A TMDL that addressed dissolved lead water quality impairments in the Cache River watershed has been completed (FTN 2012). This TMDL determined that dissolved lead loads did not need to be reduced. The nonpoint source and total target dissolved lead loads from the TMDL that apply to the recommended subwatersheds are shown in Table 6.4.

Table 6.4. TMDL dissolved lead target loads for stream reaches in recommended subwatersheds of the Cache River (FTN 2012).

HUC name (12-digit HUC no.)	ADEQ stream reaches lead impaired	Flow condition	Nonpoint source lead target load, lbs/day	Total target lead load, lbs/day
Overcup Ditch (80203020405)	019*	Low flows	0.065	0.102
		Dry conditions	0.425	0.670
		Mid range	1.92	3.02
		Moist conditions	4.96	7.80
		High flows	23.7	37.4
Culotches Bay Slough-Cache River (80203020806)	017	Low flows	0.110	0.182
		Dry conditions	0.809	1.35
		Mid range	3.87	6.45
		Moist conditions	8.14	13.6
		High flows	24.5	40.8
Maloy Bayou-Cache River (80203020807)	016	Low flows	0.113	0.188
		Dry conditions	0.834	1.39
		Mid range	3.99	6.64
		Moist conditions	8.39	14.0
		High flows	25.2	42.0

* Swan Pond Ditch drains to stream segments 031 and 029, Overcup Ditch drains to ADEQ stream segment 019.

Although the TMDL calculations indicate dissolved lead loads do not need to be reduced, the stream segments continue to be assessed as not meeting the dissolved lead criteria. Therefore, dissolved lead concentrations from the ADEQ water quality stations associated with the lead impaired stream segments in the recommended subwatersheds were examined (Appendix C). Table 6.5 summarizes the results of comparing available dissolved lead measurements from the period 2010 through 2014 to their dissolved lead criteria.

Table 6.5. Percentage of measurements from 2008 through 2014 exceeding lead criteria.

HUC name (12-digit HUC no.)	ADEQ water quality station	Number of dissolved lead measurements*	Percent exceedences
Overcup Ditch (80203020405)	UWCHR02	18	0%
Maloy Bayou-Cache River (80203020807)	WHI0032	4	0%
Culotches Bay Slough-Cache River (80203020806)			

*dissolved lead criteria are calculated using measured hardness, therefore, only dissolved lead data associated with hardness measurements are evaluated.

It appears that reevaluation of the dissolved lead impairment for these stream reaches is warranted, as none of the measurements appear to exceed their dissolved lead criteria. Therefore, there is no lead load reduction target for this plan, and lead will not be addressed through implementation of management practices. Rather, the lead impairments will be addressed through collection of dissolved lead measurements to determine if the lead impairment listing of the Cache River (particularly stream segments 016 through 019) is still valid.

6.3.3 Sulfate

There has been no TMDL study addressing sulfate impairment in the watershed, so percent load reduction targets for sulfate have not been determined. An empirical analysis of the data from 2010 through 2014 was used to develop a sulfate load reduction target for this plan (Appendix D). For the Cache River, stream segments where less than 25% of sulfate measurements from an assessment period exceed the sulfate criterion are assessed as meeting the criterion (ADEQ 2014a). During the period 2010 through 2014, 27% (3 of 11) of sulfate measurements from the ADEQ water quality station associated with the Number Twenty-six Ditch and Swan Pond Ditch subwatersheds (UWCHR04) exceeded the criterion. An estimated reduction factor for sulfate was determined by multiplying the sulfate concentrations that exceed the criterion by an iteratively increasing reduction factor until less than 25% of the sulfate measurements exceed the criterion. The sulfate measurements need to be reduced 9% for less than 25% of the sulfate measurements to exceed the criterion. Therefore, for this plan, the sulfate load reduction target is 10%.

6.3.4 Copper

There has been no TMDL study addressing copper impairment in the watershed, so percent load reduction targets for dissolved copper have not been determined. An empirical analysis of the data from 2010 through 2014 was used to develop dissolved copper load reduction targets for this plan (Appendix E). Stream segments are listed as impaired due to high levels of dissolved copper when more than one measurement during the assessment period exceeds the acute or chronic copper criteria. Estimated reduction factors for dissolved copper were determined by multiplying the dissolved copper concentrations from the period 2010 through 2014 that exceed their criteria by an iteratively increasing reduction factor until less than 2 of the dissolved copper measurements exceed their criteria. The results of this analysis are summarized in Table 6.6.

Table 6.6. Estimated reduction targets for dissolved copper in recommended subwatersheds.

HUC name (12-digit HUC no.)	ADEQ water quality station	Number of dissolved copper measurements*	Reduction so <2 measurements exceed criteria
Mud Creek-Big Creek Ditch (80203020501)	WHI0196	38	36%
Rogers Bayou-Big Creek Ditch (80203020503)	WHI0196	38	36%
	WHI0026	27	34%
Lost Creek Ditch (80203020502)	WHI0172	28	87%

*dissolved copper criteria are calculated using measured hardness, therefore, only dissolved copper data associated with hardness measurements are evaluated.

The reduction targets listed in Table 6.6 are significant. However, as can be seen in the data tables in Appendix E, all dissolved copper measurements since 2012, from all three water quality stations, appear to meet their dissolved copper criteria. It appears that the copper source related to these criteria exceedences has already been addressed. Therefore, in this plan, the dissolved copper impairment in the recommended subwatersheds will be addressed through continued monitoring of dissolved copper. If all dissolved copper measurements from these stations continue to meet their criteria, the copper impaired stream segments should be removed from the impaired waters list during the 2016 or 2018 ADEQ state integrated water quality assessment.

7.0 IDENTIFICATION OF MANAGEMENT STRATEGIES

This section discusses nonpoint source management strategies for the recommended 12-digit HUC subwatersheds of the upper and lower Cache River watersheds. The proposed management units are identified. Management strategies that have been used in the upper and lower Cache River watersheds are identified, along with management strategies that are planned for the future. Structural and nonstructural management strategies are discussed separately. In addition, management strategies identified by stakeholders are identified. Discussion of the management strategies is organized by pollutant and pollutant source to be addressed. As discussed in Section 6.3, the priority pollutants that will be addressed in the recommended subwatersheds through implementation of management strategies are turbidity and sulfate. These pollutants will be reduced by reducing erosion, and transport of eroded material to surface waters, in the recommended subwatersheds.

This discussion is focused on nonpoint pollution sources identified for the recommended 12-digit HUC subwatersheds. However, there is much work ongoing throughout the Cache River watershed to address flooding, drainage, irrigation, and other water resources issues, some of which have been discussed in previous sections of this plan. These activities can be addressed in future watershed implementation plans.

7.1 Management Units

The 12-digit HUC subwatersheds of the Cache River watershed are used to define management areas for this plan. There are 57 12-digit HUC subwatersheds in the Cache River watershed. Six of these 12-digit HUC subwatersheds are recommended for management through this plan (see Section 5.4). The 12-digit HUC is a recommended sized unit for water quality improvement because: 1) it is small enough that improvements in water quality associated with implementing management practices can be observed within a reasonable time frame; 2) it is large enough that significant reductions in targeted pollutants can occur through management; and 3) it provides a sense of place and community involvement for stakeholders (EPA 2014b).

7.2 Stakeholder Recommended Management Strategies

Stakeholder meetings were held to receive input on what management practices are preferred and have been successfully implemented in the upper and lower Cache River watersheds. Management strategies identified by the stakeholders are listed in Tables 7.1 and 7.2, along with information and comments from stakeholders.

Table 7.1. Management strategies recommended by upper Cache River watershed stakeholders.

Practice	Comments
Drop Pipes	This is an effective practice, when correctly installed and maintained. Collared drop pipes and drop pipes with flashboard risers are most commonly used.
Irrigation water management	There are a number of irrigation water management practices recommended by NRCS. Stakeholders using these practices are using, and losing, less water.
Nutrient management	Interest in and use of variable rate fertilization practices is increasing in this area.
Cover crops	Interest in this practice is increasing. Cropping rotation must be considered when selecting cover crops to prevent the cover crop from becoming a problem weed.
Two-stage ditches	At least one farmer stakeholder refused to use this practice because it takes up too much land that could be used for growing. It was suggested that this may be a good practice to deal with stormwater from developed areas.
Filter strips, buffer strips, field borders	Stakeholders supported the use of field borders. Filter strips were suggested for use around towns to reduce impacts of stormwater runoff.
Tailwater recovery	This practice was suggested as a way to reduce nutrient and sediment runoff while increasing habitat. It was suggested that at least part of the recovery pond be set up to function as a wetland.
Reduced tillage	This practice is not widely used in the upper Cache River watershed.
Sediment basins	Sediment basins were suggested to trap sand coming off Crowley's Ridge.
Grassed waterways	
Wildlife habitat	Holding water on fields during the winter is a relatively common practice in the upper Cache River watershed. Some landowners are planting switchgrass for quail habitat. Want to keep beaver out.

Table 7.2. Management strategies recommended by lower Cache River watershed stakeholders.

Practice	Comments
Land leveling	
Stream buffer zones	Stream buffer zones are widely used in Woodruff County. Most were developed through the WREP.
Cover crops	Effectiveness of cover crops is being studied in Bayou Bartholomew watershed.
Winter water storage	There are several incentive programs for this practice. This practice allows infiltration to recharge groundwater, as well as providing waterfowl habitat.
Meander restoration	Reforestation of riparian areas and reconnecting the stream with reforested floodplains provides multiple benefits, including reduced flooding upstream, and filtering/collection of sediment and nutrients.
Filter strips, field borders	A stakeholder raised the concern that filter strips and/or field borders may slow down field drainage.
Channel and ditch maintenance	Drainage ditches can become overgrown within two years to the point that flooding increases. Grubbing the Cache and DeView main channels to remove logs and debris would improve drainage. It was suggested that this effort begin at the mouth of the rivers and proceed upstream, to reduce negative effects of the work.

7.3 Management Strategies for Concentrated Flow Erosion (Gullies) in the Upper Cache River Watershed

Headcutting and gully erosion of cropland and pasture have been identified as a priority source of turbidity in three of the recommended 12-digit HUC subwatersheds for the upper Cache River watershed (Table 5.15). Reducing erosion will reduce turbidity levels in the impaired stream reaches, and make it possible for these stream reaches to meet their numeric turbidity water quality standards. Reduced turbidity means improved visibility for predatory sport fish, such as crappie and bass, and reduced sedimentation in stream channels, which also supports desirable sport fish and their prey. Table 7.3 summarizes structural controls that reduce gullies and headcutting that have been implemented in the upper Cache River watershed, and are proposed for the recommended subwatersheds of the upper Cache River watershed. Table 7.4 is a summary of nonstructural control strategies for gullies and headcutting that have been implemented in the upper Cache River watershed, and those proposed for the recommended subwatersheds of the upper Cache River watershed.

Table 7.3. Structural controls to reduce gully erosion and headcutting in the upper Cache River watershed.

Project/program (Agency/organization)	Practices	Location	Status
07-1500 Poinsett County Erosion Control Project Phase II (Poinsett County Conservation District)	Water control structures	Poinsett County	Complete
Public Law 566 (NRCS)	Ponds	Entire watershed	Complete
Upper Cache Great Outdoors Initiative (NRCS)	Eligible practices included water control structures, ponds, and sediment control basins	Clay, Craighead, Greene, and Lawrence Counties	Complete
Ducks Unlimited habitat projects (Arkansas Ducks Unlimited)	Flooded agricultural fields	State wide	Ongoing
Mud Drive (AACD)	Winter flooding of agricultural crop land	Entire watershed	Ongoing
EQIP (NRCS)	Eligible practices include grade stabilization structures, water control structures, ponds, and sediment basins	Entire watershed	Ongoing
Regional Conservation Partnership Program (stakeholders)	Eligible practices could include grade stabilization structures, water control structures, ponds, and sediment basins	Entire watershed	Suggested for future

Table 7.4. Nonstructural controls to reduce gully erosion and headcutting in the upper Cache River watershed.

Project/program (Agency/organization)	Practices	Location	Status
EQIP (NRCS)	Eligible practices include critical areas planting, forage and biomass planting, ground cover, tree/shrub planting, grassed waterways, and mulching	Entire watershed	Ongoing
Regional Conservation Partnership Program (stakeholders)	practices could include critical area planting, mulching, and grassed waterways	entire watershed	Suggested for future

7.3.1 Past Management Strategies

There have been a number of Section 319 projects and NRCS practices implemented in the upper Cache River watershed that can reduce gully formation and headcutting.

7.3.1.1 Structural Controls

There have been two Section 319 projects in the upper Cache River watershed that included management practices that reduce gully formation and head cutting. Structural control practices have also been installed through NRCS projects. NRCS projects in the upper Cache River watershed have involved the use of structural control practices such as water control structures and ponds. In addition to water storage, ponds can serve to stabilize channels and stop head cutting, as well as acting as sediment traps. Water control structures reduce the impacts of vertical drops to drainage channels, which can prevent gully formation and/or head cutting. Water control structures are the structural control practice that has been most widely used in the upper Cache River.

7.3.1.2 Nonstructural Controls

Vegetation, in waterways and critical area plantings, stabilizes soil and prevents erosion. Mulching and other ground covers protect soils from the erosive force of rainfall, again stabilizing soil and reducing erosion. These practices have been, and are, promoted through several projects and programs in the upper Cache River watershed (see Table 7.4).

7.3.1.3 Effectiveness

The installation of over 430 water control structures in the Bayou DeView watershed in Jackson County prevented 36,980 tons of soil from entering Bayou DeView. As a result, dissolved lead concentrations in Bayou DeView have declined to the point that the numeric water quality criterion for lead in Bayou DeView is being met (EPA 2014). It has been estimated that the Section 319 erosion control project in Poinsett County (07-1500) will reduce sediment in runoff by 446.2 tons/year (ANRC 2012b). A recent study found that drop pipe water control structures with flashboard risers reduce TSS concentrations in runoff from fields in the Arkansas delta up to 95% (Ecological Conservation Organization 2009).

7.3.2 Ongoing and Planned Management Strategies

A number of the programs that support management strategies that reduce concentrated flow erosion are ongoing. This includes U of A Extension programs, ANRC nonpoint source program, and NRCS conservation programs. Priority areas for management strategies that reduce concentrated flow erosion are croplands and pasture lands in the recommended 12-digit HUC subwatersheds of the upper Cache River.

There are several management strategies that address gully erosion that are proposed for the three recommended subwatersheds of the upper Cache River where this is a priority source of turbidity. These include grassed waterways, water control/grade stabilization structures, holding water on fields during winter, ponds or sediment basins, and, critical area planting on pasture. In Iowa, the use of reduced tillage practices, cover crops, and grassed waterways have been found effective in reducing gully erosion on cropland (Green Lands Blue Waters 2014). NRCS recommends grassed waterways with grade stabilization structures as an effective management strategy for gully erosion (NRCS 2009). Work on Arkansas Discovery Farms also shows that vegetative cover in critical areas reduces gully erosion on pasture (U of A Extension Service 2013). Several programs support these management strategies in the upper Cache River watershed (see tables 7.3 and 7.4), and they are familiar to stakeholders in the area (see table 7.1).

7.4 Management Strategies for Streambank Erosion in the Cache River Watershed

Streambank erosion is a priority source of turbidity in the recommended subwatersheds of the Cache River watershed. Reducing erosion will reduce turbidity levels in the impaired stream reaches, so the numeric turbidity water quality standards can be met. Reduced turbidity means improved visibility for predatory sport fish, such as crappie and bass, and reduced sedimentation in stream channels, which also supports desirable sport fish and their prey. Figures 5.3, 5.5, and 5.6 show areas in recommended 12-digit HUC subwatersheds where management strategies for streambank erosion will be implemented.

Table 7.5 summarizes structural controls that reduce streambank erosion that have been implemented, or are planned for the recommended subwatersheds of the Cache River. Table 7.6

summarizes nonstructural controls that reduce streambank erosion that have been implemented, or are planned for the recommended subwatersheds of the Cache River.

Table 7.5. Structural controls to reduce streambank erosion in the Cache River watershed.

Project/program (Agency/organization)	Practices	Location	Status
01-600 Cache River Sediment Prevention Project (County Conservation District)	430 water control structures	Jackson County	Complete
06-1700 Cross County Erosion Control Project (Cross County Conservation District)	422 water control structures	Cross County	Complete
07-1500 Poinsett County Erosion Control Project Phase II (Poinsett County Conservation District)	Water control structures	Poinsett County	Complete
Cache River MRBI (NRCS)	Eligible practices include water control structures	Monroe, Woodruff Counties	Complete
Lower Cache River Section 1135 Project (City of Clarendon, USACE)	Restore natural meanders and connections to floodplain, reforestation	Cache River, Monroe County	Complete
Upper Cache Great Outdoors Initiative (NRCS)	Eligible practices included water control structures	Clay, Craighead, Greene, and Lawrence Counties	Complete
Middle Cache CCPI MRBI (Jackson County Conservation District)	Eligible practices include water control structures	Overcup Ditch 11-digit HUC, Jackson County	Ongoing

Table 7.6. Nonstructural controls to reduce streambank erosion in the Cache River watershed.

Project/program (Agency/organization)	Practices	Location	Status
Expansion of Cache River NWR (USFWS)	Expansion of acquisition boundary by 102,000 acres	Area surrounding NWR	Complete
MRBI WREP Wetland Restoration (TNC)	Reforestation of riparian areas	Cross, Poinsett, Jackson, Monroe, Woodruff Counties	Complete
06-400 Sediment Assessment - The Cache River Watershed of Arkansas Phase II	Streambank inventory and erosion potential assessment	Swan Pond Ditch, Overcup Ditch, Culotches Bay Slough	Complete
Expansion of Cache River NWR (USFWS)	Acquisition and reforestation of up to 34,800 acres through voluntary sales and easements	Area within acquisition boundary	Ongoing
Middle Cache CCPI MRBI (Jackson County Conservation District)	Eligible practices include riparian buffers and tree and shrub establishment.	Overcup Ditch 11-digit HUC, Jackson County	Ongoing
Healthy Forests Reserve Program (NRCS)	Restoration, enhancement, and protection of private forest lands along streambanks	Private forest lands	Ongoing
EQIP (NRCS)	Eligible practices include riparian buffers, tree and shrub establishment, and native plantings	Entire watershed	Ongoing
Conservation Reserve Program (Farm Service Agency)	Remove environmentally sensitive land from agricultural production, i.e., riparian buffer	Bottomland hardwoods, highly erodible lands	Ongoing

7.4.1 Past Management Strategies

Much work has been done in areas of the Cache River watershed that reduces streambank erosion. This work has included Section 319 projects and NRCS projects, as well as restoration work involving a number of state and federal conservation agencies.

7.4.1.1 Structural Controls

Structural controls that reduce streambank erosion have been installed through Section 319 and NRCS projects. Structural control practices that have been implemented as part of these projects include water control structures, and restoration of stream meanders (Table 7.3). Water control structures reduce the impacts of vertical drops to stream channels, reducing streambank and channel erosion. Restoration of the stream meanders in the lower Cache River is expected to result in a more stable channel, which would reduce streambank erosion.

7.4.1.2 Nonstructural Controls

Nonstructural controls that can reduce streambank erosion include programs that restore and replant riparian areas. In 2012, the USFWS proposed to expand the acquisition boundary for the Cache River NWR (USFWS 2012). The expansion was approved in 2013. In 2014 and 2015, around 1,605 acres were added to the NWR through voluntary private land sales. Since 1999, over 28,000 acres have been added to the NWR (personal communication, E. Johnson, USFWS, 1/15/16). Newly acquired riparian lands are restored, e.g., reforestation (National Wildlife Refuge Association 2014). In 2013, hardwoods were planted on 174 acres within the NWR. Since 1999, around 13,000 acres within the NWR have been planted with hardwoods NWR (personal communication, E. Johnson, USFWS, 1/15/16). In addition, reforestation of riparian areas is part of the meander restoration project in Monroe County (TNC 2015b, USACE 2012).

7.4.1.3 Effectiveness

Information on estimated sediment reduction from installation of water control structures in the upper Cache River watershed is given in Section 7.2.1.3. What portion of this is due to reduced streambank erosion is unknown.

Reforestation of riparian areas, and restoration of natural meanders in the lower Cache River watershed is expected to reduce streambank erosion. Long term data records for TSS and turbidity do not necessarily show declines in these parameters in the lower Cache River watershed (Section 3.2.1.3). However, the source of the TSS and turbidity impacting the lower Cache River and Bayou DeView may not be on the main stem Cache River or Bayou DeView.

7.4.2 Ongoing and Planned Activities

A number of the programs that support management strategies that reduce streambank erosion are ongoing in the Cache River watershed. This includes NRCS EQIP and MRBI projects, NRCS and Farm Service Agency easement programs, and Ducks Unlimited habitat projects. In addition, the USFWS and its partners are continuing to work with landowners interested in selling land or granting easements to expand the NWR. The AGFC Stream Team program also supports streambank restoration projects.

Riparian buffers will be created and restored through NRCS programs (EQIP and Healthy Forest Reserve Program), the Farm Service Agency easement programs, and/or the USFWS expansion of the NWR. Vegetation on ditch banks also reduces erosion. Water control and grade stabilization structures can also reduce streambank erosion where field ditches join streams or large drainage ditches. These management strategies are supported by NRCS EQIP and U of A Extension Service. Restoration of eroding streambanks requires careful consideration of sediment load balance and conditions upstream and downstream. In other states, two-stage ditches have been identified as a stable configuration for agricultural drainage ditches that reduces erosion of ditch banks.

In 2016, USFWS expects to acquire an additional 2,000 acres of land within the Cache River NWR acquisition boundary. In addition, 130 willing sellers with a total of 32,800 acres have been identified within the acquisition boundary (National Wildlife Refuge Association 2015). This includes lands in the Culotches Bay Slough and Maloy Bayou recommended subwatersheds. The USFWS also plans to plant hardwoods on 352 acres within the NWR during 2016 NWR (personal communication, E. Johnson, USFWS, 1/15/16).

7.5 Management Strategies for Reduction of Sheet/Rill/Wind Erosion from Croplands in the Cache River Watershed

Cropland erosion has been identified as priority source of turbidity in the recommended subwatersheds of the upper Cache River watershed. Reducing erosion reduces turbidity levels in the impaired stream reaches so they can meet their numeric turbidity water quality standards. Reduced turbidity means improved visibility for predatory sport fish, such as crappie and bass, and reduced sedimentation in stream channels, which also supports desirable sport fish and their prey. Table 7.7 summarizes structural controls that reduce cropland erosion that have been implemented, or are planned for the recommended subwatersheds of the upper Cache River watershed. Table 7.8 summarizes nonstructural controls that reduce cropland erosion that have been implemented, or are planned, for the Cache River watershed.

Table 7.7. Structural controls for cropland erosion in the Cache River watershed.

Project/program (Agency/organization)	Practices	Location	Status
01-600 Cache River Sediment Prevention Project (County Conservation District)	430 water control structures	Jackson County	Complete
06-1700 Cross County Erosion Control Project (Cross County Conservation District)	422 water control structures	Cross County	Complete
07-1500 Poinsett County Erosion Control Project Phase II (Poinsett County Conservation District)	Water control structures	Poinsett County	Complete
Cache River MRBI (NRCS)	Eligible practices included tailwater recovery and water control structures	Monroe, Woodruff Counties	Complete
RCPP Rice Stewardship Partnership Project (NRCS, Ducks Unlimited)	Water management, sediment and nutrient runoff control, waterfowl habitat	30 counties, including all of the Cache River watershed	Complete
Upper Cache Great Outdoors Initiative (NRCS)	Eligible practices included water control structures	Clay, Craighead, Greene, and Lawrence Counties	Complete
EQIP (NRCS)	Eligible practices include shallow water development and management (i.e., flooded fields), grade stabilization structures, and water control structures	Entire watershed	Ongoing
Mud Drive (AACD)	Keep water on fields over winter using water control structures	Watershed croplands	Ongoing

Table 7.8. Nonstructural controls for cropland erosion in the Cache River watershed.

Project/program (Agency/organization)	Practices	Location	Status
Cache River MRBI (NRCS)	Eligible practices included residue management/no till, conservation crop rotation, cover crop, filter strip, critical area planting, and mulching	Monroe, Woodruff Counties	Complete
Expansion of Cache River NWR (USFWS)	Expansion of acquisition boundary by 102,000 acres	Area surrounding NWR	Complete
Expansion of Cache River NWR (USFWS)	Acquisition and reforestation of up to 34,800 acres through voluntary sales and easements	Area within acquisition boundary	Ongoing
EQIP (NRCS)	Eligible practices include critical area planting, mulching, cover crop, filter strips, field borders, residue management, mulching, water control structures, grade stabilization structures, land leveling, and grassed waterway	Entire watershed	Ongoing

7.5.1 Past Management Strategies

Much work has been done in areas of the Cache River watershed that reduces cropland erosion. This work has included Section 319 projects and NRCS projects, as well as restoration work involving a number of state and federal conservation agencies.

7.5.1.1 Structural Controls

Structural controls used in the Cache River watershed have primarily been related to water management. Water control structures slow water, reducing sheet and rill erosion, and allowing sediments to settle out of runoff so it isn’t carried to surface waters.

7.5.1.2 Nonstructural Controls

Nonstructural controls that have been used in the Cache River watershed to reduce cropland erosion have primarily involved providing some kind of ground cover to protect soils from the erosive force of precipitation and runoff. This includes mulches, crop residue, cover crops, and water ponded on fields. Reforestation, and restoration of native plant cover on land acquired for conservation and wildlife habitat also protects soils from erosion. Field buffer, filter strips, and buffer strips reduce the amount of eroded soil that is carried to surface waters.

7.5.1.3 Effectiveness

Information on expected sediment load reduction was available for the Section 319 erosion control project in Poinsett County (07-1500). Reportedly, this project was expected to reduce sediment in runoff by 446.2 tons/year (ANRC 2012b). Sediment reductions associated with other erosion control projects in the Cache River watershed are discussed in Section 4.2.1.3. Sediment and TSS reduction has been studied for a number of the structural and nonstructural controls that have been used in the Cache River watershed. This information is discussed in Section 7.7.

7.5.2 Ongoing and Planned Activities

Several programs that support management strategies that reduce cropland erosion are ongoing in the Cache River watershed. This includes NRCS EQIP and MRBI projects, and Ducks Unlimited habitat projects. NRCS and Farm Service Agency easement programs reduce the amount of cropland eroding. In addition, the USFWS and its partners are continuing to work with landowners interested in selling land or granting easements to restore habitat and expand the NWR. The Middle Cache River CCPI MRBI project has been funded for 2016.

These projects will provide incentives for implementation of management practices that will reduce corpland erosion. Ducks Unlimited continues to work with landowners in the Cache River watershed, particularly rice growers, to keep water on fields during the winter. The AACD Mud Drive program (to encourage maintaining water on fields during the winter) provides additional opportunities for this practice.

Expansion of the Cache River NWR discussed in Section 7.3, and the reforestation and restoration of these lands will reduce the area of eroding cropland, and provide more places for sediment to settle out of runoff before it is carried to surface waters.

7.6 Management Strategies for Reduction of Sulfate

Runoff from cropland is a priority source of sulfate in two of the recommended subwatersheds of the upper Cache River. For this plan, the source of sulfate in runoff is assumed to be eroded soils. Therefore, the erosion reduction management strategies discussed above, will also reduce sulfate inputs to surface waters.

7.7 Estimated TSS Load Reductions

For a number of the management strategies identified in the previous sections, information about their effectiveness in reducing selected pollutants has been published. Published information on sediment/TSS load reductions for selected management practices is summarized in Table 7.9.

Table 7.9. Reported sediment/TSS load reduction efficiencies of management strategies for the Cache River watershed.

Practice	Expected sediment/TSS load reduction
Drop pipe structures	55% - 95%[a]
Mulch	77%[b]
Cover crop	70%[b]
Winter cover crop	76%[b]
Field borders	34%[b]
Forested riparian buffer	76%[b], 94%[c]
Winter flooding of fields	97%[d]
Pasture and hay planting	59%[b]
Grassed waterway	17%[b]
Sediment basin/pond	77%[b]
Bank stabilization/restoration	Up to 100%[e]
Filter Strips/herbaceous riparian buffer	53% - 91%[a], 31% - 98%[c]

[a] (Ecological Conservation Organization 2009)
[b] (Merriman, Gitau and Chaubey 2009)
[c] VT database
[d] (Mississippi State University Forest and Wildlife Research Center 1999)
[e] (Van Epps 2014)

7.7.1 Supporting Information for TSS Load Reductions

A recent study found that drop pipe water control structures with flashboard risers reduce TSS concentrations in runoff from fields in the Arkansas delta up to 95% (Ecological Conservation Organization 2009).

An Arkansas agricultural BMP effectiveness tool has been developed (Merriman, Gitau and Chaubey 2009). This tool uses sediment reduction rates for BMPs gleaned from literature. A number of the sediment/TSS reduction rates listed in Table 7.9 were taken from this tool.

Several streambank restoration projects have been implemented in northwest Arkansas. Sediment load reductions of 95% or more have been achieved with these natural channel design restoration projects (Van Epps 2014, Watershed Conservation Resource Center 2013).

One study was found that characterized the impacts of winter flooding of fields on water quality (Mississippi State University Forest and Wildlife Research Center 1999). This study found that winter flooding of fields could reduce TSS export as much as 97%.

7.7.2 TSS Load Reduction Estimates for Recommended Subwatersheds

Examples of the extent of management practices that would be required to achieve the target TSS reduction for the recommended 12-digit HUC subwatersheds are listed in Table 7.10. The method used to calculate these estimates are given in Appendix F. The information provided in Table 7.10 is provided for informational purposes only. Since implementation of these practices is voluntary, it is not possible at this time to say for certain how much of each practice will be used. Although widespread use of a single practice (drop pipe structures) has been effective in the upper Cache River watershed (EPA 2014), it is more common for suites of several practices to be implemented to reduce pollutants.

Table 7.10. Estimated treatment to reduce TSS loads in recommended 12-digit HUC subwatersheds to meet numeric turbidity water quality criteria.

Priority Source	Priority Pollutants	Priority Nonpoint Sources	Management Strategies	Extent
Swan Pond Ditch-Cache River - 80203020205				
Cropland	Turbidity & sulfate	Streambank erosion – 164,458 ft of eroding streambank (50%)	Herbaceous riparian buffers	33,000 ft
			streambank restoration	27,000 ft
		Gully erosion – 8,883 ac of eroding cropland (50%)	Drop pipe structure	1,500 ac treated
			Winter flooding of fields	1,200 ac
			Grassed waterway	680 ac
			Ground cover/cover crop	1,600 ac
Hay/Pasture	Turbidity	Streambank erosion – 4,569 ft of eroding streambank (50%)	Herbaceous riparian buffers	910 ft
			Forested riparian buffer	740 ft
			streambank restoration	740 ft
		Gully erosion – 304 ac of eroding hay/pasture (50%)	Pasture and hay planting	67 ac
			Grassed waterway	23 ac
			Pond	51 ac treated
Number Twenty Six Ditch-Cache River – 80203020301				
Cropland	Turbidity & sulfate	Streambank erosion – 183,468 ft of eroding streambank	Herbaceous riparian buffers	37,000 ft
			Streambank restoration	30,000 ft
		Gully erosion – 11,238 ac of eroding cropland	Drop pipe structure	1,900 ac treated
			Winter flooding of fields	1,500 ac
			Grassed waterway	860 ac
			Ground cover/cover crop	2,000 ac
		Sheet/rill/wind erosion – 11,238 ac of eroding cropland	Drop pipe structure	See Gully erosion
			Winter flooding of fields	See Gully erosion
			Grassed waterway	See Gully erosion
			Ground cover/cover crop	See Gully erosion
			Field border	68,000 ft
			Filter strip	37,000 ft
Hay/Pasture	Turbidity	Streambank erosion – 10,734 ft of eroding streambank	Herbaceous riparian buffers	2,100 ft
			Forested riparian buffer	1,700 ft
			streambank restoration	1,700 ft
		Gully erosion – 807 ac of eroding hay/pasture	Pasture and hay planting	2,500 ac
			Grassed waterway	62 ac
			Pond	140 ac treated

Table 7.10. Estimated treatment to reduce TSS loads in recommended 12-digit HUC subwatersheds to meet numeric turbidity water quality criteria (continued).

Priority Source	Priority Pollutants	Priority Nonpoint Sources	Management Strategies	Extent
Mud Creek-Big Creek Ditch – 80203020501				
Cropland	Turbidity (Lake Frierson watershed only)	Streambank erosion – 1,570 ft of eroding streambank	Herbaceous riparian buffers	1,300 ft
			Streambank restoration	1,100 ft
		Gully erosion – 858 ac of eroding cropland	Drop pipe structure	630 ac treated
			Winter flooding of fields	490 ac
			Ground cover/cover crop	650 ac
		Sheet/rill/wind erosion – 858 ac of eroding cropland	Drop pipe structure	See gully erosion
			Winter flooding of fields	See gully erosion
			Ground cover/cover crop	See gully erosion
			Field border	2,500 ft
			Filter strip	1,300 ft
Hay/Pasture	Turbidity	Streambank erosion – 949 ft of eroding streambank	Herbaceous riparian buffers	800 ft
			Forested riparian buffer	650 ft
			streambank restoration	650 ft
		Gully erosion – 519 ac eroding hay/pasture	Pasture and hay planting	480 ac
			Pond	370 ac
		Sheet/rill/wind erosion – 519 ac eroding hay/pasture	Pasture and hay planting	480 ac
			Filter strip	800 ft
Forest	Turbidity	Streambank erosion – 3,008 ft of eroding streambank	Forested riparian buffer	2,100 ft
			streambank restoration	2.100 ft
		Gully erosion – 329 ac of eroding forest	pond	240 ac treated

Table 7.10. Estimated treatment to reduce TSS loads in recommended 12-digit HUC subwatersheds to meet numeric turbidity water quality criteria (continued).

Priority Source	Priority Pollutants	Priority Nonpoint Sources	Management Strategies	Extent
Overcup Ditch - 80203020405				
Cropland	Turbidity	Streambank erosion – 195,575 ft of eroding streambank	Herbaceous riparian buffers	110,000 ft
			streambank restoration	86,000 ft
Culotches Bay Slough-Cache River - 80203020806				
Cropland	Turbidity	Streambank erosion – 47,826 ft of eroding streambank	Herbaceous riparian buffers	26,000 ft
			Forested riparian buffers	21,000 ft
			Streambank restoration	21,000 ft
Maloy Bayou-Cache River - 80203020807				
Cropland	Turbidity	Streambank erosion – 26,560 ft of eroding streambank	Herbaceous riparian buffers	14,000 ft
			Forested riparian buffers	12,000 ft
			Streambank restoration	12,000 ft

8.0 IMPLEMENTATION PROGRAM

8.1 Schedule and Milestones

As shown in Chapter 7, there are ongoing activities in the Cache River watershed that contribute to achieving the goals of this plan. Table 8.1 summarizes the schedules and milestones associated with the activities previously identified for the recommended 12-digit HUC subwatersheds. These are activities that are known and planned as of December 2015. These activities are discussed in the following sections.

8.2 Sulfate TMDL

The Clean Water Act requires that Total Maximum Daily Loads (TMDLs) be determined for all impaired waterbodies, along with the percent reduction needed in pollutant loads to the waterbody so that water quality criteria will be met. TMDLs and percent load reductions have not yet been determined for the sulfate impaired stream reaches of the Cache River. When they are determined, they will become the targets for sulfate reduction for this watershed plan. ADEQ has assigned the sulfate impairment of the Cache River a low priority for development of TMDLs. This makes it unlikely that sulfate TMDLs for the Cache River will be developed within the next five years. Therefore, ANRC and/or the Greene County Conservation District will contact ADEQ about developing sulfate TMDLs for impaired reaches of the Cache River, to request that this be done sooner rather than later.

8.3 Monitoring

Monitoring is an essential element of adaptive watershed management. The objectives of surface water quality monitoring in the Cache River watershed include:

- Identify areas where water quality is or is not attaining designated uses;
- Identify sources of pollution impairing designated uses; and
- Track changes in water quality resulting from land use changes, development, land and water management practices, and other factors.

Table 8.1. Implementation schedule for Cache River watershed.

Activity	Action (lead)	Start	End	Milestones (3-5 yrs)	Indicator	Long Term Goal
TMDL	Sulfate TMDL (ADEQ)	2018	2019	ANRC, Greene County Conservation District request sulfate TMDL	EPA approved TMDL	Sulfate water quality standard met in impaired stream reaches on the draft 2014 303(d) list
Monitoring	Dissolved copper and lead data collection for removal of stream segments in recommended subwatersheds from state impaired waters list (ADEQ)	2017	2022	Biennial 305(b) assessments, 303(d) lists	Attainment or nonattainment classification	Determine if impaired stream reaches in recommended subwatersheds meet dissolved copper and lead water quality standards
	Synoptic surveys in recommended subwatersheds to characterize TSS/sediment, and sulfate loads (Conservation Districts)	2018	2020	Survey completed Data analyzed Target areas identified	Critical areas designated for TSS and sulfate loading	Identify target areas for erosion and runoff control management strategies to achieve state sulfate and turbidity standards
	Lake Frierson synoptic survey (AGFC, Arkansas Parks and Tourism)	2018	2020	Survey completed Data analyzed	Attainment or nonattainment classification	Determine if Lake Frierson meets dissolved copper numeric water quality standards
	Annual ambient water quality monitoring (ADEQ, USGS)	2017	2050	Four years of water quality data collected	Number of long term water quality stations Number of sampling events	Identify and track changes in water quality over time
	ADEQ roving monitoring program sampling in Cache River watershed (ADEQ)	2019	2020	Roving monitoring program sampling initiated in Cache River region	Number of sampling stations Number of sampling events	Determine if impaired waterbodies in recommended subwatersheds meet numeric water quality standards

Table 8.1 Implementation schedule for Cache River watershed (continued).

Activity	Action (lead)	Start	End	Milestones (3-5 yrs)	Indicator	Long Term Goal
Monitoring	Edge-of-field monitoring contracts in Overcup Ditch subwatershed (NRCS)	2017	2030	Five nine-year contracts established for edge-of-field monitoring	Number of contracts Number of monitoring stations Acres monitored Number of sampling events	Characterize, and track changes in, water quality of runoff from crop fields where BMPs are implemented
	Cache River NWR water quality monitoring network (USFWS)	2018	2050	Water quality monitoring network established, sampling and analysis logistics finalized, and at least one sampling event	Number of monitoring sites Number of sampling events Number of samples	Characterize, and track changes in, water quality within the NWR
	Cache River NWR biological monitoring program (USFWS)	2018	2050	Biological monitoring program set up and ready for first round of biological surveys	Number of survey locations Number of species tracked Number of surveys completed	Characterize, and track changes in, of biological communities within the NWR
	Fish survey of Cache River (AGFC)	2018	2020	Fishery survey initiated	Number of survey locations Number of surveys completed	Characterize fish communities in the Cache River watershed
	Fish and macroinvertebrate survey of project area for phase 2 meander restoration (TNC)	2016	2020	Pre-restoration fish and macroinvertebrate surveys completed	Number of survey locations Number of surveys completed	Characterize pre-restoration fish and macroinvertebrate communities in the channelized sections of the lower Cache River
Information & Education	Field Days (County Conservation Districts)	2016	2030	1 to 3 field days held in recommended 12-digit HUC subwatersheds	Number of field days in recommended subwatersheds Number of attendees	Increase acceptance and use of BMPs that protect and improve water quality
	Informational booth at County fairs (County Conservation Districts)	2018	2050	Booths at 10 county fairs in counties of the Cache River watershed	Number of fairs attended Number of people visiting booths	Increase awareness of water quality issues and BMPs in Cache River watershed

Table 8.1 Implementation schedule for Cache River watershed (continued).

Activity	Action (lead)	Start	End	Milestones (3-5 yrs)	Indicator	Long Term Goal
Information & Education	Articles about Cache River water quality issues and/or appropriate BMPs (interest groups)	2018	2023	At least three articles in local newspaper or interest group newsletter	Number of articles Number of readers	Increase awareness of water quality issues and BMPs in Cache River watershed
	Presentations on Cache River water quality issues and/or appropriate BMPs (interest groups)	2018	2023	At least three presentations at interest group meetings or conferences	Number of presentations Number of people attending presentations	Increase awareness of water quality issues and BMPs in Cache River watershed
Supplemental Watershed Implementation Plans	Prepare and implement supplemental watershed implementation plans in recommended 12-digit HUC subwatersheds with turbidity and sulfate impairments (County Judges)	2017	2022	Supplemental watershed implementation plan developed for at least one recommended 12-digit HUC subwatershed	Number of implementation plans accepted	All water quality criteria met in impaired stream reaches listed in final 303(d) list within recommended subwatersheds
Implement Management Strategies in recommended 12-digit HUC subwatersheds	Middle Cache MRBI (NRCS)	2012	2018	At least five new contracts for management practices in Overcup Ditch subwatershed	Number of contracts Number of practices Number of acres treated	Turbidity and dissolved lead water quality criteria met in 2008 and 2014 impaired stream reaches in Overcup Ditch subwatershed
	EQIP General (NRCS)	2015	2022	Contract for management practices in at least one recommended 12-digit HUC subwatershed	Number of contracts Number of practices Number of acres treated	All water quality criteria met in 2008 and 2014 impaired stream reaches within recommended 12-digit HUC subwatersheds

Table 8.1 Implementation schedule for Cache River watershed (continued).

Activity	Action (lead)	Start	End	Milestones (3-5 yrs)	Indicator	Long Term Goal
Implement Management Strategies in recommended 12-digit HUC subwatersheds	Management practices in recommended 12-digit HUC subwatersheds (County Conservation Districts)	2018	2022	Begin implementation of management practices identified in supplemental watershed implementation plan(s)	Implementation goals outlined in supplemental watershed implementation plan(s)	All water quality criteria met in 2008 and 2014 impaired stream reaches within recommended 12-digit HUC subwatersheds
	Regional Conservation Partnership Program (stakeholders)	2017	2023	Funding of Regional Conservation Partnership Program obtained from NRCS	Number of practices Number of acres treated	All water quality criteria met in 2008 and 2014 impaired stream reaches within recommended 12-digit HUC subwatersheds
	Expansion of Cache River NWR (USFWS)	2015	2030	100 acres in Culotches Bay Slough and Maloy Bayou subwatersheds added to Cache NWR	Number of acres acquired in recommended subwatersheds	Reduce streambank erosion All water quality criteria met in Cache River Acquire all lands within Cache River NWR acquisition boundary
	Conservation Easements (Farm Service Agency)	2014	2030	At least one Conservation Reserve Program contract for riparian easement in one recommended subwatershed	Number of contracts in recommended subwatersheds Number of acres under contract	All water quality criteria met in 2008 and 2014 impaired stream reaches within recommended 12-digit HUC subwatersheds
Evaluate	Annual voluntary forestry BMP assessment (Arkansas Forestry Commission)	2002	2050	Two biennial surveys completed (2017 and 2020)	Published assessment reports	Estimate and document extent of forestry BMP implementation, and identify areas to focus BMP education efforts

Table 8.1 Implementation schedule for Cache River watershed (continued).

Activity	Action (lead)	Start	End	Milestones (3-5 yrs)	Indicator	Long Term Goal
Evaluate	Biennial water quality assessment (ADEQ)	2016	2022	EPA approved final 303(d) list post 2008	Attaining and nonattaining stream reaches in Lower Little River watershed	All water quality criteria met in Lower Little River impaired stream reaches listed in final 2008 and/or 2014 303(d) lists
	Track implementation of BMPs in Cache River watershed (ANRC)	2017	2022	Biennual report of implementation activities in watershed	Linear feet/acres of BMPs implemented Water quality improvement	All water quality criteria met in Lower Little River impaired stream reaches listed in final 2008 and/or 2014 303(d) lists
Update Cache River Watershed Management Plan	Public Meetings (ANRC)	2023	2023	Organize public meetings	Number of attendees	Stakeholder input to watershed management planning
	Update Watershed Management Plan (ANRC)	2023	2023	Obtain implementation data from ANRC Conduct evaluation activities	Updated watershed management plan completed Recommended 12-digit HUC subwatersheds identified Stakeholder relationships continued/ improved	Maintain watershed management plan as a living document that reflects stakeholder interest and concerns related to improving water quality in the Lower Little River watershed

8.3.1 Existing Surface Water Quality Monitoring Programs

ADEQ and USGS have active ambient surface water quality monitoring programs in the Cache River watershed. These monitoring programs are described in Section 3. Table 8.2 lists the water quality parameters monitored by ADEQ and USGS, which includes the priority pollutants identified in Sections 5.4 and 6.3. These monitoring programs must continue.

Existing water quality monitoring stations associated with impaired stream segments within the recommended subwatersheds are listed in Table 8.3. Water quality stations that are part of the ADEQ ambient water quality monitoring program are sampled monthly. Water quality stations that are part of the ADEQ roving water quality monitoring program are sampled bimonthly for a two year period, every six years.

Table 8.2. Water quality parameters being monitored in the Cache River watershed.

Parameters	ADEQ ambient	ADEQ lakes	ADEQ roving	USGS
Metals	X	X	X	X
DO	X	X	X	X
Turbidity	X	X	X	
Nutrients	X	X	X	X
TSS	X	X	X	
E. coli	X		X	X
Fecal coliform				X
Alkalinity	X	X	X	
Minerals	X	X	X	X
Temperature	X	X	X	X
Conductivity	X	X	X	X
pH	X	X	X	X
Hardness	X	X	X	X
Total organic carbon	X		X	
Suspended sediment				X

Table 8.3. Existing water quality monitoring in recommended subwatersheds.

HUC name (12-digit HUC number)	ADEQ 2014 impaired stream segments	Water quality monitoring stations	Monitoring program
Swan Pond Ditch-Cache River (80203020205)	029*	UWCHR04	ADEQ roving
Number Twenty Six Ditch-Cache River (80203020301)	027		
Mud Creek-Big Creek Ditch (80203020501)	Lake Frierson, 910*	WHI0196	ADEQ ambient
Lost Creek Ditch (80203020502)	909	WHI0172	ADEQ ambient
Rogers Bayou-Big Creek Ditch (80203020503)	910, 009	WHI0196, WHI0026	ADEQ ambient
Overcup Ditch (80203020405)	019*	UWCHR03	ADEQ roving
Culotches Bay Slough-Cache River (80203020806)	017	UWCHR02	ADEQ roving
Maloy Bayou-Cache River (80203020807)	016	WHI0032	ADEQ roving

* subwatershed drains to this segment

8.3.2 Other Surface Water Quality Monitoring Opportunities

There are opportunities for expanding surface water quality monitoring in the recommended 12-digit HUC subwatersheds. Possibilities for additional water quality monitoring include special studies, the NRCS Edge-of-field Program, sampling by volunteer stakeholders, and supplemental watershed implementation plans.

8.3.2.1 ADEQ Roving Monitoring Network

ADEQ will be requested to assign at least one roving monitoring site to each 12-digit HUC recommended subwatershed (i.e., 9 sites) during the next round of their roving monitoring network sampling in the Cache River watershed. In the ADEQ roving water quality monitoring program, samples are collected bimonthly for a two year period, every six years. These data will assist in confirming which pollutants are contributing to water quality impairments, and potential sources of these pollutants.

A single monitoring station can provide insight into pollutant sources through examination of relationships between concentration and flow. Point source pollutants would be expected to have an inverse relationship with flow, particularly during the July – September low flow period. Nonpoint source pollutants, particularly sediment, and sulfate and other pollutants that adhere to sediments, would be expected to have a positive correlation with flow.

In-situ monitoring of temperature, DO, conductivity, and turbidity during the ADEQ roving program monitoring period will also be requested to confirm evaluated assessments of DO and TDS impairment. There is typically an excellent correlation between specific conductivity and TDS, with TDS = 0.6 (sp. conductivity). DO impairment was included in the 2014 303(d) list for the lower Cache River, while TDS impairment was listed for several Upper Cache River watersheds. Because sulfate contributes to TDS, there might also be a conductivity-sulfate relationship that can be formulated for evaluation of spatial and temporal variability in sulfate concentrations throughout the watershed.

8.3.2.2 Special Studies

There have been water quality studies conducted in the Cache River watershed, including studies by ADEQ, through the ANRC Nonpoint Source Pollution Program, and by TNC. It is useful to have water quality monitoring projects associated with BMP implementation to determine the effect of the BMPs on water quality. Quality Assurance Project Plans may be needed for special water quality monitoring studies.

Synoptic surveys will be conducted with in-situ measurements of temperature, DO, conductivity and turbidity taken at the mouth of each of the tributaries to the Cache River or Bayou DeView in each of the recommended 12-digit HUC subwatersheds in the Cache River watershed. Proposed sampling locations for each subwatershed are listed in Table 8.4. These surveys will consist of two sampling events, one conducted during the winter high flow period and the second during the summer low flow period. A total of 30 samples will be collected during the surveys, 15 during each sampling event.

Table 8.4. Sampling locations for synoptic survey of recommended 12-digit HUC subwatersheds of the Cache River.

HUC name (12-digit HUC number)	Number of sampling locations	Description of sampling locations
Swan Pond Ditch-Cache River (80203020205)	1	Mouth of Swan Pond Ditch
Number Twenty Six Ditch-Cache River (80203020301)	3	Cache River inflow, Cache River outflow, mouth of Number Twenty-six Ditch
Mud Creek-Big Creek Ditch (80203020501)	1	Big Creek outflow
Lost Creek Ditch (80203020502)	2	At Peachtree Ave, Jonesboro; and mouth of Lost Creek Ditch
Rogers Bayou-Big Creek Ditch (80203020503)	2	Mouth of Big Creek Ditch, Bayou DeView outflow
Overcup Ditch (80203020405)	1	Mouth of Overcup Ditch
Culotches Bay Slough-Cache River (80203020806)	3	Cache River inflow, Cache River outflow, mouth of Culotches Bay Slough
Maloy Bayou-Cache River (80203020807)	2	At Highway 40, Cache River outflow

These synoptic surveys will help identify critical areas within the subwatersheds where TSS (turbidity) loads are greater than would be expected on a strictly areal basis. The surveys can also provide insight on spatial variability in TDS and/or sulfate concentrations, if there is a reasonable relationship between conductivity and TDS or sulfate. These synoptic surveys can be conducted with volunteers from the recommended subwatersheds as members of an AGFC Stream Team, or contracted with a local community college or university using students. Each subwatershed can easily be sampled within a day.

Additional monitoring is proposed to assess whether the copper criterion is being exceeded in Lake Frierson, and, if it is, to identify possible copper sources. Two monitoring locations are proposed in the lake: 1) near the dam; and, 2) in the riverine zone near the headwaters of the lake. Monthly sampling for copper and hardness, near the dam and in the riverine zone will be conducted for 2 years. If the copper criterion is exceeded in the inflow but not at the dam, then the copper is likely being adsorbed and transported on suspended sediment. If the copper criterion is exceeded both at the dam and in the inflow, the copper is likely in a dissolved or organic form. Dissolved copper would be more likely to be discharged by a point source. If the copper is sorbed to sediment, management practices that reduce sediment transport to Big Creek should also reduce instream copper concentrations.The ASU Ecotoxicological Research Facility in Jonesboro is exceptionally well-qualified to conduct this monitoring and is less than 30 minutes from the lake. Partners in this effort could include the Arkansas Department of Parks and Tourism (Lake Frierson State Park) and AGFC (AGFC owns Lake Frierson).

8.3.2.3 NRCS Edge-of-field Monitoring Program

NRCS has a program through EQIP to encourage landowners to assist in documenting water quality improvements resulting from their use of BMPs through monitoring water quality at the edge of their fields. Arkansas watersheds where MRBI projects are active are eligible for this program. Of the recommended 12-digit HUC subwatersheds for the Cache River, the Overcup Ditch subwatershed is eligible for this program. NRCS has identified partners to conduct the water quality monitoring, including the USDA Agricultural Research Service, U of A Cooperative Extension Service, U of A at Pine Bluff, and Arkansas State University. Monitoring contracts for up to nine years are available (NRCS 2015b).

8.3.2.4 Volunteer Monitoring

The agencies that traditionally have conducted water quality monitoring in Arkansas face budgetary constraints that make it difficult to expand, or even maintain existing, water quality monitoring networks. Trained stakeholder volunteers are one option for expanding water quality monitoring while working within budgetary constraints. The AGFC Stream Team program trains and guides volunteers in water quality monitoring of streams. Volunteer water quality monitoring programs have been able to effectively contribute to evaluation of water quality in Northwest Arkansas (Massey and Haggard 2009).

8.3.2.5 Supplemental Watershed Implementation Plans

Ultimately, monitoring is the only approach that can document load reductions and support of designated uses and water quality standards. ANRC will coordinate with ADEQ and other agencies, such as the AGFC Stream Team, to monitor water quality as part of watershed implementation planning. A minimal in situ monitoring program for temperature, DO, conductivity, and turbidity will be established at a site downstream from areas where management practices are to be implemented. When possible, at least one year of monitoring data will be collected prior to implementing management practices. Monitoring will be established as soon as an implementation site has been identified, even if one full year of monitoring is not achievable. Monitoring will be re-initiated one year following completed implementation of the management practices and continued for 2 consecutive years. Construction and transient effects have been observed up to a year following completion of structural restoration efforts, which confounds the analysis of practice effectiveness and efficiency. Monitoring will be discontinued for 2 consecutive years and then re-initiated during the 5^{th} year after the initial re-initiation (Table 8.5). Where possible, an ADEQ roving monitoring site will be established downstream from the implementation site where a full suite of water quality constituents, including TSS, metals, sulfate, and TDS, can be monitored and used to evaluate practice effectiveness and efficiency. Relationships among constituents, such as TDS and conductivity, TSS and turbidity, turbidity and sulfate will be evaluated for use at similar sites where only in-situ monitoring might be feasible.

Table 8.5. Proposed schedule for BMP effectiveness monitoring.

Activity	Duration	Overall time period
Pre-implementation monitoring	1 year	1
BMP construction/implementation	Variable	1+x
Transient effects from construction/implementation	1 year	2+x
Water quality monitoring	2 years	4+x
No water quality monitoring	2 years	6+x
Resume water quality monitoring	1 year	7+x

If funds are available, in-situ monitoring can be continuous throughout the 5 year period. Lag times following implementation of BMPs have been observed for years in larger catchments before improvements are observed (Meals et al., 2010). The main components of lag time include the time required for an installed practice to produce an effect, the time required for the effect to be delivered to the water resource, the time required for the water body to respond to the effect, and the effectiveness of the monitoring program to measure the response (Meals et.al., 2010). The magnitude of lag time is highly site and pollutant specific, but may range from months to years for relatively short-lived contaminants such as indicator bacteria, years to decades for excessive P levels in agricultural soils, and decades or more for sediment accumulated in river systems (Meals et al., 2010).

8.3.2.6 NWR Water Quality Monitoring

The USFWS has proposed development and implementation of a water quality monitoring network within the Cache River NWR (Holt, Hunt and Faustini 2015).

8.3.3 Biological Monitoring

No indication was found of routine biological monitoring programs active in the Cache River watershed. However, ADEQ, USGS, ANRC, AGFC, and USFWS have funded biological monitoring projects in the lower Cache River watershed. AGFC has proposed at least one biological study of the watershed (AGFC 2015c). Surveys of fish and macroinvertebrates in the area of phase 2 of the meander restoration project in the Cache River downstream of Bayou DeView have been initiated (T. Wentz, ADEQ, personal communication, 12/1/15). In addition, the USFWS has proposed routine monitoring of invasive, threatened, and endangered species within the Cache River NWR (Holt, Hunt and Faustini 2015).

8.4 Information and Education

Watershed-based management is fundamentally a social activity (Thornton and Laurin 2005). While technical solutions to problems are necessary for effective watershed management, they are not sufficient. Decisions on how to improve water quality to achieve designated uses, implement management practices, and restore stream habitat, are ultimately based on the socioeconomic perceptions, beliefs and values of landowners and stakeholders on how these technical solutions will affect them. The Information and Education objectives of this watershed-based plan, therefore, are to:

- Increase local landowner and public awareness of the need for, and the benefits of, watershed restoration and protection practices to achieve designated uses and water quality standards;
- Increase stakeholder support and sustained participation in watershed management activities to achieve water quality standards; and
- Improve the understanding of how meeting water quality standards and environmental improvements contribute to increased economic and social capital in the community.

Outreach and Education programs by County Conservation Districts, AGFC, USACE, USFWS, USFS, NRCS, and interest groups such as The Nature Conservancy, Ducks Unlimited, and Farm Bureau, have been working toward achieving these objectives in the Cache River watershed for over 10 years. These organizations will continue to promote water quality management in the watershed to achieve water quality standards. These organizations are both stakeholders and implementation partners. Since they have been active in the watershed in the past, these organizations have established relationships with stakeholder landowners in the watershed, as well as with each other.

Following is a discussion of information and education activities in the Cache River watershed. A section on past information and education efforts is followed by a section that discusses ongoing activities. Table 8.5 provides examples of information and education activities within the Cache River watershed.

Table 8.6 Information and education activities in the Cache River watershed.

Practice	Project 04-112 (Woodruff County)	Project 06-1700 (Cross County)	Project 13-900 (Greene County)	U of A Cooperative Extension Service	Interest Groups	USACE	USFWS	NRCS	County Conservation Districts	AGFC	Arkansas Department of Parks and Tourism
Meetings			x	x	x	x	x	x			
Field days			x	x				x			
News articles	x	x		x		x	x		x		
Presentations	x					x				x	x
Fair display	x			x				x			
Flyer/ brochure	x	25 posted		x	x	x	x		x	x	x
Newsletter	x	475 recipients			x			x			
Email	x										
Phone survey		110 people									
Radio											
Website				x	x	x	x	x	x	x	x
Signs								x		x	x

8.4.1 Previous Information and Education Efforts in the Cache River Watershed

Examples of information and education efforts that have occurred in the Cache River watershed over the last 5 years are discussed below. Organizations that have been involved in these efforts include state and federal agencies, counties, and nonprofit organizations.

8.4.1.1 County Conservation Districts

The Section 319 projects in the Cache River watershed were led by County Conservation Districts. These projects included information and education elements, including news articles, newsletters, presentations, and emails (Table 8.6). The AACD has used their website, brochures, and news articles to get the word out about the Arkansas Mud Drive.

8.4.1.1 U of A Cooperative Extension Service

The U of A Cooperative Extension Service has hosted a series of public meetings in nonpoint source priority watersheds. The purpose of these meetings is to offer a forum for watershed residents to identify issues and discuss solutions, with the idea of stirring interest in watershed planning and management practice implementation. One of these meetings was held in the Cache River watershed in October 2014 (Perez and Higgins 2015).

8.4.1.2 NRCS

MRBI projects involve information and outreach activities. These include stakeholder meetings, field days, discovery farms, presentations, and providing program information on the NRCS website. NRCS provides information and education on how to select and implement management practices, benefits of management practices, and maintenance of management practices.

8.4.1.3 USACE

The USACE has conducted public meetings as part of its projects in the Cache River watershed, including restoration of the lower Cache River stream meanders, removal of the Cache River obstructions near Grubbs, and preparation of their Cache River watershed management plan. USACE also provides information on projects in the Cache River watershed on the Memphis District website, and in reports associated with the projects.

8.4.1.4 USFWS

During its effort to expand the acquisition boundary for the Cache River NWR, the USFWS solicited public comments on the proposed expansion. This involved public meetings, news releases to local media, and mailed flyers (USFWS 2012).

8.4.2 Ongoing and Planned Information and Education Efforts in the Cache River Watershed

Information and education programs of the U of A Cooperative Extension Service, U of A Department of Agriculture, NRCS, MRBI projects, and agricultural and natural resources interest groups are ongoing and will continue. Information and education activities will be part of all future Section 319 projects in the Cache River watershed.

8.4.2.1 U of A Department of Agriculture

Field days and workshops are hosted at the agricultural experiment stations of the U of A Department of Agriculture for the transfer of information to producers and landowners. The Discovery Farms program is also an information and educational program of the U of A Department of Agriculture. Information provided includes operations and maintenance practices to reduce inputs and impacts on natural resources.

8.4.2.2 Interest Groups

Interest groups such as the Arkansas Farm Bureau, Arkansas Soybean Promotion Board, Arkansas Rice Federation, Ducks Unlimited, Audubon Arkansas, TNC, and National Wildlife Refuge Association provide information to their members, constituents, and the public through a variety of means including websites, newsletters, and annual conferences. Information provided includes sustainable practices to improve and restore water quality and other natural resources, and the economic and societal benefits of these practices.

8.4.2.3 Public Lands

The state parks, state WMAs, state natural area, and Cache River NWR within the Cache River watershed provide opportunities for information and education. One of the objectives of the Cache River NWR is to provide "environmental education and interpretation opportunities for the public" (USFWS 2010). Public use of these lands is encouraged, and information about their characteristics and importance is included on websites and in brochures produced by the managing agencies (i.e., Arkansas Department of Parks and Tourism, AGFC, Arkansas Natural Heritage Commission, USFWS).

8.5 Supplemental Watershed Implementation Plans

Watershed implementation plans (WIPs) are required under the Clean Water Act for waterbodies for which TMDLs have been completed. Therefore, WIPs are needed to address the turbidity and lead impairments in the Cache River watershed, including those in the recommended subwatersheds. The purpose of WIPs is to provide a roadmap for how the water quality will be improved so that it meets state water quality standards.

The process of developing a WIP can increase the implementation of voluntary management practices by encouraging stakeholder buy-in and leveraging technical and financial resources. Locally developed WIPs are envisioned as the mechanism for implementing management practices in the Cache River recommended subwatersheds. A WIP will be prepared for each recommended 12-digit HUC subwatershed of the Cache River as a supplement to this Watershed-Based Management Plan. The WIPs will emphasize the management practices and associated pollutants and sources that are being targeted within each recommended subwatershed. These plans will include more specific information about pollutant sources that exist and how these sources will be addressed by management practices. WIPs for Number Twenty-six Ditch and Maloy Bayou subwatersheds will include streambank inventories and erosion potential assessments. Updated estimates of the load reduction expected through implementation of management practices will be included.

8.6 Implement Management Strategies

Management strategies that are, and will be, implemented in the Cache River watershed to reduce turbidity and sulfate water quality criteria exceedences are listed in table 8.7, along with the priority pollutant sources within the recommended 12-digit HUC subwatersheds that they address.

Table 8.7 Management strategies for the Cache River watershed.

Strategy	Gully Erosion (Swan Pond Ditch, Number Twenty-six Ditch, Mud Creek subwatersheds)	Streambank Erosion (all recommended subwatersheds)	Sheet/Rill/Wind Erosion (Number Twenty-six Ditch and Mud Creek subwatersheds)
Prevent detachment (erosion)			
Tree/shrub planting/ reforestation	X	X	X
Forested riparian buffer		X	
Herbaceous riparian buffer		X	
Drop pipe water control structure	X	X	X
Grade stabilization structure	X		X
Winter flooding of fields	X		X
Ground cover/cover crop	X		X
Grassed waterways	X		
Pond	X		
Pasture and hay planting	X		X
Ground cover/cover crop	X		X
Streambank restoration		X	
Land leveling			X
Interrupt transport			
Riparian buffer			X
Field border			X
Grassed waterways	X		X
Pond, sediment basin	X		X
Filter strip			X

8.7 Evaluation

Evaluation is a required activity for adaptive watershed management. The evaluation framework outlined below considers three major elements of the implementation of a watershed-based plan: program inputs, outputs, and outcomes. These elements will be evaluated for information/education, monitoring, and implementation of management practices. ANRC will be responsible for evaluation of the watershed management plan in 2023. Agencies and organizations will provide information about their implementation activities to ANRC for the evaluation.

In 2023, priorities and ongoing management measures will be evaluated and modified in light of changes in water quality, land use, regulations, public opinion, and scientific understanding that have occurred since this version of the plan was approved. The usefulness of management measures will be determined based on their effectiveness as evaluated against the criteria identified in Section 8.11. This evaluation will involve examination of water quality data collected as part of routine monitoring programs and special studies or projects. The ultimate and long-term goal is to restore impaired stream segments to fuly supporting their designated uses, Given changes in technology, land use, and socioeconomic conditions within the watershed, five years is a reasonable period both for establishing and assessing interim goals.

8.7.1 Inputs

The inputs for implementation of this plan are the assistance programs available, and stakeholder participation. Indicators that measure this component of the plan implementation are listed in Table 8.8. The stakeholders and organizations that participate in implementation of this plan will provide the ANRC with annual totals for these inputs indicators for the period 2017 through 2022 by April 2023.

8.7.2 Outputs

The outputs for implementation of this plan are development of TMDLs and supplemental watershed implementation plans, implementation of nonpoint source management practices, information and education, and monitoring. Indicators that measure this component of the plan implementation are listed in Table 8.9. The stakeholders and organizations that participate in implementation of this plan will provide ANRC with annual totals for these indicators for the period 2017 through 2022 by April 2023.

Table 8.8. Indicators of inputs for implementation of this watershed management plan.

Implementation Task	Activity	Indicator
Monitoring	Monitoring	Resources spent on monitoring in Cache River watershed Hours and number of personnel involved
Information & Education	Field Days (County Conservation Districts)	Hours and number of people involved Cost Number of attendees
	Informational booth at County fairs (County Conservation Districts)	Number of people visiting booths Hours and number of people involved in manning booths
	Articles about Cache River water quality issues and/or appropriate BMPs (interest groups)	Hours and number of people involved Cost
	Presentations on Cache River water quality issues and/or appropriate BMPs (interest groups)	Hours and number of people involved Cost Number of attendees
Implement Management Strategies	Assistance programs in the Cache River watershed	Resources distributed to Cache River watershed Hours and number of people assisting stakeholders in cache River watershed Number of Cache River watershed stakeholders requesting assistance

Table 8.9. Indicators of outputs of implementation of this watershed management plan.

Implementation Task	Activity	Indicator
Monitoring	Monitoring	Number of active water quality monitoring stations Number of turbidity/sediment data collected Number of dissolved lead data collected Number of dissolved copper data collected Number of biological surveys
Information & Education	Field Days (County Conservation Districts)	Number of field days
	Informational booth at County fairs (County Conservation Districts)	Number of fairs attended
	Articles about Cache River water quality issues and/or appropriate BMPs (interest groups)	Number of articles published
	Presentations on Cache River water quality issues and/or appropriate BMPs (interest groups)	Number of presentations
Implement Management Strategies	Assistance programs in the Cache River watershed	Number/amount of management practices implemented Number of contracts/projects started and finished

8.7.3 Outcomes

The intended outcomes for this implementation plan include improvement in water quality, and increased awareness of, and interest in, water quality concern of the Cache River watershed. The long term goal of this watershed-based plan is that impaired waterbodies in the Cache River watershed will meet water quality criteria and support their designated uses. The primary water quality indicators for this goal in the Cache River watershed are turbidity levels, and dissolved copper, dissolved lead, and sulfate concentrations. The secondary indicators are indicators of biological integrity, including the condition of endangered fish and mussel communities. Within the next five years, the goals of this plan are to reduce the number of turbidity and sulfate measurements that exceed applicable state water quality criteria, and remove stream segments listed for dissolved copper and dissolved lead from the state impaired waters list.

The monitored waterbodies in the Cache River watershed are assessed by ADEQ every two years to develop the Arkansas integrated water quality assessment report, which includes the 303(d) list of impaired waterbodies. Progress toward achieving the goal of improved water quality will be evaluated during the Arkansas biennial integrated water quality assessment.

Implementation of this plan will be considered successful if:

- A watershed implementation plan has been developed and implemented for at least one recommended 12-digit HUC subwatershed in both the upper and lower Cache River watersheds by 2023,
- By 2023, the percentage of sulfate criteria exceedences at ADEQ station UWCHR04 has decreased from the percentage during the 2008 integrated water quality assessment,
- By 2023, the percentage of turbidity criteria exceedances at ADEQ stations UWCHR02, UWCHR04, and WHI0032 has decreased from the percentage during the 2008 integrated water quality assessment,
- By 2023, ADEQ stream reaches 016, 017, and 019 have been assessed as meeting numeric water quality criteria for dissolved lead, and
- By 2023, ADEQ stream reaches 009, 909, and 910 have been assessed as meeting numeric water quality criteria for dissolved copper.

If these criteria are not satisfied, the management approaches, scientific knowledge, and stakeholder knowledge and opinions in the recommended subwatersheds will be re-evaluated and management elements adjusted accordingly. This evaluation will take into account the fact that it can take more than five years, or even decades, before water quality improvements resulting from implementation of management measures become apparent (Meals et al. 2010). The time period required to see significant changes in water quality is, in part, a function of how close to management activities water quality is measured.

8.8 Update Watershed-based Management Plan

Development of the supplemental implementation plans for the recommended 12-digit HUC subwatersheds will be part of the update of this watershed management plan. ANRC will be responsible for preparing a comprehensive update of this watershed management plan in 2023.

This update will consider and address the following information.

- results of the evaluation of the implementation of this plan, described in Section 8.7,
- relevant information about the Cache River system and how it works, nonpoint source management practices, and pollutant sources in the watershed that has been developed since 2016,
- Changes in water quality related issues in the watershed,
- Changes in water quality management assistance programs, and
- Changes in land use, industry, population, and/or economy in the watershed.

ANRC will prepare a summary of the evaluation of implementation of the previous plan and changes in the watershed over the period since completion of the previous watershed management plan. This summary will be presented at two or more public stakeholder meetings, with separate meetings for the upper and lower Cache River watershed. At these meetings, stakeholders will provide input on adjustments to management of and/or goals for the Cache River watershed. This may include a focus on management in other 12-digit HUC subwatersheds for water quality improvement or protection.

ANRC will prepare a draft update of this watershed-based management plan utilizing the information from the implementation evaluation and the public meetings, and any other information it deems appropriate. This update will also be presented at public stakeholder meetings in the upper and lower Cache River watershed to elicit feedback. The final update of the watershed-based management plan will then be prepared, incorporating stakeholder comments. The updated plan will be available to the public on the arkansaswater.org website.

9.0 COSTS, BENEFITS, AND ASSISTANCE

This section discusses costs that will be associated with implementation of this watershed management plan, the economic and environmental benefits of implementing this plan, and technical and funding assistance that is available for implementing this plan.

9.1 Cost

The cost information provided below are estimates. Actual costs may differ from those given below for a viariety of reasons.

9.1.1 Monitoring

Estimated costs for synoptic surveys (Section 8.3.2.2) are $5,000 for two in-situ monitors, and $5,000 for personnel to collect and enter the information into www.ArkansasWater.org.

The cost of monitoring the effects of management practices (Section 8.3.2.5) can vary from the cost of in-situ instrumentation with volunteer monitoring through the AG&FC Stream Team or similar volunteer arrangement(approximately $5,000 for an in-situ instrument with four parameters plus a backup instrument) to $40-50,000 per year for the USGS to monitor the site.

9.1.2 Supplemental Watershed Implementation Plans

Estimated costs for preparing the supplemental information for the Cache River Watershed-Based Management Plan is $15-20,000 for each HUC12 priority watershed, if Section 319 funds are requested for implementing the management practices. Section 319 funds are not available for preparing the plan, only for implementation and/or monitoring of management practices, outreach and/or education products.

9.1.3 Estimated Cost of Implementing Management Practices in Recommended Subwatersheds

The cost of implementing management practices to reduce nonpoint source pollution can be variable, depending on materials markets, site conditions (e.g., slope, soil type), and location within the subwatershed. Table 9.1 lists available cost information for management practices identified in Section 7. The majority of the costs shown in Table 9.1 are the 2015 funding allocations specified for the NRCS Arkansas EQIP. While these allocations do not necessarily reflect the actual cost of implementing the practices, they provide an idea of relative costs of management practices.

Table 9.1. Cost information for selected management practices for the Cache River watershed.

Sediment source	Practice	Unit Cost
Gully erosion	Grassed waterways	$757 - $1,208 / acre
	Sediment basins/ ponds	Sediment basin: $1.33 - $2.91 /cubic foot; Pond: $2.06 - $3.33 /cubic foot
Gully erosion, streambank erosion, sheet/rill/wind erosion	Water control structures	Flashboard riser: $3.03 - $3.78 /foot diameter.; culvert: $1.51 - $2.90 /foot diameter.; gates: $1,475 - $1,712 /foot; prefab structure: $28.61 /square foot; Drop pipes: $0.90 - $1.55 /foot diameter; Drop structures: $37.95 - $46.88 /square foot; Check dams: $26.68 /ton; Embankments: $2.93 - $4.28 /cubic yard
	Filter strips	$66.65 - $468.33/acre
	Critical area planting	$213.59 - $1,057/acre
Sheet/rill/wind erosion	Field borders	$99.1 - $480.64/acre
Sheet/rill/wind erosion, streambank erosion	Riparian buffers	$170 - $278/acre
	Land easements or sale	Landowner paid market value of sold land FSA easements pay $2,100 to $2,900/acre
	Grade stabilization structure	Check dam: $26.68/ton Embankment with pipe: $2.93 - $4.28 /cubic yard Drop pipe: $0.90 - $1.55/ foot diameter Drop structure: $37.95 - $46.88/square foot
Sheet/rill/wind erosion, gully erosion	Ground covers	Conservation cover: $18.59 - $234 / acre; Mulch: $294 - $5,808 /acre; Cover crop: $30.83 - $81.65 /acre; Forage & biomass planting: $188 - $303 /acre; Critical area planting: $213 - $1,057 /acre
	Tree/shrub planting/ reforestation	Site prep: $17.50 - $231 /acre; Plant establishment: $0.11 - $9.74 /plant; Pruning: $93.86 - $278 /acre
	Forage & biomass planting	$231.13 - $331.54 /acre
Streambank erosion	Restoration of Cache River meanders	$3.5 million per meander
	Streambank protection	$7.47 - $107.45 / linear foot

Table 9.2 provides examples of costs for implementation of selected management practices (for which cost information is readily available) to reduce TSS loads to meet the numeric turbidity water quality criteria in the recommended 12-digit HUC subwatersheds. These examples illustrate relative costs to achieve the target TSS load reductions listed in Table 6.2 using different management practices. The practice extents used to calculate these costs are taken from Table 7.10.

Table 9.2. Estimate of relative costs for implementing management practices to reduce TSS load in recommended subwatersheds of the Cache River.

Practice	Unit cost	No. 26 Ditch	Swan Pond Ditch	Overcup Ditch	Big Creek Ditch	Culotches Bay Slough	Maloy Bayou
Streambank protection	$100/ft	$3,170,000	$2,774,000	$8,600,000	$385,000	$2.100,000	$1,200,000
50 foot herbaceous riparian buffer	$200/ac	$9,900	$8,580	$27,720	$440	$6,600	$3,520
Water control structure*	$500 each	$12,500	$10,000	NA	$4,000	NA	NA
Cover crop	$60/ac	$120,000	$96,000	NA	$39,000	NA	NA
30 foot filter strip	$250/ac	$350	$5,750	NA	$250	NA	NA
30 foot field border	$300/ac	$14,400	NA	NA	$600	NA	NA

*Assume one structure for each 75 acres of treated area

9.2 Estimated Economic and Environmental Benefits

There are costs associated with implementing best management practices, as noted in Section 9.1 above. However, there are also environmental benefits associated with these management practices, both to the landowner and to downstream users. Environmental benefits that humans receive from nature are called ecosystem services, and include goods or products (provisioning services) that typically have market value, such as timber production, commercial fisheries, agricultural production, and biochemical extracts. In addition, there are other services and benefits provided by ecosystems that are not as easy to value economically, but are critical to our quality of life, such as erosion control, improved air and water quality through contaminant removal, and pollination (regulating services); soil moisture retention, nutrient cycling, and soil formation (supporting services); and fishing, bird watching, and wildflowers (cultural services) that provide aesthetic pleasure. Various environmental benefits associated with ecosystem services are listed in Table 9.3.

Table 9.3. Benefits and ecosystem services associated with increased soil health and best management practices.

Ecosystem service or environmental benefit	Description
Contaminant removal	Contaminants (sediment, nutrients (N, P), heavy metals, pesticides) absorbed onto soils, chelated by organic matter, or filtered from runoff, or taken up by vegetation, reducing contaminant loading/concentrations in receiving waterbodies.
Erosion control	Vegetation, soil cover, or impounded water reduces impacts of rainfall in disrupting soil particles and/or reducing soil transport in runoff, including settling in impounded water, to receiving waterbodies.
Fish habitat	Riparian vegetation, organic debris reduces soil and bank erosion and provides structure in streams for fish and other aquatic organisms.
Flood mitigation	Soil organic matter, vegetation, retains water, slow water flow, and attenuate peak flow to reduce flooding.
Forage quality	Improved vegetative cover, soil organic matter, and nutrient cycling increase forage quality for grazing and increase animal production.
Nutrient retention -cycling	Nutrient retention and slow release to crops reduces fertilizer requirements and associated costs, improves yields and reduces nutrient loading to receiving waterbodies.
Soil formation	Vegetation, no/reduced tillage, and mulch add organic matter to soils, increase infiltration, reduce compaction, and improve soil structure and soil health, for potential increased crop yields or animal production.
Soil moisture retention	Increased soil organic matter from vegetative cover or residue retains water and increases soil moisture. Each 1 percent increase in soil organic matter helps soils hold about 20,000 gallons more water per acre, reducing irrigation costs.
Timber production	Forested riparian buffers reduce soil/bank erosion, reduce nutrient and other contaminant loading, improve fish habitat, and provide harvestable timber for additional revenue.
Water purification	Contaminate sorption, filtering through soils and vegetative/organic debris, and uptake improves water quality by purifying the water.
Waterfowl habitat	Winter water retention, forested riparian buffers increase habitat for waterfowl and potential hunting leases.
Wildflower/wildlife habitat	Filter strips, buffers, riparian corridors, conservation reserves provide additional habitat for wildflowers, birds, and wildlife and can be leased for hunting.

Best management practices proposed for the Cache River subwatersheds are listed in Table 9.4 along with the environmental benefits that accrue from the implementation of these BMPs. While not all these benefits have direct marketable economic value, there have been economic assessments of several of them. For example, cover crops can increase soil organic matter, retain nutrients, and improve soil moisture holding capacity and contribute to increased yield in the cash crop planted in cover crop fields. In one study of cover crops planted on about 5,000 acres, the seed cost for the cover crop was about $100,000 or about $26/acre, but resulted in a savings of about $57,000 in nitrogen fertilizer retained/produced by the cover crop, and increased corn yields, on average, by 12.8 bushels/acre. Cover crops were estimated to provide about $244,000 in net economic benefits or about $69/acre (Strom 2016). For irrigated fields, each 1 percent increase in organic matter helps store about 20,000 gallons more per acre, which can decrease the frequency of irrigation sets due to increased field capacity for soil moisture.

Other ecosystem services have intrinsic environmental benefits and value that are more difficult to economically assess. During a reconnaissance to assess the effectiveness of the filter strips, the farmer remarked that during the year he would sometimes just drive around the filter strips to look at the wildflowers. He said, “If you had told me that one of the major benefits of filter strips would have been wildflowers, I would have looked at you like you were nuts and walked away. But, I enjoy their beauty.” (Thornton, personal communication, 2011).

Table 9.4. Environmental benefits associated with implementing best management practices in the Cache River subwatersheds.

Best Management Practice	Contaminant removal	Erosion control	Fish habitat	Flood mitigation	Forage quality	Nutrient retention	Soil formation	Soil moisture	Timber production	Water purification	Water-fowl habitat	Wildlife-flower habitat
Bank stabilization/ stream restoration	•	•	•	•		•				•	•	•
Riparian buffer	•	•	•	•		•			•	•	•	•
Water control structure	•	•				•				•	•	
Mulch		•										
Cover crop	•	•		•	•	•	•	•		•		•
Filter strips	•	•		•	•	•	•	•		•		•
Field border	•	•		•	•	•	•	•		•		•

9.3 Technical Assistance

There are a number of agencies and organizations that are active in the Cache River watershed that provide technical expertise that will be useful in implementing this watershed-based management plan.

9.3.1 Monitoring

Agencies and universities conducting water quality monitoring generally have their own technical resources. Technical assistance for volunteer water quality monitoring programs is available through the Arkansas Game and Fish Commission Stream Team Program.

9.3.2 Information and Education

Technical assistance with information and education activities is available through the ADEQ Public Outreach and Assistance Division, Watershed Conservation Resource Center, U of A Cooperative Extension Service, and others. A number of resources are also available from EPA through the Nonpoint Source Outreach Toolbox (http://cfpub.epa.gov/npstbx/index.html).

The ADEQ Public Outreach and Assistance Division offers technical assistance and resources to interested citizens and groups. The Watershed Outreach and Education program of this division provides "a variety of tools and services to facilitate and promote awareness, appreciation, knowledge, and stewardship of water resources" (ADEQ 2015g).

9.3.3 Supplemental Watershed Implementation Plans

EPA has a watershed planning website with links to a number of resources to assist watershed management plan developers (https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/watershed-plannning-builder-and-guides).

9.3.4 Management Strategies

There are a number of sources for technical assistance for management strategies in recommended 12-digit HUC subwatersheds. These are summarized in Table 9.5 and discussed below. These sources provide assistance with selecting, designing, constructing/implementing, operating, and maintaining management strategies that address the priority pollutants identified for this plan (see Section 7).

9.3.4.1 NRCS

The NRCS has several programs that involve helping landowners to address natural resource concerns through planning, guidance, and technical expertise. These include the Conservation Stewardship Program, Environmental Quality Improvement Program (EQIP), and Conservation Technical Assistance program. NRCS technical assistance is available at USDA Service Centers.

9.3.4.2 County Conservation Districts

Conservation Districts for the counties in the Cache River watershed work closely with NRCS to provide technical support to landowners, including information and guidance about management practices for protecting soil and water resources. The AACD is a sponsor of the Arkansas Mud Drive. Through this program, County Conservation Districts can provide technical assistance on flooding fields for waterfowl habitat and water quality improvement.

9.3.4.3 Cooperative Extension Service

The U of A Cooperative Extension Service provides technical assistance through a range of programs and services including soil, and water testing; assistance with water management; Discovery Farms, and field days and on-farm demonstrations. Cooperative Extension Service also maintains an extensive library of up-to-date, research-based fact sheets, applied research publications, and best management practice manuals and guidelines.

9.3.4.4 U of A Agricultural Experiment Station

The experiment station program of the U of A Division of Agriculture generates, interprets, and distributes information and technology useful to farmers in Arkansas, including those in the Cache River watershed.

Table 9.5. Technical assistance resources for the Cache River watershed.

Practice	NRCS	County Conservation Districts	U of A Cooperative Extension	U of A Experiment Stations	ADEQ	EPA	ADTH	Product Manufacturers	TNC	USFWS	AGFC	Ducks Unlimited	USACE	Other Interest Groups
Water control structures	x	x	x	x				x		x		x		
Ground covers	x	x	x	x				x						
Grassed waterways	x	x	x	x										
Sediment basins/ ponds	x	x	x	x	x	x	x				x			x
Stormwater pollution prevention plans					x	x	x							x
Tree/shrub planting/ reforestation	x	x							x	x		x	x	
Riparian buffers	x	x	x						x	x	X			
Winter flooding of fields	x	x							x	x	X	x	x	
Field borders, filter strips	x	x	x	x							X			
Land easements or sale	x								x	x	X	x		
Restoration of Cache River meanders									x	x	x	x	x	
Critical area planting	X	x	X	x					X	X	X			
Forage & biomass planting	X	X	X	X					X	x	X			
Grade stabilization structures	x	X	x	X					x					

9.3.4.5 ANRC Nonpoint Source Program

Every five years, the ANRC prepares a nonpoint source management plan. This plan includes information on management practices for a number of activities to reduce nonpoint source pollution, including practices for mining, construction, and agriculture. This plan is available from the ANRC website (www.arkansaswater.org).

9.3.4.6 TNC

The Cache River watershed is part of the Big Woods focus area of TNC. TNC has been involved in a number of projects in this watershed, including reforestation efforts, leasing and buying of land for habitat and water quality protection, and restoration of meanders of the Cache River in the channelized area downstream of Bayou DeView. With this experience and contacts in the lower Cache River watershed, TNC is a good technical resource for several of the planned management activities.

9.3.4.7 USFWS

The USFWS can provide technical assistance with habitat management and restoration. For private landowners, assistance is available primarily through the Partners for Fish and Wildlife Program. Through this program, landowners can receive technical assistance with projects that improve or restore habitat for species of concern, or improvement or restoration of important habitats, such as wetlands (USFWS Arkansas Ecological Field Services Office 2015). Activities that improve or restore habitat can also improve or restore water quality.

9.3.4.8 AGFC

AGFC offers technical assistance and advice to private landowners on managing wildlife habitat on their lands through the Private Lands Program. Working with landowners, private lands biologists can develop written wildlife management plans with recommendations for locations for management activities. In addition, these personnel are well versed in the state and federal programs that can provide funding assistance for implementing the recommended practices (AGFC 2011). A number of the habitat management practices recommended by AGFC can also improve water quality.

9.3.4.9 Ducks Unlimited

Ducks Unlimited has assisted with numerous habitat conservation and restoration projects in the Cache River watershed. This organization also provides technical assistance to farmers regarding winter flooding of fields for waterfowl habitat. This practice can also improve water quality.

9.3.4.10 USACE

The USACE has provided technical assistance designing and implementing several projects in the Cache River watershed that can improve water quality, including restoration of meanders in the Cache River downstream of Bayou DeView, and clearing the log jams on the Cache River near Grubbs. The USACE has developed a watershed management plan for the Cache River watershed, and has proposed a comprehensive study of the watershed. The USACE has indicated that they are available to provide design assistance with restoration of the remainder of the channelized meanders in the Cache River downstream of Bayou DeView (USACE 2015a).

9.3.4.11 Others

Industry organizations, such as Arkansas Builders and Contractors, Inc., as well as ADEQ, EPA, and AHTD, can provide technical assistance with construction and mining erosion and stormwater BMPs. ADEQ manages the state mining program, and has produced a manual that describes erosion control practices for surface mining. EPA has prepared a series of factsheets on BMPs that can be used to control erosion and sediment at construction sites. The AHTD has prepared a manual describing erosion and sediment control practices for construction sites. Although geared toward addressing road construction sites, the BMPs described in the AHTD manual are applicable to any construction site. Industry organizations, ADEQ and EPA provide technical assistance for preparation of stormwater pollution prevention plans. There are also independent organizations and companies that can provide training and assistance with pollution prevention plans.

9.4 Funding Assisstance

A number of organizations that are active in the Cache River watershed have programs to provide funding assistance for activities that are part of implementing this watershed-based management plan. Organizations and funding assistance programs are discussed below.

9.4.1 Monitoring

ADEQ, USGS, and ANRC have funded water quality monitoring projects in the Cache River watershed. ADEQ's monitoring is self-funded. ANRC has provided funding for university and TNC water quality monitoring projects in the Cache River watershed. Table 9.6 summarizes funding sources for monitoring in the Cache River watershed. The "$" symbol indicates a source that has committed to fund practices in the Cache River watershed over the next 3 years or so. The "X" symbol indicates other potential funding sources.

There are also other potential funding sources for water quality and biological monitoring in the Cache River watershed (Table 9.6). One of these is the AGFC Stream Team program, which can provide funding for volunteer monitoring programs through mini-grants (AGFC 2015b). The NRCS Edge-of-field Water Quality Monitoring Program offers financial assistance to landowners for installation and maintenance of water quality monitoring systems (NRCS 2015b). NRCS allocated $2 million nationally for this program for the 2016 fiscal year (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/quality/tr/?cid=stelprdb1240285).

Table 9.6. Funding assistance for water quality and biological monitoring in the Cache River watershed.

Project/Activity	ANRC/EPA	NRCS	AGFC	ADEQ	USGS
11-1600 Cache River Monitoring	$				
13-500 Middle Cache River Monitoring	$				
MRBI Edge of Field Monitoring		X			
06-400 Sediment Assessment: The Cache River Watershed of Arkansas	$				
Routine ambient monitoring				$	$
Fish/mussel surveys			X		
Stream teams			X		
Special studies	X			X	

The AGFC funds water quality and biological monitoring across the state through the federally funded State Wildlife Grants program. In 2015, AGFC proposed a fish survey of the White and Cache Rivers, which was not selected for a State Wildlife Grant. However, this remains a potential funding source for monitoring in the Cache River watershed. AGFC received $533,622 for State Wildlife Grants (http://www.wildlifearkansas.com/grants.html).

9.4.2 Information and Education

Funding assistance for past information and education activities in the Cache River watershed has come from a variety of sources. All projects funded through the ANRC Nonpoint Source Program (Section 319(h) funds) are required to include an education and outreach component. In addition, information and education activities have been included in the budgets of restoration projects lead by USACE and TNC.

Projects funded through USDA NRCS and FSA cost-share and easement programs are often used as demonstrations in NRCS and Conservation District outreach and education programs.

There are several private foundations that fund education, and which may fund environmental education. The EPA also provides grants for environmental education (http://www2.epa.gov/education/environmental-education-ee-grants).

9.4.3 Supplemental Watershed Implementation Plans

The ANRC nonpoint source program has provided funding assistance for watershed planning in the past. It is possible that EPA will stipulate in the future that Section 319 funds be used only for implementation of management practices, not for watershed planning. However, state nonpoint source program funds will continue to be a source for assistance with the costs of watershed planning in the future. Other potential sources for funding assistance for watershed planning include private foundations, industries, and interest groups.

9.4.4 Funding Assistance for Nonpoint Source Pollution Management Practices in the Cache River Watershed

Over the years, funding has been provided for implementation of management practices in the Cache River watershed. Additional funding has been allocated for implementing management practices in the Cache River watershed over next 3 years or so. Table 9.7 lists management practices for the highly recommended 12-digit HUC subwatersheds of the Cache River watershed along with funding sources. The "$" symbol indicates a source that has committed to fund practices in the Cache River watershed over the next 3 years or so. The "X" symbol indicates other potential funding sources.

9.4.4.1 NRCS

There are several NRCS programs active in Arkansas that provide funding assistance for development and installation of management practices that are applicable in the recommended subwatersheds of the Cache River watershed. These programs provide funding to individuals, rather than organizations or governments. These programs include the MRBI, EQIP, Agricultural Conservation Easements Program, and, Watershed Protection and Flood Prevention Operations (PL566). Information about these programs, including cost-share requirements and funding caps, is available online (http://www.ar.nrcs.usda.gov/programs/) or from a local USDA service center, local conservation district, or local cooperative extension agents.

The 2016 national budget for the EQIP program is $1,350 million. The 2016 budget for PL566 is $200 million. The budget for the Agricultural Conservation Easement Program is $450 million. In 2016, the NRCS MRBI program is investing $30 million in 73 projects nation-wide. There are three MRBI projects in the upper Cache River watershed and one MRBI project in the lower Cache River watershed that have been funded for 2016 (NRCS 2015).

9.4.4.2 USDA Farm Services Agency

The USDA Farm Services Agency (FSA) manages the Conservation Reserve Program. Through this program, landowners can receive payments for taking wetlands, or moist soils areas, out of production (as in the former Wetlands Reserve Program).

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Table 9.7 Funding assistance for management practices in the Cache River watershed.

Strategy	NRCS MRBI	NRCS EQIP	NRCS Agricultural Easements Program	NRCS PL555	ANRC nonpoint source program	AGFC	Arkansas Association of County Conservation Districts Mud Drive	Nonprofit organizations	USFWS Partners for Fish and Wildlife	Land and Water Conservation Fund	USDA FSA Conservation Reserve Program	Improvement Districts	Industrial Sponsors
Tree/shrub planting/ reforestation	$		X		X	X		X	X		X		X
Riparian buffers	$	$	X		X	X		X	X		X		X
Water control structures, winter flooding of fields	$	$			X		X	X	X				X
Ground cover/cover crop	$	$			X								
Field borders, filter strips	$	$	X		X						X		
Land easements or sale			X			X		X		$	X		X
Restoration of Cache River meanders	X					X		X	X			X	X
Grassed waterways	X	X											
Sediment basins/ponds		X		X									
Critical area planting	X	X	X		X	X		X	X		X		X
Grade stabilization structures	X	X			X			X				X	X
Forage & biomass planting	X	X	X		X	X		X	X		X		X

Through this program, FSA can also provide financial assistance for habitat restoration on the easements, including reforestation (NRCS 2015c).

9.4.4.3 USFWS

Funding is available for individuals through the USFWS Partners for Fish and Wildlife program. Funding from this program may require cost-share. The national 2016 budget for the Partners for Fish and Wildlife program is $54.2 million.

The USFWS is also a sponsor of the Arkansas Mud Drive program.

Land and Water Conservation Fund dollars are used to add land to the Cache River NWR (National Wildlife Refuge Association 2015). The 2016 budget request from the Land and Water Conservation Fund for the Cache River NWR was $2 million (USDA and US Department of the Interior 2015). Funds from the sale of the Federal Migratory Bird Hunting and Conservation Stamp (The Duck Stamp) have also been used to purchase of land for the Cache River NWR (USFWS 2005). Other potential sources of funds for USFWS acquisition of land for the Cache River NWR include the North American Wetlands Conservation Act Fund, and non-government partners (USFWS 2012).

9.4.4.4 ANRC

ANRC manages the state Section 319 grant program. This program provides grants to non-profit groups, organizations and academic institutions for projects related to reduction, control or abatement of nonpoint source pollution. Matching contributions are required for these grants. The 2016 proposed national budget for the Section 319 grant program is $164,915 thousand (EPA 2015).

ANRC also manages the Agricultural Water Quality Loan Program to assist landowners in installing conservation practices that reduce nonpoint source pollution. This program provides low interest loans to individuals, partnerships, or companies. Loans are obtained through County Conservation Districts (ANRC 2013).

9.4.4.5 County Conservation Districts

County Conservation Districts have acted as co-sponsors of Section 319 grant program projects in the Cache River watershed, and have contributed cost-share funds to these projects. In addition, the AACD contributed funding to the Mud Drive program in 2015. At this point it is unknown if the Mud Drive program will continue in 2016.

9.4.4.6 AGFC

The AGFC Stream Team Mini-Grants can be used to fund stream clean-up and stream bank stabilization projects. State Wildlife Grants can be used to address habitat issues, such as erosion and sedimentation, that impact species of greatest conservation need. In addition, AGFC has programs that fund the expansion of protected wildlife areas through direct purchase of land or the purchase of easements.

9.4.4.7 Other Organizations

A variety of other organizations have contributed funding to restoration projects in the Cache River watershed. Nonprofit organizations such as Ducks Unlimited, TNC, and Audubon Arkansas; Improvement Districts; and local industries contributed funding to the project to restore the meanders in the channelized section of the Cache River downstream of Bayou DeView. Industries contribute funding primarily through organizations like TNC and Ducks unlimited.

A number of these organizations have also provided financial resources for purchase of land or easements in the Cache River watershed. These easement and land purchase programs are all voluntary – landowners participate in them at their own discretion. TNC and Ducks Unlimited have programs that purchase land or easements for conservation, in some cases with the assistance of local industries. Ducks Unlimited and its partners have invested $48.7 million to improve waterfowl habitat in Arkansas (Ducks Unlimited 2015). In the 2013 fiscal year, TNC spent $5 million on purchases of conservation lands and easements in Arkansas (TNC 2013b).

9.4.4.8 Non-monetary Support

Agencies, organizations, and individuals can support implementation of nonpoint source management practices in ways other than providing funds. Organizations such as TNC and

Audubon Arkansas can contribute volunteer labor for implementation of BMPs. AGFC provides free warm season forb and grass seed to landowners for restoration of habitat for bobwhite quail and other grassland songbirds. The Arkansas Forestry Commission provides tree seedlings for reforestation of bottomland hardwoods in the Cache River watershed.

9.4.4.9 Tax Incentives

Tax incentives are a slightly different financial mechanism for encouraging the use of management practices. The Arkansas Private Wetland and Riparian Zone Creation, Restoration, and Conservation Tax Credits Act of 1995 allows the application of a tax credit against Arkansas state taxes by taxpayers involved in conservation or restoration of riparian zones. Detailed information on this program is available from ANRC, who manages the program (http://anrc.ark.org/divisions/water-resources-management/wetlands-riparian-zone-tax-credit/).

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APPENDIX A

Public Meeting Attendees

Cache River Watershed Management Plan
McCrory Meeting – March 30, 2015

MEETING SIGN-IN SHEET

Project: ARKANSAS WATERSHED PLAN Public Meeting	**Meeting Date:** 3/30/15
Facilitator:	**Place/Room:** McCrory

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Selena Medrano	ADEQ	682-0662	5301 Northshore D.	medrano@adeq.ar.state.us
Joe Turney	Farmer	870.219-6779		JoeTurney59@yahoo.com
John Reidhar	Argr. Bus	870-256 4916	3638 Reidhar Ln DesArc	jtr010 centurytel.net
David Graves	AGFC	870-319-0668	1201 Hwy 49 N Brinkley, AR 72021	David.Graves@agfc.ar.gov
Cody Harington	ANRC	501-837-9045		
Brandon Martin	Farmer	870-897-3570	2540 Greene 317 Rd Bono AR 72416	bandit7150@yahoo.com
[illegible]	Woodruff County	870 347 5206	500 North third St.	woodruffcofudge@gmail.com
Nelson Childers	NRCS	870-972-4761	3407 S. Caraway Jonesboro, 72401	nelson.childers@ar.usda.gov
Ryne Dubach	Holden Conner	870-523-6576	2301 McLain St Newport, AR 72112	ryned@holdenconner.com
Shelley Evins	Holden Conner	870-523-6576	2301 McLain St Newport, AR 72112	sfe@holdenconner.com
Keith Scoggins	NRCS			Keith.scoggins@ar.usda.gov

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MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	Meeting Date:	3/30/15
Facilitator:		Place/Room:	~~[illegible]~~ McCrory

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Jim Wise	ADEQ	5016820663	5301 Northshore Dr	Wise@ADEQ.state.AR.US
Doyle Fowler	City of McCrory	870 919 6067	P.O. Box 397 McCrory	doylewfowler001@hotmail.com
Homer Reeves	City of McCrory	870-734-6714	185 South 3rd Cotton Plant	
Jason Phillips	USFWS	870-347-1617	26320 Hwy 33, Augusta	jason_phillips@fws.gov
Jason Allmon	USACE	9015440766	167 N. Main St Memphis, TN 38103	Jason.E.Allmon@us.army.mil
Claude Garner		870-919-3115	603 Kimberly Dr McCrory, AR 72101	claude.garner@gmail.com
Greg James	H&J	870-512-8438		greg.james@hughes.net
Janice Marsh	WCCD	8703472593	Box 519 Augusta 72006	

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Meeting Sign-In Sheet

Project:	ARKANSAS WATERSHED PLAN Public Meeting	Meeting Date:	3/30/15
Facilitator:		Place/Room:	McCrory

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Todd Cullen	Farmer/landowner	870-701-0366	J'Boro 416 Huntcliff Dr.	
Jeff Reichow	Farmer/LO "	870 256-4465	Des Arc	eatrice @ centurytel.net
Paul Holloway	Retired	501 2816606	Des Arc	
Mark Cutker	AFC	870 945 1454	PO Box 38 Hazen Ar	mark.cutrer@arkansas.gov
Matt Morrison	ADH	501-278-7374	112 Brantley Rd Searcy, AR	Matt.Morrison@arkansas.net
JEFF Phillips	JACKSON COUNTY JUDGE	870-512-9256	208 MAIN ST NEWPORT, AR 72112	phillipsjudge@yahoo.com
Caleb Thompson	M.D. Thompson + Son	870-731-2526	P.O. Box 388 McCrory, AR 72101	mdtco@centurytel.net
ALAN MORRIS	landowner	870-731-2518	PO Box 750 McCrory, AR 72101	
VANCE THOMPSON	M.D. THOMPSON & Son	870-919-6213	P.O. Box 388 McCRORY	mdtco@centurytel.net
NATHAN DAVIS	U.S. SENATOR Boozman Office	(870) 268-6925	300 S. CHURCH ST, STE 400 JBRO 72401	nathan_davis@boozman.senate.gov
Keith Weaver	USFWS	870 347 2074		
Jason Miller	TNC	501 614 5080	601 N. University Little Rock, 72205	jmiller@tnc.org
Lisa Chapple	Farmer WCCD Board	870-919-6242	PO Box 56 72101	lisachapple80@yahoo.com

MEETING SIGN-IN SHEET

Project: ARKANSAS WATERSHED PLAN Public Meeting | **Meeting Date:** 3/30/15

Facilitator: | **Place/Room:** [illegible] McCrory

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Mark Cain	McCrory City Council	870-919-0538	306 Wade St McCrory	
Shawn Phillips	Corps of Engineers	901 544-3321	167 North Main Memphis TN 38103	
Daniel Greenfield	AGFC	870-638-0831	1201 Hwy 49 North Brinkley, AR 72021	daniel.greenfield@agfc.ar.gov
Don Graves	Retired	870-919-6368	P.O. Box 211 McCrory	
Wally Smith	—	270-293-2067	200 Walnut Apt! Augusta AR 72006	smith.wally46@yahoo.com
[illegible]	Land Owner	870-731-2518	McCrory AR 72101	—
Russell Hagood	Sen. Cotton	(501) 295-8681		russell_hagood@cotton.senate.gov

Cache River Watershed Management Plan
Jonesboro Meeting – March 30, 2015

Meeting Sign-In Sheet

Project: ARKANSAS WATERSHED PLAN Public Meeting	**Meeting Date:** 3/30/15
Facilitator:	**Place/Room:** Jonesboro

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Jim Wise	ADEQ			
Selena Medrano	ADEQ			
Kenny Clark	Willow Slough	870 252-3653	170 JA Newport	KCCLARK49@yahoo.com
Eugene Neff	Craighead County Hwy Dept	870 219-4329	2800 Moore Rd	eneff@craigheadcounty.org
Omer Overbay	Greene Co	870-450-4306		omeroverbay@1960@gmail.com
Terry Simmons	Ag Watch Craighead Network	870 931-7500	101 S. Church Jonesboro 72401	
Greg Hogue	Ark Dept Health	870-897-0955	611 E. Washington Jonesboro	gregory.hogue@arkansas.gov
Brett Timmons	AGFC	870-972-5438	600-B E. Lawson Rd.	brett.timmons@agfc.ar.gov
David Long	~~AGFC~~	870 ~~219-324~~ 972-5438	" " "	Joseph.long@agfc.~~state.~~ar.gov
John Sloan		870-680-3039	PO Box 187 Jonesboro 72403	johntsloan@yahoo.com
Todd Cullen		870-761-0368		cullen.todd@gmail.com
Cleo Watkins				cd watkins 121@Gmail
Starr Fenner	ASU	870 972 3644	PO Box 1500 State Univ Ar 72467	sfenner@astate.edu

MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	**Meeting Date:**	3/30/15
Facilitator:		**Place/Room:**	Jonesboro

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Dale Freeman	Co. Judge	870-759-0988	315 West Main 72467	
T. Ray Sefczynski	NRCS	870-598-2288	168 E Main St Piggott AR 72454	ray.sefczynski@AR.usda.gov
Adam Eades	NRCS	870 239 8586 x3	206 N Rockingchair Rd Paragould 72450	adam.eades@ar.usda.gov
John Daughhetee	Dept of Health	870-926-5324	PO Box 93 Walnut Ridge 72476	john.Daughhetee@arkansas.gov
Charles Glover	AACD	870-974-1346	P.O Box 280 Tyronza 72386	glover152@rittermail.com
Brandon Martin	Farmer	870-897-3570		
Shannon Davis	Farmer	8709265050		shannondavisfarms@gmail.com
Nathan Davis	U.S. Senator Boozman	(870) 268-6925		nathan_davis@boozman.senate.gov
Alec Farmer		(870) 926 5662		
Joe Turney				

Meeting Sign-In Sheet

Project:	ARKANSAS WATERSHED PLAN Public Meeting	**Meeting Date:**	3/30/15
Facilitator:		**Place/Room:**	Jonesboro

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Dawn Fox	NRCS	870-972-4671 ext [illegible]	3407 S. Caraway Rd Ste 5, Jonesboro, AR	dawn.fox@ar.usda.gov
Joe Christian	Farmer	870 219-1403	jlag@suddenlink.net	
SHERLAND HAMILTON	PRESIDENT Cache River - Bayou DeView Improvement District	870-594-4305	P.O. BOX 8 RECTOR, AR. 72461	hamilton RECTORARKANSAS @ GMAIL.COM
Carlos (Blackie) Blackburn	Attorney	501-691-9430	1405 Elmwood Pl Jonesboro, AR 72401	CEBNOATAR@GMAIL.COM

Cache River Watershed Management Plan
McCrory Meeting – August 25, 2015

MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	**Meeting Date:**	8-25-15
Facilitator:		**Place/Room:**	McCrory

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Jamie Marsh	WCCD		PO 52 McCrory AR.	
Nancy Marsh			〃	〃
[illegible]			600 Pike [illegible]	
MS Gray	House of Rep			michaeljohngrayar@gmail.com
Peyton Daniel	Farmer			WPDANIEL3@yahoo.com
Johnny Taylor	Farmer			johnnywaynetaylor@yahoo

Meeting Sign-In Sheet

Project: ARKANSAS WATER PLAN Public Meeting	**Meeting Date:** 8/25/15
Facilitator: Kent	**Place/Room:** McCrory

Name	Company	Phone	Mailing Address	E-Mail
Frank Mauldin	Private owned	870-731-5670	3 Woodruff 656	
Bobby Bower	Farm Bureau / Land owner	870-731-4061	1003 Jackson, Augusta, AR	cacheriverpapa@yahoo.com
Sheland Hamilton				
H.T. Moore				
Doyle Fowler	City of McCrory	870-731-2041	P.O. Box 897 McCrory	doylewfowler001@hotmail.com
Ross Dunn	AR FB	501-285-2374	PO Box 71 Little Rock	Ross.Dunn@ARFB.com
David Graves	AGFC	870-734-4581	1201 Hwy 49 N Brinkley, AR 72021	
Doug McClellan	NRCS	870 972-4761	3407 Caraway Jonesboro, AR 72011	doug.mcclellan@ar.usda.gov
[illegible]	Woodruff Co	870-919-6757	[illegible]	
Keith Scoggins	NRCS	870 238 3285	810 Hwy 64 E Suite 3	Keith.scoggins@ar.usda.gov
Bari Cain			P.O.B 967 McCrory AR	
Charles Coley	Coley Farms	870 731 2456	3630 W737 S McCrory	
[illegible]	Michael & Lisa Chappell Farm	870 919 4242	PO Box 56 McCrory	

Meeting Sign-In Sheet

Project: ARKANSAS WATER PLAN Public Meeting

Meeting Date: 8-25-15

Facilitator:

Place/Room: McCrory

Name	Company	Phone	Mailing Address	E-Mail
Jimmy Flanagan	NRCS	501-690-2271	10637 Hwy 33 North Des Arc	flanman67@yahoo.com
Caleb Thompson	M.D. Thompson & Son Co.	870-731-2526	P.O. Box 388 McCrory, AR 72101	mdtco@centurytel.net
Keith Weaver	USFWS	870 347 2074	26320 Hwy 33 Augusta, AR 72006	keith_weaver@fws.gov
Bob Cartwright	Poinsett Co			
JEFF Phillips	JACKSON Co.			
Jason Milks	TNC			
Barbara Miller	ADEQ	501.683.5407		millerb@adeq.state.ar.us
GENE SULLIVAN				
Russell Hagood	Sen. Cotton			
Wes Ward	Arkansas Ag Dept	870-897-0952		wes.ward@aad.ar.gov
Michael Coley		870-208-6133		
Scott Horton		(870)347-2505	3828 Woodruff 265 McCrory, AR 72101	SCOTT.HORTON@AFBIC.com
CARROLL FRAZE				

Cache River Watershed Management Plan
Jonesboro Meeting – August 25, 2015

Meeting Sign-In Sheet

Project: ARKANSAS WATERSHED PLAN Public Meeting		Meeting Date:	8/25/15 Jonesboro
Facilitator:		Place/Room:	Forrest Wood Crowley's Ridge Nature Center

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Mike Hamilton	UACES / NRCS	870-919-5061	3407 County Rd Jonesboro	mkhamilton@uaex.edu
Dusty Kennemore	Greene County Drainage	870 476 4562	2210 Windwood Cir Paragould	dusty@grmco.net
Bob Young	DU	870-926-0250	4408 Sage Meadows Blvd, Jonesboro, AR	rtyoung5455@sbcglobal.net
Jerry McCoy	Willow Slough	870 251 2807	1822 Jackson Newport AR 72401	
Bob Cantrell	Poinsett Co Judge	870-919-2968	Harrisburg Ar.	Judge@PoinsettCounty.us
[illegible]	Farmer Drainage Dist #2	870-249-3410	4358 Ark 119 Rd Delaplaine	ECleveland@Centurytel.net
Ross Dunn	ARFB	501-295-2374	PO Box 31 Little Rock, AR 72203	Ross.Dunn@arfb.com
H.T. Moore	Cache River DD	870-239-2225	P.O. Box 726 Paragould, AR	htm@goodwinmoore.com
Jeff Phillips	Jackson County Judge	870-512-9252	208 Main St Newport 72112	phillipsjudge@yahoo.com
Chas. Frierson	Cache R. DD	8709321643	PO Box 8007 Jonesboro 72403	cdfrierson3@hotmail.com
Ed Hill	Craighead Cty	870 933 4500	911 Union Jonesboro AR	ehill@craigheadcounty.[illegible]
Jason Carbaugh	AGFC	870-926-7072	600-B East Lawson Rd Jonesboro, AR 72404	Jason.Carbaugh@agfc.ar.gov
Tyler Nutt	Nutt Farms	870-926-6076	2342 CR 780 Jonesboro, AR 72401	tnuttfarms@yahoo.com

MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	**Meeting Date:**	8/25/15 Jonesboro
Facilitator:		**Place/Room:**	Forrest Wood Crowley's Ridge Nature Center

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Kenny Clark	Willow Slough	870-217-3971	170 T A 221 Newport 72112	KCCLARK49@yahoo.com
Lukets Debbie Odum	River Chase Farms	404-6801845		
Glen Worlow	~~West~~	501-412-0907	3237 Hwy 228 Walnut Ridge, AR.	
Sheland Hamilton	Cache River - Bayou DeView Imp. Dist	870-595-4305	P.O. Box 8 Rector, AR 72461	Sheland, Rector Arkansas @ Gmail . Com
John Sloan	farm Owner	870-932-2671	PO Box 187 Jonesboro AR 72403	johntsloan@yahoo.com
Keith Weaver	USFWS	870 347 2074	26320 Hwy 33 Augusta, AR 72006	keith_weaver@fws.gov
Cody Harrington	ANRC			Cody.Harrington@Arkansas.gov
Jake Bussenger	AFC	~~[illegible]~~ 870-761-3270		Jacob.Bussenger@Arkansas.gov
Chuck Long	AGFC	870 215-3633	PO Box 183 Marmaduke, AR 72443	cflong@agfc.ar.gov
Raney Nutt	Land owner	870-926-0260	Paragould Ar 2094 Greene 724 Rd	raneynutt@yahoo.com
T. Ray Sitzynski	Conservationist	870-598-2287x3	168 E Main St Piggott AR 72454	ray.sitzynski@usda.gov

Meeting Sign-In Sheet

Project: ARKANSAS WATERSHED PLAN Public Meeting		**Meeting Date:** 8/25/15	Jonesboro
Facilitator:		**Place/Room:** Forrest Wood Crowley's Ridge Nature Center	

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Terry Gray	Delaplaine Seed Co.	(870) 215-1023	P.O. Box 35 Delaplain, AR	R2RBK1@gmail.com

MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	**Meeting Date:**	8-25-15
Facilitator:		**Place/Room:**	Jonesboro

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Jeff Morris	Sen. Tom Cotton	(870)933-6223		Jeff_Morris@cotton.senate.gov
Jerry Davis		870 926-1154		jerldavis@hotmail.com
Virginia Buy	Big Lake Drainage Dist	870 239-1315	256 Greene Rd 116 Delaplaine, AR	9b72425@centurytel.net
Randy Young	ANRC	501 682 3961		
TERENCE TEEL	AGFC	870-972-5438		TERENCE.TEEL@agfc.ar.gov
Tony Ramick	ANRC	501 682-3914		Tony.ramick@arkansas.gov
Thomas Lindsey	AFC	870-932-2251	P.O. BOX 17087 Jonesboro, AR 72403	Thomas.Lindsey@ARKANSAS.gov
Doug McClellan	NRCS	870 972-4671	3507 S. Caraway Jonesboro, AR 72410	doug.mcclellan@ar.usda.gov
Rusty A. McMillon	Greene County	870-335-8679	~~County Judge's Office~~ 320 W. Court Paragould, AR	cojudge@greenecountyar.com
Jason Milks	TNC			

Cache River Watershed Management Plan
McCrory Meeting – December 8, 2015

MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	Meeting Date:	12-8-15
Facilitator:		Place/Room:	~~[illegible]~~ McCrory, AR

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Jeff Reichar		8702585333		
John Reichar				
Charles Dallas				
Jeff Phillips				
Keith Weaver				
Doyle Fowler				
Jason Phillips	USFWS			
Jason Milks	TNC			
John House	Arkansas Archeological Survey	870-535-4509	Mail slot 4814 UAPB Pine Bluff, AR 71601	jhhouse@uark.edu
Barbara Miller	ADEQ			
David Graves	AGFC			

MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	Meeting Date:	12-8-15
Facilitator:		Place/Room:	McIvory

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
[illegible signature]				
N. Davis	U.S. Senator Boozman			

Meeting Sign-In Sheet

Project: ARKANSAS WATERSHED PLAN Public Meeting	Meeting Date: 12-8-15
Facilitator:	Place/Room: McCrory

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
David Oaks	AFC	870-633-6693		david.oaks@arkansas.gov

Cache River Watershed Management Plan
Jonesboro Meeting – December 8, 2015

MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	**Meeting Date:**	12-8-15
Facilitator:		**Place/Room:**	Jonesboro AGFC

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
James Foster	AGFC			
Dusty Kennemore	GCCD			
Kenny Clark	Willough Slough	870-252-3653		
Jerry Davis	Retired	870-933-0111		
Charles Frierson	Cache R. DD	8709324643		
Thomas Lindsey	AFC	870-932-2251		
Jason Milks	TNC	501-804-6244		jmilks@tnc.org
Marvin Thaxton	Atty	501 454-0734	12 Lakeside Ln 18 Newport	mdtjd@suddenlink.net

MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	Meeting Date:	12-8-15
Facilitator:		Place/Room:	Jonesboro AGFC

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Bob Young	Ducks Unlimited			
Brett Timmons	AGFC			
Nelson Childers	NRCS			

Meeting Sign-In Sheet

Project: ARKANSAS WATERSHED PLAN Public Meeting		**Meeting Date:**	12-8-15
Facilitator:		**Place/Room:**	Jonesboro AGFC

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
David Long	AWF	870-253-4377		
Jim Hargis		870-243-2567		
SHERLAND HAMILTON	Cache River Bayou DeView	~~870~~		
Jennifer Bouldin	ASU	870-972-2570		
Kirk Drupe	A-State			rgrippo@astate.edu

Cache River Watershed Management Plan
McCrory Meeting – February 24, 2016

MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	**Meeting Date:**	2-24-16
Facilitator:		**Place/Room:**	Cache McCrory

	Name	Organization or Occupation	Phone	Mailing Address	E-Mail
*	Ron Chastain	Sen Boozman's office	501-372-7153		ron_chastain@boozman.senate.gov
*	Steven Stroh	AR FARM BUREAU	870 830 5502		steven.stroh@arfb.com
*	Harvey Joe Sanner	AAM-of AR	501-516-7000	Des Arc, AR 72040 P.O. Box 450	BannerHarveyJoe@gmail.com
	John Sloan	self	870-680-3039	PO Box 187 Jonesboro AR 72403	johntsloan@yahoo.com
	Jim Hargis				
	Keith Weaver	USFWS			
	Charles Outlaw	Judge			
*	Clyde Williams	NRCS	870-347-2543	174 Hwy 64 Augusta	Clyde.williams@ar.usda.gov
	Jimmy Flanagan Jr	NRCS	870-347-2593		

MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	Meeting Date:	2-24-16
Facilitator:		Place/Room:	Cache McCrory

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
David Graves				
Barbara Miller	ADEQ			
Mike Skarda	Prairie Co Judge	501-516-6991	605 Hwy 38 East DeAnn, Ar	county of prairie at centurytel.net

Cache River Watershed Management Plan
Jonesboro Meeting – February 24, 2016

MEETING SIGN-IN SHEET

Project:	ARKANSAS WATERSHED PLAN Public Meeting	Meeting Date:	2-24-16
Facilitator:		Place/Room:	Cache Jonesboro

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
* Jeremy Wesson	AR Farm Bureau	501-517-3122	12 Palmer Ct Searcy 72143	jeremy.wesson@arfb.com
* Kevin McGaughey	ANRC	501-772-6366		Kevin.mcgaughey@arkansas.gov
Shannon Davis	Cache River Drainage Dist	8709265050		
Nathan Davis	U.S. Senator John Boozman	870-268-6925	300 S. Church St, Suite 400 Jboro, AR 72401	nathan_davis@boozman.senate.gov
[illegible]	Greene Co Con District			
Adam Eades				
Jim Hargis				
Thomas Lindsey	AFC	870-		
Doug McClellan	NRCS			
* Dan Duie Wie	JA Co EMA	870-217-3876	PO Box 155 Diaz, Ar. 72043	jacksoncoem@suddenlink.com
Rusty A. McMillon	Greene County Judge			
Judge Phillips	Jackson Co.			

Meeting Sign-In Sheet

Project:	ARKANSAS WATERSHED PLAN Public Meeting	Meeting Date:	2-24-16
Facilitator:		Place/Room:	Cache - Jonesboro

Name	Organization or Occupation	Phone	Mailing Address	E-Mail
Kenny Clark	Willough			
Terence Teel	AGFC			Terence.Teel@agfc.ar.gov
James Loatey	AGFC			
Jacob Bussenger	AFC	870-761-3270		
Chuck Long	AGFC			
Mark Lambert	ARFB			mark.lambert@arfb.com
John Sloan				

APPENDIX B

Data Inventory

Table 1. Surface water quality monitoring stations in the upper Cache River watershed.

Station ID	Monitoring Agency/Organization	Waterbody	Date of first sample	Date of most recent sample	Source
WHI0196	ADEQ	Big Creek Ditch	7/8/2008	1/6/2015	ADEQ database
WHI0172	ADEQ	Lost Creek	8/27/2002	1/6/2015	ADEQ database
WHI0026	ADEQ	Big Creek Ditch	9/11/1990	1/6/2015	ADEQ database
UWCHR03	ADEQ	Cache River	6/13/1994	3/4/2013	ADEQ database
UWCHR04	ADEQ	Cache River	6/13/1994	3/4/2013	ADEQ database
CR012	TNC	Cache River	4/27/2004	6/6/2005	319 report
CR013	TNC	Cache River	4/27/2004	6/6/2005	319 report
CR014	TNC	Cache River	4/27/2004	6/6/2005	319 report
CR015	TNC	Cache River	4/27/2004	6/6/2005	319 report
CR016	TNC	Cache River	4/27/2004	6/6/2005	319 report
CR017	TNC	Cache River	4/27/2004	6/6/2005	319 report
CR018	TNC	Cache River	4/27/2004	6/6/2005	319 report
CR019	TNC	Cache River	4/27/2004	6/6/2005	319 report
CR020	TNC	Cache River	4/27/2004	6/6/2005	319 report
CR021	TNC	Cache River	4/27/2004	6/6/2005	319 report

Table 1. Surface water quality monitoring stations in the upper Cache River watershed (continued).

Station ID	Monitoring Agency/Organization	Waterbody	Date of first sample	Date of most recent sample	Source
CR022	TNC	Cache River	4/27/2004	6/6/2005	319 report
BDV009	TNC	Bayou DeView	4/27/2004	6/6/2005	319 report
BDV010	TNC	Bayou DeView	4/27/2004	6/6/2005	319 report
BDV011	TNC	Bayou DeView	4/27/2004	6/6/2005	319 report
SKDI	ASU	Skillet Ditch	8/6/2013	1/14/2014	STORET
WIDI	ASU	Willow Ditch	8/6/2013	1/14/2014	STORET
USGS-EG	ASU	USGS Cache River gage at Egypt	8/6/2013	1/14/2014	STORET
WCRD	ASU	West Cache River Ditch	8/6/2013	1/14/2014	STORET
NTSD	ASU	Number 26 Ditch	8/6/2013	1/14/2014	STORET
KEDI	ASU	Kellow Ditch	8/6/2013	1/14/2014	STORET
BDDI	ASU	Beaver Dam Ditch	8/6/2013	1/14/2014	STORET
SPDI	ASU	Swan Pond Ditch	8/6/2013	1/14/2014	STORET
SCCR	ASU	Scatter Creek	8/6/2013	1/14/2014	STORET
BGLA	ASU	Big Gum Lateral	8/6/2013	1/14/2014	STORET
EASL	ASU	East Slough	8/6/2013	1/14/2014	STORET

Table 1. Surface water quality monitoring stations in the upper Cache River watershed (continued).

Station ID	Monitoring Agency/Organization	Waterbody	Date of first sample	Date of most recent sample	Source
SFBC	ASU	South Fork Big Creek	8/6/2013	1/14/2014	STORET
LCRD	ASU	Little Cache River Ditch	8/6/2013	1/14/2014	STORET
FTSL	ASU	Fish Trap Slough	8/6/2013	1/14/2014	STORET
SUCR	ASU	Sugar Creek	8/6/2013	1/14/2014	STORET
LCDI	ASU	Lost Creek Ditch	8/6/2013	1/14/2014	STORET
MUCR	ASU	Mud Creek	8/6/2013	1/14/2014	STORET
07077080	USGS	Little Cache River Ditch No. 1	10/4/1972	7/30/1975	NWIS
07077380	USGS	Cache River	10/5/1965	9/1/1998	NWIS
07077400	USGS	Cache River	4/9/1974	7/31/1984	NWIS
07077650	USGS	Big Creek Ditch	9/28/1960	10/5/1988	NWIS
07077660	USGS	Bayou DeView	4/9/1974	9/20/1994	NWIS

Table 2. Groundwater quality monitoring wells in the upper Cache River watershed.

Well ID	Monitoring Agency/ Organization	Aquifer	Date of first sample	Date of most recent sample	Source
15N03E12ABB1	USGS	Memphis Sand	8/5/2014	8/5/2014	NWIS
13N02E06BB2	USGS	MRV	6/24/2010	7/31/2014	NWIS
13N01E02AB1	USGS	MRV	8/17/2001	7/31/2014	NWIS
13N03E29AAA1	USGS	Terrace Deposits	8/3/1973	7/31/2014	NWIS
19N03E36AD1	USGS	MRV	7/29/2014	7/29/2014	NWIS
15N01E26DDA1	USGS	MRV	7/15/1999	7/29/2014	NWIS
17N04E30CDC1	USGS	Terrace Deposits	8/7/1967	7/29/2014	NWIS
16N04E23CAC1	USGS	MRV	7/28/2014	7/28/2014	NWIS
20N05E34BD1	USGS	MRV	7/28/2014	7/28/2014	NWIS
17N02E35AB1	USGS	MRV	7/19/2012	7/19/2012	NWIS
13N03E21CC2	USGS	MRV	7/17/2012	7/17/2012	NWIS
13N01E11AA1	USGS	no information	7/17/2012	7/17/2012	NWIS
13N01E01CC1	USGS	MRV	7/17/2012	7/17/2012	NWIS
13N03E29DDC1	USGS	MRV	6/24/2010	7/17/2012	NWIS
13N01E03AAA1	USGS	MRV	8/14/2007	7/17/2012	NWIS
13N03E31BB1	USGS	MRV	7/8/2004	7/17/2012	NWIS
16N02E34BDA1	USGS	Pleistocene Valley Trains	7/1/1998	6/29/2010	NWIS
13N02E32AAA1	USGS	MRV	6/24/2010	6/24/2010	NWIS

Table 2. Groundwater quality monitoring wells in the upper Cache River watershed (continued).

Well ID	Monitoring Agency/ Organization	Aquifer	Date of first sample	Date of most recent sample	Source
13N03E30AA1	ADEQ	MRV	6/24/2010	6/24/2010	NWIS
13N03E28AB1	ADEQ	MRV	6/24/2010	6/24/2010	NWIS
13N03E29BA1	ADEQ	Memphis Sand	6/24/2010	6/24/2010	NWIS
13N03E22CA1	ADEQ	MRV	6/24/2010	6/24/2010	NWIS
13N03E21CB2	ADEQ	MRV	6/24/2010	6/24/2010	NWIS
14N02E32DDC1	USGS	MRV	6/24/2010	6/24/2010	NWIS
14N01E34DC1	ADEQ	MRV	6/24/2010	6/24/2010	NWIS
14N02E27DD2	ADEQ	no information	6/24/2010	6/24/2010	NWIS
13N02E35DDB1	USGS	MRV	8/12/2009	6/24/2010	NWIS
CRA038	ADEQ		7/27/1989	8/17/2009	STORET
CRA039	ADEQ		6/13/1995	8/17/2009	STORET
CRA900	ADEQ		7/17/2006	8/17/2009	STORET
CRA045	ADEQ		6/14/1995	8/11/2009	STORET
CRA002	ADEQ		6/1/1989	8/10/2009	STORET
CRA005	ADEQ		6/1/1989	8/10/2009	STORET
CRA048	ADEQ		7/28/1998	8/10/2009	STORET
13N02E35DC1	ADEQ	MRV	6/25/2008	6/25/2008	NWIS
13N02E35DAC1	USGS	Terrace Deposits	6/19/1969	8/14/2007	NWIS
20N05E34DBA1	USGS	Terrace Deposits	8/8/1967	8/13/2007	NWIS

Table 2. Groundwater quality monitoring wells in the upper Cache River watershed (continued).

Well ID	Monitoring Agency/ Organization	Aquifer	Date of first sample	Date of most recent sample	Source
13N01W23BC1	USGS	Pleistocene Valley Trains	6/17/1998	7/9/2004	NWIS
13N02E02AD1	USGS	MRV	7/15/1995	7/8/2004	NWIS
13N01W35CBC1	ADEQ	MRV	8/17/2001	8/17/2001	NWIS
13N01E05BBB1	USGS	MRV	7/30/1973	8/17/2001	NWIS
15N06E21CC3	ADEQ	MRV	8/14/2001	8/14/2001	NWIS
20N05E34DB1	ADEQ	MRV	8/14/2001	8/14/2001	NWIS
14N02E18BDD1	USGS	Terrace Deposits	8/21/1974	7/8/1999	NWIS
15N03E19ADA1	USGS	Terrace Deposits	6/25/1974	7/8/1999	NWIS
14N04E07CCA	USGS	Cenozoic Erathem	5/13/1996	5/13/1996	NWIS
19N06E18AD1	ADEQ	MRV	9/1/1995	9/1/1995	NWIS
15N04E04BC1	ADEQ	Memphis Sand	8/30/1995	8/30/1995	NWIS
17N03E07CA1	ADEQ	MRV	8/30/1995	8/30/1995	NWIS
19N05E11BB1	ADEQ	MRV	8/30/1995	8/30/1995	NWIS
20N05E22DB1	ADEQ	MRV	8/30/1995	8/30/1995	NWIS
12N01W15DA2	ADEQ	Terrace Deposits	8/24/1995	8/24/1995	NWIS
13N01W35CB2	ADEQ	no information	8/24/1995	8/24/1995	NWIS
19N05E15AC1	ADEQ	MRV	8/9/1995	8/9/1995	NWIS
20N06E30AC2	ADEQ	no information	8/9/1995	8/9/1995	NWIS
21N06E30AA1	ADEQ	MRV	8/8/1995	8/8/1995	NWIS

Table 2. Groundwater quality monitoring wells in the upper Cache River watershed (continued).

Well ID	Monitoring Agency/ Organization	Aquifer	Date of first sample	Date of most recent sample	Source
18N05E05BA1	ADEQ	Wilcox Group	8/3/1995	8/3/1995	NWIS
18N04E25CB1	ADEQ	no information	8/3/1995	8/3/1995	NWIS
16N03E21AC1	ADEQ	MRV	8/2/1995	8/2/1995	NWIS
17N03E36DA1	ADEQ	MRV	8/2/1995	8/2/1995	NWIS
17N04E03CC1	ADEQ	MRV	8/2/1995	8/2/1995	NWIS
13N01E11BB1	ADEQ	no information	7/15/1995	7/15/1995	NWIS
13N03E05BB1	ADEQ	no information	7/15/1995	7/15/1995	NWIS
14N02E33BA1	ADEQ	MRV	7/15/1995	7/15/1995	NWIS
14N03E32BC1	ADEQ	no information	7/15/1995	7/15/1995	NWIS
14N01E35AC1	ADEQ	MRV	7/15/1995	7/15/1995	NWIS
15N02E34BB1	ADEQ	MRV	7/15/1995	7/15/1995	NWIS
15N03E17AD1	ADEQ	MRV	7/15/1995	7/15/1995	NWIS
15N02E19CC1	ADEQ	MRV	7/14/1995	7/14/1995	NWIS
12N07E12CD1	ADEQ	MRV	7/12/1995	7/12/1995	NWIS
11N01E27AA1	ADEQ	no information	7/10/1995	7/10/1995	NWIS
10N01E08BC2	ADEQ	MRV	7/10/1995	7/10/1995	NWIS
12N02E21BA1	ADEQ	MRV	7/10/1995	7/10/1995	NWIS
12N01E25BB1	ADEQ	MRV	7/10/1995	7/10/1995	NWIS
19N04E01BDB1	USGS	Nacatoch Sand	8/1/1984	8/1/1984	NWIS

Table 2. Groundwater quality monitoring wells in the upper Cache River watershed (continued).

Well ID	Monitoring Agency/ Organization	Aquifer	Date of first sample	Date of most recent sample	Source
14N03E24AAD2	USGS	Memphis Sand	6/20/1956	12/9/1976	NWIS
17N04E32AAD1	USGS	Terrace Deposits	8/22/1974	8/22/1974	NWIS
13N02E16AAA1	USGS	Terrace Deposits	8/3/1973	8/21/1974	NWIS
20N06E28DDA1	USGS	Terrace Deposits	7/16/1974	7/16/1974	NWIS
18N04E21CAA1	USGS	Terrace Deposits	7/12/1974	7/12/1974	NWIS
17N03E02BDB1	USGS	MRV	8/8/1967	7/12/1974	NWIS
19N05E34ACD1	USGS	Terrace Deposits	6/27/1974	6/27/1974	NWIS
19N04E11DAA2	USGS	Terrace Deposits	6/27/1974	6/27/1974	NWIS
21N07E19DBB2	USGS	Terrace Deposits	6/26/1974	6/26/1974	NWIS
14N01E21BBB1	USGS	Terrace Deposits	8/3/1973	8/3/1973	NWIS
14N01E09CBB1	USGS	Terrace Deposits	8/3/1973	8/3/1973	NWIS
15N03E30BCB1	USGS	Terrace Deposits	8/3/1973	8/3/1973	NWIS
15N01E23DDA1	USGS	Terrace Deposits	8/3/1973	8/3/1973	NWIS
16N02E08CBB1	USGS	Terrace Deposits	8/2/1973	8/2/1973	NWIS
15N03E05BBB1	USGS	Terrace Deposits	8/1/1973	8/1/1973	NWIS
16N03E27BBA1	USGS	Terrace Deposits	8/1/1973	8/1/1973	NWIS
16N03E01ADC1	USGS	Terrace Deposits	8/1/1973	8/1/1973	NWIS
17N03E17BBA1	USGS	MRV	8/1/1973	8/1/1973	NWIS
19N05E31BBB1	USGS	Terrace Deposits	7/31/1973	7/31/1973	NWIS

Table 2. Groundwater quality monitoring wells in the upper Cache River watershed (continued).

Well ID	Monitoring Agency/ Organization	Aquifer	Date of first sample	Date of most recent sample	Source
19N05E27BBA1	USGS	Terrace Deposits	7/31/1973	7/31/1973	NWIS
19N04E29AAA1	USGS	Terrace Deposits	7/31/1973	7/31/1973	NWIS
20N06E29CDC1	USGS	Terrace Deposits	7/31/1973	7/31/1973	NWIS
13N01E05ACA1	USGS	MRV	7/30/1973	7/30/1973	NWIS
13N02E06BBA1	USGS	Terrace Deposits	7/30/1973	7/30/1973	NWIS
17N02E28ABB1	USGS	Terrace Deposits	7/27/1973	7/27/1973	NWIS
12N01E19ACA1	USGS	MRV	8/10/1967	8/10/1967	NWIS
13N01E33BCD1	USGS	MRV	8/10/1967	8/10/1967	NWIS
14N02E15DDD1	USGS	Terrace Deposits	8/10/1967	8/10/1967	NWIS
21N07E07BDC1	USGS	Terrace Deposits	7/14/1955	8/8/1967	NWIS
18N03E31BAB1	USGS	MRV	11/9/1966	11/9/1966	NWIS
18N03E31DBC1	USGS	MRV	8/31/1966	8/31/1966	NWIS
18N04E01BCC1	USGS	MRV	8/29/1966	8/29/1966	NWIS
15N01E13CCC1	USGS	Terrace Deposits	6/15/1966	6/15/1966	NWIS
16N02E34BDB1	USGS	MRV	6/15/1966	6/15/1966	NWIS
13N01E28ACC1	USGS	MRV	7/22/1965	7/22/1965	NWIS
13N03E08AAA2	USGS	MRV	7/21/1965	7/21/1965	NWIS
15N03E18DDD1	USGS	Terrace Deposits	7/21/1965	7/21/1965	NWIS
17N04E31BAB1	USGS	Terrace Deposits	7/21/1965	7/21/1965	NWIS

Table 2. Groundwater quality monitoring wells in the upper Cache River watershed (continued).

Well ID	Monitoring Agency/ Organization	Aquifer	Date of first sample	Date of most recent sample	Source
18N03E10ACC1	USGS	MRV	7/21/1965	7/21/1965	NWIS
19N05E03BBA1	USGS	MRV	7/14/1955	7/14/1955	NWIS
19N04E01ABB1	USGS	Terrace Deposits	7/14/1955	7/14/1955	NWIS
13N01W34AAA1	USGS	Terrace Deposits	9/11/1953	9/11/1953	NWIS
21N06E26ABA1	USGS	Terrace Deposits	9/9/1953	9/9/1953	NWIS
14N03E24AAD1	USGS	Claiborne Group	5/3/1950	5/3/1950	NWIS
14N04E18BDC1	USGS	Memphis Sand	5/3/1950	5/3/1950	NWIS

APPENDIX C

Analysis of dissolved lead data from recommended 12-digit HUC subwatersheds

Evaluation of Dissolved Lead Data

Dissolved lead data from ADEQ water quality stations UWCHR02 and WHI0032 are evaluated below. The numeric water quality criteria for dissolved lead that apply at these stations are shown in Table 1. In Table 2, dissolved lead data from station UWCHR02 are compared to the numeric water quality criteria. Dissolved lead data from station WHI0032 are compared to the numeric water quality criteria in Table 3.

Table 1. Arkansas numeric water quality criteria for dissolved lead.

Acute Dissolved Lead Criterion	Chronic Dissolved Lead Criterion
{1.46203 - [(ln hardness)(0.145712)]}* $e^{[1.273(\ln hardness)]-1.460}$	{1.46203 - [(ln hardness)(0.145712)]} * $e^{[1.273(\ln hardness)]-4.705}$

Table 2. Dissolved lead data from UWCHR02 compared to water quality criteria.

Date Sampled	Hardness (mg/L)	Dissolved Lead (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
6/13/1994	43.5	Not detected	36.90	1.44		
9/12/1994	139.	Not detected	155.90	6.08		
4/10/1995	63	Not detected	58.43	2.28		
7/17/1995	77	Not detected	74.94	2.92		
10/2/1995	96	Not detected	98.52	3.84		
2/19/1996	50	Not detected	43.86	1.71		
5/6/1996	27	Not detected	20.42	0.80		
10/7/1996	85	Not detected	84.72	3.30		
10/22/2001	72	Not detected	68.96	2.69		
3/25/2002	25	Not detected	18.56	0.72		
7/29/2002	95	Not detected	97.25	3.79		
11/4/2002	78	Not detected	76.15	2.97		
1/7/2003	33	2.86	26.19	1.02		YES
3/10/2003	34	2.32	27.18	1.06		YES
4/28/2003	55	2.12	49.37	1.92		YES
6/23/2003	90	Not detected	90.94	3.54		
8/25/2003	183	Not detected	219.22	8.54		
8/4/2008	155	Not detected	178.44	6.95		
8/12/2008	154	Not detected	177.01	6.90		
3/10/2009	52	0.33	46.05	1.79		
3/10/2009	51	Not detected	44.96	1.75		
4/5/2011	38	Not detected	31.20	1.22		
6/7/2011	46.3	Not detected	39.87	1.55		
8/9/2011	220	Not detected	275.41	10.73		
10/11/2011	119	Not detected	128.58	5.01		
12/5/2011	34.4	Not detected	27.58	1.07		
12/6/2011	31.2	Not detected	24.43	0.95		
2/7/2012	39.8	Not detected	33.05	1.29		

Date Sampled	Hardness (mg/L)	Dissolved Lead (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
3/13/2012	22.5	Not detected	16.28	0.63		
5/8/2012	27.0	Not detected	20.42	0.80		
7/24/2012	216	Not detected	269.22	10.49		
9/18/2012	104	Not detected	108.80	4.24		
10/30/2012	116	Not detected	124.58	4.85		
1/8/2013	61.8	Not detected	57.05	2.22		
3/5/2013	35.2	0.33	28.38	1.11		

Table 3. Dissolved lead data from WHI0032 compared to water quality criteria.

Date Sampled	Hardness (mg/L)	Dissolved Lead (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
6/7/1994	80.4	U	79.07	3.08		
9/13/1994	169	U	198.63	7.74		
4/10/1995	63	U	58.43	2.28		
7/17/1995	65	U	60.74	2.37		
10/2/1995	73	U	70.15	2.73		
2/26/1996	68	U	64.24	2.50		
5/6/1996	37	U	30.19	1.18		
9/30/1996	88	U	88.44	3.45		
10/22/2001	61	U	56.14	2.19		
3/25/2002	25	U	18.56	0.72		
7/29/2002	64	U	59.58	2.32		
11/4/2002	88	U	88.44	3.45		
1/7/2003	41	2.21	34.29	1.34		YES
3/10/2003	29	2.32	22.31	0.87		YES
4/28/2003	61	1.71	56.14	2.19		
6/23/2003	49	U	42.78	1.67		
8/25/2003	120	U	129.93	5.06		
8/4/2008	121	U	131.27	5.12		
8/12/2008	134	U	148.97	5.81		
3/10/2009	47	0.31	40.62	1.58		
3/10/2009	48	U	41.70	1.62		

APPENDIX D

Analysis of sulfate data from recommended 12-digit HUC subwatersheds

Evaluation of Sulfate Data

Sulfate data from ADEQ station UWCHR04 is evaluated below. The numeric sulfate water quality criterion that applies at this station on the Cache River is 30 mg/L. To be assessed as meeting the sulfate water quality standard, less than 25% of measurements during the assessment period can exceed the numeric criterion. The table below lists sulfate measurements from ADEQ station UWCHR04 for the period 2010 through 2014, along with indicators of the measurements that exceed the numeric sulfate water quality criterion. Because more than 25% of these measurement exceed the numeric criterion, an estimated sulfate load reduction factor was determined by multiplying the sulfate concentrations that exceed the criterion by an iteratively increasing reduction factor until less than 25% of the sulfate measurements exceed the criterion. The reduction factor determined using this method is .09. The last two columns in the table below show sulfate values reduced by 9% , and which reduced measurements exceed the numeric sulfate criterion.

Table 1. Sulfate data from ADEQ station UWCHR04

Date	Sulfate, mg/L	Exceed criterion?	Sulfate reduced by 9%, mg/L	Exceed criterion?
6/13/1994	15.2			
9/12/1994	9.8			
1/16/1995	14			
4/10/1995	11.1			
7/17/1995	9.8			
10/2/1995	9.3			
2/19/1996	9.6			
5/6/1996	10.6			
10/7/1996	9			
10/22/2001	6.55			
1/28/2002	4.73			
3/25/2002	4.39			
5/21/2002	4.9			
7/29/2002	12.83			
9/23/2002	6.64			
11/4/2002	9.4			
1/7/2003	5.36			
3/10/2003	7.69			
4/28/2003	10.6			
6/23/2003	11.8			
8/25/2003	14			
4/4/2011	16.4			
6/6/2011	34.3	YES	31.2	YES
8/8/2011	25			
12/5/2011	3.05			

2/6/2012	4.56			
3/12/2012	5.84			
5/7/2012	57.9	YES	52.7	YES
7/23/2012	32.9	YES	29.9	NO
9/17/2012	9.5			
1/7/2013	12.4			
3/4/2013	6.38			

APPENDIX E

Analysis of dissolved copper data from recommended 12-digit HUC subwatersheds

Evaluation of Dissolved Copper Data

Dissolved copper data from ADEQ water quality stations WHI0026, WHI0172, and WHI0196 are evaluated below. The numeric water quality criteria for dissolved copper that apply at these stations are shown in Table 1. In Table 2, dissolved copper data from station WHI0026 are compared to the numeric water quality criteria. Dissolved copper data from stations WHI0172 and WHI0196 are compared to the numeric water quality criteria in Tables 3 and 4, respectively.

Table 1. Arkansas numeric water quality criteria for dissolved copper.

Acute Dissolved Copper Criterion	Chronic Dissolved Copper Criterion
$0.960* e^{[0..9422(\ln hardness)]-1.464}$	$0.960* e^{[0.8545(\ln hardness)]-1.465}$

Table 2. Dissolved copper data from WHI0026 compared to water quality criteria.

Date Sampled	Hardness (mg/L)	Dissolved Copper (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
9/11/1990	132	Not detected	22.10	14.39		
10/9/1990	46	Not detected	8.19	5.85		
11/6/1990	70	Not detected	12.16	8.37		
12/18/1990	24	Not detected	4.44	3.35		
1/15/1991	18	Not detected	3.38	2.62		
2/12/1991	34	Not detected	6.16	4.52		
3/12/1991	48	Not detected	8.52	6.06		
4/9/1991	34	Not detected	6.16	4.52		
4/30/1991	22	Not detected	4.09	3.11		
5/7/1991	78	Not detected	13.46	9.18		
6/11/1991	78	Not detected	13.46	9.18		
7/9/1991	78	Not detected	13.46	9.18		
8/13/1991	76	Not detected	13.14	8.98		
9/10/1991	112	Not detected	18.93	12.51		
10/1/1991	94	25	16.05	10.77	YES	YES
11/5/1991	40	Not detected	7.18	5.19		
12/3/1991	28	Not detected	5.13	3.82		
1/21/1992	32	Not detected	5.82	4.29		
2/25/1992	20	Not detected	3.74	2.87		
3/17/1992	150	Not detected	24.93	16.05		
3/17/1992	28	Not detected	5.13	3.82		
4/21/1992	46	Not detected	8.19	5.85		
5/12/1992	144	Not detected	23.99	15.50		
7/7/1992	38	Not detected	6.84	4.97		
8/4/1992	54	Not detected	9.52	6.70		
9/1/1992	108	Not detected	18.30	12.12		
9/22/1992	53.2	Not detected	9.39	6.62		
10/27/1992	82.8	Not detected	14.24	9.66		

Date Sampled	Hardness (mg/L)	Dissolved Copper (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
11/23/1992	27.2	Not detected	4.99	3.73		
1/26/1993	31.5	Not detected	5.73	4.23		
4/12/1994	43.8	Not detected	7.82	5.61		
5/10/1994	67.2	Not detected	11.70	8.08		
6/7/1994	20.4	Not detected	3.81	2.92		
7/5/1994	24.6	5	4.54	3.42	YES	YES
8/16/1994	175	Not detected	28.83	18.31		
9/20/1994	55.2	Not detected	9.72	6.83		
10/18/1994	80.8	Not detected	13.92	9.46		
11/15/1994	67.9	5.1	11.82	8.15		
12/13/1994	21	Not detected	3.91	2.99		
1/3/1995	41	4	7.35	5.30		
2/6/1995	32	4.01	5.82	4.29		
3/21/1995	66	4.4	11.50	7.96		
4/18/1995	93.2	3.6	15.92	10.69		
5/9/1995	30	3.82	5.47	4.06		
6/20/1995	256	7.89	41.26	25.34		
8/1/1995	147	2.7	24.46	15.78		
8/29/1995	311	7.2	49.56	29.93		
9/26/1995	60	4.6	10.52	7.34		
10/23/1995	88	5.1	15.09	10.18		
11/20/1995	51	4.3	9.02	6.38		
12/19/1995	43	5	7.68	5.52		
1/23/1996	44	2.8	7.85	5.63		
2/20/1996	36	5	6.50	4.74		YES
3/26/1996	29	4.5	5.30	3.94		YES
4/23/1996	35	3.6	6.33	4.63		
5/21/1996	42	3.8	7.51	5.41		
6/11/1996	44	Not detected	7.85	5.63		
7/16/1996	37	Not detected	6.67	4.85		
7/16/1996	47	3.2	8.35	5.95		
9/3/1996	170	4.8	28.05	17.86		
11/5/1996	53	4.3	9.36	6.60		
1/21/1997	29	Not detected	5.30	3.94		
3/4/1997	19	Not detected	3.56	2.75		
5/20/1997	55	4.2	9.69	6.81		
9/23/1997	122	Not detected	20.52	13.45		
11/12/1997	104	Not detected	17.66	11.74		
1/6/1998	72	4.48	12.49	8.57		
5/12/1998	18	3.3	3.38	2.62		YES
11/9/1998	61	3.84	10.68	7.44		
12/15/1998	69	3.53	12.00	8.27		
3/23/1999	32	2.12	5.82	4.29		
5/11/1999	31	3.1	5.64	4.17		
7/20/1999	55	3.11	9.69	6.81		
9/21/1999	94	4.66	16.05	10.77		

Date Sampled	Hardness (mg/L)	Dissolved Copper (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
11/2/1999	94	6.88	16.05	10.77		
1/4/2000	20	3.06	3.74	2.87		YES
3/14/2000	68	3.29	11.83	8.16		
3/23/2000	64	3.11	11.17	7.75		
5/9/2000	57	4.21	10.02	7.02		
7/18/2000	320	0.64	50.91	30.67		
9/19/2000	313	1.76	49.86	30.09		
11/14/2000	51.1	4.48	9.04	6.40		
1/23/2001	44	3.5	7.85	5.63		
3/6/2001	19	2.12	3.56	2.75		
5/8/2001	104	5.81	17.66	11.74		
7/17/2001	278	1.21	44.59	27.19		
9/18/2001	73	4.61	12.65	8.67		
11/13/2001	73	2.94	12.65	8.67		
1/8/2002	39	4.21	7.01	5.08		
5/28/2002	40	5.9	7.18	5.19		YES
7/23/2002	68	15.55	11.83	8.16	YES	YES
9/17/2002	42	31	7.51	5.41	YES	YES
11/12/2002	68	7.83	11.83	8.16		
1/21/2003	56	3.12	9.85	6.92		
3/25/2003	38	9.82	6.84	4.97	YES	YES
5/27/2003	30	11.9	5.47	4.06	YES	YES
7/22/2003	58	6.13	10.19	7.13		
9/30/2003	231	Not detected	37.45	23.21		
11/18/2003	30	4.63	5.47	4.06		YES
1/6/2004	37	2.15	6.67	4.85		
3/2/2004	39	3.04	7.01	5.08		
5/4/2004	34	2.83	6.16	4.52		
7/6/2004	54	2.54	9.52	6.70		
8/31/2004	65	2.68	11.34	7.86		
11/9/2004	30	5.43	5.47	4.06		YES
1/18/2005	23	2.21	4.26	3.23		
3/22/2005	65	1.99	11.34	7.86		
5/17/2005	86	3.85	14.76	9.98		
6/20/2005	290	2.18	46.40	28.19		
7/26/2005	57	3.06	10.02	7.02		
9/27/2005	41	3.4	7.35	5.30		
11/1/2005	115	5.19	19.41	12.79		
1/3/2006	80	8.06	13.79	9.38		
3/7/2006	104	9.81	17.66	11.74		
5/2/2006	53	4.34	9.36	6.60		
7/11/2006	149	6.49	24.78	15.96		
9/12/2006	92	4.14	15.73	10.57		
11/28/2006	44	4.41	7.85	5.63		
1/30/2007	25	2.28	4.61	3.47		
3/13/2007	56	4.4	9.85	6.92		

Date Sampled	Hardness (mg/L)	Dissolved Copper (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
5/1/2007	50	5.23	8.86	6.28		
7/10/2007	43	3.52	7.68	5.52		
9/5/2007	273	3.31	43.83	26.78		
11/6/2007	68	3.06	11.83	8.16		
1/15/2008	40	3.23	7.18	5.19		
3/11/2008	24	10.3	4.44	3.35	YES	YES
5/27/2008	66	4.43	11.50	7.96		
7/8/2008	166	4.96	27.43	17.50		
9/9/2008	52	4.4	9.19	6.49		
11/4/2008	92	4.2	15.73	10.57		
1/20/2009	71	10.1	12.32	8.47		YES
3/31/2009	26	6.93	4.78	3.59	YES	YES
5/5/2009	31	9.98	5.64	4.17	YES	YES
7/7/2009	156	6.25	25.87	16.60		
9/8/2009	111	9.92	18.77	12.41		
11/23/2009	65	11.7	11.34	7.86	YES	YES
1/19/2010	41	9.79	7.35	5.30	YES	YES
6/22/2010	357	7.35	56.44	33.67		
8/10/2010	383	1.28	60.31	35.76		
10/5/2010	90.2	15.6	15.44	10.39	YES	YES
2/22/2011	80	4.05	13.79	9.38		
4/26/2011	21	2.47	3.91	2.99		
6/28/2011	156	7.82	25.87	16.60		
10/11/2011	69.7	3.06	12.11	8.34		
12/12/2011	12.2	1.85	2.34	1.88		
2/21/2012	43.1	2.1	7.70	5.53		
4/24/2012	49.7	3.62	8.81	6.25		
6/5/2012	73.2	3.79	12.68	8.69		
8/14/2012	69.9	0.63	12.14	8.36		
10/2/2012	86.5	5.44	14.84	10.03		
12/17/2012	59.2	2.54	10.38	7.25		
2/12/2013	47.7	2.44	8.47	6.03		
4/9/2013	54.6	2.05	9.62	6.77		
6/18/2013	51.2	3.06	9.06	6.41		
8/27/2013	63.4	2.27	11.08	7.69		
10/29/2013	74.7	2.74	12.93	8.85		
12/16/2013	28.3	1.96	5.18	3.86		
2/18/2014	42	2.18	7.51	5.41		
4/22/2014	31.4	1.86	5.71	4.22		
6/10/2014	29.3	2.41	5.35	3.98		
8/26/2014	80.6	1.11	13.89	9.44		
10/28/2014	57.2	2.7	10.05	7.04		
12/1/2014	94.8	3.02	16.18	10.84		
2/10/2015	72	2.74	12.49	8.57		
4/7/2015	35.6	2.38	6.43	4.70		
6/9/2015	34.8	4.11	6.29	4.61		

Date Sampled	Hardness (mg/L)	Dissolved Copper (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
8/4/2015	62.1	1.38	10.86	7.55		
10/13/2015	105	2.53	17.82	11.83		
12/7/2015	25.7	1.8	4.73	3.55		
2/9/2016	68	2.32	11.83	8.16		
4/12/2016	30.8	1.86	5.61	4.15		
6/14/2016	43.9	2.4	7.83	5.62		

Table 3. Dissolved copper data from WHI0172 compared to water quality criteria.

Date Sampled	Hardness (mg/L)	Dissolved Copper (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
9/17/2002	67	23.7	11.67	8.06	YES	YES
11/12/2002	143	3.4	23.84	15.41		
1/21/2003	62	1.89	10.85	7.54		
3/25/2003	87	6.66	14.92	10.08		
5/27/2003	98	9.48	16.70	11.16		
7/22/2003	51	7.75	9.02	6.38		YES
9/30/2003	148	0.68	24.62	15.87		
11/18/2003	36	5.54	6.50	4.74		YES
1/6/2004	67	2.34	11.67	8.06		
3/2/2004	63	11.9	11.01	7.65	YES	YES
5/4/2004	78	4.15	13.46	9.18		
7/6/2004	101	3.48	17.18	11.45		
8/31/2004	91	5.69	15.57	10.47		
11/9/2004	173	2.62	28.52	18.13		
1/18/2005	23	2.17	4.26	3.23		
3/22/2005	21	2.36	3.91	2.99		
5/17/2005	79	2.98	13.63	9.28		
7/26/2005	108	1.32	18.30	12.12		
9/27/2005	111	2.17	18.77	12.41		
11/1/2005	2	Not detected	0.43	0.40		
1/3/2006	96	3.28	16.37	10.96		
3/7/2006	90	10.2	15.41	10.37		
5/2/2006	57	6.33	10.02	7.02		
7/11/2006	111	6.63	18.77	12.41		
9/12/2006	165	6.13	27.28	17.41		
11/28/2006	31	3.65	5.64	4.17		
1/30/2007	27	2.01	4.96	3.71		
3/13/2007	59	3.72	10.35	7.23		
5/1/2007	50	3.98	8.86	6.28		
7/10/2007	85	3.27	14.60	9.88		
9/5/2007	81	3.63	13.95	9.48		
11/6/2007	86	2.35	14.76	9.98		
1/15/2008	30	2.26	5.47	4.06		

Date Sampled	Hardness (mg/L)	Dissolved Copper (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
3/11/2008	21	3.04	3.91	2.99		YES
5/27/2008	72	2.71	12.49	8.57		
7/8/2008	80	7.75	13.79	9.38		
9/9/2008	98	3.3	16.70	11.16		
11/4/2008	94	3.2	16.05	10.77		
1/20/2009	78	6.87	13.46	9.18		
3/31/2009	33	5.84	5.99	4.40		YES
5/5/2009	31	4.91	5.64	4.17		YES
7/7/2009	82	3.28	14.11	9.58		
9/8/2009	57	13.2	10.02	7.02	YES	YES
11/23/2009	55	9.11	9.69	6.81		YES
1/19/2010	33	6.29	5.99	4.40	YES	YES
6/22/2010	73	9.78	12.65	8.67		YES
8/10/2010	67	159	11.67	8.06	YES	YES
12/28/2010	62	2.26	10.85	7.54		
2/22/2011	97	2.59	16.53	11.06		
4/26/2011	28	27.8	5.13	3.82	YES	YES
6/28/2011	35	8.89	6.33	4.63	YES	YES
8/9/2011	97.3	1.62	16.58	11.09		
10/11/2011	95	0.75	16.21	10.86		
12/12/2011	9.37	2.84	1.83	1.50	YES	YES
2/21/2012	39.8	1.69	7.14	5.17		
4/24/2012	104	1.63	17.66	11.74		
6/5/2012	82.5	6.82	14.20	9.63		
8/14/2012	105	Not detected	17.82	11.83		
10/2/2012	76.1	3.59	13.16	8.99		
12/17/2012	83.5	2.03	14.36	9.73		
2/12/2013	36.6	2.06	6.60	4.81		
4/9/2013	60.1	2.02	10.53	7.35		
6/18/2013	53.4	3.97	9.42	6.64		
8/27/2013	103	1.76	17.50	11.64		
10/29/2013	107	1.78	18.14	12.03		
12/16/2013	62	2.85	10.85	7.54		
2/18/2014	36	1.55	6.50	4.74		
4/22/2014	38.4	2.16	6.91	5.01		
6/10/2014	30.7	3	5.59	4.14		
8/26/2014	74.8	2.49	12.94	8.86		
10/28/2014	75.7	2.21	13.09	8.95		
12/1/2014	75.6	0.77	13.07	8.94		
2/10/2015	77.8	1.67	13.43	9.16		
4/7/2015	35.5	2.53	6.41	4.68		
6/9/2015	29.4	2.45	5.37	3.99		
8/4/2015	123	2.16	20.68	13.55		
10/13/2015	105	1.31	17.82	11.83		
12/7/2015	25.5	2.95	4.70	3.53		
2/9/2016	93.5	0.88	15.97	10.72		

Date Sampled	Hardness (mg/L)	Dissolved Copper (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
4/12/2016	34	1.87	6.16	4.52		
6/14/2016	71	1.83	12.32	8.47		

Table 4. Dissolved copper data from WHI0196 compared to water quality criteria

Date Sampled	Hardness (mg/L)	Dissolved Copper (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
7/8/2008	83	4.77	14.28	9.68		
9/9/2008	62	6.22	10.85	7.54		
11/4/2008	90	7.85	15.41	10.37		
1/20/2009	58	5.97	10.19	7.13		
3/31/2009	26	5.96	4.78	3.59	YES	YES
5/5/2009	28	7.24	5.13	3.82	YES	YES
7/7/2009	83	6.78	14.28	9.68		
9/8/2009	74	10.9	12.81	8.78		YES
11/23/2009	60	8.92	10.52	7.34		YES
1/19/2010	40	8.1	7.18	5.19	YES	YES
6/22/2010	96	15.7	16.37	10.96		YES
8/10/2010	77	22.5	13.30	9.08	YES	YES
10/5/2010	77.3	6.05	13.35	9.11		
12/28/2010	75	7.2	12.98	8.88		
2/22/2011	78	5.84	13.46	9.18		
4/26/2011	23	4.69	4.26	3.23	YES	YES
6/28/2011	80.7	11.6	13.90	9.45		YES
8/9/2011	95.7	9.23	16.33	10.93		
10/11/2011	86.6	7.12	14.86	10.04		
12/12/2011	9.76	1.57	1.90	1.55		YES
2/21/2012	39.7	1.79	7.13	5.15		
4/24/2012	92.3	5.41	15.78	10.60		
6/5/2012	80.3	3.34	13.84	9.41		
8/14/2012	93	7.8	15.89	10.67		
10/2/2012	69.3	5.43	12.04	8.30		
12/17/2012	75.5	4.78	13.06	8.93		
2/12/2013	50.1	2.15	8.87	6.29		
4/9/2013	54.1	2.62	9.54	6.72		
6/18/2013	72.6	4.26	12.58	8.63		
8/27/2013	78.4	4	13.53	9.22		
10/29/2013	81.3	5.44	14.00	9.51		
12/16/2013	33.1	3.45	6.00	4.41		
2/18/2014	40.4	2.05	7.24	5.23		
4/22/2014	30	1.78	5.47	4.06		
6/10/2014	26.4	2.14	4.85	3.64		
8/26/2014	84.5	3.7	14.52	9.83		
10/28/2014	75.4	4.72	13.04	8.92		

Date Sampled	Hardness (mg/L)	Dissolved Copper (ug/L)	Water Quality Criteria (ug/L)		Exceed Criteria?	
			Acute	Chronic	Acute	Chronic
12/1/2014	78.1	3.31	13.48	9.19		
2/10/2015	84.3	4.38	14.49	9.81		
4/7/2015	35.8	2.71	6.46	4.72		
6/9/2015	51.8	4.68	9.16	6.47		
8/4/2015	78.2	2.58	13.50	9.20		
10/13/2015	94.1	4.04	16.07	10.78		
12/7/2015	24.1	1.6	4.45	3.36		
2/9/2016	67.2	2.84	11.70	8.08		
4/12/2016	28.7	1.84	5.25	3.91		
6/14/2016	67.3	3.13	11.72	8.09		

To be assessed as meeting dissolved copper water quality criteria, no more than 1 measurement during the evaluation period can exceed the numeric criteria. Table 5 summarizes the number of measurements from each station that exceed criteria during the period 2010 through 2014. It is noteworthy that there have been no exceedences of the dissolved copper criteria since 2012.

Table 5. Number of measurements from 2010 – 2014 exceeding dissolved copper criteria.

Station	Number of measurements	Number exceeding acute criteria	Number exceeding chronic criteria
WHI0026	27	2	2
WHI0172	28	5	6
WHI0196	29	3	6

Estimated load reduction factors for dissolved copper to meet the dissolved copper water quality standards were determined by multiplying the dissolved copper concentrations from the period 2010 through 2014 that exceed their criteria by an iteratively increasing reduction factor until less than 2 of the dissolved copper measurements exceed their criteria. Table 6 shows the results of this analysis for all three water quality stations.

Table 6. Estimated copper load reduction factors to meet dissolved copper water quality criteria.

Station ID	Date	Dissolved Copper (ug/L)	Reduction factor	Reduced dissolved copper (ug/L)	Acute criteria exceeded?	Chronic criteria exceeded?
WHI0026	1/19/2010	9.79	0.34	6.46	NO	YES
WHI0026	10/5/2010	15.6	0.34	10.3	NO	NO
WHI0172	1/19/2010	6.29	0.87	0.82	NO	NO
WHI0172	6/22/2010	9.78	0.87	1.27	NO	NO
WHI0172	8/10/2010	159	0.87	20.7	YES	YES

WHI0172	4/26/2011	27.8	0.87	3.61	NO	NO
WHI0172	6/28/2011	8.89	0.87	1.16	NO	NO
WHI0172	12/12/2011	2.84	0.87	0.37	NO	NO
WHI0196	1/19/2010	8.1	0.36	5.18	NO	NO
WHI0196	6/22/2010	15.7	0.36	10.0	NO	NO
WHI0196	8/10/2010	22.5	0.36	14.4	YES	NO
WHI0196	4/26/2011	4.69	0.36	3.00	NO	NO
WHI0196	6/28/2011	11.6	0.36	7.42	NO	NO
WHI0196	12/12/2011	1.57	0.36	1.00	NO	NO

APPENDIX F

Estimation of treatment extents to achieve target reduction of TSS loads from recommended 12-digit HUC subwatersheds

Swan Pond Ditch-Cache River - 80203020205

Watershed area =	24350.41	acres (from CAST)		
Non-water watershed =	23690.51	acres (based on 2010 land cover)		
Pasture/hay area =	609	acres	304.5	acres eroding (50%)
Cropland area =	17,678	acres	8,839	acres eroding (50%)
Stream miles =	67.32	miles =	355,449.6	ft (from CAST)
Ditch miles =	12.06	miles =	63,676.8	ft (from CAST)
Cropland streambanks =	62.29	miles =	328,915.4	ft (total * proportion cropland cover)
Pasture streambanks =	1.73	miles =	9,137.4	ft (total * proportion pasture cover)

Target TSS Load Reduction: 13%

Practices	Assumed load reduction	Proportion of source to treat for target reduction	Source	Assumed proportion of source contributing load*	Amount of source treated	Extent units
drop pipe structure	0.75	0.1733333	cropland	0.5	1,500	acres
mulch (assume 1% crop)	0.77	0.1688312	cropland	0.5	30	acres
pond	0.77	0.1688312	pasture/hay	0.5	51	acres
grassed waterway	0.17	0.7647059	cropland	0.05	680	acres
			pasture/hay	0.05	23	acres
herbaceous riparian buffer	0.65	0.2	cropland streambank	0.5	33,000	ft
			pasture/hay streambank	0.5	910	ft
forested riparian buffer	0.80	0.1625	pasture/hay streambank	0.5	740	ft
cover crop	0.73	0.1780822	cropland	0.5	1,600	acres
streambank restoration	0.80	0.1625	cropland streambank	0.5	27,000	ft
			pasture/hay streambank	0.5	740	ft
pasture hay planting	0.59	0.220339	pasture/hay	0.5	67	acres
winter field flooding	0.97	0.1340206	cropland	0.5	1,200	acres

* Notes:

50% of cropland and pasture/hay assumed to be eroding

50% of streambanks assumed to be eroding based on TNC Bank Erosion Hazard Index (TNC 2009)

Gully erosion assumed on 5% of cropland and pasture/hay

Number Twenty Six Ditch-Cache River – 80203020301

Watershed area =	33647.6	acres (from CAST)			
Non-water watershed =	32,366	acres (based on 2010 land cover)			
Pasture/hay area =	1,615	acres	807.5	acres eroding (50%)	
Cropland area =	22,477	acres	11,238.5	acres eroding (50%)	
Stream miles =	81.48	miles =	430,214.4	ft (from CAST)	
Ditch miles =	12.91	miles =	68,164.8	ft (from CAST)	
Cropland streambanks =	69.4955	miles =	366,936.3	ft (total * proportion crop cover)	
		* 0.5 =		183,468.1	ft eroding streambank
Pasture streambanks =	4.06574	miles =	21,467.1	ft (total * proportion pasture cover)	
		* 0.5 =		10,733.5	ft eroding streambank

Target TSS Load Reduction: 13%

Practices	Assumed load reduction	Proportion of source to treat for target reduction	Source	Assumed proportion of source contributing load*	Amount of source treated	Extent units
drop pipe structure	0.75	0.173333	cropland	0.5	1,900	acres
pond	0.77	0.168831	pasture/hay	0.5	140	acres
grassed waterway	0.17	0.764706	cropland	0.05	860	acres
			pasture/hay	0.05	62	acres
herbaceous riparian buffer/ filter strip	0.65	0.2	cropland streambank	0.5	37,000	ft
			pasture/hay streambank	0.5	2,100	ft
cover crop	0.73	0.178082	cropland	0.5	2,000	acres
streambank restoration	0.80	0.1625	cropland streambank	0.5	30,000	ft
			pasture/hay streambank	0.5	1,700	ft
pasture hay planting	0.59	0.220339	pasture/hay	0.5	2,500	ft
field border	0.35	0.371429	cropland	0.5	68,000	ft
winter field flooding	0.97	0.134021	cropland	0.5	1,500	acres
forested riparian buffer	0.80	0.1625	pasture/hay streambank	0.5	1,700	ft

* Notes:

50% of cropland and pasture/hay assumed to be eroding

50% of streambanks assumed to be eroding based on TNC Bank Erosion Hazard Index results for Swan Pond Ditch (TNC 2009)

Gully erosion assumed on 5% of cropland and pasture/hay

Lake Frierson in Mud Creek -Big Creek Ditch – 80203020501

Lk Frierson watershed area =	10.2	sq mi =	6,528	acres (from TMDL, FTN 2007)	
Pasture/hay area =	1,038	acres (from TMDL)		519	acres eroding (50%)
Forest area =	3,290	acres (from TMDL)		329	acres eroding (10%)
Cropland area =	1,717	acres (from TMDL)		858.5	acres eroding (50%)
Stream miles =	7.00118	miles =	36,966	ft (total * proportion Frierson watershed)	
Ditch miles =	0	miles			
Cropland streambanks =	1.98203	miles =	10,465	ft (total * proportion crop cover)	
		* 0.15 =		1,569.8	ft eroding streambank
Forest streambanks =	3.79784	miles =	20,053	ft (total * proportion forest cover)	
		* 0.15 =		3,007.9	ft eroding streambank
Pasture/hay streambanks =	1.19822	miles =	6,327	ft (total * proportion pasture cover)	
		* 0.15 =		949.0	ft eroding streambank

Target TSS Load Reduction: 55%

Practices	Assumed load reduction	Proportion of source to treat for target reduction	Source	Assumed proportion of source contributing load*	Amount of source treated	Extent units
drop pipe structure	0.75	0.73333	cropland	0.50	630	acres
pond	0.77	0.71429	pasture/hay	0.50	370	acres
			forest	0.10	240	acres
herbaceous riparian buffer/ filter strip	0.65	0.84615	cropland streambank	0.15	1,300	ft
			pasture/hay streambank	0.15	800	ft
cover crop	0.73	0.75342	cropland	0.50	650	acres
streambank restoration	0.80	0.6875	cropland streambank	0.15	1,100	ft
			pasture/hay streambank	0.15	650	ft
			forest streambank	0.15	2,100	ft
winter field flooding	0.97	0.56701	cropland	0.50	490	ft
field border	0.35	1.57143	cropland	0.15	2,500	ft
forested riparian buffer	0.80	0.6875	pasture/hay streambank	0.15	650	ft
			forest streambank	0.15	2,100	ft
pasture hay planting	0.59	0.9322	pasture/hay	0.50	480	acres

* Notes:

50% of cropland and pasture/hay assumed to be eroding

10% of forest assumed to be eroding

15% of streambanks assumed to be eroding based on TNC Bank Erosion Hazard Index results for Culotches Bay Slough (TNC 2009)

Overcup Ditch - 80203020405

Watershed area =	24374.7	acres (from CAST)		
Cropland area =	21,645	acres	10822.5	acres eroding (50%)
Stream miles =	30.16	miles =	159,245	ft (from CAST)
Ditch miles =	21.98	miles =	116,054	ft (from CAST)
Cropland streambanks =	46.3008	miles =	244,468	ft (total * proportion cropland cover)
			*0.80 =	195,575 ft eroding streambank

Target TSS Load Reduction: 35%

Practices	Assumed load reduction	Proportion of source to treat for target reduction	Source	Assumed proportion of source contributing load*	Amount of source treated	Extent units
herbaceous riparian buffer	0.65	0.538462	cropland streambank	0.8	110,000	ft
streambank restoration	0.80	0.4375	cropland streambank	0.8	86,000	ft

* Notes:

50% of cropland assumed to be eroding

80% of streambanks assumed to be eroding based on TNC Bank Erosion Hazard Index (TNC 2009)

Culotches Bay Slough-Cache River - 80203020806

Watershed area =	25532.6	acres (from CAST)		
Cropland area =	18,664	acres	9,332	acres eroding (50%)
Stream miles =	82.61	miles =	436,181	ft (from CAST)
Ditch miles =	0	miles (from CAST)		
Cropland streambanks =	60.3868	miles =	318,842	ft (total * proportion cropland cover)
		* 0.15 =	47,826.3	ft eroding streambank

Target TSS Load Reduction: 35%

Practices	Assumed load reduction	Proportion of source to treat for target reduction	Source	Assumed proportion of source contributing load*	Amount of source treated	Extent units
herbaceous riparian buffer	0.65	0.5384615	cropland streambank	0.15	26,000	ft
streambank restoration	0.80	0.4375	cropland streambank	0.15	21,000	ft
forested riparian buffer	0.80	0.4375	cropland streambank	0.15	21,000	ft

* Notes:
15% of streambanks assumed to be eroding based on TNC Bank Erosion Hazard Index (TNC 2009)

Maloy Bayou-Cache River - 80203020807

Watershed area =	24,745.4	acres (from CAST)		
Cropland area =	13,288	acres	6,644	acres eroding (50%)
Stream miles =	62.45	miles =	329,736	ft (from CAST)
Ditch miles =	0	miles (from CAST)		
Cropland streambanks =	33.53	miles =	177,064	ft (total * proportion cropland cover)
Target TSS Load Reduction:	35%			

Practices	Assumed load reduction	Proportion of source to treat for target reduction	Source	Assumed proportion of source contributing load*	Amount of source treated	Extent units
herbaceous riparian buffer	0.65	0.538462	cropland streambank	0.15	14,000	ft
streambank restoration	0.80	0.4375	cropland streambank	0.15	12,000	ft
forested riparian buffer	0.80	0.4375	cropland streambank	0.15	12,000	ft

* Notes:
50% of cropland assumed to be eroding
15% of streambanks assumed to be eroding based on TNC Bank Erosion Hazard Index results for Culotches Bay Slough (TNC 2009)