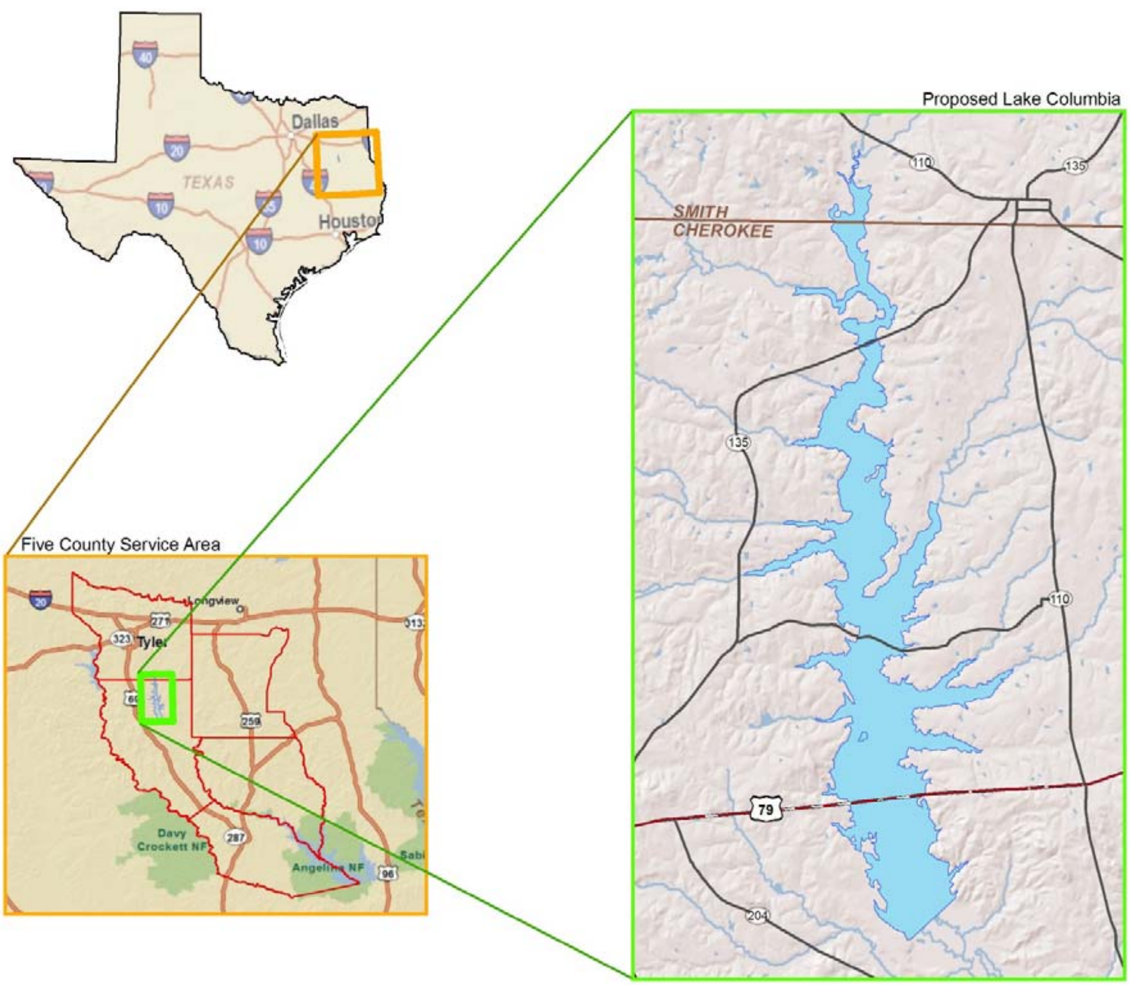
US Army Corps of Engineers
Fort Worth District

Lake Columbia
Regional Water Supply Reservoir Project
Draft Environmental Impact Statement
Volume 1 - Report

January 2010



DRAFT
ENVIRONMENTAL IMPACT STATEMENT
LAKE COLUMBIA
REGIONAL WATER SUPPLY RESERVOIR PROJECT

Lead Agency:	Department of the Army U.S. Army Corps of Engineers Fort Worth District
Project Location:	Cherokee and Smith Counties, Texas
Comments on this EIS Should be Directed to:	Mr. Brent Jasper, EIS Project Manager U.S. Army Corps of Engineers (USACE) Fort Worth District 819 Taylor Street P.O. Box 17300 Fort Worth, Texas 76102-0300 817/886-1863
Date Draft EIS Filed with EPA:	__________
Date by Which Comments Must be Received by the USACE:	__________

ABSTRACT

The Angelina & Neches River Authority (ANRA) proposes to construct, operate, and maintain a dam and reservoir known as Lake Columbia (the "Project") on Mud Creek, a tributary of the Angelina River, in Cherokee and Smith Counties, Texas. The dam would impound 195,500 acre-feet of water extending approximately 14 miles upstream in Cherokee and Smith Counties and would inundate 10,133 acres at the conservation pool elevation. The proposed Project would involve the discharge of dredged and fill material into approximately 220 acres of waters of the United States (U.S.) associated with the construction of the dam. The Project would adversely impact 5,746.5 acres of waters of the U.S. associated with clearing, excavation, filling, and inundation of the reservoir site. The proposed Project requires authorization from the U. S. Army Corps of Engineers (USACE) for the discharge of dredged and fill material into the waters of the U.S. under Section 404 of the Clean Water Act, and for work affecting navigable waters of the U.S. under Section 10 of the Rivers and Harbors Act of 1899. The USACE has determined that the permit decision is a major federal action with the potential to significantly affect the quality of the human environment. Therefore, the USACE has determined that preparation of an Environmental Impact Statement (EIS) is necessary. This draft EIS describes the environmental impacts associated with the Project and its alternatives and with alternatives available to the USACE, i.e., issuance of a Department of the Army permit, issuance of a permit with conditions, or denial of the permit application.

Responsible Official for EIS: ____________________________

Richard J. Muraski, Jr.
Colonel, Corps of Engineers
Commanding

SUMMARY

INTRODUCTION

The Angelina & Neches River Authority (ANRA) proposes to construct, operate, and maintain a dam and reservoir known as Lake Columbia (the "Project") on Mud Creek, a tributary of the Angelina River, to be located in Cherokee and Smith Counties, Texas. The proposed Project requires authorization from the U. S. Army Corps of Engineers (USACE) for the discharge of dredged and fill material into the waters of the United States under Section 404 of the Clean Water Act, and for work affecting navigable waters of the United States under Section 10 of the Rivers and Harbors Act of 1899. Evaluation of a standard individual permit is a federal action subject to review under the National Environmental Policy Act (NEPA). The USACE has determined that the permit decision is a major federal action with the potential to significantly affect the quality of the human environment. Under the provisions of NEPA and the Council on Environmental Quality's implementing regulations (40 CFR 1500-1508), preparation of an Environmental Impact Statement (EIS) is necessary. There are three alternatives available to the USACE: 1) issue the permit, 2) issue the permit with special conditions, or 3) deny the permit. Permit denial is referred to as the No Action Alternative.

The proposed Lake Columbia dam would be constructed on Mud Creek approximately five miles southeast of Jacksonville, in Cherokee County, Texas, and approximately three miles downstream from the U.S. Highway 79 bridge over Mud Creek. The dam would impound water approximately 14 miles upstream in Cherokee and Smith Counties at an average width of approximately 1.1 miles and would inundate approximately 10,133 acres at the conservation pool elevation of 315 feet National Geodetic Vertical Datum (NGVD) ("Permit Area"). Within the 10,655.5-acre Permit Area (i.e., reservoir area at conservation pool elevation plus dam site area), there are 5,746.5 acres of waters of the U.S., 5,351 acres of which are wetlands, that would be impacted by the construction and operation of Lake Columbia.

The basic and primary purpose of the proposed Lake Columbia Project is water supply. Specifically, it is to provide an additional water supply for Angelina, Cherokee, Nacogdoches, Rusk, and Smith counties in east Texas ("Five-County Area") to meet projected needs through the year 2060 and beyond. Water from the proposed reservoir would be used primarily to meet future municipal, industrial, and steam electric power demands. ANRA was issued a water right by the Texas Water Commission in 1985 (Permit to Appropriate State Water No. 4228). This permit authorizes the development and construction of the reservoir on Mud Creek in Cherokee and Smith Counties, with capacity to impound up to 195,500 acre-feet of water. The permit also authorizes the diversion of up to 85,507 acre-feet of water per year from the reservoir for municipal and industrial uses.

This EIS describes the proposed construction and operation of the dam and reservoir, including ANRA's proposed Mitigation Plan. It identifies alternatives to the Proposed

Action available to ANRA, including the No Action Alternative and the Toledo Bend Pipeline Alternative, and identifies alternatives available to USACE relative to the Department of the Army permit. It describes the environmental consequences of implementing the Proposed Action, No Action, and Toledo Bend Pipeline alternatives.

Section 2 of the EIS addresses the purpose and need for the Project. Section 3 presents the description and screening of alternatives to the Project, including a detailed description of the Proposed Action and a summary of impacts with respect to alternatives, including a discussion of cumulative impacts. Section 4 discusses the affected environment and the environmental consequences of the alternatives, organized by specific resources of potential concern. Section 5 describes the coordination process with the relevant governmental regulatory and resource agencies and the public, and Section 6 lists the preparers of the EIS. Section 7 contains a list of references cited in the text.

SUMMARY OF IMPACTS

Tables S-1 and S-2 present a summary and comparison of the environmental impacts of the Proposed Action and other alternatives evaluated. Detailed descriptions of the environmental consequences of the No Action, Proposed Action, and Toledo Bend Pipeline alternatives along with mitigation measures for each resource are contained in Section 4.

Cumulative effects which result from the incremental impact of a project when added together with past, present, and reasonably foreseeable future actions have also been evaluated. The potential contributing effects of 15 past and present actions and 13 reasonably foreseeable future actions on 13 identified resource areas have been assessed and their relative contributions to cumulative effects on pertinent resources delineated.

The results of the cumulative effects analysis show cumulative impacts would occur. Analysis of predicted Project-related effects revealed that surface-water quality, waters of the U.S., vegetation, and aquatic biology would incur the greatest impacts. Agricultural land usage and logging operations were also identified as having moderate relative contributions to cumulative effects on these resources.

Table S-1 Comparison of Environmental Features Impacted by the Toledo Bend Pipeline Alternative and the Proposed Lake Columbia

ENVIRONMENTAL FEATURE	TOLEDO BEND ALT. [a]			L. COLUMBIA [b]		
	Miles [f]	Acres [c]	Number	Miles	Acres	Number
Upland Forest	41.5	502.4	-	-	2,247	-
Shrub Upland + Grassland (Non-forested Land)	28.8	348.8	-	-	2,616	-
Bottomland Hardwood Forest (Deciduous Forested Wetland)	0.9	10.7	-	-	3,689	-
Herbaceous Wetland	0.5	5.5	-	-	1,518	-
Shrub Wetland	ND	ND	-	-	144	-
Hillside Bog	-	-	-	-	0.5	-
Minor Streams [g]	-	-	73	39	47	-
Major Streams [g]	-	-	21	70	255	-
Lacustrine (Pond/Lake)			1	-	63	-
New Channel	-	-	-	3	30	-
State Parks	0	0	-	-	0	0
State Wildlife Management Areas	0	0	-	-	0	0
National Forests	13.1	159.2	1	-	0	0
Federal Wildlife Management Areas	0	0	-	-	0	0
Number of Federal T/E Species Potentially Occurring [d]	-	-	4	-	-	5
Number of State T/E Species Potentially Occurring [d]	-	-	19	-	-	19
Urban	7.8	94.6	-	-	14	-
High Probability For Cultural Resources Sites [e]	70.0	843.9	-	-	1,272	-

NOTE: For Toledo Bend Pipeline alternative, terminal storage reservoir of several hundred acres not included. Location of such a reservoir has not been determined.

a = Based on USGS Topographic Map review.
b = Data largely taken from FNI, 2003a except for Minor/Major Streams and Lacustrine Habitat taken from USGS Topographic Map review.
c = Acreage calculations assume a 100-foot construction ROW along 86 miles of pipeline.
d = Based on TPWD county records. The potential occurrence of federally listed species in the Permit Area has been ruled out based on either the availability of habitat and/or site-specific surveys of potential habitat (i.e., Red-cockaded woodpecker - FNI, 2003a).
e = High probability areas were assessed as all areas within 400 meters (125 feet) of extant waterways/drainages commonly accepted by the Texas Historical Commission. Because of the presence of waterways and drainages along the entire length, the majority of the proposed pipeline length is considered to be High Probability.
f = Miles of pipeline route traversing indicated feature.
g = For pipeline route, number of streams crossed; for L. Columbia, minor = intermittent, major = perennial jurisdictional streams.
ND = Non-discernable from USGS Topographic Map review.
T/E = Threatened or endangered species.

Table S-2 Impact Summary and Alternatives Comparison

Resource/Impact Issue	Lake Columbia Proposed Action Impact	No Action Alternative Impact	Toledo Bend Pipeline Alternative Impact
Physiography and Topography			
Modification of topography in the Permit Area	Topography would be altered by construction of dam and inundation of valley.	No modification of topography.	Construction of intake structure and pump station at Toledo Bend. Construction of several hundred-acre terminal reservoir near proposed reservoir site.
Geology			
Alteration of strata	10,133 acres would be inundated and sediment would slowly accumulate in the reservoir. Downstream channel scoured near the dam to expose deeper layers.	No changes to geology.	Strata would be altered to depth of pipeline and terminal reservoir construction. Lignite deposits in southern Rusk County could not be extracted where pipeline runs.
Soils			
Loss of prime farmland soils	135 acres of prime farmland soils would be lost.	No impact on prime farmland soils.	Minimal impacts to prime farmland soils anticipated, except unknown at terminal reservoir site.
Increase in erosion from disturbance	Erosion would occur during construction activities, but erosion control measures would be used.	Existing soils would not be disturbed.	Erosion would occur during construction activities, but erosion control measures would be used.
Groundwater			
Declining groundwater levels	Switch from groundwater to surface water would reduce groundwater drawdown.	Groundwater drawdown would increase from increasing withdrawals.	Switch from groundwater to surface water would reduce groundwater drawdown.
Surface Water			
Sediment delivery	Sediment delivery to Mud Creek increased during construction, but reduced during operation.	No impacts on sediment.	Sediment delivery to various streams crossed by the pipeline route and at terminal reservoir site increased during construction.
Water quality	Water releases would increase base flows, raise dissolved oxygen, reduce turbidity.	Water quality would be unchanged.	Short-term effects at stream crossings. Inter-basin transfer would cause slight decrease in flows in Sabine Basin and slight increase in Neches Basin.
Loss of waters of U.S. including wetlands	5,746.5 acres of waters of U.S. would be impacted. To be compensated by mitigation plan.	No change in waters of U.S.	Temporary construction impacts, and loss of waters of U.S. at pump station/intake at Toledo Bend. Some conversion of forested wetlands along pipeline route. Unknown

Resource/Impact Issue	Lake Columbia Proposed Action Impact	No Action Alternative Impact	Toledo Bend Pipeline Alternative Impact
			potential impacts at terminal reservoir site.
Downstream hydrologic & fluvial geomorphic impacts	Flood peaks reduced. Approximate 16 percent decrease in 100-year floodplain. Some channel scouring below dam site.	No downstream impacts.	No downstream impacts in Mud Creek. Short-term impacts on other streams crossed. Potential impacts associated with terminal reservoir.
Hydropower	Negligible change in Sam Rayburn hydropower production (0.01%).	No impact on hydropower.	Negligible change in Toledo Bend hydropower production.
Climatology/Air Quality			
Potential exceedance of ambient air quality standards. Climate changes.	Fugitive dust emissions would likely increase particulate concentrations during construction. Slight local increase in relative humidity and moderation of temperatures with lake.	No impact on climatology/air quality.	Fugitive dust emissions over larger area during construction of pipeline and terminal reservoir.
Noise			
Increase in noise levels	Some increase during construction. Boat traffic would generate noise on the lake.	No impact on noise.	Some increase in noise over a larger area during construction of pipeline and terminal reservoir. Pump stations noise during operation.
Vegetation			
Impacts to vegetation, including wetland and riparian vegetation	5,351.5 acres of wetlands would be impacted and mostly converted to open water—to be compensated by Mitigation Plan. Development around lake would impact vegetation—to be addressed by Water Quality Regulations. 1,195 acres of wetlands established around water's edge.	No impact on vegetation.	Wetland vegetation impacted primarily at stream crossings and intake pump station. Other vegetation impacts at several hundred-acre terminal reservoir site and along entire ROW, including approximately 160 acres through Sabine National Forest. Potential conversion of forested wetlands along pipeline route.
Threatened or endangered (T/E) species	T/E species (Neches River rose-mallow) not known to exist within Permit Area.	No impact on T/E species.	T/E species may exist within counties traversed by pipeline.
Fish and Wildlife			
Threatened or endangered species	T/E species not known to exist within Permit Area.	No impact on T/E species.	T/E species may exist within counties traversed by pipeline, particularly red-cockaded woodpeckers in Sabine National Forest.

Resource/Impact Issue	Lake Columbia Proposed Action Impact	No Action Alternative Impact	Toledo Bend Pipeline Alternative Impact
Habitat alteration	Terrestrial and stream habitat converted to open water habitat. All terrestrial and some aquatic species displaced.	No direct impact on habitat. Trend of conversion of forest to pasture and timber plantations likely to continue.	Habitat cleared along pipeline route and terminal reservoir. Timber removal in Sabine National Forest may require EIS.
Downstream impacts	Floodplain size and flood magnitude decreased. Increased base flows result in increased stream aquatic habitat.	No downstream impacts.	No downstream impacts in Mud Creek. Short-term impacts on other streams crossed.
Cultural Resources			
Impacts to cultural resources	1,272 acres of high probability areas for cultural resources within Permit Area. Inundation of 23 known archaeological sites; 13 sites located on or adjacent to shoreline. Additional surveying necessary to inventory all sites.	No impact to cultural resources.	No surveys conducted, but approximately 70 miles of high probability areas for cultural resources could be impacted, plus several hundred-acre terminal reservoir site.
Impacts to historic structures	Eight historic structures potentially impacted. NRHP eligibility unknown.	No impact to historic structures, except site looting could continue.	No surveys conducted, but historic structures unlikely, except potentially in cities.
Socioeconomics			
Population change	Population increases may exceed projections because of available water and presence of lake.	Projected population increases may not occur because of insufficient water supply.	Population increases likely to meet projections.
Employment and income change	Temporary increase of 2,000 jobs during construction. Permanent increase of 32 jobs from operation. 361 jobs generated from recreational spending prompted by the lake.	Employment and income would not change.	Temporary increase of jobs during construction. Permanent increase of jobs from operation. Higher cost of water equivalent to outflow of $46M per year from the local area.
Land Use and Recreation			
Conversion of land use	Approximately 11,000 acres of existing agricultural and forested land converted to lake and residential use.	No impact on land use.	Approximately 1,000 acres affected along ROW, including timber removal in 13-mile reach through Sabine National Forest, plus several hundred-acre terminal reservoir site.
Recreation supply and demand	Private land made available for recreation with opportunities for water sports and camping. New demand from new residents and visitors.	No impact on recreation. Reduced potential for opening private lands for public recreation at Lake Columbia site.	No impact on recreation. Reduced potential for opening private lands for public recreation at Lake Columbia site.
Aesthetics			

Resource/Impact Issue	Lake Columbia Proposed Action Impact	No Action Alternative Impact	Toledo Bend Pipeline Alternative Impact
Change in landscape character	Forested and agricultural area converted to lake view.	No impact on aesthetics.	Loss of timber and other vegetation along pipeline corridor and at terminal reservoir site.
Environmental Justice			
Low income or minority population disproportionately affected	No disproportionality identified.	No disproportionality identified.	No disproportionality identified.
Cost			
Estimated cost of alternatives	$191M capital; $15M annual; $0.53 per 1,000 gallons	None	$398M capital, $46M annual; $1.65 per 1,000 gallons

ACRONYMS AND ABBREVIATIONS

(AAFCU)	average annual functional capacity unit
(AAHU)	Average Annual Habitat Unit
(ac-ft, or AF)	acre-feet
(ACHP)	Advisory Council on Historic Preservation
(AFY)	acre-feet per year
(ANRA)	Angelina & Neches River Authority
(APE)	Area of Potential Effect
(BMP)	Best Management Practice
(BOD)	5- day biochemical oxygen demand
(BTA)	Big Thicket Association
(CEA)	cumulative effects analysis
(CFR)	Code of Federal Regulations
(cfs)	cubic feet per second
(CR)	County Road
(dBA)	decibels, A-weighted
(DO)	dissolved oxygen
(DWU)	Dallas Water Utilities
(EIS)	Environmental Impact Statement
(EPA)	U. S. Environmental Protection Agency
(FCI)	functional capacity index
(FCU)	functional capacity unit
(FHWA)	Federal Highway Administration
(FM)	Farm-to-Market road
(FNI)	Freese and Nichols, Inc.
(GAM)	Groundwater Availability Model
(GLO)	General Land Office
(gpm)	gallons per minute
(GWQ)	groundwater quality
(HEP)	Habitat Evaluation Procedure
(HESI)	Horizon Environmental Services, Inc.
(HGM)	Hydrogeomorphic Model
(HSI)	Habitat Suitability Index
(HU)	Habitat Unit
(IBI)	index of biotic integrity
(IO)	isolated occurrence
(LAN)	Lockwood, Andrews & Newnam, Inc.
(MCL)	maximum contaminant level
(MCW)	Mud Creek watershed
(MCWD)	Mud Creek watershed downstream of dam site
(MCWU)	Mud Creek watershed upstream of dam site
(mgd)	million gallons per day
(mg/L)	milligrams per liter
(MOA)	Memorandum of Agreement

(MSL)	mean sea level
(NAC)	Noise Abatement Criteria
(NAGPRA)	Native American Graves Protection and Repatriation Act
(NEPA)	National Environmental Policy Act of 1969
(NETMWD)	Northeast Texas Municipal Water District
(NGVD)	National Geodetic Vertical Datum
(NHPA)	National Historic Preservation Act
(NNL)	National Natural Landmark
(NPS)	National Park Service
(NRHP)	National Register of Historic Places
(NRIS)	National Register Information System
(NRNL)	National Register of National Landmarks
(OSHA)	Occupational Safety & Health Administration
(OVN)	overnight visitors
(PA)	Programmatic Agreement, or Permit Area
(PEP)	Population Estimates Program
(PMF)	probable maximum flood
(PMFL)	probable maximum flood level
(RCT)	Railroad Commission of Texas
(RCW)	red-cockaded woodpecker
(RF)	return flow
(RFFA)	reasonably foreseeable future action
(RJBCO)	R. J. Brandes Company
(ROW)	right-of-way
(SAE)	Society of Automotive Engineers
(SAL)	State Archeological Landmark
(SDP)	Shoreline Development Plan
(SDA)	shoreline development area
(SH)	State Highway
(SOW)	Scope of work
(SPI)	Schaumberg & Polk, Inc.
(SWPPP)	Storm Water Pollution Prevention Plan
(SWQ)	surface water quality
(SWUS)	surface waters of the United States
(TAC)	Texas Administrative Code
(TARL)	Texas Archeological Research Laboratory
(TCEQ)	Texas Commission on Environmental Quality
(TCP)	Traditional Cultural Property
(TDWR)	Texas Department of Water Resources (TCEQ predecessor)
(T/E)	threatened or endangered
(THC)	Texas Historical Commission
(TMDL)	Total Maximum Daily Load
(TNHP)	Texas Natural Heritage Program
(TNRCC)	Texas Natural Resource Conservation Commission (TCEQ predecessor)
(TPWD)	Texas Parks and Wildlife Department
(TRA)	Trinity River Authority

(TRWD)	Tarrant Regional Water District
(TSS)	total suspended solids
(TWC)	Texas Water Commission (TCEQ predecessor)
(TWDB)	Texas Water Development Board
(TxDOT)	Texas Department of Transportation
(UAA)	use attainability analysis
(µg/L)	micrograms per liter
(US)	United States
(USACE)	U. S. Army Corps of Engineers
(USBR)	U.S. Bureau of Reclamation
(USDA)	U.S. Department of Agriculture
(USEPA)	U.S. Environmental Protection Agency
(USFWS)	U.S. Fish and Wildlife Service
(USGS)	U.S. Geological Survey
(WAA)	wetland assessment area
(WAM)	Water Availability Model
(WUG)	Water User Group
(WSC)	water supply corporation
(WWTP)	wastewater treatment plant

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1.0 INTRODUCTION

1.1 LEAD FEDERAL AGENCY'S RESPONSIBILITY AND LEGISLATIVE AUTHORITY

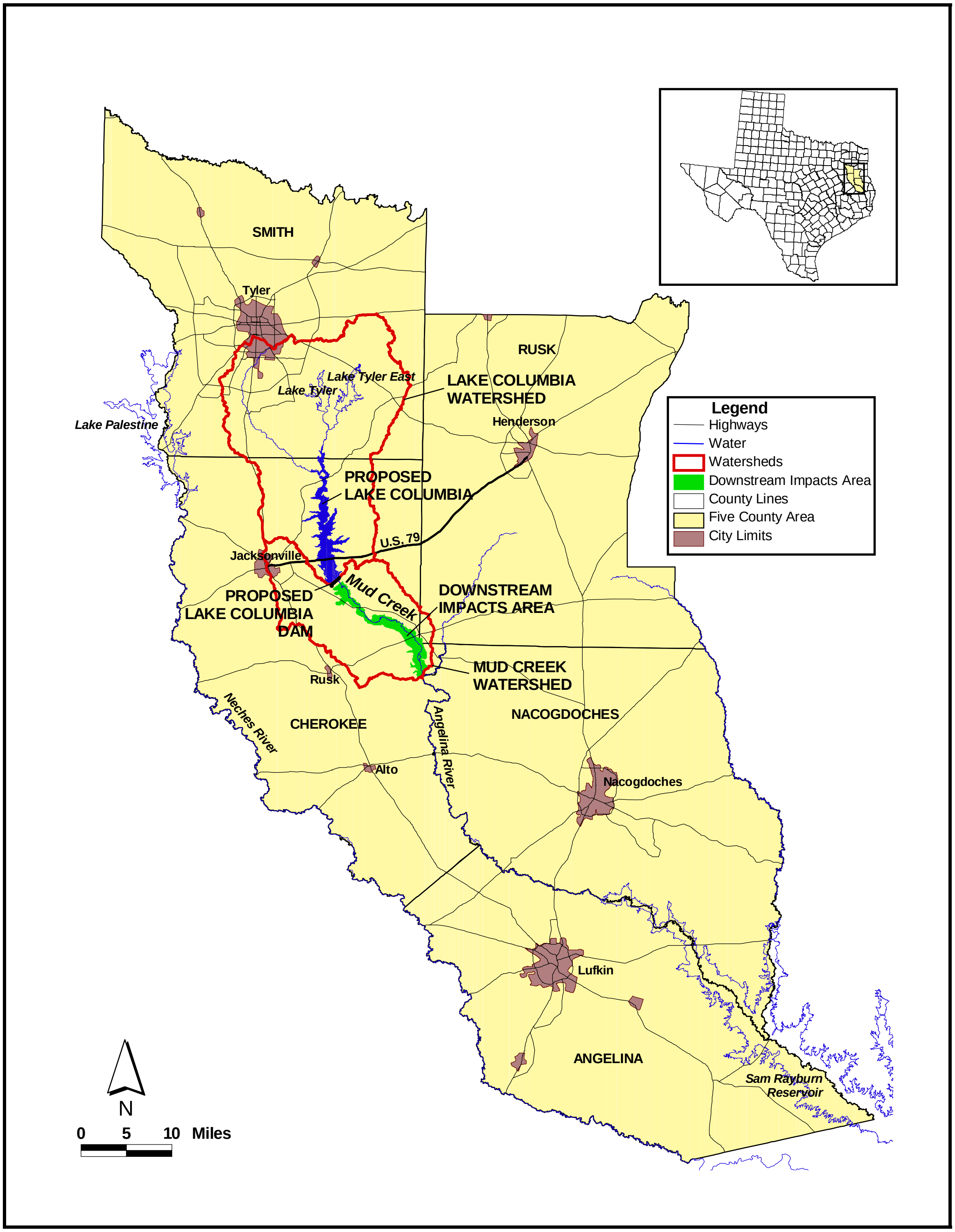
The Angelina & Neches River Authority (ANRA) proposes to construct, operate, and maintain a dam and reservoir known as Lake Columbia (the "Project") on Mud Creek, a tributary of the Angelina River, in Cherokee and Smith Counties, Texas (Figures 1.1-1 and 1.1-2). The proposed Project requires authorization from the U. S. Army Corps of Engineers (USACE) to discharge approximately 672,000 cubic yards of dredged and fill material into the waters of the United States (U.S.) under Section 404 of the Clean Water Act, and for work affecting navigable waters of the U.S. under Section 10 of the Rivers and Harbors Act of 1899. Evaluation of a standard individual permit is a federal action subject to review under the National Environmental Policy Act of 1969 (NEPA). Overall this proposal would result in impacts to approximately 5,746.5 acres of waters of the U.S. The USACE has determined that the permit decision is a major federal action with the potential to significantly affect the quality of the human environment. Under the provisions of NEPA and the Council on Environmental Quality's implementing regulations (40 CFR 1500-1508), preparation of an Environmental Impact Statement (EIS) is necessary. The USACE published a Notice of Intent to prepare an EIS for the proposed Lake Columbia reservoir in the June 28, 2005 Federal Register, Volume 70, No. 123, page 37094.

1.2 DESCRIPTION OF THE APPLICANT

ANRA, with its offices in Lufkin, Texas, is an agency created by the Texas Legislature under Article 16, Section 59 of the Texas Constitution. It is recognized as an independent governmental agency authorized to construct, maintain, and operate any and all works necessary for the purpose of controlling, storing, and preserving water resources in its 17-county jurisdiction in the Neches River Basin. ANRA receives no tax revenues from the State. ANRA is seeking authorization from the USACE to discharge dredged and fill material associated with construction of Lake Columbia in order to supply surface water for municipal and industrial purposes.

1.3 PROJECT SUMMARY

ANRA began initial planning for Lake Columbia (formerly Lake Eastex or Mud Creek) in 1978. ANRA's early efforts led to the issuance of a water right by the Texas Water Commission in 1985 (Permit to Appropriate State Water No. 4228). This permit authorizes the development and construction of the dam and reservoir on Mud Creek in Cherokee and Smith counties, with capacity to impound up to 195,500 acre-feet of water. The permit also authorizes the diversion of up to 85,507 acre-feet of water per year from the reservoir for municipal and industrial uses.



Note: "Permit Area" includes Proposed Lake Columbia footprint and dam site.

Figure 1.1-1 Project Location Map

Figure 1.1-2 Lake Columbia Topographic Map

The proposed Lake Columbia dam would be constructed on Mud Creek approximately five miles southeast of the city of Jacksonville, in Cherokee County, Texas, approximately three miles downstream from the U.S. Highway 79 bridge over Mud Creek, and approximately 16 miles upstream of the confluence of Mud Creek with the Angelina River. The dam would impact an area of approximately 220 acres and would impound water approximately 14 miles upstream in Cherokee and Smith counties at an average width of approximately 1.1 miles. The reservoir created by the dam would inundate 10,133 acres at the top of the conservation pool, i.e., at an elevation of 315 feet National Geodetic Vertical Datum (NGVD) (FNI, 2003a).

The reservoir would be designed to provide a firm yield of 85,507 acre-feet of water per year for municipal, industrial and power generation customers in Angelina, Cherokee, Nacogdoches, Rusk, and Smith counties (FNI, 2005a). Firm yield is defined as the maximum amount of water that could be withdrawn from the reservoir every year during a repeat of the historical critical drought. For Lake Columbia, the historical critical drought period has been determined to be July 1962 through May 1969 (FNI, 2005a). In accordance with the water right, the lake would contain 195,500 acre-feet of water at the conservation pool elevation of 315 feet (FNI, 2007c).

For purposes of this EIS, the "Permit Area" is defined to include the footprint of the normal conservation pool of the reservoir below elevation 315 feet NGVD and the limits of construction in the vicinity of the dam, or a total of approximately 10,655.5 acres. Other areas of interest discussed in this EIS are also shown on Figure 1.1-1 and include: (1) the "Five-County Area" that encompasses Angelina, Cherokee, Nacogdoches, Rusk, and Smith counties; (2) the "Mud Creek Watershed" above the mouth of the stream; (3) the "Lake Columbia Watershed" above the proposed dam site; and (4) the "Downstream Impacts (or Study) Area", which comprises the existing Mud Creek 100-year floodplain for a distance of approximately 16 miles from below the dam site to the confluence with the Angelina River.

The geographical areas of primary interest with respect to the existing resources addressed in this EIS and the potential impacts of the proposed action are:

- Physiography/Topography, Geology, Soils, Noise, Cultural Resources, Aesthetics: Permit Area
- Groundwater, Climatology/Air Quality, Socioeconomics (including Environmental Justice), Land Use/Recreation: Five-County Area
- Surface Water: Lake Columbia Watershed (above proposed dam site), Downstream Impacts Area
- Ecology (Vegetation, Fish & Wildlife): Permit Area, Downstream Impacts Area
- Cumulative Impacts: Mud Creek Watershed, Five-County Area

1.4 SUMMARY OF PUBLIC SCOPING

One of the important required activities associated with preparation of an EIS is the solicitation and review of public and agency input. This input serves as an integral component of the identification and analysis of potential environmental impacts associated with the proposed action and alternatives. This process of determining the key environmental issues to be addressed in the EIS document is termed "scoping."

The June 28, 2005 Federal Register Notice of Intent included an announcement of a public scoping meeting to be held August 18, 2005 in Jacksonville, Texas. On July 18, 2005, the USACE published and distributed a Public Notice to all interested parties on the USACE's mailing list to inform them about the proposed reservoir, the preparation of the EIS, and the public scoping meeting. At that time, a notice informing the public of the EIS scoping meeting was also published in local newspapers. The formal 60-day comment period related to the Public Notice and the EIS scoping process, as established by the USACE, extended from July 14 through September 18, 2005.

1.4.1 Public Scoping Meeting

On August 18, 2005, the USACE conducted the EIS scoping meeting in Jacksonville, Texas. It is estimated that over 50 people attended. Information was provided describing the proposed action, questions from participants were addressed, and comments were solicited from the interested public. Both written and oral comments were received and recorded.

1.4.2 Agency Scoping Meeting

A special scoping meeting for governmental regulatory and resource agencies was held in Jacksonville, Texas on August 19, 2005. There were representatives of approximately seven agencies attending. Information regarding key aspects of the Project was discussed, and appropriate state and federal agencies provided input regarding the scope and analyses for the EIS.

1.4.3 Comments Received

Ultimately, 80 submissions containing 170 comments were received from the public and agencies. Issues identified during the scoping process that are addressed in this EIS include the following:

- Whether there is need for water in the foreseeable future.
- Water supply availability
- Loss of hydropower revenue downstream resulting from reduced flows.
- Impacts on downstream water rights holders.
- Downstream impacts from changes in hydrology and sediment discharge.

- Appropriateness of proposed areas to mitigate for loss of wetlands as compared to impacted area.
- Effects on waterfowl habitat.
- Effects on threatened and endangered species.
- Effects on organisms, including migratory birds, both in the proposed reservoir and downstream.
- Effect of wetlands created by the reservoir.
- Effects on downstream wetland habitat.
- Cumulative impacts with other projects.
- Locations of unmarked graves.
- Impacts on cultural properties of the Caddo Nation.
- Impacts on Lake Sam Rayburn.
- Impacts to economy of Five-County Area.
- Tax payments to local governments.
- Effects on local property values.
- Shoreline management, including access to the proposed reservoir.
- Impacts on transportation facilities, including required relocations of highways and railroads.

Numerous public comments included opinions or concerns determined to be outside the scope of this EIS. Additionally, some comments included opinions that provided no substantive information to define the scope of the EIS document. Some individuals requested information related to effects on their specific properties including issues associated with timber and/or mineral rights. These are legal issues related to the purchase of land and easements and were not addressed as part of this EIS. Many commenters expressed their favorable or unfavorable opinions regarding the proposed Project with little or no explanation of anticipated effects such opinions have not been addressed in this EIS.

1.5 ORGANIZATION OF THIS EIS

Following this introductory section, Section 2 addresses the purpose and need for the Project. Section 3 presents a description and screening of alternatives to the Project, including a description of ANRA’s Preferred Alternative (Proposed Action) and a summary of impacts with respect to alternatives, including cumulative impacts. Section 4 discusses the affected environment and the environmental consequences of the alternatives, organized by specific resources of potential concern, with specific cumulative impacts also addressed. Section 5 describes the coordination process with the relevant governmental regulatory and resource agencies and the public, and Section 6 lists the preparers of the EIS. Section 7 contains a list of references cited in the text.

2.0 PURPOSE AND NEED

2.1 PURPOSE OF THE PROJECT

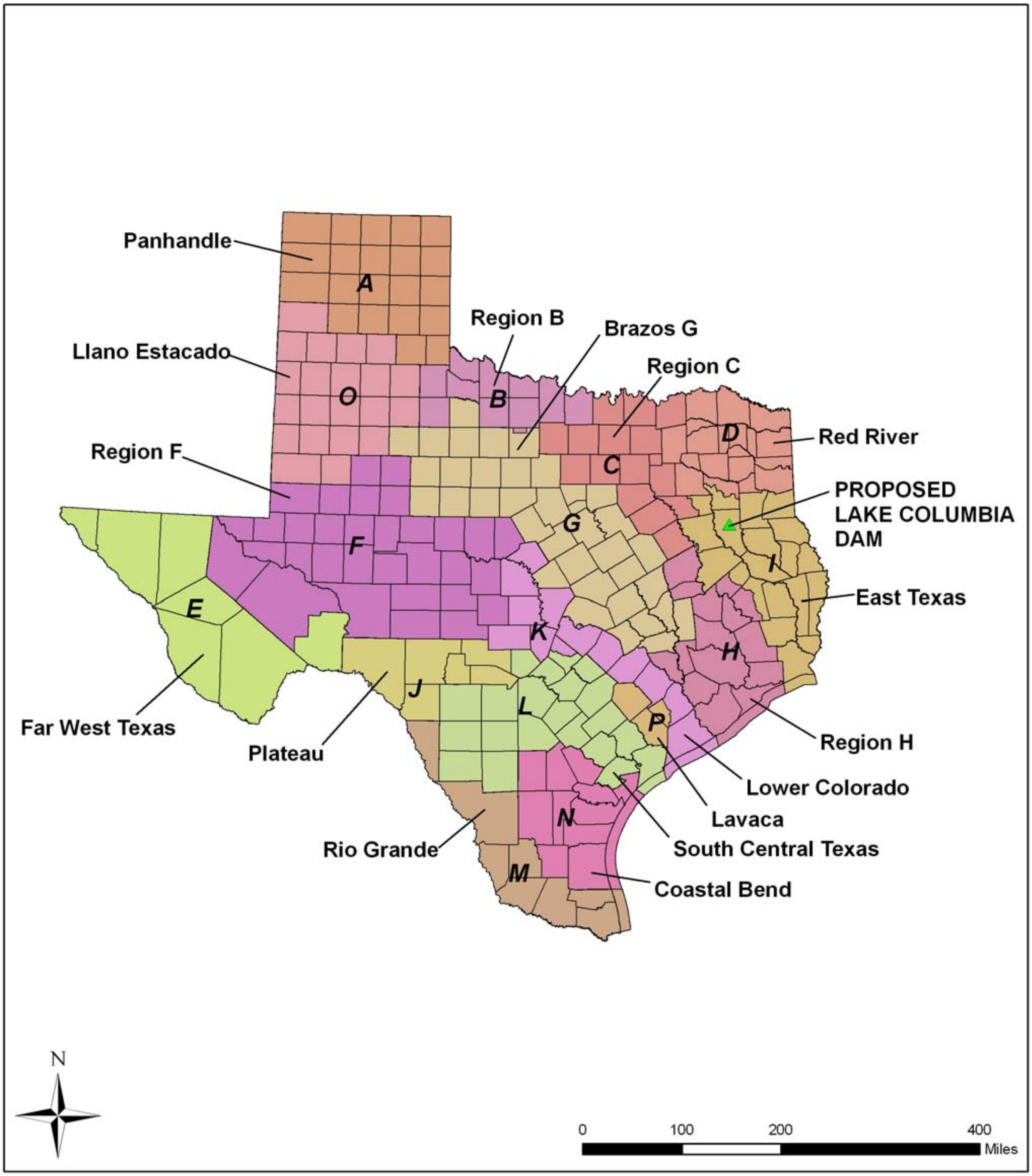
The basic and primary purpose of the proposed Lake Columbia Project is water supply. Specifically, it is to provide an additional water supply for Angelina, Cherokee, Nacogdoches, Rusk, and Smith counties in east Texas ("Five-County Area") to meet projected needs through the year 2060 and beyond. Water from the proposed reservoir would be used primarily to meet future municipal, industrial, and steam electric power demands.

2.2 REGIONAL WATER SUPPLY PLANNING

Pursuant to provisions in Senate Bill 1 (75th Texas Legislature), the Texas Water Development Board (TWDB), the state water planning agency, has divided the state into water planning regions (see Figure 2.2-1), and a group of stakeholders representing broad interests has been appointed in each region to conduct water supply planning studies and to develop water supply plans, often referred to as regional plans. This regional planning process now is in its third 5-year cycle, with the most recent regional plans having been completed in 2006. Each 2006 regional plan incorporates projections of future population growth and associated water demands by decade out to the year 2060 and analyzes the available supplies from existing sources and their ability to meet future water demands. Where future supply shortages have been identified, the regional planning groups, working with local water suppliers within each region, have established new strategies for meeting these projected demand shortages. In some regions, these strategies have involved the construction of new reservoirs to capture and develop new surface water supplies.

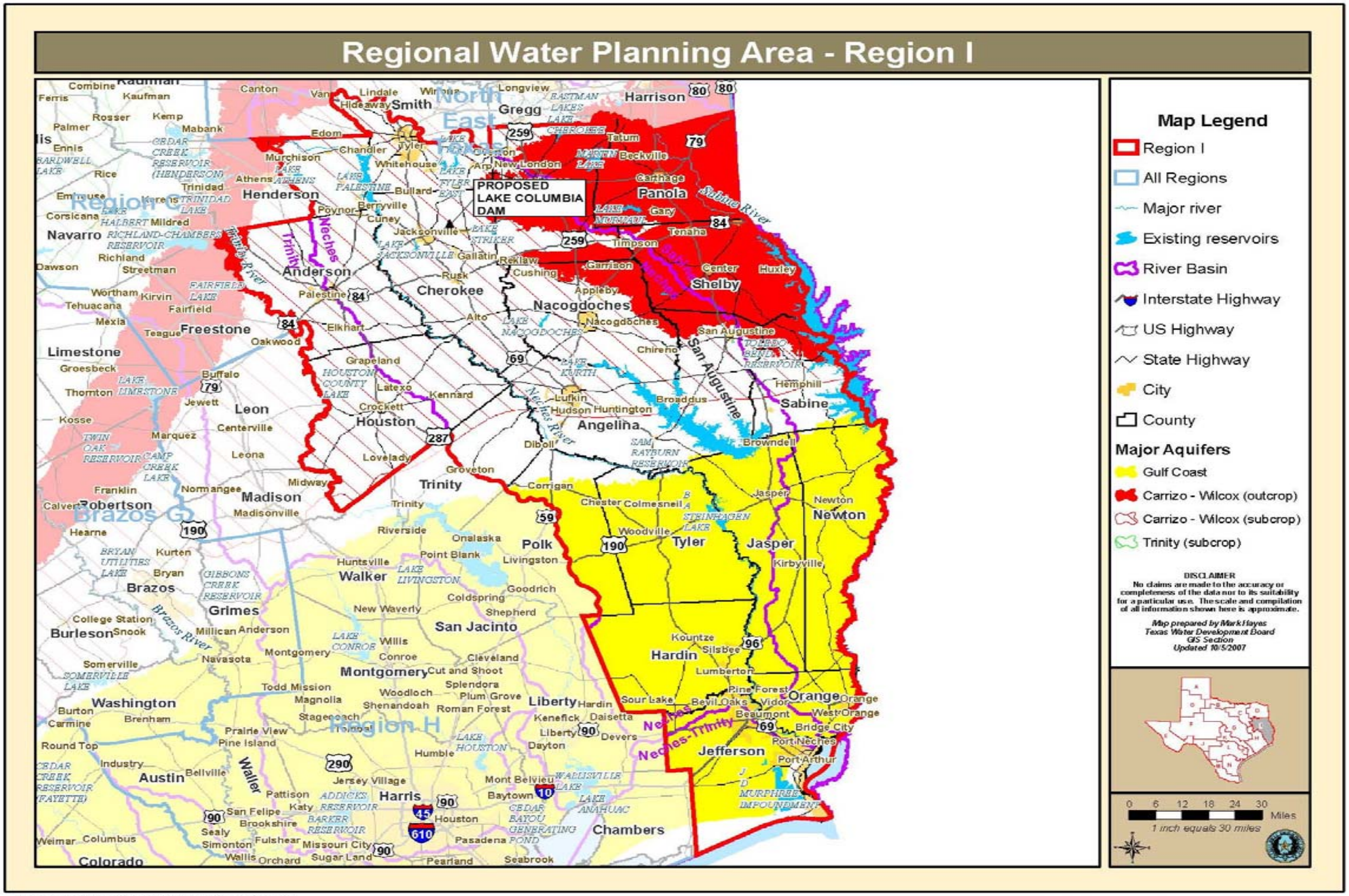
The planning region that includes ANRA's service area and the proposed Lake Columbia is referred to as the East Texas Region and is designated as Region I. The location, jurisdictional boundaries, and primary water features of this region are delineated on the map in Figure 2.2-2. The principal surface water sources in Region I are the Sabine and Neches Rivers and their tributaries. The Angelina River is a major tributary of the Neches. The principal groundwater sources within the region are the Carrizo-Wilcox and Gulf Coast aquifers, with the Carrizo-Wilcox providing the primary supply within the Five-County Area associated with the proposed Lake Columbia Project.

The East Texas Regional Water Planning Group is composed of 21 voting members and 13 non-voting members representing a broad spectrum of water interests throughout the region. This group meets several times each year to coordinate local and regional planning strategies and efforts, and sometimes meets monthly when important water planning activities require discussion and/or decisions. In its deliberations to develop the latest 2006 regional water plan, the East Texas Regional Water Planning Group



Source: TWDB, 2009

Figure 2.2-1 Regional Water Planning Areas



MAP SOURCE: Texas Water Development Board

Source: TWDB, 2009

Figure 2.2-2 East Texas (Region I) Regional Water Planning Area

considered a number of strategies to meet future water supply shortages, including water conservation, wastewater reuse, expanded use of existing supplies, and Lake Columbia.

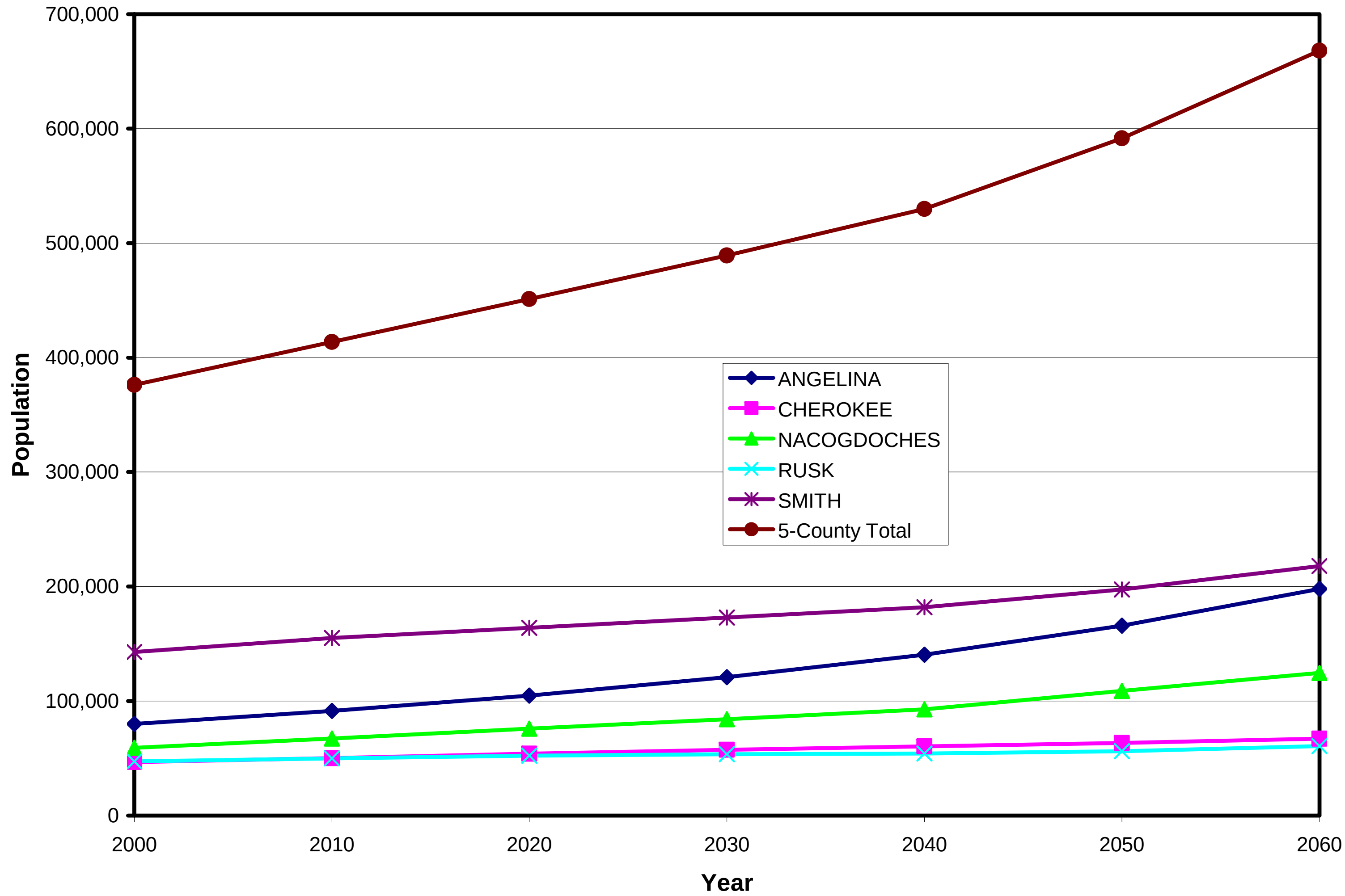
The studies and planning conducted by regional planning groups such as the East Texas Regional Planning Group are considered to be the official source for establishing future water supply needs within the state and for identifying strategies to meet those needs. It is the results from these regional planning efforts that form the basis for the State Water Plan that is developed by the Texas Water Development Board (TWDB) every five years pursuant to the requirements of Senate Bill 1. Hence, to a large extent, the information compiled and evaluated by the East Texas Regional Planning Group in preparing the Region I regional plan provides the foundation for establishing the need for the proposed Lake Columbia Project.

2.3 NEED FOR THE PROJECT

The population of the Five-County Area associated with Lake Columbia (see Figure 1.1-1) was approximately 380,000 in 2000. It is projected to increase by about 76% to 670,000 by 2060. Population projections for this area based on data from the Region I regional plan are shown in Figure 2.3-1. These population projections originally were made by the TWDB specifically for the regional water planning process, and they formed the basis for the municipal and industrial water demand projections used by the East Texas Regional Planning Group in evaluating the adequacy of existing water supplies for purposes of developing the 2006 regional plan.

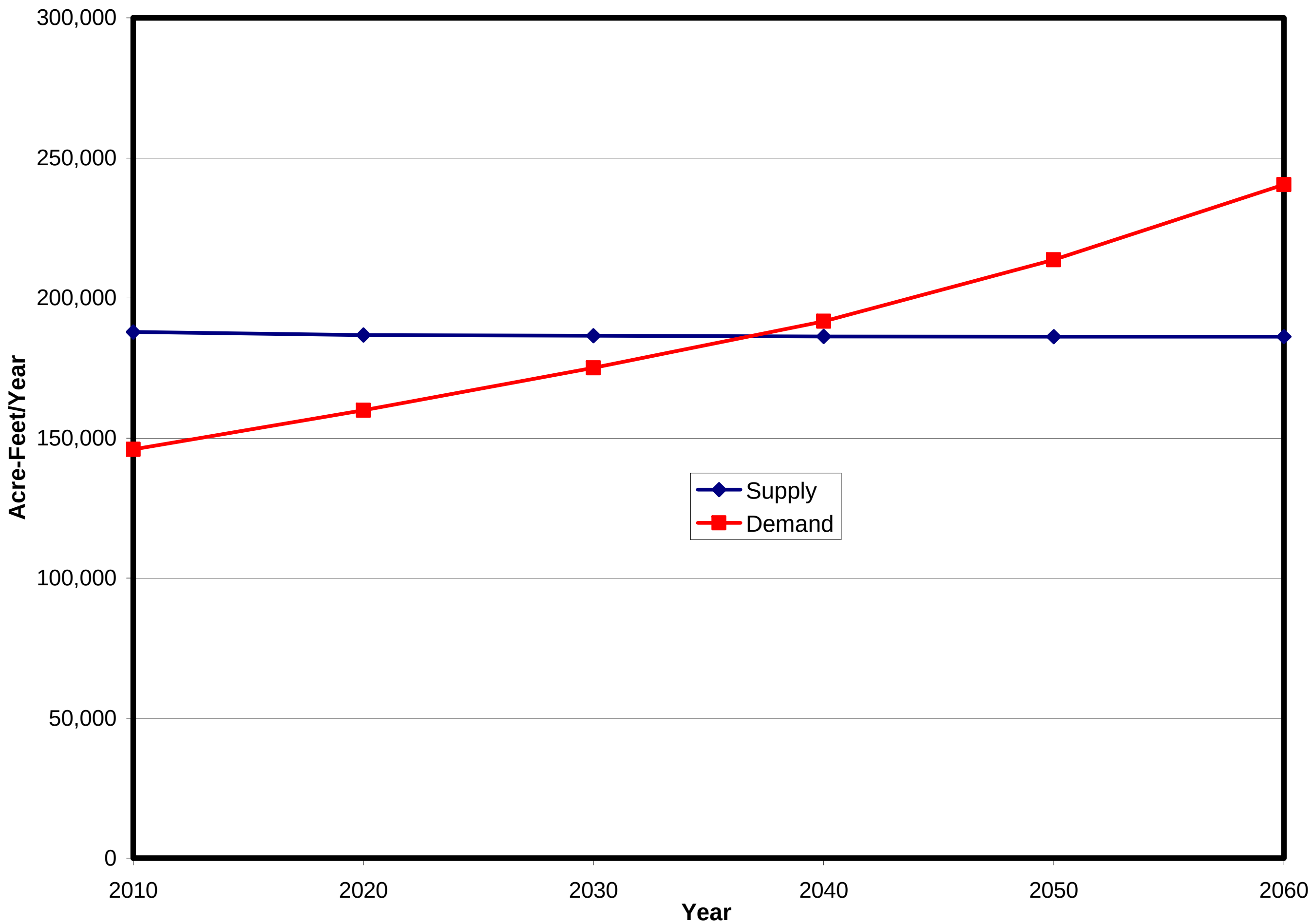
Data from the 2006 Region I Plan show that the projected total water demand for municipal, manufacturing, and steam electric uses in the Five-County Area will exceed the existing available supply some time between 2030 and 2040. This is illustrated by the graph in Figure 2.3-2, which reflects the total demands and supplies of all entities that supply and consume water in the five counties for municipal, manufacturing, and steam electric purposes.

However, not all entities that supply and consume water in the five counties are expected to experience shortages between 2030 and 2040. Some of these entities, which are referred to as “water user groups” (WUGs) in the regional plans, have surplus supplies, which partially offset the shortages of other WUGs when the total demands and supplies are considered as in Figure 2.3-2. Surplus water is owned and controlled by the individual WUGs and generally is not available to other WUGs with projected shortages. There are 25 WUGs in the five counties that are projected to have shortages that cannot be met by existing infrastructure and supplies. Total shortages for these WUGs by county over the 2010-2060 planning horizon are plotted on the graph in Figure 2.3-3. These WUGs are listed individually in Table 2.3-1 with their projected shortages noted by decade through 2060. As shown, the total shortage for the Five-County Area is projected to be approximately 68,000 acre-feet by 2060. Most of the shortages are for steam electric use. While not all of the WUGs with shortages in the Five-County Area are Lake Columbia participants, Lake Columbia is a recommended strategy in the 2006 Region I Plan that represents a regional supply that could potentially help meet the overall projected shortages.



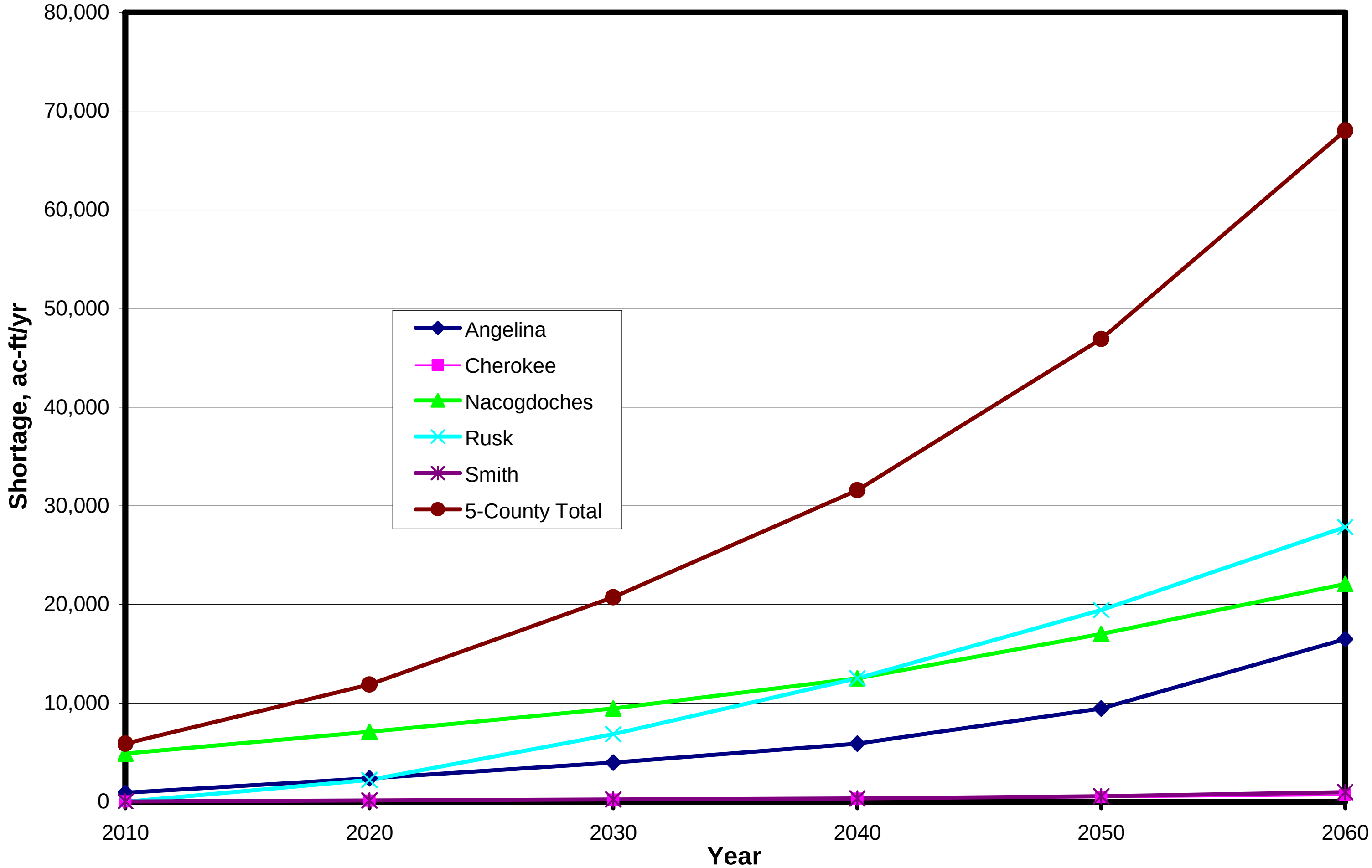
Source of data: TWDB, 2007b

Figure 2.3-1 Population Projections for Angelina, Cherokee, Nacogdoches, Rusk, and Smith Counties



Source of data: SPI, 2006

Figure 2.3-2 Municipal, Manufacturing, and Steam Electric Supply and Demand Angelina, Cherokee, Nacogdoches, Rusk, and Smith Counties



Source of data: SPI, 2006

Figure 2.3-3 Shortages for Municipal, Manufacturing, and Steam Electric Water User Groups (WUGs)

Table 2.3-1 Municipal, Manufacturing, and Steam Electric Water User Groups With Projected Water Supply Shortages

Water User Group	County	Projected Shortages (acre-feet per year)					
		2010	2020	2030	2040	2050	2060
County-Other	Angelina	30	127	251	411	709	1,143
Diboll	Angelina	32	187	374	618	965	1,441
Four Way WSC	Angelina	0	0	0	0	0	225
Hudson	Angelina	41	194	393	630	980	1,444
Hudson WSC	Angelina	0	108	242	435	698	1,066
Lufkin	Angelina	827	1,748	2,725	3,805	5,104	6,657
Manufacturing [a]	Angelina	0	0	0	0	995	4,504
SUBTOTAL	**Angelina**	**930**	**2,364**	**3,985**	**5,899**	**9,451**	**16,480**
Manufacturing	Cherokee	20	65	107	148	187	244
New Summerfield [a]	Cherokee	0	44	88	124	165	213
Rusk [a]	Cherokee	0	0	0	42	116	212
SUBTOTAL	**Cherokee**	**20**	**109**	**195**	**314**	**468**	**669**
Appleby WSC	Nacogdoches	0	0	0	0	183	458
County-Other [a]	Nacogdoches	0	0	0	0	0	291
Lilly Grove SUD	Nacogdoches	0	0	94	205	435	677
Manufacturing	Nacogdoches	0	0	243	578	1,024	1,431
Nacogdoches [a]	Nacogdoches	0	0	804	1,906	3,616	5,175
Steam Electric	Nacogdoches	4,828	6,911	8,079	9,504	11,241	13,358
Swift WSC	Nacogdoches	78	162	235	325	498	688
SUBTOTAL	**Nacogdoches**	**4,906**	**7,073**	**9,455**	**12,518**	**16,997**	**22,078**
Steam Electric	Rusk	0	2,218	6,862	12,522	19,423	27,834
SUBTOTAL	**Rusk**	**0**	**2,218**	**6,862**	**12,522**	**19,423**	**27,834**
Bullard	Smith	0	13	42	71	124	195
Community Water Co.	Smith	37	88	111	132	171	227
Dean WSC	Smith	0	21	68	112	200	328
Jackson WSC [a]	Smith	0	0	0	0	28	68
Lindale	Smith	0	0	0	8	33	59
Lindale Rural WSC	Smith	0	0	0	0	0	73
R P M WSC	Smith	0	0	0	0	1	6
SUBTOTAL	**Smith**	**37**	**122**	**221**	**323**	**557**	**956**
5-COUNTY TOTAL SHORTAGES		**5,893**	**11,886**	**20,718**	**31,576**	**46,896**	**68,017**

[a] Current Lake Columbia participant

Source: SPI, 2006

Groundwater is not recognized in the 2006 Region I Plan as a viable strategy for satisfying all of the projected future demands. Groundwater Conservation Districts regulate pumping in four of the five counties (excluding Smith), and additional withdrawals are limited. TWDB studies indicate that there is insufficient groundwater of suitable quality available to meet all of the projected shortages. The current source of supply for municipal, manufacturing, and steam electric uses in the Five-County Area comprises approximately 40% groundwater and 60% surface water. The TWDB Queen City/Sparta/Carrizo Wilcox Groundwater Availability Model (GAM) was used in the 2006 Region I Plan to analyze regional groundwater availability (TWDB, 2004). To maintain an acceptable level of aquifer sustainability, groundwater availability for the planning period was defined as the amount of groundwater that could be withdrawn over the next 50 years that would not cause more than 50 feet of water level decline (or more than a 10% decrease in the saturated thickness in outcrop areas). In Smith County, the GAM indicated that even current demands could not be met with available supplies based on the above criteria, as groundwater is already being over-drafted. In Cherokee County, the Carrizo-Wilcox aquifer is almost fully allocated, and the Queen City-Sparta is unreliable and of poor quality in some areas. In Angelina County, the Yegua and Carrizo-Wilcox aquifers have limited capacity for expanded development. In Nacogdoches County, steam electric demands and the City of Nacogdoches both have significant projected needs that cannot be met by groundwater (SPI, 2006).

Texas Commission on Environmental Quality (TCEQ) rules (30 TAC §290.45 – Texas Administrative Code, Minimum Water System Capacity Requirements) require that groundwater-based community water systems have a minimum well capacity of 0.6 gallons per minute (gpm) per connection. ANRA has performed analyses based on historical and projected groundwater supply and demand for WUGs in the Five-County Area (ANRA, 2007a). Based on historical data from the TCEQ Water Utilities Data Base and ANRA's projections on the number of connections, many WUGs will not be able to provide groundwater at that minimum capacity in the future.

Lake Columbia has been identified in the 2006 Region I Plan (SPI, 2006) as a recommended water supply strategy for various WUGs within the Five-County Area. Lake Columbia is the only reservoir recommended as a strategy for meeting needs in Region I. ANRA's commitments to supply water from Lake Columbia to these and other WUGs, as presented in the 2006 Region I Plan, are shown in Table 2.3-2. The values in the table represent the contractual supply amounts for the Lake Columbia participants. At this time, the total contracted amount is 53,869 acre-feet per year.

There are 18 entities in the Five-County Area that are currently participants in the Lake Columbia Project to the extent of a combined 63-percent share, as shown in Table 2.3-3. These entities comprise cities, water supply corporations, Cherokee County, and an industry, Temple-Inland Corporation. It should be noted that in 2009, the Texas Legislature passed HB 3861 that authorized the Texas Water Development Board to participate in the Lake Columbia Project for the uncommitted share. Many of the local participants have expressed a desire to secure alternative water sources and reduce their reliance on groundwater because of increasing problems with groundwater quality and

Table 2.3-2 Region I Contractual Water Needs for Lake Columbia Service Area

ANRA (Units: Acre-Feet per Year)							2006 Water Plan East Texas Region
Current Customers	**% Yield**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Angelina County Manufacturing (Temple Inland)	10.0%	8,551	8,551	8,551	8,551	8,551	8,551
Cherokee County-Other	4.5%	3,848	3,848	3,848	3,848	3,848	3,848
City of Jacksonville	5.0%	4,275	4,275	4,275	4,275	4,275	4,275
City of New Summerfield	3.0%	2,565	2,565	2,565	2,565	2,565	2,565
North Cherokee WSC	5.0%	4,275	4,275	4,275	4,275	4,275	4,275
City of Rusk	5.0%	4,275	4,275	4,275	4,275	4,275	4,275
Rusk Rural WSC	1.0%	855	855	855	855	855	855
Nacogdoches County-Other	0.5%	428	428	428	428	428	428
City of Nacogdoches	10.0%	8,551	8,551	8,551	8,551	8,551	8,551
City of New London	1.0%	855	855	855	855	855	855
City of Troup	5.0%	4,275	4,275	4,275	4,275	4,275	4,275
City of Arp	0.5%	428	428	428	428	428	428
Smith County-Other	1.0%	855	855	855	855	855	855
Jackson WSC	1.0%	855	855	855	855	855	855
City of Whitehouse	10.0%	8,551	8,551	8,551	8,551	8,551	8,551
Total Demand	**62.5%**	**53,442**	**53,442**	**53,442**	**53,442**	**53,442**	**53,442**
Potential Future Customers							
Nacogdoches County Steam Electric Power		4,828	6,911	8,079	9,504	11,241	13,358
Total Demand Current and Future Customers		**58,270**	**60,353**	**61,521**	**62,946**	**64,683**	**66,800**
Current Supplies	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Lake Columbia		0	0	0	0	0	0
Total Supplies		**0**	**0**	**0**	**0**	**0**	**0**
Supplies Less Current Customer Demand		**-53,442**	**-53,442**	**-53,442**	**-53,442**	**-53,442**	**-53,442**
Supplies Less Current and Potential Customer Demand		**-58,270**	**-60,353**	**-61,521**	**-62,946**	**-64,683**	**-66,800**

Source: SPI, 2006, Chapter 4A, Appendix B. Note: City of Alto in Cherokee County is currently a 0.5% participant in the Project, but was not at the time the Region I plan was prepared, and therefore is not reflected in this table. Total demand is currently 63.0% of yield, or 53,869 acre-feet/year.

limited supply. ANRA has stated that other entities may join the Project at a later date. As a wholesale water provider, ANRA is projected to have a shortage of 53,869 acre-feet/year by 2060 considering only the current Project participants, or 66,800 acre-feet/year including potential future customers within the Five-County Area. ANRA has contractual demands projected to begin in 2010. ANRA currently has no available water supply, and Lake Columbia is the recommended strategy identified in the Region I Plan to meet this shortage.

As presented in the 2006 Region C (North Texas) Plan (FNI, 2006c), Dallas Water Utilities (DWU), which is in the North Texas planning region, has listed Lake Columbia as a potential alternative water supply strategy. Specifically, DWU is considering entering into a contract with ANRA for 35,800 acre-feet of water per year from Lake Columbia and delivering this water to the DWU service area through a proposed pipeline from Lake Palestine. Lake Columbia is approximately 20 miles from Lake Palestine.

Table 2.3-3 Lake Columbia Participants

Participant	County	% Participation
Afton Grove WSC	Cherokee	1.0
Alto, City of	Cherokee	0.5
Arp, City of	Smith	0.5
Blackjack WSC	Cherokee	1.0
Caro WSC	Nacogdoches	0.5
Cherokee County	Cherokee	3.0
Jackson WSC	Smith	1.0
Jacksonville, City of	Cherokee	5.0
Nacogdoches, City of	Nacogdoches	10.0
New London, City of	Rusk	1.0
New Summerfield, City of	Cherokee	3.0
North Cherokee WSC	Cherokee	5.0
Rusk, City of	Cherokee	5.0
Rusk Rural WSC	Cherokee	1.0
Stryker Lake WSC	Cherokee	0.5
Temple-Inland Corp.	Angelina	10.0
Troup, City of	Smith	5.0
Whitehouse, City of	Smith	10.0
Total		**63.0**

Source: ANRA, 2009a

In summary, the above discussion demonstrates that in the Five-County Area:

- Total water demand is projected to exceed supply between 2030 and 2040.
- Water User Groups (WUGs) with supply shortages are projected to have a total shortage of 68,000 acre-feet per year by 2060. Some of these WUGs are Lake Columbia participants.
- Groundwater is not recognized in the 2006 Region I Plan as a viable strategy for satisfying all of the projected future needs.
- Some WUGs with groundwater-based community water systems will not be able to provide groundwater at the TCEQ-required minimum capacity in the future.
- Lake Columbia has been identified in the 2006 Region I Plan as a recommended water supply strategy for various WUGs within the Five-County Area.
- ANRA has contracts with local entities and water user groups for 53,869 acre-feet per year from Lake Columbia.
- Dallas Water Utilities is considering contracting with ANRA for 35,800 acre-feet of water per year from Lake Columbia.

Based on an independent evaluation, the USACE has determined the information presented in the Region I plan appears to be reasonable.

3.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

3.1 INTRODUCTION

This section discusses the alternatives available to the USACE with regard to the permit application for Lake Columbia (Proposed Action) and to ANRA for potentially supplying water to meet the municipal, manufacturing, and power generation needs of water users in the Five-County Area, including the needs of ANRA's wholesale water customers. The water supply alternatives include the No Action alternative, the proposed Lake Columbia alternative, and the Toledo Bend Pipeline alternative. This section also discusses a variety of water supply alternatives that have been considered, but that have been rejected as infeasible for one or more reasons, including environmental, technological, economic, and legal considerations; these infeasible alternatives are not analyzed in detail. Table 3.1-1 summarizes all of the water supply alternatives considered and lists their general advantages and disadvantages and reasons for elimination from consideration, if applicable.

In the early 1990s, ANRA initially conducted a comprehensive water planning study to identify potential water supply alternatives for the region (LAN, 1991a). All existing water supply reservoirs in the Sabine, Trinity, and Neches River Basins were evaluated for suitability to meet the projected water demands of the Five-County Area. In the Sabine and Trinity, only Toledo Bend Reservoir had uncommitted water available. An alternative comprising a pipeline from Toledo Bend Reservoir to serve the Five-County Area is included in this EIS. In the Neches River Basin, Lakes Sam Rayburn/B.A. Steinhagen and Palestine were the only lakes with significant supplies of uncommitted water. Expanded use of groundwater was also considered as a means to meet future demands. Various potential new reservoirs in addition to Lake Columbia were also evaluated in the LAN study. Of those, only Little Cypress Reservoir was considered; however, Little Cypress now is no longer being pursued.

The 2006 Region I Plan considered water conservation, wastewater reuse, expanded use of existing supplies including groundwater, and potential new reservoirs as water supply strategies for meeting future demands in the planning region. Lake Columbia was recommended as one of the water supply strategies (SPI, 2006).

3.2 ALTERNATIVES AVAILABLE TO USACE

The USACE has determined that the Proposed Action would require authorization under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act (see Section 1.1). There are three alternatives available to the USACE: 1) issue the permit, 2) issue the permit with special conditions, or 3) deny the permit. Permit denial is referred to as the No Action alternative.

Table 3.1-1 Summary of Alternatives Considered

Alternative	Key Advantages	Key Disadvantages	Reason for Elimination from Consideration, if Applicable
Alternatives Considered in Detail			
No Action	• Has no environmental impacts associated with new surface water development project • Requires no capital investment	• Does not provide needed water supply • Water demand shortages would not be satisfied	• Fails to meet purpose and need – retained as mandated under NEPA regulations
Lake Columbia (Proposed Action)	• Provides sufficient water to offset demand shortages • Provides water at lowest cost - $0.53 per 1,000 gallons • Economic stimulus to area • State water right permit has been issued	• Various adverse environmental impacts	• Retained for analysis as the Proposed Action, as it meets the purpose and need
Pipeline from Toledo Bend Reservoir	• Adequate water available to meet projected demands • Avoids construction of new surface water reservoir project	• Requires 86-mile pipeline, with 13 miles through Sabine Nat'l. Forest • High cost of water - $1.65 per 1,000 gallons • Requires booster pump stations and terminal storage reservoir • Subject to TCEQ inter-basin transfer rules • Requires amendment of state water right permit • Various adverse environmental impacts	• Retained for analysis, as it meets the purpose and need
Alternatives Considered but Eliminated from Detailed Analysis			
Groundwater	• Avoids construction of new surface water reservoir project • Has minimal environmental impacts associated with new surface water project • Where available, supplies are in	• Insufficient water available to meet future demands • Water quality poor in some areas	• Fails to meet purpose and need so eliminated from consideration

Alternative	Key Advantages	Key Disadvantages	Reason for Elimination from Consideration, if Applicable
	close proximity to needs		
Sam Rayburn Reservoir Flood Pool Reallocation	• Provides sufficient water to offset demand shortages	• Requires reallocation of flood storage to conservation storage • Reallocation of storage requires Congressional action • Requires amendment of state water right permit • Requires 76-mile pipeline with associated environmental impacts • Major environmental impacts associated with raising pool	• Reallocation of flood pool would not be practicable
B.A. Steinhagen Reservoir	• Provides sufficient water to offset demand shortages	• State water right does not currently permit this • Farthest distance, requires very long pipeline	• Highest cost • Complicated water rights issues
Lake Palestine	• Eliminates impacts of L. Columbia	• Insufficient uncommitted water • Dallas likely to claim uncommitted water	• Fails to meet purpose and need
Alternative Dam Sites	• None	• Potential impacts from geologic faults and wastewater discharges	• Proposed Lake Columbia site determined to be best site of those evaluated

3.3 WATER SUPPLY ALTERNATIVES

3.3.1 No Action Alternative

Under the No Action alternative, the USACE would deny a permit for the proposed action. As such, Lake Columbia would not be constructed, and the potential impacts to the human or natural environment associated with the Proposed Action would not occur.

Implementation of the No Action alternative would not meet the defined purpose and need for the Project, since projected water demand shortages would not be satisfied. However in accordance with Section 404(b)(1) and 40 CFR 1502.14(d), the No Action alternative must be addressed in the EIS process and serves as a basis for comparison of the environmental impacts among alternatives. Additionally under the Section 404(b)(1) guidelines the USACE may render a favorable decision on an individual permit only if such a decision is in the public interest and the proposed project represents the least environmentally damaging practicable alternative.

The No Action alternative does not mean that there would be no impacts. No Action would mean that existing water resources would continue to be used, and expanded if possible. This would particularly apply to groundwater, as existing surface water supplies have little additional water available for future use. However, as discussed in Sections 2 and 4.4, additional groundwater resources to meet projected needs are not widely available in the region. Expanded groundwater extraction could result in excessive aquifer drawdown. With the No Action alternative, some projected demand shortages in the Five-County Area would remain unsatisfied.

3.3.2 Toledo Bend Reservoir Pipeline

The approximate proposed alignment of this alternative is depicted on Figure 3.3-1. This alternative would involve construction of a large-diameter pressure pipeline approximately 86 miles in length extending from the upper part of Toledo Bend Reservoir on the Sabine River generally westward to a terminal reservoir located near the proposed Lake Columbia site in the Neches Basin. EPA performed an analysis of this alternative in 2003 and determined the project would require a 66-inch diameter pipeline originating at Toledo Bend Reservoir, with a decrease in size in the downstream direction to a terminal point in the Neches Basin (EPA, 2003). They estimated the cost of this alternative at $0.69/1,000 gallons. The EPA analysis is contained in Appendix A.

An evaluation of this proposal by the applicant's consultant, Freese & Nichols, Inc. (FNI), concluded that the EPA cost estimates are low and do not comply with standards used for a project of this type. They state that a 72-inch diameter pipeline would be required along the entire route, stating, "[Moving from larger to smaller pipelines] is not standard practice and would have impacts to the life cycle costs of the transmission system." (FNI, 2007b). Freese & Nichols' analysis of this alternative is contained in Appendix B. An intake structure and pump station would be required at Toledo Bend, and two booster pump stations would be necessary to convey water along the route (EPA,

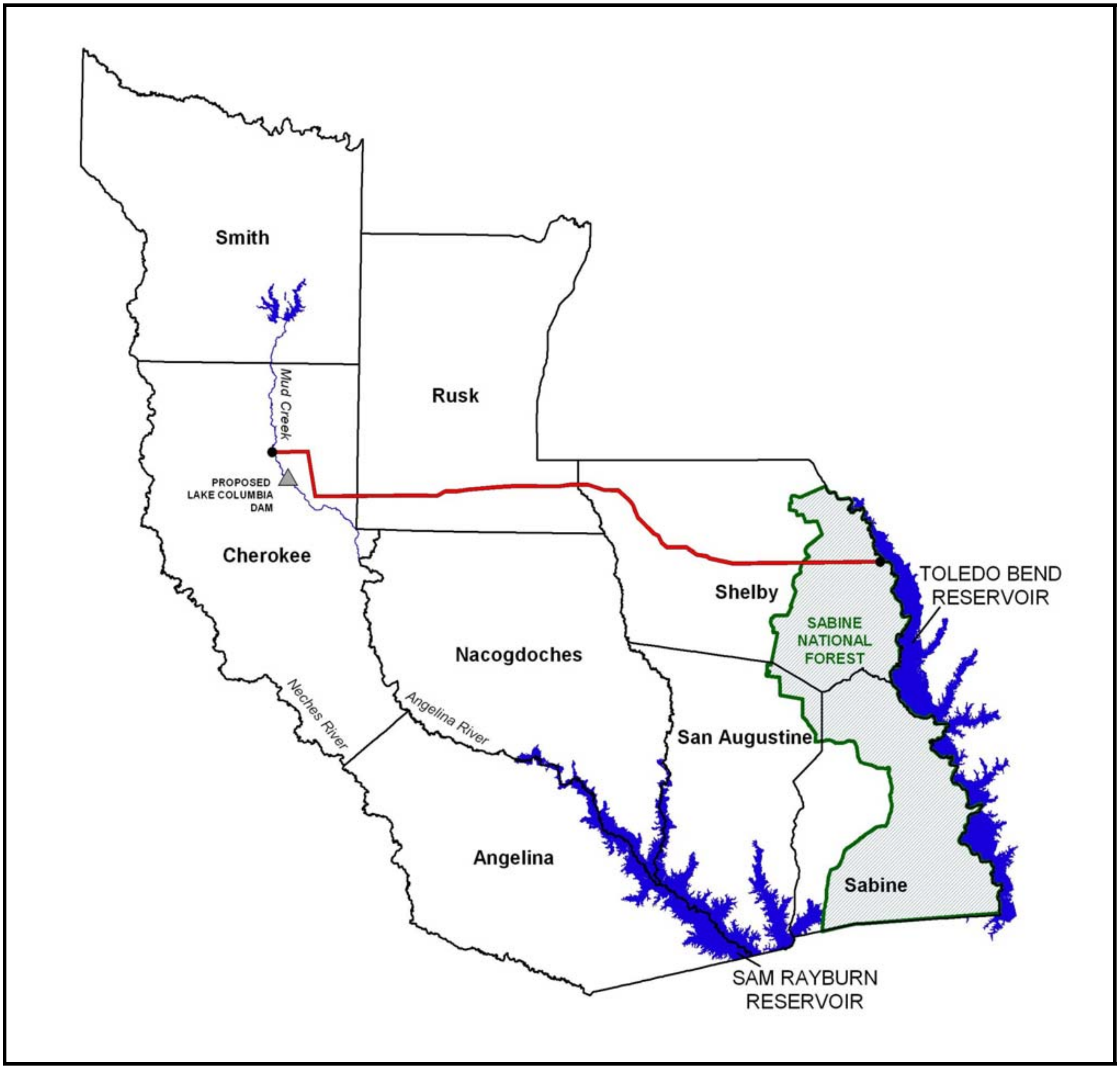


Figure 3.3-1 Toledo Bend Reservoir Pipeline Alternative

2003). However, FNI stated that inadequate right-of-way was included in the EPA estimate, as discussed below, and more significantly, a terminal reservoir that would likely occupy several hundred acres, would be required at the receiving end of the pipeline (FNI, 2007b). The exact size and location of the intake, pumping stations, and terminal reservoir have not been determined. The pipeline and associated facilities would be capable of delivering 85,507 acre-feet of Toledo Bend water per year to the Five-County Area. This delivery would involve an inter-basin transfer of water (from the Sabine Basin to the Neches Basin) and would require special authorization from TCEQ and amendment of the applicant's water right permit. The cost of water from the Toledo Bend Pipeline alternative as determined by FNI ($1.65/1,000 gallons) is estimated to be more than three times that of the proposed Lake Columbia ($0.53/1,000 gallons).

The anticipated pipeline route would be designed to parallel existing highways in most areas, although routes through several cities (Center, Timpson, Mount Enterprise, Reklaw) are not described (EPA, 2003). The intake structure/pump station and approximately the first 13 miles of the pipeline route would be located in the Sabine National Forest. In addition, the EPA analysis considered clearing and land acquisition in right-of-way widths ranging from about 4 to 24 feet. However, a line of this size would likely require a right-of-way of 100 feet in width for construction and 50 feet permanently (Stover, 2007). This could result in disturbance of over 1,000 acres for construction, with a permanent right-of-way of approximately 500 acres.

The pipeline would likely impact sensitive areas including 13 miles of disturbance bisecting the Sabine National Forest and numerous waters of the U.S. including major crossings at the Angelina River, Attoyac Bayou, and Stryker Creek and adjacent wetlands. Approximately one mile of the pipeline would traverse a designated U.S. Fish & Wildlife Service (USFWS) Priority 1 bottomland hardwood preservation area at the confluence of the Angelina River and Stryker Creek at the U.S. Highway 84 crossing (USFWS, 1985). This alternative would impact approximately 12 acres of the Priority 1 area, considering a 100-foot construction right-of-way.

Under the Toledo Bend Pipeline alternative, streams, vegetation, wildlife, and aquatic communities along the 86-mile pipeline route, at the intake structure and pump station on Toledo Bend Reservoir, and in the vicinity of the terminal reservoir at the delivery point in the Neches Basin would be adversely impacted to varying degrees. Approximations of the miles of pipeline traversing different environmental features and of the related acreages assuming a 100-foot construction right-of-way width have been estimated and are presented in a later table in Section 3.3.5 along with similar information for environmental features affected by the proposed Lake Columbia Project.

3.3.3 Alternatives Eliminated from Detailed Analysis

Current information regarding alternatives considered in the EIS process but eliminated from detailed analysis is presented below.

3.3.3.1 Expanded Use of Groundwater

As discussed in Sections 2 and 4.4, current TWDB studies indicate there is additional groundwater available in certain locations within the Five-County Area. However, there is insufficient groundwater of suitable quality available to meet all projected water demand shortages. In some places, groundwater is already being over drafted. There are significant water needs for municipal uses and steam electric generation in the Five-County Area that can only be met with surface water.

3.3.3.2 Sam Rayburn Reservoir Flood Storage Reallocation

The available water supply from Sam Rayburn Reservoir, operated as a system in conjunction with B.A. Steinhagen Reservoir downstream, is already fully needed to meet the estimated future demands of the Lower Neches Valley Authority, the owner of the water rights for the reservoirs (SPI, 2006). However, the reallocation of flood control storage in the reservoir to conservation storage has been considered as a potential means for developing an additional water supply from Sam Rayburn Reservoir. This would require raising the normal lake level about a foot above the top of the existing conservation pool into the flood pool. A rise in lake level of this amount would result in more frequent inundation of the existing shoreline, including environmental features, structural facilities, and cultural resources and would likely require mitigation, replacement, relocation, and/or real estate acquisition. This modification would also result in disruptions to the use of existing shoreline facilities. As many as five marinas have operated on the reservoir; currently there are three active marinas (USACE, 2009). Additionally, adverse impacts would likely occur in conjunction with the inundation of high quality forested wetlands located in the upper end of the reservoir. There would also be potentially significant cultural resources impacts. As stated by EPA (2003), “Most importantly, the quality of the habitat that would be inundated is higher than the quality of the habitat that would be destroyed through the creation of Lake Columbia.”

The most significant adverse impact associated with the reallocation of flood storage in Sam Rayburn Reservoir may be increased flood damage downstream along the Angelina and Neches Rivers. Flood control is the primary federal purpose for this reservoir.

Conveying water from Sam Rayburn to the Five-County Area also would require a 76-mile pipeline with associated intake and pumping facilities and a terminal reservoir. With the cost of water from the Toledo Bend Pipeline alternative being more than three times that of the proposed Lake Columbia, it is likely that delivering water to the Five-County Area from Sam Rayburn Reservoir would also be considerably more expensive than the proposed Project. Finally, the reallocation of storage in the flood pool would require approval of the USACE, a corresponding Act of Congress, and acquisition of a new state water right permit or amendment of the existing permit for the reservoir. For these reasons, the use of Sam Rayburn Reservoir as a potential supply for water in the Five-County Area is not considered to be a practicable alternative.

3.3.3.3 B.A. Steinhagen Reservoir

B.A. Steinhagen Reservoir is downstream of Sam Rayburn Reservoir and is operated in conjunction with Sam Rayburn as a water supply system for users in the lower Neches Basin. Much of the inflow to Steinhagen Reservoir originates as hydropower releases from Rayburn. Because of complicated water rights issues, the only uncommitted water available from B.A. Steinhagen would be released from Sam Rayburn, and would require acquisition of a new state water right permit. It is estimated that approximately 130,000 acre-feet per year could be available through this alternative (SPI, 2006). However, to convey water from B.A. Steinhagen Reservoir to the Five-County Area would require a pipeline 134 miles long, an intake structure and pump station on Steinhagen, five booster pump stations along the pipeline (LAN, 1991a), and a terminal reservoir, similar to the Toledo Bend Pipeline alternative. This would be a more costly alternative than the Toledo Bend Pipeline, which would be 86 miles long and require only two booster pump stations. Since the Toledo Bend Pipeline was the most costly alternative investigated, at more than three times the estimated cost of water from Lake Columbia, the use of B.A. Steinhagen Reservoir as a source of supply for the Five-County Area is not considered practicable.

3.3.3.4 Lake Palestine

Lake Palestine has a yield of approximately 238,000 acre-feet per year of which approximately 5,000 acre-feet/year is uncommitted (EPA, 2003). The major rights to water that are committed from Lake Palestine belong to the cities of Dallas, Tyler, and Palestine. While some of the committed water is currently unused, this unused water is not necessarily available for use in the Five-County Area, since this would require a willing seller. The City of Dallas is the only entity with significant unused water from the reservoir. However, Dallas intends to fully use its share of Lake Palestine water and is currently investigating the construction of a pipeline from the reservoir to the Dallas-Fort Worth metroplex. This is also the pipeline that Dallas would potentially use to convey water from Lake Columbia and other sources if such supplies were to be available. It is highly unlikely that Dallas would be willing to sell any of its Lake Palestine water and may even claim the remaining uncommitted water from the reservoir. Consequently, Lake Palestine is not considered to be a viable alternative for supplying water to the Five-County Area.

3.3.3.5 Alternative Dam Sites

During the water supply planning studies originally performed for ANRA (LAN, 1991a and b), alternative dam sites for the proposed Lake Columbia were also evaluated. Alternate dam sites located further upstream could potentially be impacted by a fault within the Mount Enterprise fault zone (see Section 4.2). Additionally, a dam located in this area would likely impound water to the Tyler Lakes. Therefore alternative dam sites at this location are considered unfeasible. Dam sites at downstream locations could also be impacted by a similar fault. Another alternate dam site located approximately one mile downstream of the proposed dam site was considered but was determined to be unfeasible due to potential water quality problems associated with effluent from the Jacksonville wastewater treatment plants. Based on these considerations and constraints the applicant determined the proposed dam should be located upstream of Keys Creek and between the Mount Enterprise faults (Boyd, 2009). Relocation of the proposed dam site would require a major amendment of ANRA's existing water right permit, Permit No. 4228 (issued June 25, 1985).

3.3.4 Description of ANRA's Preferred Alternative (Proposed Action)

The proposed Lake Columbia dam would be constructed on Mud Creek approximately five miles southeast of Jacksonville, in Cherokee County, Texas, approximately three miles downstream from the U.S. Highway 79 bridge over Mud Creek, approximately one mile upstream of Keys Creek, and approximately 16 miles upstream of the confluence of Mud Creek with the Angelina River (see Figures 1.1-1 and 1.1-2). The dam construction would impact an area of approximately 220 acres, would impound water approximately 14 miles upstream in Cherokee and Smith Counties at an average width of approximately 1.1 miles, and would inundate 10,133 acres at the conservation pool elevation of 315 feet National Geodetic Vertical Datum (NGVD). The drainage area upstream of the proposed dam site is approximately 384 square miles. As stated in Section 1.3, for purposes of this EIS, the Permit Area is defined as the normal pool area below elevation 315 feet NGVD and the limits of construction in the vicinity of the dam, or approximately 10,655.5 acres. Within this Permit Area, there are approximately 5,746.5 acres of waters of the U.S. that would be impacted by the construction and operation of Lake Columbia.

Water Right Permit No. 4228 authorizes ANRA to construct the dam at the proposed site and to divert and use 85,507 acre-feet of water per year from Lake Columbia, should it be constructed. The firm yield of the reservoir has been estimated to be 75,700 acre-feet per year using the February 2005 version of the Texas Commission on Environmental Quality's (TCEQ) Neches Basin Water Availability Model (WAM) under the assumption of no upstream return flows (SPI, 2006). With upstream return flows included, the full 85,507 acre-feet per year of authorized diversion is available as a firm supply from the reservoir (FNI, 2005a). As permitted by the state, the proposed lake would contain 195,500 acre-feet of water at the conservation pool elevation of 315 feet NGVD.

The 100-year flood level of the proposed reservoir is estimated to be at an elevation of 322.59 feet NGVD. The probable maximum flood (PMF), an extreme event used for dam and spillway design, would cause the lake level to reach a maximum elevation of 334.08 feet NGVD (FNI, 2007c).

3.3.4.1 Construction

Construction of the proposed dam and spillway is estimated to take approximately 2-1/2 years after a construction contract is awarded. The construction of the proposed dam and spillway, in conjunction with other construction-related activities, would result in the discharge of 672,000 cubic yards of fill into approximately 220 acres of waters of the United States. The footprint of the dam and spillway structure would occupy 164 acres.

The total estimated amount of above-grade fill required for the dam is 3.6 million cubic yards. The proposed dam would be constructed as an earth fill structure with an impervious clay core and cutoff, a bentonite slurry trench approximately 40-100 feet deep to control seepage under the dam, and soil cement to control erosion on the upstream face of the dam. Large quantities of clay suitable for the core and sand suitable for the soil cement are reportedly available in the reservoir area within about two miles of the dam site (FNI, 2003a). Specific locations for borrow material have not been specified, but borrow would be obtained from areas located within the reservoir footprint, rather than being imported from elsewhere. Since the borrow areas would be ultimately inundated by the reservoir, the only potential long-term effects from this action would be related to cultural resources. Some of the reservoir footprint including the borrow area would be cleared, but in most areas, trees would be left standing to provide additional habitat for fish and other aquatic life. Concrete would also be used for some of the structural features of the dam, including the service spillway and the outlet works. The dimensions of the dam are presented in Table 3.3-1. The proposed reservoir clearing plan including public access points is presented in Figure 3.3-2. Additional clearing would be performed to create approximately 100-foot wide boat lanes within the reservoir extending into six to eight major tributaries of Mud Creek.

Table 3.3-1 Lake Columbia Dam Dimensions

Height above stream bed	67 feet
Top of dam elevation	336 feet NGVD
Length	6,800 feet
Fill required above grade	3.6 million cubic yards
Dam and spillway footprint	164 acres
Service spillway length	200 feet
Service spillway elevation	315 feet NGVD
Emergency spillway length	1,100 feet
Emergency spillway elevation	324 feet NGVD
Outlet works	two 48-inch diameter pipes

Source: FNI, 2009a

The outlet works for Lake Columbia would consist of a vertical intake tower located within the reservoir near the toe of the dam, a conduit through or below the base of the embankment, and control valves. The intake tower would have selective withdrawal capabilities to facilitate the release of water from near the surface, at mid-depth, or near the bottom, depending on lake level and water quality considerations. The service spillway for the dam would be an uncontrolled overflow structure 200 feet wide constructed in a cut through the left (east) abutment. It would have vertical reinforced concrete sidewalls and a concrete ogee section, with a stilling basin downstream. Approach and outlet channels would be excavated through the abutment with sloping sides and protected with a combination of soil-cement and grass. Floods up to the 50-year event would pass through the service spillway. The emergency spillway, which would pass larger flood flows up to the probable maximum flood, would be a grassed earth channel 1,100 feet wide excavated through the right abutment. The side slopes may be protected with soil cement. An eight-foot deep concrete cutoff wall at the crest is planned for a control section.

Construction would also include access roads, equipment staging areas, and borrow areas. Borrow areas would be located in the reservoir pool upstream of the dam.

ANRA's preferred method for land acquisition would be to acquire properties (fee simple or easement) by willing buyer/willing seller agreements. If necessary to acquire properties required to complete the project, ANRA would exercise its power of eminent domain to acquire land in the absence of willing sellers.

There are a number of conflicts identified in the LAN study that would have to be resolved to construct the dam and reservoir (LAN, 1991a). These conflicts were updated by Schaumberg Polk, Inc. (SPI, 2003b) and ANRA as follows:

- Two highway crossings would require major modifications: U.S. 79 and S.H. 135. The most critical is U.S. 79, which would require a 5,000-foot long bridge over the main body of the proposed reservoir above the dam. The S.H. 135 bridge would be considerably smaller at roughly 1,000 feet long and would cross in the upper part of the reservoir near the headwaters. There is no defined design for these bridges, but they would likely be constructed with concrete columns and drill shafts supporting a concrete superstructure (beams and bridge deck). The bridges would most likely be elevated above the 100-year flood level. The Texas Department of Transportation (TxDOT) would close FM 2064 and FM 2750 where they cross the proposed lake area if the lake is constructed.
- Five county roads would require realignment or relocation, and six sections of roadway would be abandoned.
- The Union Pacific railroad paralleling FM 2064 would require realignment.
- Fifteen sections of electric power lines, including four sections of high-voltage transmission lines, would require relocation, placement into conduits along bridges, or reconstruction on towers on concrete footings.
- Approximately 10 oil and gas pipelines would require re-routing, anchoring, or other modifications.
- Texas Railroad Commission records indicate that all wells located within the proposed reservoir site below 315 NGVD have been plugged and abandoned except for one, the Hancock No. 1, which has been inactive for more than a year. Other wells in the vicinity drilled within the last five years have been drilled as horizontal wells with wellheads located away from the proposed reservoir site.
- Eight underground communication utilities would require relocating or modifications.
- One water line would require relocation.

- Four houses and eight out-buildings would be affected by the construction of the proposed dam and spillway. Two houses and one out-building would be affected by the 318 ft NGVD fee simple purchase and 326 ft NGVD flowage easement boundaries. These 15 structures would be acquired by ANRA.

3.3.4.2 Operation

It is likely that water would eventually be pumped to most participants via pipelines. However, four current Project participants are located downstream from the dam site, and water would be delivered to them via releases from reservoir storage using the existing channel of Mud Creek. Those participants are City of Alto, Caro Water Supply Corporation, City of Nacogdoches, and Temple-Inland Corporation. Together, their commitments for water from Lake Columbia comprise 21 percent of the projected yield of the proposed reservoir, or about 18,000 acre-feet per year. The release schedule has not been developed, but this quantity of water on an annual basis is equivalent to a constant release from the reservoir of approximately 25 cubic feet per second (cfs).

When the water level of the reservoir falls below the conservation pool elevation of 315 feet, inflows would be stored. When the reservoir is at or above 315 feet, inflows, including flood flows, would be passed downstream through either the intake tower, the service spillway, or the emergency spillway.

3.3.4.3 Mitigation

Mitigation Plan

ANRA has proposed to compensate for the impacts to the 5,746.5 acres of waters of the U.S. and other wildlife habitat within the Permit Area as detailed in its Mitigation Plan (FNI, 2009b). The complete plan is attached as Appendix C. The goal of the plan is to replace and/or restore aquatic functions and services in waters of the U.S. that are expected to be lost because of the development of the proposed Lake Columbia. ANRA proposes to provide mitigation through a combination of on-site compensatory mitigation (within the proposed reservoir footprint), near-site minimization of adverse impacts (land immediately surrounding the proposed reservoir and land within the upstream watershed and 100-year floodplain of Mud Creek downstream of the dam), and off-site compensatory mitigation. The on-site and near-site portions primarily involve minimization of impacts and habitat regulation through implementation of ANRA’s adopted Water Quality Regulations (Appendix D), acquisition of land and easements, regulating the amount of reservoir footprint and shoreline that can be cleared and modified, and establishment of approximately 1,195 acres of fringe wetlands. The off-site portion involves replacing impacted waters of the U.S. with functionally equivalent land within the Neches Basin, primarily in the area of Big Thicket National Preserve, and with the purchase of mitigation bank credits, if necessary.

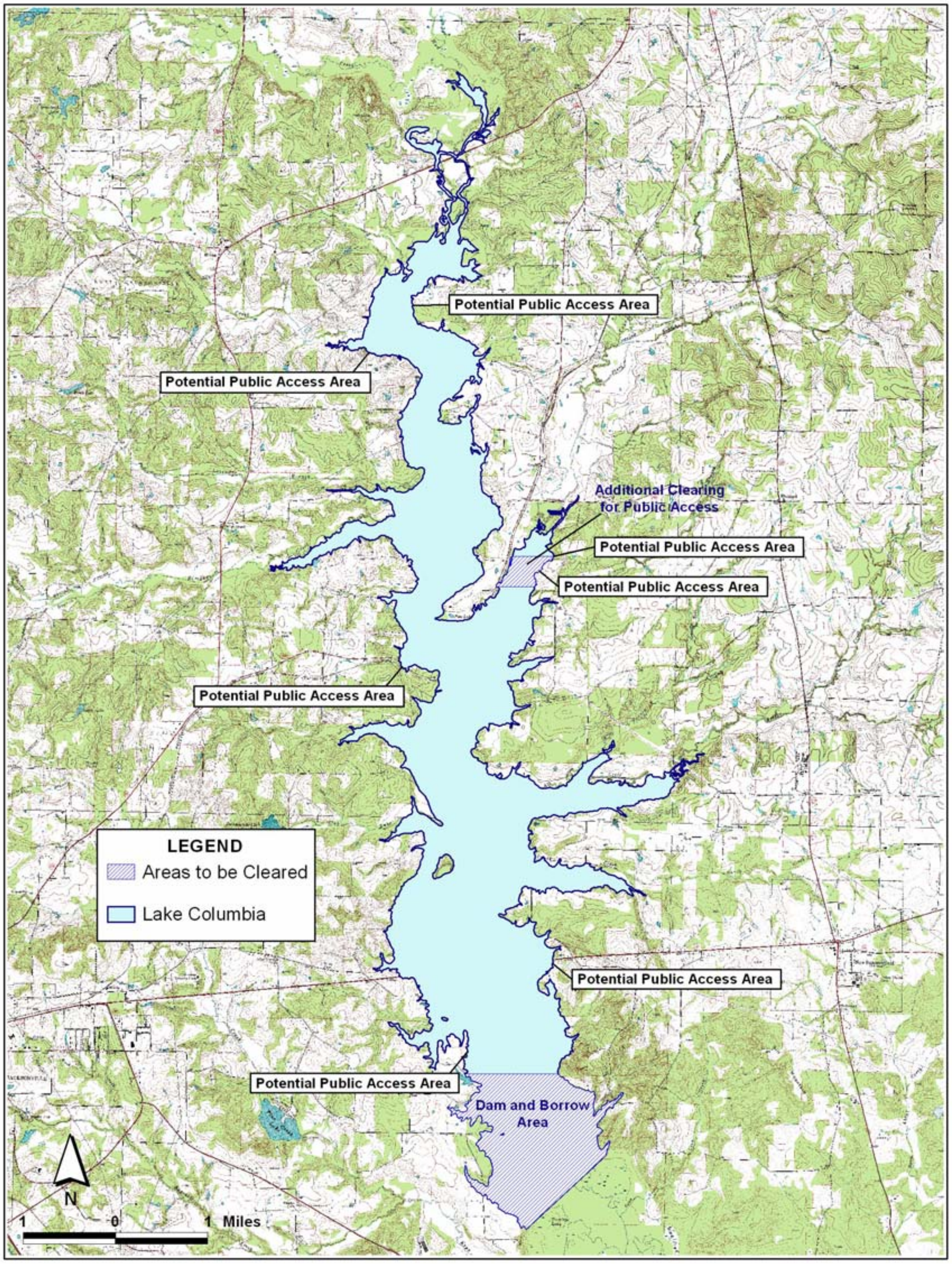


Figure 3.3-2 Lake Columbia Clearing and Public Access Plan

Measures to minimize overall adverse effects on surrounding lands include:

- Limiting timber harvesting and clearing to wetland enhancements.
- Eliminating livestock grazing.
- Limitations on public access and consumptive uses.
- Restoration of degraded forested wetlands.
- Preservation of intermittent streams and riparian buffers.
- Preservation of perennial streams and riparian buffers.

A Hydrogeomorphic Model (HGM) analysis has been performed for this EIS. An HGM analysis determines losses to the major wetland functions of the impacted waters and attempts to quantify such losses in terms of what is referred to as Functional Capacity Units (FCUs). This HGM process is described in detail in Section 4.5.2.2, and the resulting loss in FCUs because of the construction and operation of Lake Columbia are presented and quantified.

ANRA has received a financial commitment from the Texas Water Development Board (TWDB), which will loan funds for the purchase of land. ANRA's plan states that it would acquire suitable land that would directly compensate for the HGM-calculated loss of FCUs. The applicant believes the proposed mitigation plan would satisfy the goal of no overall net loss of wetland functions and would provide a significant benefit to public interests by assisting in the preservation of a national and internationally recognized ecosystem in the Neches Basin (FNI, 2003a; FNI, 2009b). This plan has been endorsed by the Big Thicket Association, The Conservation Fund, and The Nature Conservancy (BTA, 2007b). The Big Thicket Association has a strategic plan that identifies available high quality wetlands that meet or exceed the quality of lands that would be impacted by Lake Columbia, including bottomland tracts in the lower, middle, and upper Neches as some of the highest priority tracts (BTA, 2006, 2007a).

The applicant's preferred alternative is the only alternative for which a mitigation plan has been prepared. Should the Toledo Bend Pipeline or another alternative be pursued, a mitigation plan would be developed for that.

Water Quality Regulations

In order to regulate future shoreline activities, ANRA has adopted "Lake Columbia Water Quality Regulations" under its authority pursuant to Texas Senate Bill 1362 (2003). These regulations identify and define various water quality zones within the immediate Lake Columbia watershed with prohibited activities and requirements on certain regulated activities to minimize impacts on water quality in the reservoir and to prevent potential erosional impacts related to future shoreline development. These regulations include habitat preservation and/or restoration requirements to prevent potential impacts related to future shoreline development. ANRA's Lake Columbia Water Quality Regulations are provided in Appendix D.

Key elements of the Water Quality Regulations are:

- No construction of pipelines and utility lines within Lake Columbia.
- Construction of or enlargement of existing Hazardous or Municipal Solid Waste facilities is prohibited within the Lake Columbia watershed, with exceptions for existing cities.
- Unapproved petroleum storage tanks with a capacity greater than 100 gallons are prohibited in the No Discharge Zone (2,000 feet from the lake).
- Forestry Best Management Practices (BMPs) are mandatory for all forestry activities in the No Discharge Zone. Forestry BMPs have been defined by the Texas Forest Service and are followed by the Texas forestry industry on a volunteer basis (TFS, 2004). BMPs refer to conservation practices that can be used to protect water quality from nonpoint source pollution during forestry (silvicultural) operations (TFS, 2009).
- Limits and controls are placed on on-site sewage facilities in the No Discharge Zone.
- Property owners are required to take action to prevent erosion from occurring on their property in the No Discharge Zone.
- Any construction between elevations 315 and 330 (Construction Regulated Zone) is regulated and must be approved by ANRA.
- Any shoreline property that is to be subdivided must contain a Shoreline Habitat Plan that states how the shoreline habitat will be maintain, restored and protected, with the means and methods of stabilizing the shoreline to prevent erosion identified. At least sixty percent (60%) of all shoreline within 50 feet of the elevation 315 level must be maintained in a natural condition.
- All development within the No Discharge Zone equal to or greater than one acre must comply with TCEQ TPDES General Permit No. TXR150000. All other development must control runoff and sedimentation.

Public Education and Involvement

Reservoir owners throughout Texas and the South have developed successful programs to incorporate the public in protecting reservoir water quality. ANRA proposes to utilize similar successful efforts at Lake Columbia. ANRA proposes to make the public a stakeholder in the water quality protection process. The key elements of this would be:

- Placement of signs along roadways declaring the driver is “Entering the Lake Columbia watershed, please protect our water”
- Provide published and web based information on best management practices for lawn care and other property management issues dealing with pesticides and herbicides use, which could impact the watershed water quality.

- Provide signs at all public boat launch facilities informing the public of the problems of invasive fish, mussels, and aquatic plants and the public's role in dealing with the issue. Work with TPWD and other responsible agencies in developing an aggressive program, consistent with the Texas Aquatic Vegetation Management Plan, to deal with invasive fish and aquatic species.
- The operation of a marina on Lake Columbia could only take place through an ANRA-issued permit. A condition of the permit to operate would be to assure the marina operator would comply with the Clean Texas Marina Program or a similar program to assure environmentally responsible operation.
- ANRA would serve as a resource for the Cherokee County Soil and Water Conservation District, organized property owners groups, and other area segments of the public to develop preventive actions and cost-effective solutions to water quality issues within the watershed of Lake Columbia.

ANRA is currently engaged in a 12-month water quality research project to establish baseline data for a large number of water quality elements. The project will sample water quality at seven sites around the proposed Lake Columbia footprint. This information will allow ANRA to provide ongoing sampling and testing in the future to measure any changes in water quality relative to the baseline data. ANRA operates the Clean Rivers Program within the Upper Neches River Basin including the Lake Columbia portion of the Mud Creek watershed. ANRA has been the Texas Commission on Environmental Quality's Clean Rivers Program partner since the program's inception in 1997.

Purchase of Land Up to Elevation 318 feet NGVD

The applicant proposes to purchase land around the proposed reservoir up to an elevation of 318 feet NGVD to institute permitted use controls on its fee title land. Land uses permitted by ANRA may include placement of a water pump in the lake for domestic irrigation use and construction of a fishing pier or boat dock. ANRA's permit standards for these and other land uses adjacent to the proposed Lake Columbia are currently in draft form and have not yet been adopted by ANRA's Board of Directors. However, the permit standards are similar to permitted uses in place currently at various reservoirs around the state (ANRA, 2007). This measure would also lessen the potential of indirect adverse effects to existing wildlife habitat occurring on approximately 1,150 acres of land contiguous to the Permit Area. The average width of the area between 315 NGVD and 318 NGVD to be protected around the perimeter of the proposed reservoir is estimated to be 50 feet.

Regulate Recreational and Commercial Activities

ANRA proposes to obtain authority and/or cooperate with resource agencies to regulate boating, fishing, hunting, and other recreational or commercial activities on and surrounding the proposed new reservoir (ANRA, 2007). As Reservoir Manager, ANRA would enact and enforce regulations to minimize potential adverse effects to water quality including erosion control, septic tank restrictions, and nonpoint source pollution.

Flowage Easement Restrictions

ANRA proposes to obtain flowage easements to further regulate development around the proposed Lake Columbia. Flowage easements would be purchased between elevations 318 feet NGVD and 326 feet NGVD (i.e., the predicted 500-year flood elevation within the reservoir). This measure would result in restrictions being placed on approximately 3,350 acres designed to minimize the potential for indirect adverse effects of development upon wildlife habitat and water quality in the immediate vicinity of the reservoir while avoiding flood damage to habitable structures that might otherwise be placed within this area. The average width of the area to be protected between elevations 318 feet NGVD and 326 feet NGVD around the perimeter of the proposed reservoir is estimated to be approximately 200 feet.

3.3.5 Comparative Analysis of Alternatives

Specific information regarding the areas that would be impacted by the Toledo Bend Pipeline alternative and the proposed Lake Columbia is presented in Table 3.3-2. For this purpose and because of the lack of site-specific information, approximations of the miles of pipeline traversing different environmental features and of the related acreages assuming a 100-foot construction right-of-way width have been made for the Toledo Bend Pipeline alternative. Corresponding acreages that would be impacted by Lake Columbia also have been determined. As shown, depending on the particular environmental feature being considered, the impacts in terms of surface area of these two alternatives vary considerably.

Table 3.3-3 summarizes and compares the general environmental impacts of the Proposed Action, No Action alternative, and Toledo Bend Pipeline alternative. Detailed descriptions of impacts are presented in Section 4.0, Affected Environment and Environmental Consequences. The summarized impacts assume the absence of potential mitigation measures, the implementation of which would potentially minimize the indicated impacts.

Table 3.3-2 Comparison of Environmental Features Impacted by the Toledo Bend Pipeline Alternative and the Proposed Lake Columbia

ENVIRONMENTAL FEATURE	TOLEDO BEND ALT. [a]			Lake COLUMBIA [b]		
	Miles [f]	Acres [c]	Number	Miles	Acres	Number
Upland Forest	41.5	502.4	-	-	2,181.6	-
Shrubland + Grassland (Non-forested Land)	28.8	348.8	-	-	2,378.6	-
Bottomland Hardwood Forest (Deciduous Forested Wetland)	0.9	10.7	-	-	3,689	-
Herbaceous Wetland	0.5	5.5	-	-	1,518	-
Shrub Wetland	ND	ND	-	-	144	-
Hillside Bog	-	-	-	-	0.5	-
Minor Streams [g]	-	-	73	39	47	-
Major Streams [g]	-	-	21	70	255	-
Lacustrine - Pond/Lake			1	-	63	-
New Channel	-	-	-	3	30	-
State Parks	0.0	0.0	-	-	0.0	0
State Wildlife Management Areas	0.0	0.0	-	-	0.0	0
National Forests	13.1	159.2	1	-	0.0	0
Federal Wildlife Management Areas	0.0	0.0	-	-	0.0	0
Number of Federal T/E Species Potentially Occurring [d]	-	-	4	-	-	4
Number of State T/E Species Potentially Occurring [d]	-	-	19	-	-	18
Urban	7.8	94.6	-	-	14.0	-
High Probability For Cultural Resources Sites [e]	70.0	843.9	-	-	1,272	-

NOTE: For Toledo Bend Pipeline alternative, the terminal storage reservoir of several hundred acres is not included. The location and size of such a reservoir has not been determined.

a = Based on USGS Topographic Map review.
b = Data largely taken from FNI, 2003a except for Minor/Major Streams and Lacustrine Habitat taken from USGS Topographic Map review.
c = Acreage calculations assume a 100-foot construction ROW along 86 miles of pipeline.
d = Based on TPWD county records. The potential occurrence of federally listed species in the Permit Area has been ruled out based on either the availability of habitat and/or site-specific surveys of potential habitat (i.e., Red-cockaded woodpecker - FNI, 2003a).
e = High probability areas were assessed as all areas within 400 meters (125 feet) of extant waterways/drainages commonly accepted by the Texas Historical Commission. Because of the presence of waterways and drainages along the entire length, the majority of the proposed pipeline length is considered to be High Probability.
f = Miles of pipeline route traversing indicated feature.
g = For pipeline route, number of streams crossed; for L. Columbia, minor = intermittent, major = perennial jurisdictional streams.
ND = Non-discernable from USGS Topographic Map review.
T/E = Threatened or endangered species.

Table 3.3-3 Impact Summary and Alternatives Comparison

Resource/Impact Issue	Lake Columbia Proposed Action Impact	No Action Alternative Impact	Toledo Bend Pipeline Alternative Impact
Physiography and Topography			
Modification of topography in the Permit Area	Topography would be altered by construction of dam and inundation of valley.	No modification of topography.	Construction of intake structure and pump station at Toledo Bend. Construction of several hundred-acre terminal reservoir near proposed reservoir site.
Geology			
Alteration of strata	10,133 acres would be inundated and sediment would slowly accumulate in the reservoir. Downstream channel scoured near the dam to expose deeper layers.	No changes to geology.	Strata would be altered to depth of pipeline and terminal reservoir construction. Lignite deposits in southern Rusk County could not be extracted where pipeline runs.
Soils			
Loss of prime farmland soils	135 acres of prime farmland soils would be lost.	No impact on prime farmland soils.	Minimal impacts to prime farmland soils anticipated, except unknown at terminal reservoir site
Increase in erosion from disturbance	Erosion would occur during construction activities, but erosion control measures would be used.	Existing soils would not be disturbed.	Erosion would occur during construction activities, but erosion control measures would be used.
Groundwater			
Declining groundwater levels	Switch from groundwater to surface water would reduce groundwater drawdown.	Groundwater drawdown would increase from increasing withdrawals.	Switch from groundwater to surface water would reduce groundwater drawdown.
Surface Water			
Sediment delivery	Sediment delivery to Mud Creek increased during construction, but reduced during operation.	No impacts on sediment.	Sediment delivery to various streams crossed by the pipeline route and at terminal reservoir site increased during construction.
Water quality	Water releases would increase base flows, raise dissolved oxygen, reduce turbidity.	Water quality would be unchanged.	Short-term effects at stream crossings. Inter-basin transfer would cause slight decrease in flows in Sabine Basin and slight increase in Neches Basin.
Loss of waters of U.S. including wetlands	5,746.5 acres of waters of U.S. would be impacted. To be compensated by mitigation plan.	No change in waters of U.S.	Temporary construction impacts, and loss of waters of U.S. at pump station/intake at Toledo Bend. Some conversion of forested wetlands along pipeline route. Unknown

Resource/Impact Issue	Lake Columbia Proposed Action Impact	No Action Alternative Impact	Toledo Bend Pipeline Alternative Impact
			potential impacts at terminal reservoir site.
Downstream hydrologic & fluvial geomorphic impacts	Flood peaks reduced. Approximate 16 percent decrease in 100-year floodplain. Some channel scouring below dam site.	No downstream impacts.	No downstream impacts in Mud Creek. Short-term impacts on other streams crossed. Potential impacts associated with terminal reservoir.
Hydropower	Negligible change in Sam Rayburn hydropower production (0.01%).	No impact on hydropower.	Negligible change in Toledo Bend hydropower production.
Climatology/Air Quality			
Potential exceedance of ambient air quality standards. Climate changes.	Fugitive dust emissions would likely increase particulate concentrations during construction. Slight local increase in relative humidity and moderation of temperatures with lake.	No impact on climatology/air quality.	Fugitive dust emissions over larger area during construction of pipeline and terminal reservoir.
Noise			
Increase in noise levels	Some increase during construction. Boat traffic would generate noise on the lake.	No impact on noise.	Some increase in noise over a larger area during construction of pipeline and terminal reservoir. Pump stations noise during operation.
Vegetation			
Impacts to vegetation, including wetland and riparian vegetation	5,351.5 acres of wetlands would be impacted and mostly converted to open water—to be compensated by Mitigation Plan. Development around lake would impact vegetation—to be addressed by Water Quality Regulations. 1,195 acres of wetlands established around water's edge.	No impact on vegetation.	Wetland vegetation impacted primarily at stream crossings and intake pump station. Other vegetation impacts at several hundred-acre terminal reservoir site and along entire ROW, including approximately 160 acres through Sabine National Forest. Potential conversion of forested wetlands along pipeline route.
Threatened or endangered (T/E) species	T/E species (Neches River rose-mallow) not known to exist within Permit Area.	No impact on T/E species.	T/E species may exist within counties traversed by pipeline.
Fish and Wildlife			
Threatened or endangered species	T/E species not known to exist within Permit Area.	No impact on T/E species.	T/E species may exist within counties traversed by pipeline, particularly red-cockaded woodpeckers in Sabine National Forest.

Resource/Impact Issue	Lake Columbia Proposed Action Impact	No Action Alternative Impact	Toledo Bend Pipeline Alternative Impact
Habitat alteration	Terrestrial and stream habitat converted to open water habitat. All terrestrial and some aquatic species displaced.	No direct impact on habitat. Trend of conversion of forest to pasture and timber plantations likely to continue.	Habitat cleared along pipeline route and terminal reservoir. Timber removal in Sabine National Forest may require EIS.
Downstream impacts	Floodplain size and flood magnitude decreased. Increased base flows result in increased stream aquatic habitat.	No downstream impacts.	No downstream impacts in Mud Creek. Short-term impacts on other streams crossed.
Cultural Resources			
Impacts to cultural resources	1,272 acres of high probability areas for cultural resources within Permit Area. Inundation of 23 known archaeological sites; 13 sites located on or adjacent to shoreline. Additional surveying necessary to inventory all sites.	No impact to cultural resources.	No surveys conducted, but approximately 70 miles of high probability areas for cultural resources could be impacted, plus several hundred-acre terminal reservoir site.
Impacts to historic structures	Eight historic structures potentially impacted. NRHP eligibility unknown.	No impact to historic structures, except site looting could continue.	No surveys conducted, but historic structures unlikely, except potentially in cities.
Socioeconomics			
Population change	Population increases may exceed projections because of available water and presence of lake.	Projected population increases may not occur because of insufficient water supply.	Population increases likely to meet projections.
Employment and income change	Temporary increase of 2,000 jobs during construction. Permanent increase of 32 jobs from operation. 361 jobs generated from recreational spending prompted by the lake.	Employment and income would not change.	Temporary increase of jobs during construction. Permanent increase of jobs from operation. Higher cost of water equivalent to outflow of $46M per year from the local area.
Land Use and Recreation			
Conversion of land use	Approximately 11,000 acres of existing agricultural and forested land converted to lake and residential use.	No impact on land use.	Approximately 1,000 acres affected along ROW, including timber removal in 13-mile reach through Sabine National Forest, plus several hundred-acre terminal reservoir site.
Recreation supply and demand	Private land made available for recreation with opportunities for water sports and camping. New demand from new residents and visitors.	No impact on recreation. Reduced potential for opening private lands for public recreation at Lake Columbia site.	No impact on recreation. Reduced potential for opening private lands for public recreation at Lake Columbia site.
Aesthetics			

Resource/Impact Issue	Lake Columbia Proposed Action Impact	No Action Alternative Impact	Toledo Bend Pipeline Alternative Impact
Change in landscape character	Forested and agricultural area converted to lake view.	No impact on aesthetics.	Loss of timber and other vegetation along pipeline corridor and at terminal reservoir site.
Environmental Justice			
Low income or minority population disproportionately affected	No disproportionality identified.	No disproportionality identified.	No disproportionality identified.
Cost			
Estimated cost of alternatives	$191M capital; $15M annual; $0.53 per 1,000 gallons	None	$398M capital, $46M annual; $1.65 per 1,000 gallons

3.3.6 Cumulative Effects Context

This section provides the conceptual, procedural, and substantive context for resource-specific cumulative effects as addressed in Section 4.0. This section begins with background information related to definitions and an 11-step cumulative effects assessment (CEA) process (Section 3.3.6.1). The spatial and temporal boundaries for the cumulative effects considerations for the proposed Lake Columbia Project are described in Subsections 3.3.6.2 and 3.3.6.3. Subsection 3.3.6.4 summarizes the potential contributing effects of 15 past and present actions on 13 identified resource areas. Subsection 3.3.6.5 does similarly for the contributed effects from 13 reasonably foreseeable future actions. Finally, Subsection 3.3.6.6 describes the key findings from the analyses of the 28 other actions. These findings provide the bases for the resource-specific cumulative effects information in Section 4.0. As appropriate, summary cumulative effects comments are included for each of the 13 resource areas in relation to the No Action, Proposed Action (the Lake Columbia Project), and Toledo Bend Pipeline alternatives. The most detailed cumulative effects information is included for the Proposed Action.

3.3.6.1 Definitions and 11-Step CEA Process

The evaluation of cumulative effects (CEs) (also referred to as cumulative impacts) is an emerging issue in impact studies; the definition that follows is from the Council on Environmental Quality's (CEQ's) National Environmental Policy Act (NEPA) Regulations (Council on Environmental Quality, 1978):

> "Cumulative impact" is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The cumulative effects assessment (CEA) study described herein is in consonance with the above definition and with the policy of the Corps of Engineers relative to addressing the cumulative effects of water resources plans such as the proposed Lake Columbia Project. This policy is (U.S. Army Corps of Engineers, 1999):

> The cumulative effects of the plan and other similar activities should be analyzed. Each proposed water resource development activity is but a piece of a large-scale program. The combined beneficial and adverse economic, environmental and social impacts of individual projects, each of which may be relatively minor, can have a significant regional or national impact. At each level of the evaluation and review process it is necessary to assess the cumulative beneficial and adverse effects of individual project impacts. Significant effects should guide the decisions.

Furthermore, the undertaking of a CEA is in consonance with Principle 5 of the Corps' Environmental Operating Principles. Specifically, Principle 5 states that the Corps should seek ways and means to assess and mitigate cumulative impacts to the environment, and bring systems approaches to the full life cycle of our processes and work (U.S. Army Corps of Engineers, 2003).

In order to conduct this CEA, the CEQ's 11-step process was used (Council on Environmental Quality, 1997). Steps 1 to 4 relate to scoping, Steps 5 to 7 to describing the affected environment, and Steps 8 to 11 to determining the environmental consequences. The specific steps are as follows:

- Step 1 --Identify the significant cumulative effects issues associated with proposed action and define the assessment goals.

- Step 2 -- Establish the geographic scope (boundary) for the analysis.

- Step 3 -- Establish the time frame (past and future temporal boundaries) for the analysis.

- Step 4 -- Identify other actions affecting the resources of concern. As noted earlier, "other actions" include past, present, and reasonably foreseeable future actions (RFFAs). To facilitate these identifications and delineate their potential effects, the following definition of RFFAs was utilized.

  Actions identified by analysis of formal plans and proposals by public and private entities that have primary (direct) or secondary (indirect) impacts on common resources. RFFAs also include potential actions that are beyond mere speculation when incorporated in plans or documents by credible private or public entities. RFFAs may also include events forecasted by trends, probable occurrences, policies, regulations, or other credible data that may have bearing on the resources.

- Step 5 -- Characterize the resources identified in scoping in terms of their response to change and capacity to withstand stresses.

- Steps 6 and 7 -- Characterize the stresses affecting these resources and their relation to regulatory thresholds; and define an historical baseline condition and trends for the resources.

- Step 8 -- Identify the important cause-and-effect relationships between human activities and the affected resources. Matrix-style tables are used herein.

- Step 9 -- Determine the magnitude and significance of the cumulative effects.

- Step 10 -- Modify or add alternatives or mitigation or protection strategies to avoid, minimize, or mitigate significant cumulative effects.

- Step 11 -- Monitor the cumulative effects of the selected alternative and adapt management as appropriate.

Between this subsection, Section 4, and Appendices C and D, this EIS includes each of the 11 CEA steps. Finally, this 11-step process has been upheld in case law (Mandelker, 2007; Smith, 2006; and Rumrill and Canter, 1997).

3.3.6.2 Spatial Boundaries and Supporting Rationale

A total of five spatial areas (or boundaries) have been defined for this CEA study. The areas are shown on Figure 1.1-1. They include:

- The Permit Area (PA), which includes the footprint of the proposed normal conservation pool of the Lake Columbia reservoir below elevation 315 ft. NGVD, and the limits of construction in the vicinity of the proposed dam. The size of the PA is 10,655.5 acres. It is located in the northeastern part of Cherokee County and the southern part of Smith County.

- The Mud Creek Watershed (MCW), which encompasses the drainage area above the mouth of the stream as it discharges into the Angelina River. The MCW represents an appropriate spatial area for addressing all land uses and other actions which may affect pertinent resources. The total drainage area of the MCW is 554 square miles. It is located in the northeast quadrant of Cherokee County and the southeast quadrant of Smith County. For purposes of this CEA study, the MCW has been divided into three parts. The upper portion (MCWU) reflects the drainage area that is above the proposed Lake Columbia dam site. The size of the MCWU is 384 square miles. The shoreline development area (SDA) is located in the MCWU, thus it is referred to herein as MCWU-SDA. In general, the SDA reflects the land area one mile away from the entire lake shoreline. The downstream impacts area refers to the area along Mud Creek below the dam site to the stream’s confluence with the Angelina River. It is listed herein as MCWD. The specific downstream area reflects the 100-year floodplain for a distance of about 16 miles from below the dam site to the Angelina River confluence. The total size of the watershed of this downstream area is 170 square miles.

- The Five-County Area, which would be provided with water from the proposed Lake Columbia Project. The five counties in their north to south pattern include Smith, Rusk, Cherokee, Nacogdoches, and Angelina counties. The code for the Five-County Area is 5-CA.

In order to focus this CEA study, specific spatial areas were identified for the 13 specific resources. Table 3.3-4 delineates the pertinent study areas used for each of the resources.

Table 3.3-4 Primary Study Boundaries Associated with the Potentially Impacted Resources

Potentially Impacted Resources	Primary Impact Study Boundaries[a]				
	PA	MCWU-SDA	MCWU	MCWD	5-CA
Physiography and Topography (Section 4.1)	x	x			
Geology (Section 4.2)	x	x			
Soils (Section 4.3)	x	x			
Groundwater (Section 4.4)	x	x	x	x	x
Surface Water (Section 4.5)					
– Hydrology (Section 4.5.1.1)	x		x	x	
– Quality (Section 4.5.1.2)	x		x	x	
– Waters of the U.S. (Section 4.5.1.3)	x		x	x	
Climatology/Air Quality (Section 4.6)	x		x		x
Noise (Section 4.7)	x	x			
Ecology (Section 4.8)					
– Vegetation (Section 4.8.1)	x	x	x		
– Wildlife (Section 4.8.2)	x	x	x		
– Aquatic Biology (Section 4.8.3)	x	x	x	x	
– Threatened/Endangered Species (Section 4.8.4)	x	x	x	x	
Cultural Resources (Section 4.9)	x	x			
Socioeconomics (Section 4.10)					
– Population (Section 4.10.1.1)					x
– Labor (Section 4.10.1.2)					x
– Earnings (Section 4.10.1.3)					x
– Public Finance (Section 4.10.1.4)					x
Land Use and Recreation (Section 4.11)					
– Regional Land Use (Section 4.11.1.1)			x	x	
– Lake-Specific Land Use (Section 4.11.1.2)	x	x			
– Recreation (Section 4.11.1.3)	x	x			x
Aesthetics (Section 4.12)	x	x			
Environmental Justice (Section 4.13)			x	x	x

Note:

a: Location denotes the study spatial boundary wherein the action occurs. The boundary codes include:

PA = 10,655.5-acre Permit Area for the proposed Lake Columbia Project

MCW = Mud Creek Watershed located in the southeast quadrant of Smith County and the northeast quadrant of Cherokee County; the total area of MCW is 554 square miles. MCW can be considered in three parts – the upstream watershed above the proposed dam site (MCWU), with an area of 384 square miles; the downstream watershed below the dam site to its confluence with the Angelina River (MCWD), with an area of 170 square miles; and a potential shoreline development area within one mile of the shoreline of Lake Columbia (MCW-SDA).

5-CA = Five-County Area (Smith, Rusk, Cherokee, Nacogdoches, and Angelina counties) served by water supplies provided by ANRA.

3.3.6.3 Temporal Boundaries and Supporting Rationale

The boundary reflecting historical conditions up to the current time is from 1960 to 2010. The earlier date was chosen because several nearby reservoirs mentioned herein were impounded early in this time period. The future time period was chosen to be from 2010 to 2060. This period coincides with the water supply planning period for the proposed Lake Columbia Project.

3.3.6.4 Analysis of Contributing Effects from Past and Present Actions

Table 3.3-5 provides a summary of the contributions of 15 past and present actions in relation to their contributions to cumulative effects on study area resources for the proposed Lake Columbia Project. Features of Table 3.3-5 include 15 listed past and present actions; delineation of the location of each action in relation to three spatial boundaries; identification of the affected spatial area resources which have experienced contributed effects, and delineation of the relative contributions of the actions. Designation of which actions would continue within the future temporal boundary (2010-2060) is also included. Descriptions of each action and their contributions to cumulative effects are included in the following list.

- Lake Tyler (also called Old Lake Tyler or Lake Tyler West) and Lake Tyler East (also called New Lake Tyler) – the two lakes are located about 20 miles upstream of the northernmost boundary of the 10,655.5-acre Permit Area for Lake Columbia. The two lakes are essentially equal in surface area – 2,224 acres for Lake Tyler and 2,276 acres for Lake Tyler East. Lake Tyler was impounded in 1949, and Lake Tyler East in 1966. The conservation pool elevations are 375 ft. NGVD, and the average water depths are about 18 feet. The lakes serve as a water supply for the City of Tyler; they are managed by the City of Tyler Water Utility. A total of 73,700 acre-feet of conservation storage is available. Recreational fishing for largemouth bass is a popular activity throughout the year. During the summer months boating and personal watercraft usage is popular. Residential housing has been developed along the shorelines of both lakes.

Table 3.3-5 Past, Present, and Continuing Actions Contributing to Cumulative Effects on Study Area Resources

Actions[a]	Location[b]	Affected Study Area[b], Resources[c], and Relative Contribution[d]	Continuation 2010-2060[e]
Lake Tyler and Lake Tyler East (P, Pr)	MCWU	MCWU – SWH(L), SWQ(L)	Y
Southeasterly urbanization of Tyler (Pr)	MCWU	MCWU – SWH(L), SWQ(L), E/V(L), E/W(L)	Y
Usage of groundwater from the Carrizo-Wilcox aquifer as a local and city water supply (P)	5-CA	5-CA – GWU(H), GWQ(H)	Y
Local usage of groundwater from the Carrizo-Wilcox aquifer in the 10,655.5-acre Permit Area for Lake Columbia	PA	PA – GWU(L), GWQ(L)	N
Local recreational activities involving hunting and fishing in the Permit Area (P)	PA	PA – E/W(L), E/AB(L)	N
Local land uses in the Permit Area (P)	PA	PA – E/V(H), E/W(H), E/AB(H)	N
Wastewater treatment plant discharges (P, Pr)	MCWU, MCWD	MCWU – SWQ(L), SWUS(L), E/AB(L); MCWD – SWQ(L), SWUS(L), E/AB(L)	Y
Municipal sanitary landfills (P, Pr)	MCWU, MCWD	MCWU – GWQ(L); MCWD – GWQ(L)	Y
Agricultural lands involving pastureland, grazing (beef cattle), and production of hay (P, Pr)	MCWU, MCWD (in context of 5-CA)	MCWU – SWQ(M), SWUS (M), E/AB (M); MCWD – SWQ (M), E/AB (M)	Y
Timber production via logging operations (P, Pr)	MCWU, MCWD (in context of 5-CA)	MCWU – E/V(M), SWQ(M), SWUS(M), E/AB(M) MCWD – E/V(M), SWQ(M),SWUS(M), E/AB(M)	Y
Oil and gas production (P, Pr)	PA, MCWU, MCWD (in context of 5-CA)	PA – negligible effects MCWU – GWQ(L), SWQ(L), E/V(L) MCWD – GWQ(L), SWQ(L), E/V(L)	Y
Surface runoff from Chapel Hill oilfield located in the Lake Tyler East drainage area (P)	MCWU	MCWU – SWQ(L)	N
Lignite mining (deep mining and surface mining) (P, Pr)	PA, MCWU, MCWD (in context of 5-CA)	No current lignite mining is occurring within the three study boundaries	N
ANRA programs for meeting municipal, industrial, and steam electric power water demands (P)	5-CA	5-CA – S/P (beneficial), S/L (beneficial), S/E (beneficial), S/PF (beneficial)	Y
Industrial nonpoint pollution from a lead-acid battery plant in Tecula (northeast of Jacksonville) (P)	MCWU	MCWU – SWQ (no effects expected)	P(10)

Notes

a: P = past action within the historical time boundary (1960-2010) and which still exists at the current time (2009-2010)
Pr = past action which originated within the most recent decades (1980-2010) and which still exists

b: Location denotes the study spatial boundary wherein the action occurs. The boundary codes include:

PA = 10,655.5-acre Permit Area for the proposed Lake Columbia Project
MCW = Mud Creek Watershed located in the southeast quadrant of Smith County and the northeast quadrant of Cherokee County; the total area of MCW is 554 square miles. MCW can be considered in three parts – the upstream watershed above the proposed dam site (WCWU), with an area of 384 square miles; the downstream watershed below the dam site to its confluence with the Angelina River (MCWD), with an area of 170 square miles; and a potential shoreline development area within one mile of the shoreline of Lake Columbia (MCW-SDA).
5-CA = Five-County Area (Smith, Rusk, Cherokee, Nacogdoches, and Angelina counties) served by water supplies provided by ANRA.

c: Resources denotes the following substantive environmental topics and their related codes:

P/T = physiography and topography
G = geology
S = soils
GWU = groundwater usage
GWQ = groundwater quality
SWH = surface water hydrology
SWQ = surface water quality
SWUS = surface waters of the United States
C/AQ = climatology and air quality
N = ambient noise
E/V = ecology – vegetation
E/W = ecology – wildlife
E/AB = ecology – aquatic biology
E/TES = ecology – threatened or endangered species
CR = cultural resources
S/P = socioeconomics – human population
S/L = socioeconomics – labor
S/E = socioeconomics – earnings
S/PF = socioeconomics – public finance
LU/R = land use – regional
LU/L = land use – lake specific
LU/R = land use – recreation at Lake Columbia
A/VQ = aesthetics – visual quality
EJ = environmental justice

d: Relative contribution of the listed action to cumulative effects on pertinent resources; the contribution codes include:

L = low relative contributions; this determination is based on considering the size of the location area and the size of the action, the capacity of location area to recover from such effects, and the existence of any control or effects minimization programs for the action's effects
M = moderate relative contribution, consider the same factors as for L above, as well as potential contributions from other past or present actions
H = high relative contribution, consider the same factors as for M above, and recognize that the evaluated action may be a primary contributor to cumulative effects

e: Addresses the anticipated occurrence of the action over the future time boundary (2010-2060). The continuation codes are as follows:

Y = yes, the action will continue over the entire 50-year period
P(x) = the action will continue over a portion of the period; x denotes an estimate of the number of years of continuation
N = no, the action will not continue over the 50-year time period

Six public parks and five public boat ramps are also in shoreline areas. The Water Utility Department routinely monitors the lakes and the upstream watershed for active and potential sources of pollution. The watershed, which is within the upper reaches of the Mud Creek watershed, totals 114 square miles in area. The two lakes have and continue to reduce downstream flood flows and their timing. These lakes also provide suspended sediment control prior to downstream discharges to Mud Creek. Although identifiable, the relative contributions of these lakes to cumulative effects on surface water hydrology and surface water quality are considered as low. They would continue to be used throughout the future temporal boundary (2010 to 2060) for Lake Columbia.

- Southeasterly urbanization of Tyler – a southeastern portion of Tyler is within the upper portion of the Mud Creek Watershed. The population of Smith County, wherein Tyler is the major city, has exhibited a rapid growth pattern over the last several decades. As a consequence, Tyler has been subjected to urbanization in its southeastern area over the last three decades. Such urbanization can cause flow changes in tributaries to Mud Creek, the loss of natural habitat vegetation and wildlife in the developed area, and potential declines in downstream water quality (Reid, 1993). Such impacts would be localized, thus this action has had a low relative contribution to cumulative effects on these resources in the upper Mud Creek Watershed. Due to projections for future population growth in Smith County and Tyler, it is envisioned that the southeasterly urbanization of Tyler will continue over the future temporal boundary.

- Usage of groundwater as a local and city water supply – the Carrizo-Wilcox aquifer has been used for many decades as a water supply for individuals, local areas, and towns and cities. Water usage projections for the Five-County Area cannot be fully met by groundwater resources. Both quantity issues (excessive drawdown) and quality concerns (iron, manganese, and chlorides) have placed constraints on both current and future groundwater usage. Accordingly, historical, current, and future groundwater uses are reflected in high relative contributions to cumulative effects assigned to this action. It is expected that continuing usage of groundwater will occur in the Five-County Area over the future time period.

- Local usage of groundwater in the Permit Area – the Carrizo-Wilcox aquifer has been used for many decades by individuals living in the immediate vicinity of the proposed 10,655.5-acre Permit Area. The relative contribution of these uses to groundwater hydrology and quality resources in the Permit Area is very small. Any groundwater uses within the Permit Area would not be continued upon the construction and operation of Lake Columbia.

- Local recreational activities involving hunting and fishing in the Permit Area – hunting activities would be discontinued upon construction and operation of Lake Columbia; however, boating and fishing opportunities would be provided by Lake Columbia. Historical and current hunting and fishing have had low contributed effects on wildlife and aquatic biology.

- Local land uses in the Permit Area – there are four houses and eight out-buildings affected by the proposed dam and spillway and two houses and one out-building within the 318 ft NGVD fee simple purchase or 326 ft NGVD flowage easement boundaries (just outside the Permit Area) near the proposed dam. These 15 structures would be acquired by ANRA. Pasture land and hay production, and timbering operations on forested areas (about 5,000 acres are forested) do exist. These land uses and activities would be discontinued upon construction and operation of Lake Columbia. The relative contributed effects on several ecological features in the Permit Area are considered high due to the size of the land uses in relation to the 10,655.5-acre Permit Area.

- Wastewater treatment plant discharges – seven municipal wastewater treatment plants discharge into tributaries of Mud Creek upstream of the proposed dam site; two additional discharges are in the downstream area below the dam site. The seven upstream discharges are from the Cities of Arp, Whitehouse, Troup, and New Summerfield; and Tall Timbers Estate, Tyler Southside, and Woodmark Utilities. The daily average flow rates from the seven plants range from 0.06 mgd to 9.0 mgd. The two downstream discharges are from the Jacksonville Canada Street plant and the Jacksonville Double Creek plant. The downstream average discharges range from 1.0 to 1.75 mgd. The wastewater treatment plants have increased in flows and treatment levels from the past to present time. The discharges can affect, at a low level, the surface water quality (SWQ), surface waters of the United States (SWUS), and aquatic biology (E/AB). These plants would continue operations into the future; however, with population growth, the plant sizes (flows) and levels of treatment would be expected to increase.

- Municipal sanitary landfills – six landfills (Cities of Tyler, Bullard, Whitehouse, Arp, Troup, and New Summerfield) are in the upper Mud Creek Watershed, and one (City of Jacksonville) is in the downstream Mud Creek Watershed. As the city sizes have increased, the landfill sizes have also increased. Assuming that these landfills have covers and surface water control systems, the primary impact concerns will be related to groundwater quality. Such effects will be localized, thus this category of actions would only exhibit low relative contributions to cumulative effects. Operations at these landfills are expected to continue into the future time boundary; however, with population growth, these landfills will be expected to increase in size, and new landfills may be added in the Mud Creek Watershed.

- Agricultural lands involving pastureland, grazing (beef cattle), and production of hay – these agricultural activities will be considered in relation to land uses for these purposes in the Five-County Area. Agricultural land in the five counties totaled 1,131,900 acres in 1991 (LAN, 1991b). The Smith County agricultural land total was 40.6% or 241,240 acres; the Cherokee County total was 36.6%, or 246,470 acres. To approximate the number of acres of agricultural land in the Mud Creek Watershed in Smith County, it can be broadly assumed that the southeast quadrant (approximately 25% of the county land area) has 25% of the agricultural land in the county. Further, this assumption is based on an equal distribution of the agricultural land within the county. Based on these two simplifying assumptions, the agricultural land area in the Mud Creek Watershed in Smith County is about 60,000 acres. Following the same assumptions for the northeast quadrant of Cherokee County, the agricultural land area in the Mud Creek watershed in Cherokee County is about 61,600 acres. The total area of the entire Mud Creek Watershed is 554 square miles (354,600 acres). Accordingly, agricultural land usage in the watershed totals 121,600 acres, or 35% of the land area.

Two key environmental effects associated with agricultural land usage are soil erosion and resultant suspended sediments in water, and runoff waters from chemical usage areas (fertilizers containing nitrogen and phosphorus, and various types of pesticides). Further, these nonpoint sources of pollution can impact surface water quality (SWQ), surface waters of the United States (SWUS), and ecological characteristics as manifested in aquatic biology (E/AB). Accordingly, due to the relative large scale of this land use, agricultural land is identified as having moderate relative contributions to cumulative effects on the above resources. Such contributions are currently declining due to the implementation of numerous best management practices (BMPs) for controlling agricultural runoff. Agricultural land usage is expected to be a continuing action over the future time boundary (2010-2060) for Lake Columbia. Future relative contributions to cumulative effects on SWQ, SWUS, and E/AB are expected to decline as more emphasis is devoted to the use of BMPs.

- Timber production via logging operations – these operations will be considered in relation to land uses for these purposes in the Five-County Area. Forest land in the five counties totaled 1,745,000 acres in 1991 (LAN, 1991b). Timber in the Five-County Area is a mixture of hardwoods and softwoods, mostly pine, oak, poplar, and mixed hardwoods.

  The Texas Forest Services compiles historical data but does not have long-term plans for future timber production. Future timber production is unknown and depends on market conditions, actions by private landowners, actions by forest products companies, and the overall economy. Figure 4.11-1 displays the historical five-county annual total timber harvest from 1980 through 2007. From 1980 to 1993, the annual total timber harvest increased from about 80 million cubic feet to 120 million cubic feet. From 1993 through 2007, the annual total harvest fluctuated around the 120 million cubic feet level. Smith County had the lowest annual production level over the 28-year period; the level ranged from about 5 million to as high as 20 million cubic feet (the average across the period was about 10 million cubic feet). Annual production levels for Cherokee County ranged from about 16 million cubic feet to about 32 million cubic feet. The average annual production across the 28-year period was about 28 million cubic feet. No specific trends in annual timber harvest were noted for either Smith County or Cherokee County over the 28-year period.

As noted above, forest land in the Five-County Area totaled 1,745,000 acres in 1991. The Smith County forest land total was 42.2% of the land area, or 250,740 acres. The Cherokee County total was 58.1% of the land area, or 391,250 acres. To approximate the number of acres of forest land in the Mud Creek Watershed in Smith County; it can be broadly assumed that the southeast quadrant (approximately 25% of the county land area) has 25% of the forest land in the county. Further, this assumption is based on an equal distribution of the forest land within the county. Based on these two simplifying assumptions, the forest land area in the Mud Creek Watershed in Smith County is about 62,700 acres. Following the same assumptions for the northeast quadrant of Cherokee County, the agricultural land area in the Mud Creek Watershed in Cherokee County is about 97,800 acres. The total area of the entire Mud Creek watershed is 554 square miles (354,600 acres). Accordingly, the forested land in the watershed totals 160,500 acres, or 45% of the land area. Finally, it should be noted that current logging operations in the 10,655.5-acre Permit Area would completely cease if the proposed Lake Columbia Project occurs.

Three key environmental effects associated with logging operations are loss of vegetation, soil erosion and resultant suspended sediments in water, and runoff waters from the logged areas (Reid, 1993). Further, these nonpoint sources of pollution can impact surface water quality (SWQ), surface waters of the United States (SWUS), and ecological characteristics as manifested in aquatic biology (E/AB). Accordingly, due to the relative large scale of this land use, timber production via logging operations is identified as having moderate relative contributions to cumulative effects on the above resources. Such contributions are currently declining per unit area due to the implementation of numerous best management practices (BMPs) for controlling runoff and related impacts. Logging operations are expected to be a continuing action over the future time boundary (2010-2060) for Lake Columbia. Future relative contributions to cumulative effects on vegetation (E/V), SWQ, SWUS, and E/AB are expected to decline as more emphasis is devoted to the use of BMPs.

- Oil and gas production – the Five-County Area has been subject to production operations for several decades. As shown in a subsequent figure (Figure 4.2-5), the most recent 15 years (1993-2008) have exhibited a decline in the production of oil (from over 8 million barrels to about 3.5 million barrels per year) and an increase in the production of gas (from about 120 million cubic feet to about 350 million cubic feet). Oil and gas exploration, drilling, and production have been very limited in the Permit Area. Minimal to no production from wells that have been drilled has occurred, as the area is mostly floodplain. Railroad Commission of Texas records indicate that there is one oil and gas well located in the proposed reservoir footprint with a surface elevation below 315 feet NGVD. The records indicate this well has been plugged and abandoned. Other wells in the vicinity drilled within the last five years have been drilled as horizontal wells with wellheads located away from the proposed reservoir site and with laterals at depths of 2,000 to 4,000 feet extending into the Mud Creek bottom. Specific information on the number of historical and current wells in the Mud Creek Watershed was not readily available. However, with more stringent environmental regulations and plugging requirements for abandoned wells, surface and groundwater contamination from former wells should be minimal. Further, the land area required for drilling and production of a new well is approximately two acres. Due to these factors, the relative contributions of oil and gas production to effects on groundwater quality (GWQ), surface water quality (SWQ), and vegetation (E/V) in the upper and downstream portions of the Mud Creek Watershed are low. Effects in the Permit Area per se are negligible.

- Surface runoff from Chapel Hill oilfield located in the Lake Tyler East drainage area – this runoff may have been a contributing factor to chloride concentrations in Lake Tyler East water. Some increased chloride levels may have been released into the upper reaches of Mud Creek. The relative contribution of this pollution source to surface water quality in Mud Creek is in the low category. This oilfield source is not expected to make future contributions to increased chloride concentrations in Lake Tyler East.

- Lignite mining (deep mining and surface mining) – deep basin lignite deposits are present in the Five-County Area, primarily via lignite bands in the Wilcox Group stratigraphic unit. Deep basin lignites in the Permit Area are on the order of 800 to 1,200 feet deep, and this is considered to be too deep to be economically mined by surface means. Although no specific proposals have been made, the technology of in-situ gasification might be used in the future for lignite extraction in the Permit Area, even if Lake Columbia is completed. Some near-surface lignites have been found to the north, east, and south of the Permit Area. The eastern locations are in Rusk County and outside of the Mud Creek Watershed. The relevance of the north and south locations of near-surface lignites will depend on the specific location in relation to the Mud Creek Watershed. Historical surface mining in the watershed has been minimal, if at all. If surface mining is proposed in the watershed in the future, it would be expected that specific best management practices (BMPs) and reclamation of mined lands would be required by the State of Texas. Such practices would minimize negative effects on soils (S), surface water quality (SWQ), vegetation (E/V), wildlife (E/W), aquatic biology (E/AB), and threatened or endangered species (E/TES).

- ANRA programs for meeting municipal, industrial, and steam electric power water demands – for several decades ANRA has been assisting in meeting increasing water demands in the Five-County Area, and such programs will continue over the future time boundary for this impact study of the proposed Lake Columbia. Multiple benefits have accrued, including the promotion of socioeconomic benefits via meeting increasing water demands due to population growth, facilitating a stronger economy as reflected by support for industrial uses, and increased earning and public finance capabilities.

- Industrial nonpoint pollution from a lead-acid battery plant in Tecula (northeast of Jacksonville) – Tecula is less than one mile west of Lake Columbia. A nine-acre lead-contaminated soil site is at the battery plant location, and a two-foot soil cap has been put into place as part of a remediation program. Sampling has not revealed elevated lead levels in Mud Creek. Therefore, no future occurrences of increased levels are anticipated; however, to be conservative, Table 3.3.6-2 indicates that the first 10 years of the future time boundary could be subject to such occurrences, although the likelihood is extremely low.

3.3.6.5 Analysis of Contributing Effects from Future Actions

Table 3.3-6 contains summary impact information on 13 reasonably foreseeable future actions associated with the proposed Lake Columbia Project. The actions include:

- Widening of U.S. Highway 79 and building a 5,000-foot long bridge over the proposed Lake Columbia – the Texas Department of Transportation (TxDOT) has a list of projects scheduled for FY 2008-2010, and longer-range projects beyond that time frame. The only significant project in the Permit Area and the upstream portion of the Mud Creek Watershed involves the reconstruction of U.S. 79 as a 4-lane divided highway from east of Jacksonville eastward to the Cherokee-Rusk county line. TxDOT considers this a long-range project for the 2015-2020 time frame. This highway currently crosses Mud Creek about three miles upstream of the proposed dam site, and a bridge over the lake would have to be constructed. Construction of this bridge is identified in ANRA's reservoir plan (see Sec. 3.6.1). The identified construction phase would have some effects on local surface water hydrology and water quality. Further, local effects on air quality and noise would be anticipated. Due to the short-term construction phase (about two years), the relative contributions of this project to the above resources are considered to be low. Similarly, an approximately 1000-foot bridge would have to be constructed over proposed Lake Columbia for S.H. 135 in the upper portion of the proposed reservoir. Even less impacts would be expected from this smaller bridge.

- Development and use of public access areas and marinas along the Lake Columbia shoreline - Seven potential public access areas and related marinas have been delineated (four on the east side and three on the west side of the lake). It can be assumed that these facilities would be developed in the first 10 to 15 years of lake usage. The resultant effects would primarily occur in the Permit Area, with such effects associated with surface water quality and aquatic biology. Local noise levels would increase in the vicinity of the access points and marinas. The relative contributions of these actions on the above resources are considered to be low, in part due to seasonal and daily variations in the usage patterns of access areas and marinas.

Table 3.3-6 Reasonably Foreseeable Actions Contributing to Cumulative Effects on Study Area Resources

Actions[a]	Location[b]	Affected Study Area[b], Resources[c], and Relative Contribution[d]	Continuation 2010-2060[e]
Widening of U.S. Highway 79 and building a 5,000-ft. long bridge over the proposed Lake Columbia, plus a bridge for S.H. 135 over the upper part of the proposed reservoir	PA	PA – SWH(L), SWQ(L), C/AQ(L), N(L)	2015-2060
Development and use of public access areas and marinas along the Lake Columbia shoreline	PA, MCWU-SDA	PA – SWQ(L), E/AB(L), N(L)	2012-2060
Recreational usage of the proposed Lake Columbia and its environs	PA, MCWU-SDA	PA – SWQ(M), E/AB(M), N(M), C/AQ(M) MCWU-SDA – SWQ(M), E/AB(M), N(M), C/AQ(M)	2012-2060
ANRA regulation of recreational and commercial activities on and surrounding the proposed Lake Columbia	PA, MCWU-SDA	PA and MCWU-SDA – beneficial effects on SWQ, E/AB, SWUS, N, C/AQ	2012-2060
TPWD fisheries management plan	PA	PA –E/AB (beneficial effects)	2012-2060
Implementation of a comprehensive mitigation, conservation, and management program by ANRA	PA, MCW-SDA, MCWU, MCWD, 5-CA	Beneficial effects would occur on multiple resources	2012-2060
Shoreline developments around the proposed Lake Columbia	PA, MCW-SDA	PA – SWQ(L), E/AB(L) MCW-SDA-SWQ(L), E/AB(L)	2012-2060
Corps MOA to protect and minimize adverse effects on cultural resources	PA, MCW-SDA	Beneficial effects would accrue on cultural resources	2010-2060
Other existing and potential water resources projects	MCWU, MCWD	No effects are anticipated since the projects are outside of the MCWU and MCWD	2010-2060
Other current or potential land development projects	MCWU, MCWD	MCWU – SWQ(L)	2010-2060
Population increases in the Five-County Area	5-CA	Beneficial effects would accrue to S/L, S/E, S/PK	2010-2060
Economic developments in the Five-County Area	5-CA	Beneficial effects would accrue to S/L, S/E, S/PK	2010-2060
Dallas Water Utilities seek water allocations from the proposed Lake Columbia	5-CA	Low likelihood of occurrence	2030-2060 (?)

Table 3.3-6 Notes

a: P = past action within the historical time boundary (1960-2010) and which still exists at the current time (2009-2010)

Pr = past action which originated within the most recent decades (1980-2010) and which still exists

b: Location denotes the study spatial boundary wherein the action occurs. The boundary codes include:

PA = 10,655.5-acre Permit Area for the proposed Lake Columbia Project

MCW = Mud Creek Watershed located in the southeast quadrant of Smith County and the northeast quadrant of Cherokee County; the total area of MCW is 554 square miles. MCW can be considered in three parts – the upstream watershed above the proposed dam site (WCWU), with an area of 384 square miles; the downstream watershed below the dam site to its confluence with the Angelina River (MCWD), with an area of 170 square miles; and a potential shoreline development area within one mile of the shoreline of Lake Columbia (MCW-SDA).

5-CA = Five-County Area (Smith, Rusk, Cherokee, Nacogdoches, and Angelina counties) served by water supplies provided by ANRA.

c: Resources denotes the following substantive environmental topics and their related codes:

P/T = physiography and topography
G = geology
S = soils
GWU = groundwater usage
GWQ = groundwater quality
SWH = surface water hydrology
SWQ = surface water quality
SWUS = surface waters of the United States
C/AQ = climatology and air quality
N = ambient noise
E/V = ecology – vegetation
E/W = ecology – wildlife
E/AB = ecology – aquatic biology
E/TES = ecology – threatened or endangered species
CR = cultural resources
S/P = socioeconomics – human population
S/L = socioeconomics – labor
S/E = socioeconomics – earnings
S/PF = socioeconomics – public finance
LU/R = land use – regional
LU/L = land use – lake specific
LU/R = land use – recreation at Lake Columbia
A/VQ = aesthetics – visual quality
EJ = environmental justice

d: Relative contribution of the listed action to cumulative effects on pertinent resources; the contribution codes include:

L = low relative contributions; this determination is based on considering the size of the location area and the size of the action, the capacity of location area to recover from such effects, and the existence of any control or effects minimization programs for the action's effects

M = moderate relative contribution, consider the same factors as for L above, as well as potential contributions from other past or present actions

H = high relative contribution, consider the same factors as for M above, and recognize that the evaluated action may be a primary contributor to cumulative effects

e: Addresses the anticipated occurrence of the action over the future time boundary (2010-2060). The continuation codes are as follows:

Y = yes, the action will continue over the entire 50-year period

P(x) = the action will continue over a portion of the period; x denotes an estimate of the number of years of continuation

N = no, the action will not continue over the 50-year time period

e: Addresses the anticipated occurrence of the action over the future time boundary (2010-2060).

- Recreational usage of the proposed Lake Columbia and its environs – such usage could include fishing, boating, water skiing, use of personal watercraft, birding, and photographing wildlife and scenery. The surface area of the proposed Lake Columbia would be 10,133 acres. A survey of 25 existing Texas reservoirs revealed a relationship between the surface area of water and four categories of recreational users (Propst, Stynes, Lee, and Jackson, 1992b). Simple linear regressions were then used to project annual recreational visitors as follows – 4,300 boaters that are also campers; 15,600 non-boaters that are campers; 199,500 day users (including overnight visitors – OVN) that are boaters; and 791,100 day users (including other OVN) that are non-boaters. The annual recreational users in the four categories totaled 1,010,500. This level of recreational users would provide economic benefits to both Smith and Cherokee counties, as well as the other three counties in the Five-County Area. These recreational activities also contribute to cumulative effects on surface water quality (SWQ), aquatic biology (E/AB), noise (N), and local air quality (C/AQ) in the Permit Area and its environs. The relative contributions to cumulative effects for each of these resources are expected to be in the moderate category.

- ANRA regulation of recreational and commercial activities on and surrounding the proposed Lake Columbia – ANRA would either unilaterally or cooperatively (with other state agencies) develop and enforce regulations associated with boating, fishing, hunting, and other recreational or commercial activities associated with the proposed lake. In addition, as lake manager, ANRA would enact and enforce regulations to minimize potential adverse effects to water quality including erosion control, septic tank restrictions, and nonpoint source pollution. This action would facilitate the mitigation of direct and indirect effects of the proposed action, as well as cumulative effects, on key resources such as surface water quality (SWQ), aquatic biology (E/AB), surface waters of the U.S. (SWUS), noise (N), and air quality (C/AQ).

- TPWD fisheries management plan – the Texas Parks and Wildlife Department would develop a fisheries management plan for Lake Columbia, and it would then manage these resources (an early activity may include the stocking of fish species TPWD deems appropriate for the proposed lake). This action should begin within 1-2 years of completion of construction, and it would continue over the future time boundary for the Project. This action would benefit the aquatic biology resources (including aquatic habitat, fish and benthos, and macroinvertebrates).

- Implementation of a comprehensive mitigation, conservation, and management program by ANRA – this overall program includes implementation and enforcement of the Lake Columbia Water Quality Regulations (Appendix D); establishment and enforcement of permitted use controls around Lake Columbia in an effort to minimize adverse effects; and implementation of a Mitigation Plan (Appendix C).

In an effort to minimize overall project and associated development effects, ANRA has established Water Quality Regulations for Lake Columbia that are focused on protection of water quality. For example, Section 2 prohibits the construction and installation of pipelines and utility lines in the proposed lake. Section 3 relates to hazardous or municipal solid waste facilities in the Mud Creek Watershed and petroleum storage tanks which are prohibited in the lake's No Discharge Zone (defined as the land located horizontally 2,000 feet from the 315 feet NGVD elevation. Section 4 indicates that BMPs for forestry activities would be mandatory in the No Discharge Zone. Section 5 includes regulations associated with on-site sewage facilities and the prohibition of erosion in the No Discharge Zone. Section 6 relates to required licenses for the construction of piers, docks, and other waterfront facilities within the Construction Regulated Zone (land located at or above 315 feet NGVD and below 330 feet NGVD in designated Construction Related Zones). Finally, Section 7 relates to land development activities in the Construction Regulated Zone. This section includes requirements for Nonpoint Source (NPS) Pollution Control Plans, and Shoreline Habitat Plans for shoreline development proposals. To summarize, these Regulations include a range of controls and measures to protect water quality in Lake Columbia.

As an additional measure to minimize adverse effects associated with anticipated lake related development, ANRA plans to purchase land around the proposed Lake Columbia up to an elevation of 318 feet NGVD; this would be done in order to institute permitted use controls on its fee title land. This purchase would reduce potential adverse effects to 1,150 acres of land contiguous to the Permit Area. The average width of the area between 315 feet NGVD and 318 feet NGVD to be protected around the perimeter is estimated to be 50 feet. ANRA also plans to obtain flowage easements to further regulate development around the proposed lake. Flowage easements would be purchased between elevations 318 feet NGVD and 326 feet NGVD (i.e., the predicted 500-year flood elevation within the reservoir). This measure would result in the establishment and enforcement of restrictions on 3,350 acres designed to minimize the potential for adverse effects associated with anticipated. The average width of the area to be regulatedis approximately 200 feet.

ANRA has also developed a Mitigation Plan (Appendix C) which includes on-site and near-site mitigation involving habitat preservation by limiting the amount of Lake Columbia shoreline that can be cleared and modified and the establishment of approximately 1,195 acres of fringe wetlands; and off-site mitigation via replacing impacted waters of the U.S. with functionally equivalent land within the Neches River Basin, primarily in the area of the Big Thicket National Preserve. The mitigation is proposed as a permittee-responsible compensatory mitigation for losses of aquatic resources (Federal Register, April 10, 2008). This feature would replace the functional capacity loss associated with 5,746.5 acres of waters of the United States. A procedure for selecting off-site lands that could be used for this mitigation is in Appendix C. Further, ANRA has committed to complying with USACE regulatory requirements related to annual monitoring to ascertain if the requisite functional capacity units have been achieved (Corps Regulatory Guidance Letter 08-03, October, 2008).

To summarize, ANRA's integrated environmental management program includes mitigation measures for direct and indirect effects associated with the proposed Lake Columbia and anticipated shoreline development. Further, numerous resource conservation and protection measures are also included as means to avoid or minimize the effects of development activities along the 94-mile shoreline of the proposed lake. Accordingly, these programs provide benefits relative to key environmental resources in the study area.

- Shoreline developments around the proposed Lake Columbia – a routine consequence associated with man-made lakes is that shoreline development activities occur rapidly and typically expand over time. Such developments can include residences, townhouses, and condominiums, as well as businesses and strip malls. The housing units can range from usage 100% of the time to periodic seasonal usage on the weekends. While such developments can be anticipated, little is known about factors influencing location, spatial density, timing, and usage.

  To provide a basis for some projections for the proposed Lake Columbia shoreline developments, two nearby non-Corps lakes were studied via the use of historical aerial photographs. Lake Palestine is the nearest lake (about 25 miles northwest of proposed Lake Columbia), while Cedar Creek Reservoir is about 55 miles to the northwest. Comparative statistics on these two and the proposed Lake Columbia are presented in Table 3.3-7. Lake Palestine is located about 15 miles southwest of Tyler (a city with a population of 20,470 in July, 2008), while Cedar Creek Reservoir is located about 15 miles west of Athens (12,260 population in July, 2007). Further, Cedar Creek Reservoir is about 60 miles southeast of Dallas and the greater Dallas-Fort Worth area.

  The only two available aerial photographs for the two comparison lakes were from 1990 and 2006. Accordingly, these time snapshots were used to establish linear rates of shoreline development for each lake from its year of impoundment to 1990, and from 1990 to 2006. Table 3.3-7 includes both percentage rates and miles-based rates. The following observations can be made about these rates:

  (1) The development rates for Lake Palestine were about the same over both time periods (1.2 to 1.4% of shoreline/year, or 1.3 to 1.5 miles of shoreline/year).

  (2) The development rates for Cedar Creek Lake were higher for 1965 to 2000 than they were from 2000 to 2006 (2.1 down to 1.3 % of shoreline/year, or 2.8 down to 1.8 miles of shoreline/year).

Table 3.3-7 Comparative Information Related to Shoreline Developments

Lake	Year of Impoundment	Surface Area (acres)	Max Depth (ft.)	Shoreline (miles)	Shoreline Development[c] (% or miles)	Rate of Development[d]
Palestine	1962	25,560	58	106.6[a]	33% or 35 miles (to 1990) 55% or 59 miles (to 2006)	1962-1990: 1.2%/yr, or 1.3 miles/yr 1990-2006: 1.4%/yr, or 1.5 miles/yr
Cedar Creek	1965	32,623	53	135.3[a]	52% or 70 miles (to 1990) 73% or 99 miles (to 2006)	. 1965-1990: 2.1%/yr, or 2.8 miles/yr 1990-2006: 1.3%/yr, or 1.8 miles/yr
Columbia (proposed)	2012	10,133	56 (approx.)	94[b] (approx.)	by 2035: 32% or 35 miles by 2060: 65% or 70 miles (based on Lake Palestine rates)	2012-2060: 1.3%/yr, or 1.4 miles/yr (based on average Lake Palestine rates)

Notes:

a = shoreline miles measured from aerial photographs from 1990 and 2006
b = shoreline miles measured from elevation maps depicting the proposed Lake
c = percentage of shoreline development was based on the use of aerial photographs and the identification of housing or other structures within each mile of the perimeter
d = linear rates based upon uniform changes over time

(3) For both time periods, the shoreline development rates were greater for Cedar Creek Reservoir than for Lake Palestine (e.g., 2.8 miles of shoreline/year vs. 1.3 miles of shoreline/year from the mid-1960s to 1990; and 1.8 miles of shoreline/year. vs. 1.5 miles of shoreline/year from 1990 to 2006).

(4) The relative proximity of the Dallas-Fort Worth area was a probable cause of the greater development rates for Cedar Creek Reservoir.

Based upon the above information, it would appear that the Lake Palestine development rates would be more applicable to the proposed Lake Columbia. Accordingly, the potential linear development rate for Lake Columbia would be about 1.3% of shoreline/year, or 1.4 miles of shoreline/year. If these assumptions are reasonable, then by 2035 about 32% of shoreline (or 35 miles of the shoreline) would be developed. By 2060 about 65% of shoreline (or 70 miles) of shoreline would be developed. However, it should be noted that many factors can influence the shoreline development rate. Examples include distance from population centers, available local infrastructure, general economic conditions, and regulatory systems requiring “green” planning. Such regulatory systems could both reduce the rates of development and require greater environmental protection. The above action related to ANRA’s mitigation and protection programs should yield lower development rates which are more focused on environmental sustainability.

To conclude, shoreline development around the proposed Lake Columbia would contribute to declines in surface water quality (SWQ) and aquatic biology (E/AB); however, the relative contributions would be low, and various development programs would encourage greater environmental sensitivity in planning.

- Corps MOA to protect and minimize adverse effects on cultural resources – the Fort Worth District of the Corps of Engineers would plan to develop a Memorandum of Agreement (MOA) or Programmatic Agreement between the Corps, the Advisory Council on Historic Preservation, the Texas Historical Commission, and ANRA in relation to the construction and operation of the proposed Lake Columbia. The MOA would include a mitigation plan for avoiding or minimizing adverse effects to historic and cultural properties within the Lake Columbia Permit Area and the shoreline development area around the lake up to elevation 326. This action would be beneficial to cultural resources within these two study area boundaries. The MOA would be developed following permit issuance.

- Other existing and potential water resources projects – four other projects have been identified within the Five-County Area. Sam Rayburn Reservoir is downstream on the Angelina River and was completed in 1965. Lake Palestine is on the Neches River upstream of the confluence with the Angelina River and was completed in 1962. These two projects are outside of the Mud Creek Watershed boundary of the study and were not considered in this analysis. Lake Naconiche is a small (692 acres) flood prevention and recreational lake recently completed on Naconiche Creek in the Attoyac Bayou watershed (USDA, 1980, 1996). Attoyac Bayou is a tributary of the Angelina River downstream of Mud Creek. This lake also is outside of the Mud Creek Watershed area and thus Attoyac Bayou was not considered in the analysis. The only other potential surface water resource project is Fastrill Reservoir, which is proposed on the Neches River downstream of Lake Palestine and upstream of Sam Rayburn Reservoir and the Angelina River confluence. This is also outside the watershed study area. Furthermore, Fastrill Reservoir is speculative because it has no permits, and it can be essentially eliminated because the U.S. Fish and Wildlife Service is currently purchasing the land for the Neches River National Wildlife Refuge. There are no other reasonably foreseeable surface water development projects in the area. To illustrate, the Region I East Texas Regional Plan (SPI, 2006) evaluated water needs for the 2010-2060 timeframe. The plan states, "The only reservoir considered as a potential strategy for the needs in the current planning cycle is Lake Columbia (Eastex)" (SPI, 2006).

Based on the above information, no further analyses of these projects were conducted in relation to the cumulative impacts of the proposed Lake Columbia Project.

- Other current or potential land development projects – several projects have been identified; however, of central importance is whether or not they are within the Mud Creek Watershed. For example, most projected future growth in Smith and Cherokee counties is in Tyler (Smith County). The Cascades is a 500-acre residential and golf community currently under construction on Bellwood Lake; however, it is not in the Mud Creek Watershed. A 550-acre tract near the Cascades is proposed for a multi-purpose development, but this is also not in the Mud Creek Watershed. A 380-acre retail center known as Cumberland Park is currently under development at the intersection of U.S. 69 and Loop 49, which is in the western part of Mud Creek Watershed. The south and southeastern side of Tyler, part of which is in the Mud Creek watershed, continues to grow along with the rest of the city. These developments could have some impact on water quality, although the City of Tyler has adopted a Storm Water Management Plan to control such impacts (JCB, 2008). There are no other known proposed major development projects in the Mud Creek Watershed in Tyler (TEDC, 2009; Morgan, 2009).

  Jacksonville (Cherokee County) has recently developed the 131-acre Summers A. Norman Industrial Park. However, this development is not in the Mud Creek Watershed. Further, there are no known major development projects proposed in the Mud Creek Watershed near Jacksonville (JEDC, 2009). Communication with the Councils of Government for the five counties indicated that there are no other major known or proposed projects in the Five-County Area that could have a cumulative impact with the proposed Lake Columbia (Phillips, 2009; Kimbrough, 2009; Andrews, 2009).

- Population growth and increased water demands in the Five-County Area – the Five-County Area served by ANRA is expected to have an increase in population from 380,000 persons in 2000 to 670,000 persons by 2060. These increases will be reflected by increases in water demands across municipal and industrial sectors, and by increases in water needs associated with steam-electric power generation. These increased demands will also have associated requirements for increased infrastructure involving expansions of existing water line capacities and the development of new service lines. The anticipated increases in water demands is the primary need to be addressed by the proposed Lake Columbia Project. Regarding environmental impacts across the Five-County Area, the expanded and new water line needs would involve various locational and timing scenarios, thus construction-related impacts on noise, air quality, and land use should be localized and temporary. Positive benefits of population increases would accrue in relation to improved economic strength in the Five-County Area.

- Economic developments in the Five-County Area – with the anticipated increase in population within the Five-County Area, and assuming that an adequate water supply is available to meet increased demands, the robustness of economic indicators should improve. For example, annual total compensation of employees would be expected to increase along with an expanding population. Currently, the top five major sectors providing compensation to employees are – Smith County (health care and social assistance, manufacturing, government and government enterprises, retail trade, and professional/technical services), Rusk County (government and government enterprises, mining, manufacturing, construction, and utilities), Cherokee County (government and government enterprises, manufacturing, health care and social assistance, retail trade, and finance and insurance), Nacogdoches County (government and government enterprises, manufacturing, health care and social assistance, retail trade, and construction), and Angelina County (manufacturing, government and government enterprises, health care and social assistance, retail trade, and wholesale trade). The diversity of these sectors is indicative of a strong economy. Further, over the future time period (2010-2060), still other major sectors may appear. One example could be from significantly increased spending for recreation in Smith and Cherokee counties resulting from the development of Lake Columbia.

  To summarize, the potential impacts of economic developments in the Five-County Area are positive and beneficial to labor, earnings, and public finance.

- Dallas Water Utilities water allocations from the proposed Lake Columbia – there are some indications that Dallas would be interested in procuring such allocations to meet their ever-growing needs for expanded water supplies. No official inquiry has been received by ANRA. Since the Dallas Water Utilities already has procured allocations from the nearby Lake Palestine and is in the process of investigating conveyance facilities to its service area, the additional procurement of water from Lake Columbia would be a logical extension to Dallas' water supply. Still, this action is considered to have a low probability of occurrence, at least for the initial decades of operation of the proposed Lake Columbia.

3.3.6.6 Findings from the Analyses of Other Actions

Careful consideration of the information in Table 3.3-5 indicates that 15 past or present actions have affected several spatially delineated resources. The most frequently listed locations (study areas) included the Permit Area (PA), and the upstream and downstream portions of the Mud Creek Watershed (MCWU and MCWD). Regarding the affected resources and the actions with the greatest contributions toward the effects, the following can be noted:

- The most frequently listed affected resources included surface water quality (SWQ), surface waters of the U.S. (SWUS), vegetation (E/V), and aquatic biology (E/AB). Aquatic biology includes habitat, fish, benthos, and macroinvertebrates.
- The large majority of the listed actions exhibited relatively low contributions to cumulative effects on the resources. The two exceptions were agricultural lands and timber production via logging operations; they both had moderate relative contributions for cumulative effects on the affected resources.
- Several of the listed resources were not subject to affects from any of the 15 actions. Examples included physiography and topography, geology, aesthetics, and environmental justice.

As can also be seen from Table 3.3-5, nine of the listed 15 past and present actions will continue within the future time boundary. Again, of particular importance relative to cumulative effects are agricultural land usage and timber production via logging.

The 13 reasonably foreseeable future actions listed in Table 3.3-6 also display a variety of contributed effects to the listed resources. Again, emphasis was given to three study areas – PA, MCWU, and MCWD. Further, for certain types of actions, effects were identified from the Shoreline Development Area (MCWU-SDA). These effects were primarily associated with recreational usage of the proposed Lake Columbia and its environs. Further, such usage was identified as a moderate contributor to effects on SWQ and E/AB. Table 3.3-6 also indicates that 12 of the 13 actions will occur over the future time boundary. When these 12 are considered with the nine continuing actions from Table 3.3-5, a total of 21 actions are relevant.

Another observation about the listed actions in Table 3.3-6 is that six of the 13 future actions are anticipated to have beneficial effects on the cited resources. As can be seen, these six actions are generally related to regulatory, mitigation, or management programs, or they are associated with the beneficial effects of population increases and economic developments in the Five-County Area.

As a final note, it should be recognized that these analyses relate to the effects of other actions. The effects of the proposed action should also be incorporated in the CEA. These effects are identified and discussed in Section 4. Further, summary information from this cumulative effects context section will also be included, as appropriate, for the listed resources in Section 4.

4.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

4.1 PHYSIOGRAPHY AND TOPOGRAPHY

4.1.1 Affected Environment

The proposed Lake Columbia Permit Area is located within the Interior Gulf Coastal Plain in the piney woods of East Texas (Figure 4.1-1). The inland portion of this region is characterized by gently rolling and sometimes hilly features that level off into virtually flat terrain towards the coastline. Lake Columbia lies within the hillier interior portion about 85 miles north-northwest of the Kisatchie Escarpment. This escarpment acts as a natural transition between the inland hills and the flatter coastland. Within East Texas, streams meandering toward the southeast have cut wide, shallow valleys. Floodplains occur 100 to 150 feet below the surrounding uplands and may be from one to ten miles wide.

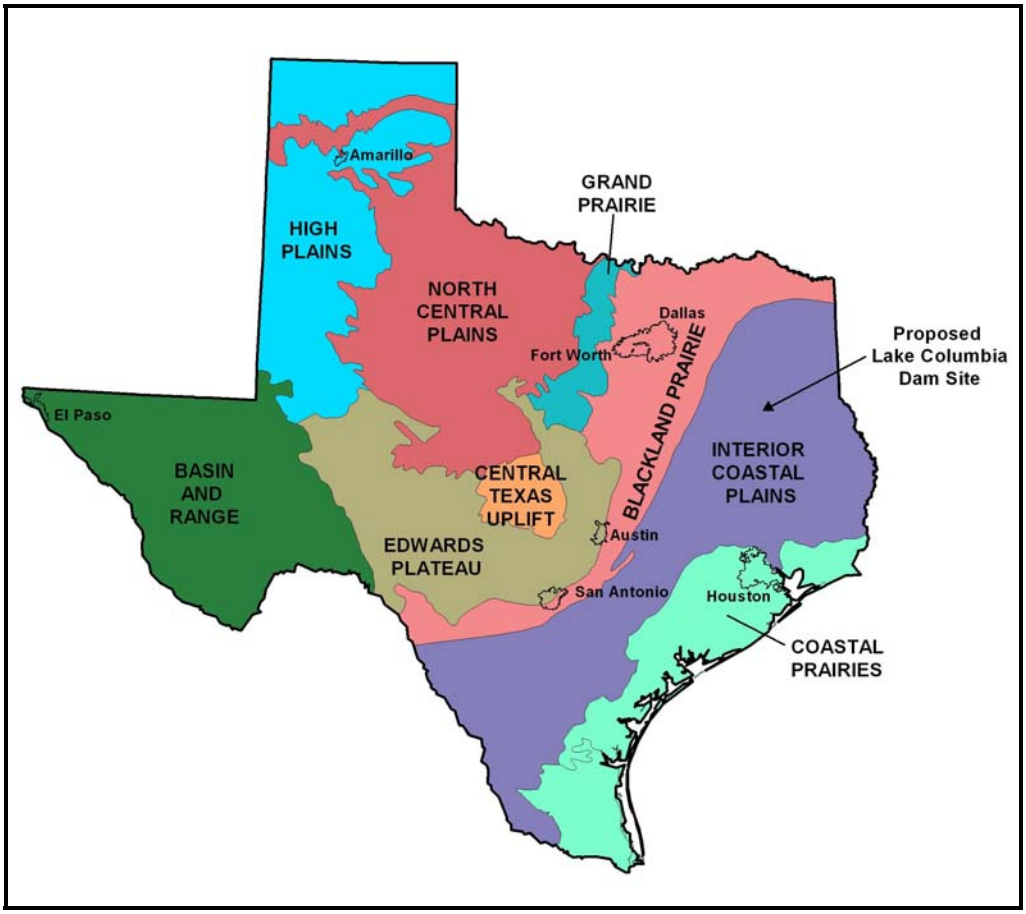


Figure 4.1-1 Physiographic Map of Texas

Lake Columbia would be located on Mud Creek which lies in a broad, flat valley/floodplain flanked by rolling hills. The Mud Creek floodplain is typically about 1-1.5 miles wide. At the proposed dam site, the Mud Creek bottom elevation is approximately 270 feet (all elevations NGVD). To the east, hills rise steeply to elevations in the range of 400-450 feet. To the west, the terrain is more gently sloping, eventually rising to about 350-450 feet. The highest elevation in the proposed Project area is Gill Mountain, 594 feet, which is approximately 2.5 miles northeast of the dam site.

4.1.2 Environmental Consequences

4.1.2.1 No Action Alternative

Under No Action, the physiographic and topographic impacts associated with either of the other alternatives would not occur. No new water bodies, valley fills, or structures would be created.

4.1.2.2 Proposed Action

Construction

The proposed dam, spillway, and construction areas would involve the discharge of approximately 672,000 cubic yards of fill material into approximately 220 acres of waters of the U.S. The actual footprint of the dam and spillway structure would be 164 acres. The total estimated amount of above-grade fill required for the dam is estimated to be 3.6 million cubic yards. The top of the dam would be at elevation 336 feet, or approximately 70 feet above the bottom of Mud Creek. The dam would be 6,800 feet long. Suitable borrow material would be obtained primarily from within the reservoir pool area. This would create pits that would eventually be inundated by the water in the reservoir.

Operation

Within the reservoir area, the existing valley and edges of the surrounding uplands would be converted into open water. Borrow pits would be submerged and not visible. The dam itself would be approximately 67 feet tall at its highest point, filling the valley, stream, and floodplain. No other topographic impacts would be expected.

Mitigation

No mitigation for physiography and topography is warranted.

4.1.2.3 Toledo Bend Pipeline Alternative

The construction of the Toledo Bend Pipeline would result in temporary disturbance along the pipeline route. An intake structure and pump station would be constructed at Toledo Bend Reservoir. Following construction, the permanent right-of-way would probably be maintained as herbaceous to scrub-shrub vegetation without any major change of topography. The terminal reservoir construction would likely result in the conversion of an upland area of several hundred acres into open water surrounded by a dike. A candidate terminal reservoir location has not been determined. No other notable physiographic and topographic impacts would be expected.

4.1.3 Cumulative Effects

As noted above, no physiographic or topographic impacts would occur in the Permit Area or Shoreline Development Area from the No Action alternative. Therefore, there is no need to consider cumulative effects on these natural resources.

The Proposed Action would affect current topographic features in the 10,655.5-acre Permit Area, including the introduction of the 6,800-foot long dam, the associated spillway, and the reservoir pool area. However, as noted above, mitigation for physiography and topography is not warranted. Further, Table 3.3-5 does not identify any past, present, and continuing actions that would impact physiography and topography; and neither does Table 3.3-6 for reasonably foreseeable future actions. Accordingly, no cumulative effects on these natural resources would occur.

The Toledo Bend Pipeline alternative would primarily consist of a buried water line. However, a terminal water storage reservoir covering several hundred acres would be needed. Its location would be near Mud Creek, possibly within the area that would be inundated by the proposed Lake Columbia. Again, while there would be some effects on local topographic features, no required mitigation measures would be needed for physiography and topopgraphy. Further, since Tables 3.3-5 and 3.3-6 did not identify other actions which would impact local physiography and topography, no cumulative effects on these natural resources would occur.

4.2 GEOLOGY

4.2.1 Affected Environment

4.2.1.1 Regional Geologic Setting

The Permit Area is located in the Interior Coastal Plains as discussed above and is also located within the Neches River basin (Figure 4.2-1). The Interior Coastal Plains are characterized by alternating belts of uncemented sands among weaker shales that erode into long, sandy ridges (Bureau of Economic Geology, 1968). Major structures influencing the region include the Sabine Uplift and the East Texas Embayment. Beginning in south-central Cherokee County near Redlawn, the axis of the embayment runs northward through Smith and Wood Counties before curving off to the east-northeast. Domal structures that are associated with salt intrusions are located along the axis of the embayment. The salt domes are slightly less dense than overlying strata and become mobile under pressure, pushing their way to the surface and causing tilting and fracturing of surrounding formations. The salt structures are of considerable economic

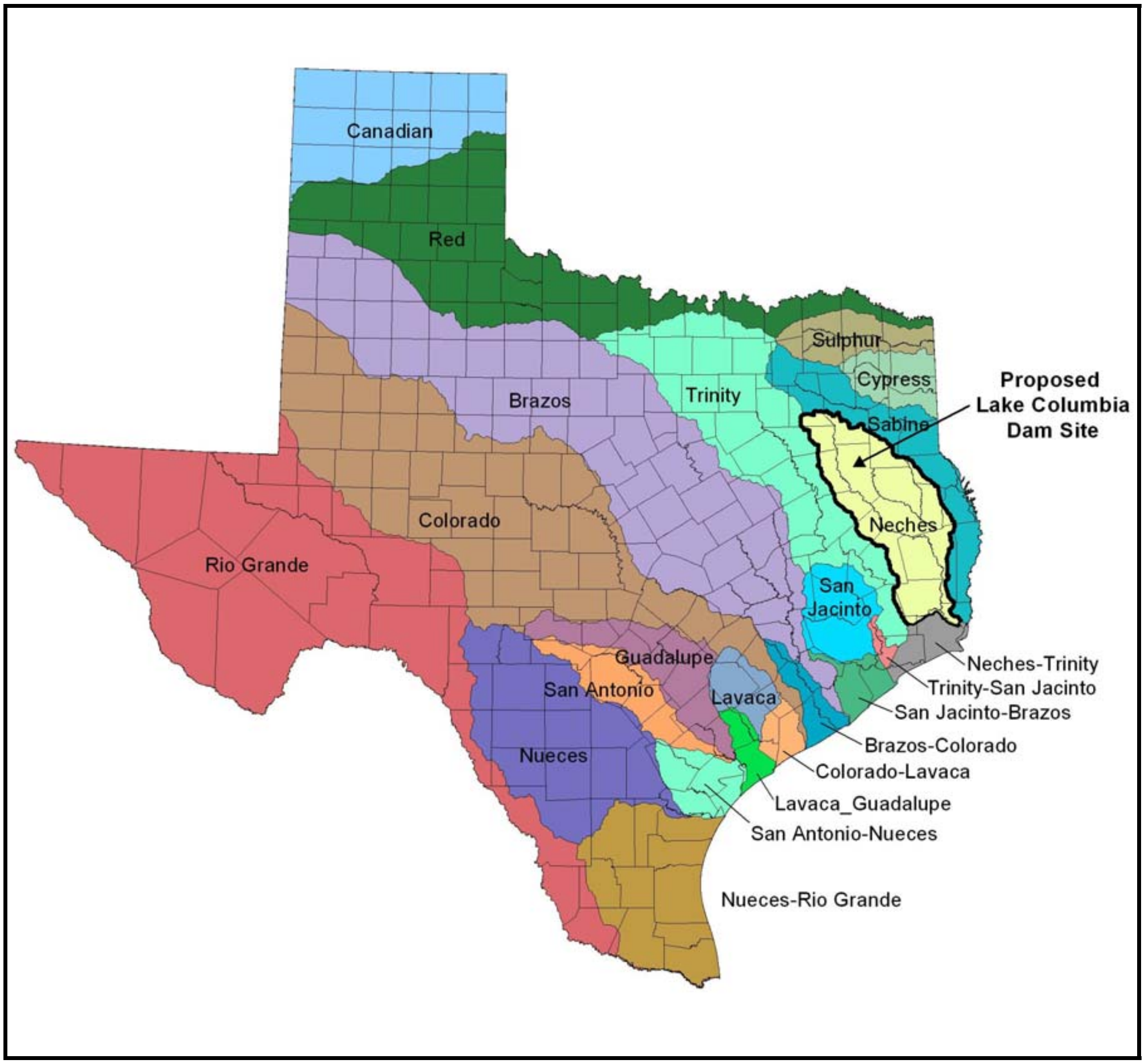


Figure 4.2-1 River Basins of Texas

importance as stratigraphic traps for oil and gas and for commercial mining. A massive bed of Louann salt occurs more than 15,000 feet below the deeper parts of the East Texas Embayment. Toward the south end of the axis, the domes veer to the southwest and follow the Elkhart-Jarvis-Mt Enterprise fault system.

In the Five-County Area, several fault systems exist. The Mexia-Talco and the Elkhart-Mt. Enterprise fault zones are the primary systems with a minor system, Rodessa system, bordering the Sabine uplift on the north. Only the Elkhart-Mt Enterprise is of interest to the Lake Columbia study area, as it bisects Cherokee County just south of Jacksonville on its eastward course across southern Rusk County (Figure 4.2-2). Microtremors have been recorded in this area. The eastern and western ends of this fault system were most active approximately 120 to 40 million years ago, and the central part, which includes the proposed site, was more active since 40 million years ago. The faults are probably related to salt creep, indicating a low seismic potential. (Jackson, 1982).

Causes of faulting are uncertain since the area is not near active tectonic plate boundaries. To account for the enormous sedimentary accumulation in the Gulf Geosyncline, a rapid sinking of the sea floor along the continental margin has been postulated suggesting that the fault zones were produced as the earth's crust was flexed downward. The faults in the nearby study area are thought to be caused from the uplifting of the earth's crust in the immediate area.

Surface stratigraphy of the Five-County Area exhibits numerous geologic units. Mention is made here of only the best known of those considered important for their resources. Among the oldest exposed rocks (Upper Cretaceous) are the Woodbine and Austin Groups. The Woodbine Group is made up of porous sands and shales and is an important oil and gas reservoir in East Texas. The Austin Group is primarily chalk with lesser amounts of shale, sandstone, and marl. Sand units appear throughout the Upper Cretaceous sequence including some of importance for their oil and gas resources.

Younger groups (Early Cenozoic) include the Wilcox, Claiborne, and Jackson. These groups include the only significant water-bearing (aquifer) formations, namely the Wilcox group, then the Carrizo, Queen City, Sparta, and Yegua formations.

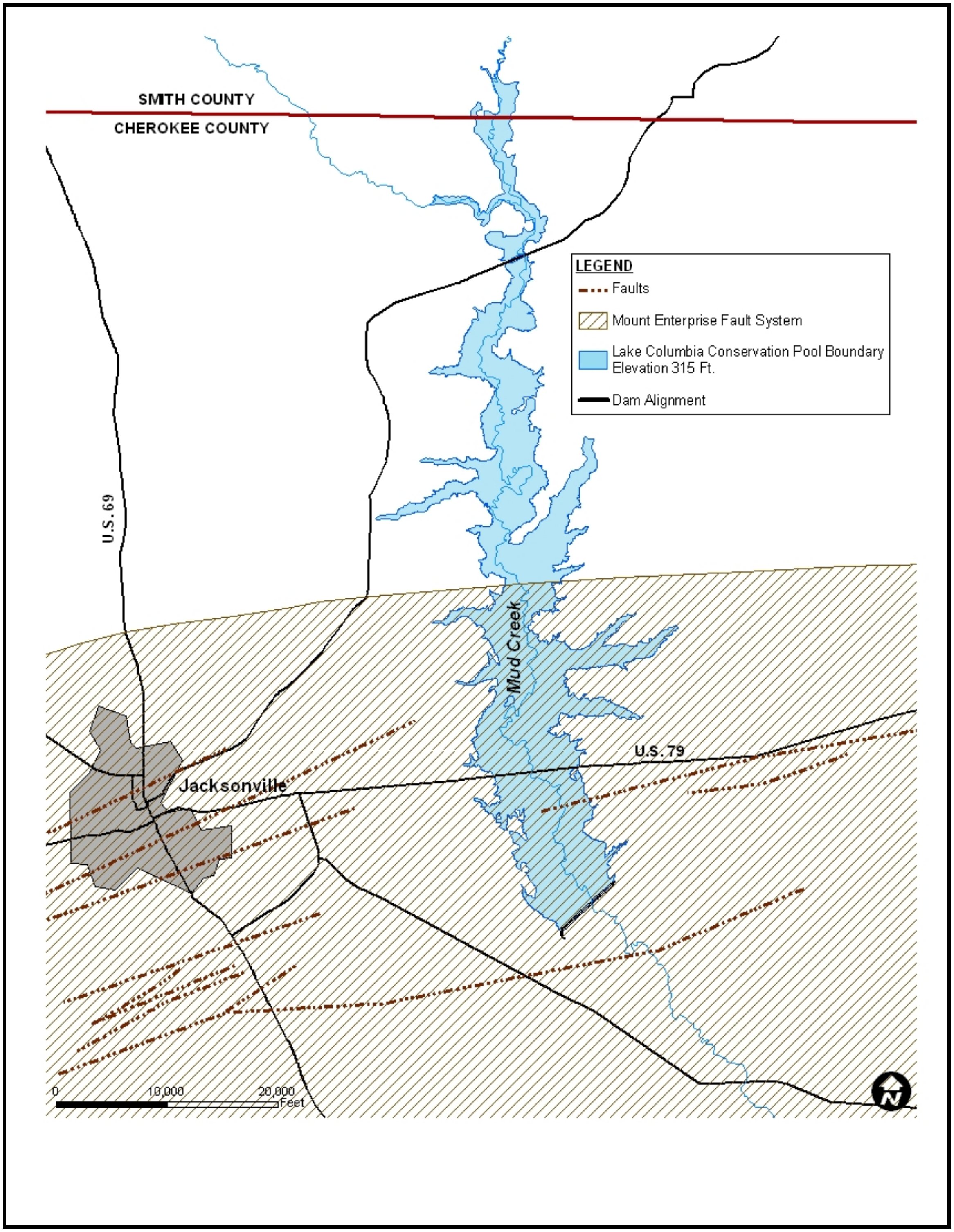


Figure 4.2-2 Mount Enterprise Fault System

4.2.1.2 Site Geology

The bedrock formation exposed at the abutments of the proposed Lake Columbia dam site is the Queen City Sand of Eocene age, while the deposits in Mud Creek are alluvium. Soil borings conducted at the proposed dam site indicated 18 to 28 feet of alluvium underlain by clays and sands of the Queen City formation. Large quantities of clay and random fill for construction of the dam are available in the reservoir area within about two miles of the dam (FNI, 2003a). The following descriptions are taken from the Geologic Atlas of Texas Palestine Sheet (Bureau of Economic Geology, 1968).

The Queen City Sand is described as:

> *"Quartz sand, fine grained, brownish gray; thin irregular beds of light brown to light gray clay; a few glauconite lentils; clay-ironstone beds and concretions common. Sand weathers pale red to grayish orange, clay weathers brownish gray to very light gray, resulting in a distinctive intermixing of colors characteristic of the formation."*

The Queen City Sand is underlain by the Reklaw Formation, the upper part of which is mostly carbonaceous clay and silt.

As stated previously, the general dip of the regional formations is predominantly southeast, however, there was not sufficient correlation of distinct horizons between borings to determine the general dip of the beds at the dam site.

The alluvial deposits present in Mud Creek are described as:

> *"Clay, silt, and sand, organic matter abundant locally, includes point bar, natural levee, stream channel, backswamp, indistinct terrace, and perhaps some Deweyville deposits, as well as a few small inliers of Tertiary formations*."

The apparent terrace deposits in the alluvium at the dam site are thought to be clays of the Queen City Sand at an elevation intermediate between the floodplains and the uplands.

Faults roughly paralleling the dam alignment are located approximately three quarters of a mile downstream and two miles upstream of the dam site and are part of the Mount Enterprise Fault System. The downstream fault reportedly dips to the northwest and is downthrown to the northwest, whereas the upstream fault is downthrown to the southeast forming a graben, defined as a downthrown block of land bordered by parallel faults. The faults in this area are considered inactive (LAN, 1991a; FNI, 2003a; Jackson, 1982).

Salt domes occur in Jackson County, and a salt pillow is mapped immediately southeast of the dam site but none were found within the immediate dam site.

4.2.1.3 Geologic Hazards

Seismicity

The proposed reservoir site is located in an area of the lowest seismic hazard risk in the U.S. (Algermissen, 1969, cited in LAN, 1991a; and Jackson, 1982). Although there is the potential for earthquakes, the potential ground motion is expected to be low. Earthquake records of Texas were examined back to 1928 from the U.S. Department of Commerce publications. Earlier records were obtained from published historical summaries. Seismic activity from the surrounding area is seldom felt in the Five-County Area and major earthquake epicenters are removed from the area. However, the New Madrid earthquakes of 1811-1812 did affect the area and reached inferred Mercalli Intensities of V-VII. In more recent times, a number of minor quakes, generally in the range of magnitude 3 to 4, have been recorded within 50 miles of the proposed Project area, including one located in Anderson County east of Jacksonville in November 1981 (Institute for Geophysics, 2009). Regional studies of seismicity (Algermissen, 1969, cited in LAN, 1991a; and Jackson, 1982) suggest a low seismic risk for this area.

Landslides

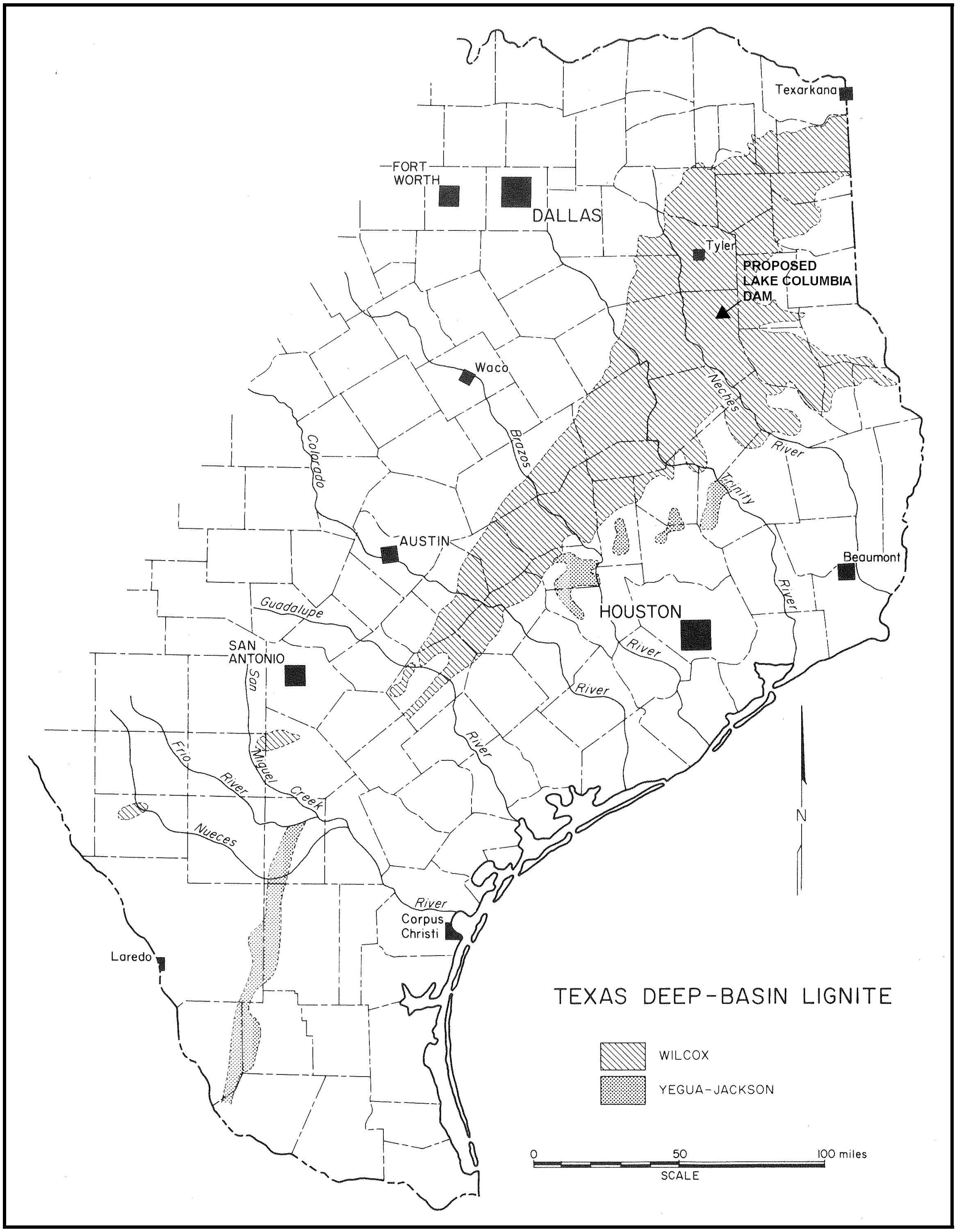
The Permit Area is located in a region with low likelihood of landslides (Radbruch-Hall et al., 1982); therefore, hazards related to landslides are expected to be minimal.

4.2.1.4 Mineral Resources

Lignite deposits are abundant in East and South Texas, with outcrops stretching from northeastern areas near Texarkana to southern areas near Laredo. Lignite bands are found in three stratigraphic units in Texas: the Wilcox Group, the Yegua Formation, and the Jackson Group. Of these, only lignites of the Wilcox Group are present in the vicinity of the proposed reservoir site. As can be observed in Figures 4.2-3 and 4.2-4, deep basin deposits are found throughout the proposed reservoir site and Five-County Area; near-surface lignites are found to the north and south of the proposed reservoir area, and also east of the area, along portions of the Toledo Bend Pipeline route. The deep basin lignites underlying the proposed Lake Columbia site are on the order of 800-1,200 feet deep (Kaiser et al., 1978). This is considered too deep to be mined economically by surface means. Exploitation by in-situ gasification would be possible; this technology has been tested but not been implemented for Texas lignite (Edgar and Richardson, 1974; Russell, et al, 1985). Construction of the proposed reservoir would not preclude in-situ gasification of deep basin lignite under the reservoir.

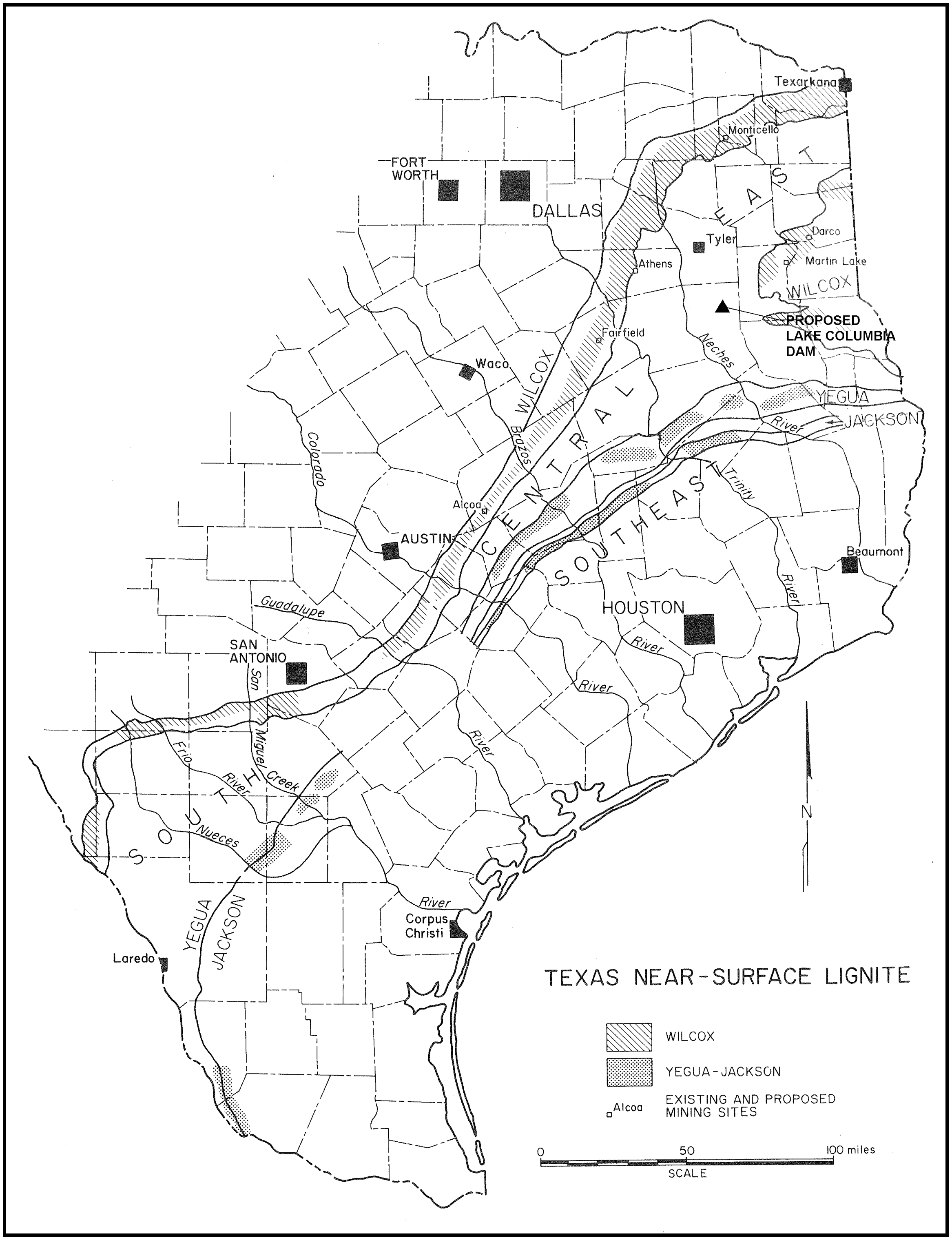
Figure 4.2-5 shows total historical oil and gas production in the Five-County Area since 1993. As shown, oil production has steadily decreased over this period, while gas production demonstrates a significant increase since about 2002.

Oil production in this area is from an extension of the Woodbine formation, with most production from near-vertical directional drilling to relatively shallow depths in the range



Source: Kaiser, 1974

Figure 4.2-3 Texas Deep-Basin Lignite



Source: Kaiser, 1974

Figure 4.2-4 Texas Near-Surface Lignite

of 4,000 to 6,000 feet. Oil reserves at these depths are limited and have been gradually depleted as production has continued during the last 15 years or so. The steady decline in oil production during this period reflects these depleted reserves, and this trend is expected to continue. While some gas production has occurred in the area pursuant to the overall development of petroleum reserves, it has been fairly limited at the relatively shallow drilling depths. However, with advances in technology for extracting gas from shale and methane beds, referred to as hydro-fracturing or "fracking," particularly at significantly deeper depths, gas production has increased substantially in the past few years as illustrated by the graph in Figure 4.2-5. Significant price increases also have been an important factor. This trend in gas production in the area is expected to continue and even accelerate in the next few decades. Oil reserves are not as prevalent at these deeper depths so oil production has not increased correspondingly and is not expected to increase.

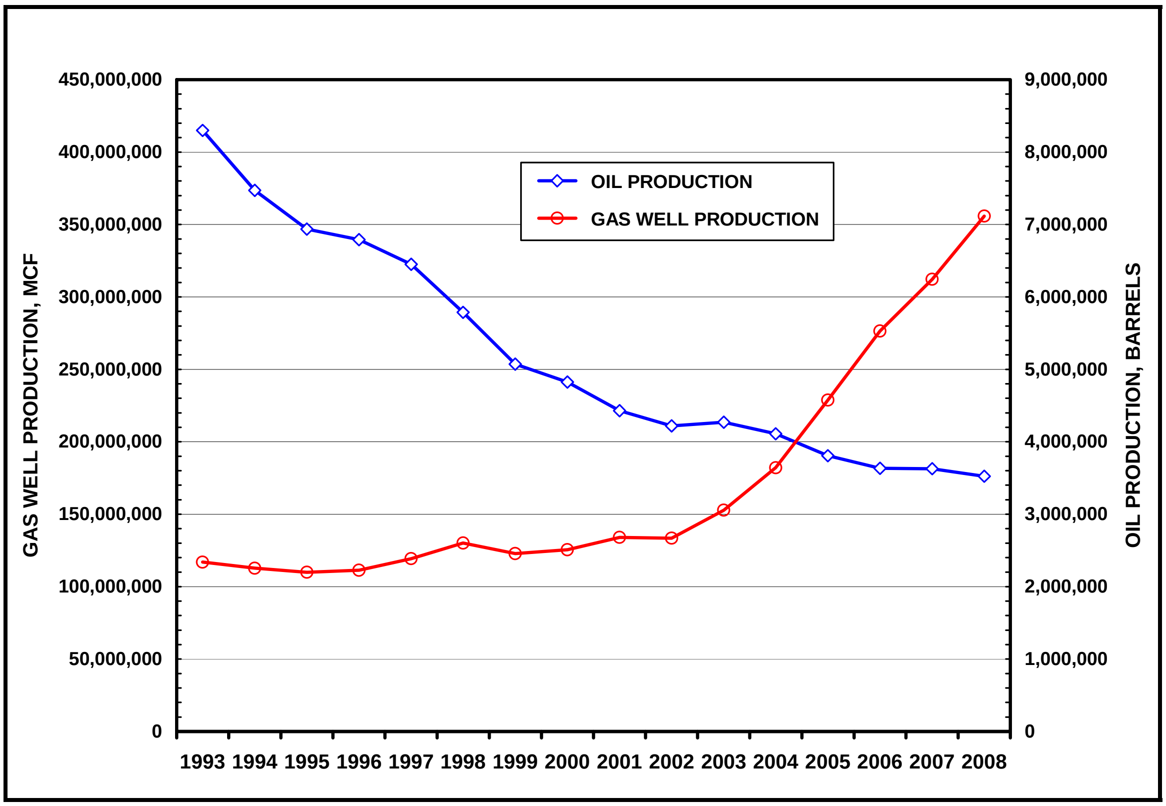


Figure 4.2-5 Oil and Gas Production in Five-County Area

Oil and gas exploration, drilling, and production have been limited in the proposed Lake Columbia site. This is primarily attributable to low or no production from the wells that have been drilled and the fact that the site is mostly floodplain. Railroad Commission of Texas records indicate that there is one well located in the proposed reservoir footprint with a surface elevation below 315 feet NGVD. The records indicate this well has been plugged and abandoned. Some wells in the vicinity that were drilled within the last five years have utilized horizontal drilling techniques with wellheads located away from the proposed reservoir site and with laterals at depths of 2,000 to 4,000 feet extending into the Mud Creek bottom. Figure 4.2-6 identifies the locations of all wells contained in the Railroad Commission of Texas data base that are not identified as "dry holes" that are adjacent to the proposed Lake Columbia site. All of these are gas wells.

With the continued depletion of the relatively shallow oil reserves in the area and the use of advanced extraction techniques with horizontal drilling to continue to expand gas exploration in the deeper beds, current trends in oil and gas production are expected to continue with little disruption attributable to land surface activities.
There are no known rock quarries or sand and gravel operations in the Permit Area.

4.2.2 Environmental Consequences

4.2.2.1 No Action Alternative

Under No Action, the geologic impacts associated with either of the other alternatives would not occur.

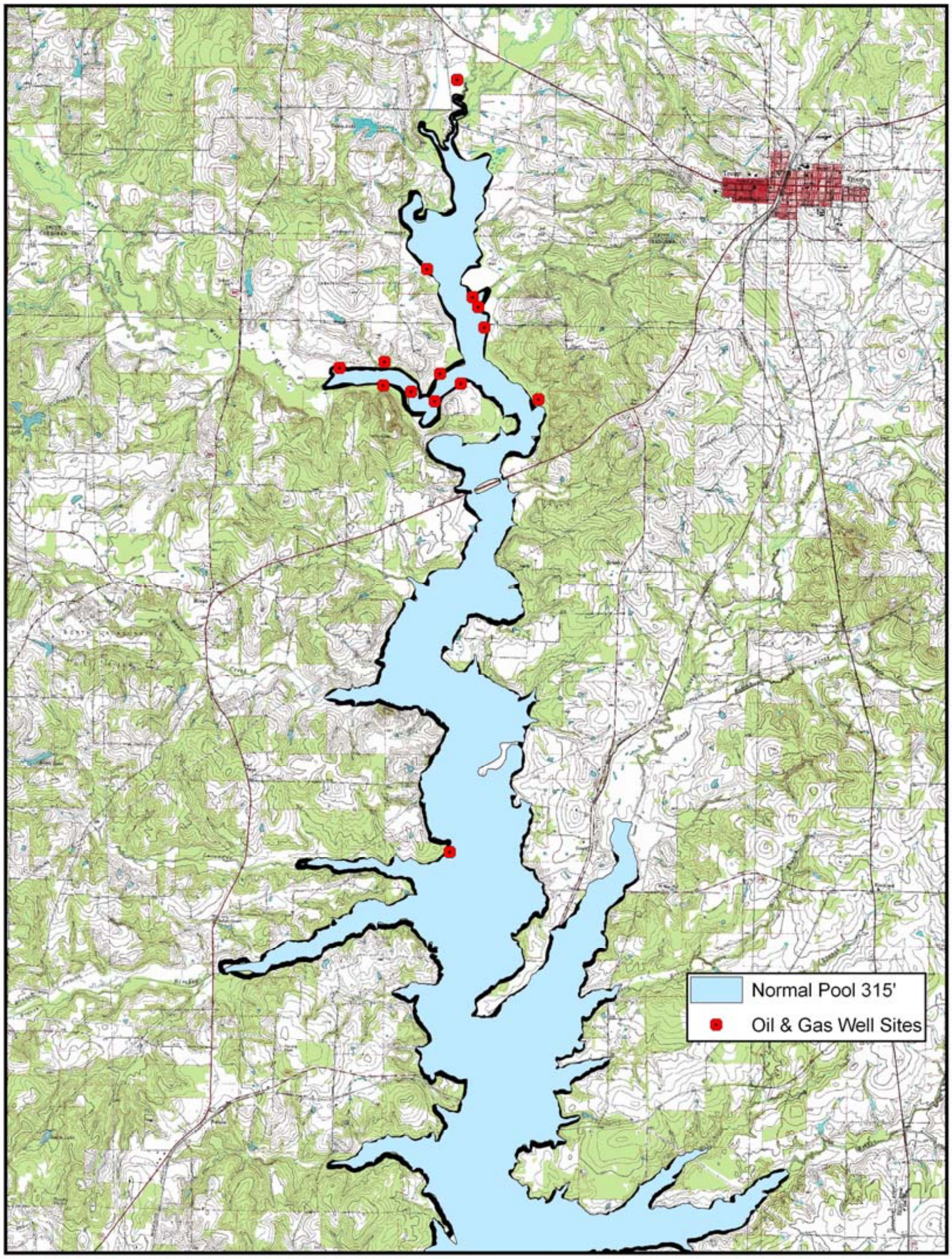
4.2.2.2 Proposed Action

Construction

At the dam site and borrow area, the original characteristics of the disturbed material would be permanently altered by the disruption of any existing stratification associated with construction activities. No impacts on seismicity or landslides would be expected. The construction of the reservoir should have little, if any, impact on recoverable mineral resources.

Operation

The primary impact to geologic elements near the proposed reservoir site is inundation of 10,133 acres of land. In addition, sediment transport and deposition within the lake would gradually bury existing strata below additional layers of alluvial material. Release of clear water from the reservoir would be expected to cause some scouring of sediments and channel degradation downstream of the dam with potential exposure of deeper layers within the channel. This is discussed in more detail in Section 4.5, Surface Water. Seismic and landslide risk are very low and no impacts on or from seismicity or landslides would be expected. Oil and gas production activities should not be affected by the proposed reservoir as oil exploration is expected to continue to decline in light of the



Source: Railroad Commission of Texas, 2009

Figure 4.2-6 Oil and Gas Wells near Proposed Lake Columbia

limited oil reserves in the area and as horizontal drilling techniques and advanced extraction methods are employed to access gas from the deeper shale and methane beds that may underlie the reservoir site. Similarly, oil and gas activities are not expected to impact the proposed Lake Columbia.

<u>Mitigation</u>

No mitigation for geology is anticipated.

4.2.2.3 Toledo Bend Pipeline Alternative

Along the pipeline route and at the terminal reservoir site, the original characteristics of the surficial material would be permanently altered by the disruption of any existing stratification associated with construction activities. Southern Rusk County and Shelby County, through which a large portion of the pipeline would be located, is an area containing lignite deposits (Kaiser, 1974; SPI, 2006). Construction of the pipeline would likely preclude future extraction of these deposits along the route.

4.2.3 Cumulative Effects

As noted above, no seismic threats in the Permit Area or Shoreline Development Area would result from the No Action alternative. This area has the lowest seismic risk hazard in the United States; it also exhibits a low likelihood for landslide occurrences. In addition, although some oil and gas production has occurred in the Five-County Area, no specific geological effects have been noted in the Permit Area. Therefore, there is no need to consider cumulative effects on these natural resources.

The construction and operation phases of the Proposed Action are also not expected to increase seismic risk and the likelihood of landslides in the Permit Area or Shoreline Development Area. Therefore, no mitigation requirements for geological impacts are anticipated. Future expansion of currently limited oil and gas production in the upper and downstream Mud Creek Watersheds may occur, with the activities expected to generate low relative contributions to impacts on groundwater quality, surface-water quality, and ecology/vegetation (Table 3.3-5). No current or future lignite mining is anticipated in the Permit Area and the upper and downstream Mud Creek Watersheds (Table 3.3-5). Accordingly, no significant cumulative effects on geological resources are expected to occur in the above three noted study areas.

No geological impacts are expected along the route for the Toledo Bend Pipeline alternative, or in the terminal storage area; therefore, no cumulative effects would be anticipated.

4.3 SOILS

4.3.1 Affected Environment

4.3.1.1 Soils of the Study Area

The Five-County Area is composed of coastal plain sediments that formed the parent material for the present soil associations. The major soils that exist in the region are listed in Table 4.3-1. Most soils in the area are characterized as loamy and sandy soils. Surface soils at the proposed Lake Columbia site are generally alluvial deposits as described in Section 4.2.1.2.

Table 4.3-1 Soil Groups in the Five-County Study Area

Soil Group	County				
	Angelina	**Cherokee**	**Nacogdoches**	**Rusk**	**Smith**
Loamy Upland Soils					
Bowie					x
Bowie-Cuthbert		x			
Cuthbert-Kirvin-Bowie				x	x
Diboll-Keltys	x				
Freestone-Woodtell					x
Freestone-Oakwood					x
Fuller-Keltys	x				
Keltys-Kurth	x				
Kirvin					x
Kirvin-Bowie-Cuthbert				x	
Nacogdoches-Alto		x			
Nacogdoches-Trawick		x	x		
Pirkey				x	
Rayburn-Corrigan-Stringtown	x				
Redsprings-Alto				x	
Rosenwall	x				
Sacul					x
Sacul-Bowie		x			
Sacul-Cuthbert			x	x	
Sacul-Cuthbert-Kirvin	x				
Sacul-Kirvin			x		
Tenaha-Lilbert-Darco				x	x
Tonkawa				x	
Woodtell	x				
Woodtell-Garner		x			
Woodtell-Lacerda			x		
Loamy and Sandy Upland Soils					
Bowie-Fuquay		x			
Cuthbert-Tenaha		x	x		
Letney-Springtown-Tehran	x				
Lilbert-Darco-Tenaha					x

Soil Group	County				
	Angelina	Cherokee	Nacogdoches	Rusk	Smith
Sandy Upland Soils					
Darco-Tenaha			x		
Fuquay-Darco		x			
Lilbert-Darco			x	x	
Pickton					x
Tonkawa			x		x
Tonkawa-Darco				x	
Wolfpen					x
Redsprings-Cuthbert-Elrose					x
Loamy to Sandy Terrace Soils					
Alazan-Moswell	x				
Attoyac-Bernaldo-Besner			x		
Loamy to Sandy Terrace Soils, cont'd.					
Bienville				x	
Besner-Mollville-Bienville	x				
Bernaldo-Attoyac				x	
Bernaldo-Keithville-Sawton	x				
Moswell-Bernaldo	x				
Moten-Multey	x				
Sawlit-Sawtown-Latex				x	
Level to Nearly Level Floodplain Soils					
Dreka				x	
Gladewater-Estes					x
Hannahatchee		x			
Keechi				x	
Koury	x				
Laneville-Mattex				x	
Mantachie					x
Mantachie-Marietta	x	x			
Marietta-Moorville-Iuka			x	x	
Ozias-Popher	x				
Tuscosso-Hannahatchee			x		

Source: LAN, 1991a

The Cherokee and Smith County soil surveys show numerous types of surface soils within the proposed dam and reservoir area. Generally, the soils are classified as terrace and floodplain soils consisting primarily of clay loam, but also fine sandy loam, and loamy fine sand (LAN, 1991a; USDA, 1959; NRCS, 2007). A summary of the soils, their relative occurrence, and their characteristics within the proposed Lake Columbia footprint are presented in Table 4.3-2. General uses of these soils are mostly wetlands, pasture, forest, and scrub/shrub.

4.3.1.2 Prime Farmlands

Prime farmland soils are defined by the U.S. Department of Agriculture as those soils which are best suited to producing food, feed, fiber, forage, and oilseed crops (7 CFR

657). These soils characteristically possess sufficient moisture, have an acceptable pH range, are not frequently flooded, do not have excessive rocks, and are not highly erodible. They typically have slopes of less than six percent. Prime farmlands produce the highest yields with minimal inputs of energy and economic resources and are important to the nation's food supply. Potential prime farmlands are found on areas of prime farmland soils. It is emphasized that prime farmland soils only reflect the potential to be prime farmlands, which is determined by the U.S. Department of Agriculture based on a number of qualifying factors, and not all prime farmlands are actually farmed.

Table 4.3-2 indicates which soils are prime farmland soils within the proposed Lake Columbia footprint. These soils comprise 135 acres, which is about 1.3 percent of the soils in the area.

4.3.2 Environmental Consequences

4.3.2.1 No Action Alternative

Under No Action, the soils impacts associated with either of the other alternatives would not occur, and conditions would remain as they are.

4.3.2.2 Proposed Action

Construction

Potential impacts to soils during construction include an increase in erosion caused by removal of vegetation and disturbance of the soil. This would occur at the dam site, construction areas, staging areas, temporary roads, and borrow areas.

In addition, soils would be excavated and removed from borrow areas for construction of the dam. Exact locations of borrow pits are unknown, but construction materials are planned to be obtained entirely from the reservoir pool area, and these areas would ultimately be inundated by the reservoir.

Operation

Soils, including approximately 135 acres (1.3% of the reservoir footprint) of prime farmland soils, would be buried, removed, or inundated within the proposed dam site and reservoir pool area and therefore would be unusable for other purposes. Normal soil and sediment transport in Mud Creek would be impeded within the reservoir. Sediment deposition would be expected to occur, mainly within the upper reaches of the lake. Conversely, the release of clear water from the dam would tend to result in some scour and movement of existing soils within the channel and floodplain a short distance downstream of the dam. Such an impact was observed by Phillips (2001) downstream of Lake Nacogdoches in Bayou Loco, which is similar to Mud Creek. This is discussed in more detail in Section 4.5.2.2.

Table 4.3-2 Soils in the Proposed Lake Columbia Footprint

Area (ac.)	Percent of Footprint Area	Description	Geomorphology	Prime Farmland	Erodibility	Drainage
4,289	40.38	Mantachie clay loam	floodplains		Not highly erodible	Somewhat poorly drained
1,703	16.03	Iuka fine sandy loam	floodplains		Not highly erodible	Moderately well drained
1,667	15.70	Marietta clay loam	floodplains		Not highly erodible	Moderately well drained
317	2.98	Bienville loamy fine sand, nearly level	stream terraces		Not highly erodible	Somewhat excessively drained
308	2.90	Sacul fine sandy loam, strongly sloping	interfluves		Highly erodible	Moderately well drained
298	2.80	Mantachie fine sandy loam	floodplains		Not highly erodible	Somewhat poorly drained
221	2.08	Bowie fine sandy loam, sloping	interfluves		Potentially highly erodible	Well drained
220	2.08	Bienville loamy fine sand	stream terraces		Not highly erodible	Somewhat excessively drained
204	1.92	Sacul fine sandy loam, sloping	interfluves		Potentially highly erodible	Moderately well drained
196	1.84	Mantachie loam, frequently flooded	floodplains		Not highly erodible	Somewhat poorly drained
114	1.07	Ochlockonee loamy fine sand	floodplains		Not highly erodible	Well drained
102	0.96	Sacul fine sandy loam, gently sloping	interfluves		Potentially highly erodible	Moderately well drained
95	0.89	Bowie fine sandy loam, gently sloping	interfluves	X	Potentially highly erodible	Well drained
89	0.83	Bienville loamy fine sand, sloping	stream terraces		Potentially highly erodible	Somewhat excessively drained
76	0.72	Sacul fine sandy loam, sloping, eroded	interfluves		Potentially highly erodible	Moderately well drained
63	0.60	Cuthbert fine sandy loam, strongly sloping	interfluves		Highly erodible	Well drained
53	0.50	Percilla soils	depressions on interfluves		Not highly erodible	Poorly drained
53	0.50	Hannahatchee fine sandy loam	floodplains		Not highly erodible	Well drained
45	0.43	Betis loamy fine sand, sloping	interfluves		Potentially highly erodible	Somewhat excessively drained
44	0.42	Lilbert loamy fine sand, sloping	interfluves		Potentially highly erodible	Well drained
39	0.37	Darco loamy fine sand, strongly sloping	interfluves		Highly erodible	Somewhat excessively drained
38	0.36	Darco loamy fine sand, sloping	interfluves		Potentially highly erodible	Somewhat excessively drained
38	0.36	Nacogdoches fine sandy loam, sloping, eroded	interfluves		Potentially highly erodible	Well drained
38	0.36	Trawick fine sandy loam, strongly sloping, eroded	interfluves		Highly erodible	Well drained
34	0.32	Angelina	floodplains		Not highly erodible	Very poorly drained

Area (ac.)	Percent of Footprint Area	Description	Geomorphology	Prime Farmland	Erodibility	Drainage
34	0.32	Sacul fine sandy loam, strongly sloping, eroded	interfluves		Highly erodible	Moderately well drained
32	0.30	Darco loamy fine sand, strongly sloping	interfluves		Highly erodible	Somewhat excessively drained
28	0.27	Elrose fine sandy loam, strongly sloping	interfluves		Highly erodible	Well drained
26	0.25	Elrose fine sandy loam, sloping	interfluves		Potentially highly erodible	Well drained
26	0.24	Woodtell fine sandy loam, gently sloping	interfluves		Potentially highly erodible	Well drained
26	0.24	Briley loamy fine sand, sloping	interfluves		Potentially highly erodible	Well drained
19	0.18	Alazan fine sandy loam, level	stream terraces	X	Not highly erodible	Moderately well drained
16	0.15	Tenaha loamy fine sand, strongly sloping	interfluves		Highly erodible	Well drained
15	0.14	Water				
11	0.10	Woodtell fine sandy loam, sloping	interfluves		Highly erodible	Well drained
6	0.06	Briley loamy fine sand, gently sloping	interfluves		Not highly erodible	Well drained
6	0.06	Elrose fine sandy loam, gently sloping	interfluves	X	Potentially highly erodible	Well drained
6	0.05	Ruston fine sandy loam, sloping	interfluves	X	Potentially highly erodible	Well drained
5	0.05	Bub-Trawick complex	interfluves		Highly erodible	Well drained
4	0.03	Owentown loamy fine sand, occasionally flooded	floodplains	X	Not highly erodible	Moderately well drained
2	0.02	Woodtell fine sandy loam, sloping, eroded	interfluves		Highly erodible	Well drained
2	0.02	Darco loamy fine sand, nearly level	interfluves		Not highly erodible	Somewhat excessively drained
2	0.02	Darco loamy fine sand, strongly sloping	interfluves		Highly erodible	Somewhat excessively drained
2	0.02	Lilbert loamy fine sand, gently sloping	interfluves		Not highly erodible	Well drained
2	0.02	Alazan fine sandy loam, sloping	stream terraces	X	Potentially highly erodible	Moderately well drained
2	0.02	Ruston fine sandy loam, gently sloping	interfluves	X	Potentially highly erodible	Well drained
1	0.01	Darco loamy fine sand, 1 to 6 percent slopes	interfluves		Potentially highly erodible	Somewhat excessively drained
1	0.01	LaCerda clay loam, sloping	interfluves		Potentially highly erodible	Moderately well drained
1	0.01	Gallime fine sandy loam, 1 to 5 percent slopes	stream terraces	X	Potentially highly erodible	Well drained
1	0.01	Bowie fine sandy loam, sloping, eroded	interfluves		Potentially highly erodible	Well drained

Source: NRCS, 2007

Mitigation

A sedimentation and erosion control plan would be prepared and implemented with various control measures in place to mitigate construction impacts.

Per the Lake Columbia Water Quality Regulations, proposed by the applicant (Appendix D), there would be additional restrictions on land and soil use within 50 feet of the conservation pool level of 315 feet NGVD, including a requirement that at least 60% of the area must be maintained in the natural condition.

4.3.2.3 Toledo Bend Pipeline Alternative

Along the pipeline route and at the terminal reservoir site, vegetation would be removed and existing soils would be disturbed over an area of at least 1,000 acres during construction. Soils would likely be excavated within the several hundred-acre terminal reservoir and used to construct the perimeter dike. Potential impacts during construction include an increase in erosion. However, a sedimentation and erosion control plan would be prepared and implemented with various control measures in place to mitigate these impacts.

Soils within the terminal reservoir area would be inundated. The pipeline route would be maintained as a right-of-way. These areas would be precluded from other uses, with the possible exception of certain non-structural uses such as agriculture and rangeland. There may be a potential loss of prime farmlands if the pipeline or terminal reservoir is constructed in such areas.

4.3.3 Cumulative Effects

As noted above, alluvial deposits comprising terrace and floodplain soils are present in the Permit Area. Prime farmland soils are associated with 135 acres of the 10,655.5-acre Permit Area, even though they are not necessarily used in farming operations. The No Action alternative would not impact the soils of the Permit Area nor the Shoreline Development Area; hence there is no need to consider cumulative effects on these soils.

The Proposed Action would involve soil excavation in the Permit Area, and in time this could lead to local soil erosion during the construction period. However, a sediment and erosion control plan would be used by ANRA to mitigate these construction phase impacts. The operational phase, with the dam and impounded water, would lead to sediment deposition primarily in the upper reaches of the reservoir from runoff from the upper Mud Creek Watershed. The dam itself would impede soil and sediment transport to the downstream segment of Mud Creek.

Other actions in the upstream and downstream Mud Creek Watersheds have or could contribute to soil erosion and sediment loading. Examples of such past, present, and continuing actions (Table 3.3-5) include agricultural land usage, timber production via logging operations, and oil and gas production operations. As shown in Table 3.3-5, the consequences of such runoff could be manifested in reduced surface-water quality in Mud Creek, disruptions in the multiple functions of waters of the U.S., and alterations in the aquatic biology of Mud Creek. The relative contributions of agricultural land usage and logging operations to these effects are expected to be in the moderate category.

Future actions in the upper and downstream Mud Creek Watersheds which would also contribute to soil erosion and its consequences include widening of U.S. Highway 79, construction of the S.H. 135 bridge, public access areas and marinas, and shoreline developments around the proposed Lake Columbia, which is estimated to encompass approximately 65% of the shoreline by 2060, as shown in Table 3.3-7. As shown in Table 3.3-6, these actions are expected to have low relative contributions to changes in surface-water quality and aquatic biology. Further, the Lake Columbia Water Quality Regulations (Appendix D) include several local area land use restrictions and controls which should minimize these contributions.

Because the combined effects of the Proposed Action and the above mentioned other actions on local and watershed-level soil erosion could become a concern relative to cumulative effects on lake water quality and biology, a monitoring program would be implemented by ANRA. Program details would be developed by ANRA, with the primary emphasis being on determining if significant cumulative effects are occurring on these two resources.

For the Toledo Bend Pipeline alternative, soil disturbance and erosion would occur during both pipeline construction and construction of the terminal storage reservoir. Other actions along the pipeline route could contribute to cumulative effects on local streams and waterbodies; however, the nature, location, and timing of such other actions have not been explored herein. ANRA's construction phase sedimentation and erosion control program, as well as the dispersed character of this alternative and the requirements for route rehabilitation, would aid in minimizing soil-related cumulative effects concerns.

4.4 GROUNDWATER

4.4.1 Affected Environment

The major source of groundwater in the study area is the Carrizo-Wilcox aquifer, but significant amounts of water are produced from the Queen City, Sparta, and Yegua-Jackson minor aquifers (Figures 4.4-1 and 4.4-2). The Carrizo-Wilcox is composed of many aquifers hosted within Tertiary age sedimentary units that dip to the southeast toward the Gulf of Mexico generally at less than 100 feet per mile. The rate of dip is greater than that of the land surface resulting in older formations cropping out to the north and west of younger formations at progressively higher elevations. The major structural features which modify the regional dip and affect groundwater flow within the aquifers include the East Texas basin, the Sabine uplift, and the Mount Enterprise fault zone. Western Smith and northwestern Cherokee County are located within the East

Texas saltdiaper province, which contains numerous salt domes that have affected Carrizo-Wilcox deposition.

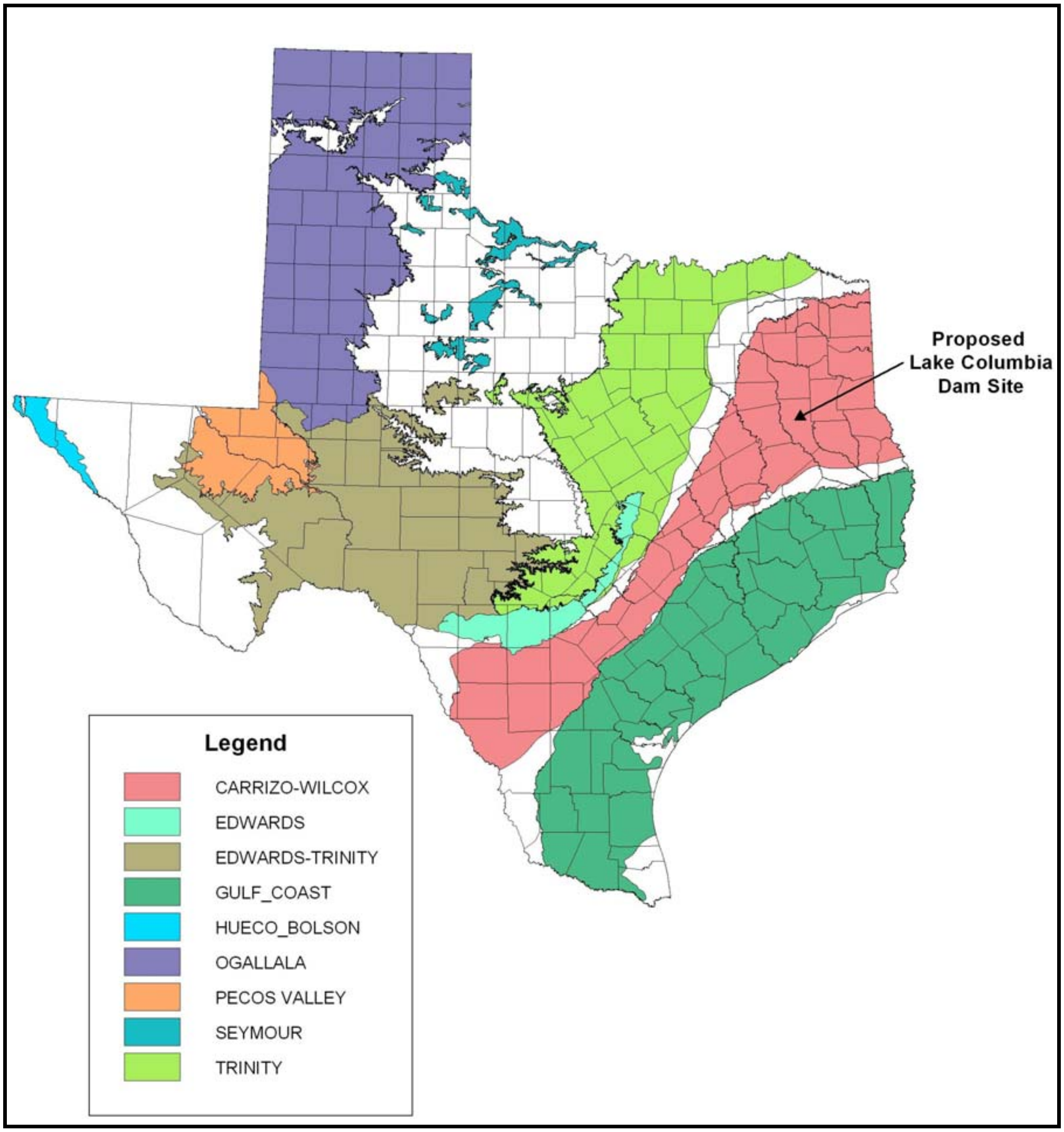


Figure 4.4-1 Major Aquifers of Texas

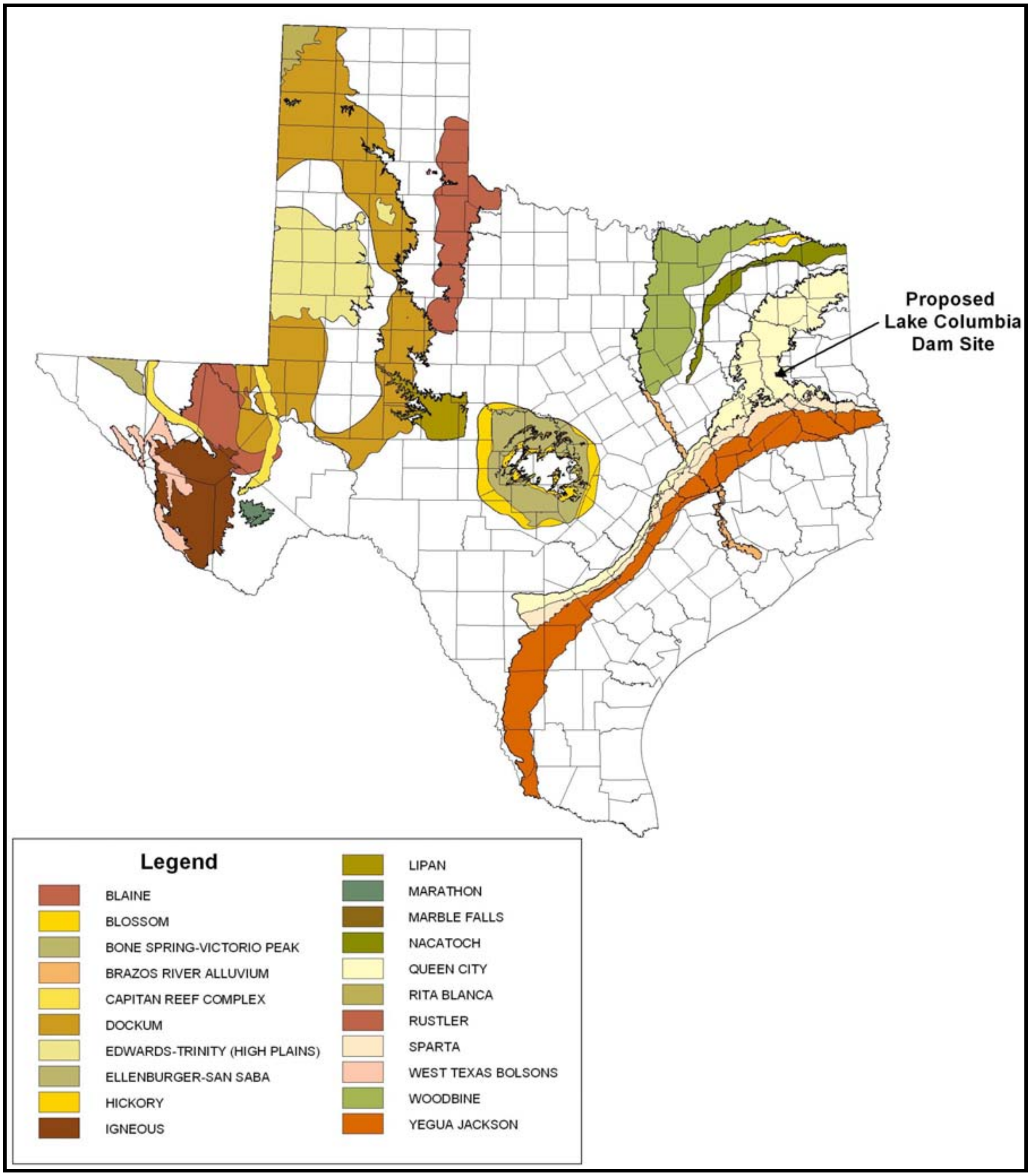


Figure 4.4-2 Minor Aquifers of Texas

The stratigraphy of the geologic units and their water-bearing characteristics which affect groundwater supply in the study area are summarized in Table 4.4-1. The geologic units supplying significant amounts of groundwater within the study area are, from oldest to youngest, the Wilcox Group; the Claiborne Group, consisting of the Carrizo, Reklaw, Queen City, Weches and the Sparta Formations; and the Jackson Group, consisting of the Cook Mountain and Yegua Formations. The major water producing hydrologic units are the Carrizo-Wilcox aquifer, Queen City aquifer, the Sparta aquifer, and the Yegua-Jackson aquifer. The Reklaw and the Weches formations are capable of producing usable amounts of water in their outcrop regions, however mostly for rural domestic and livestock use. In general these formations serve as aquitards or at least restrict the movement of water between the aquifers. In the far southern part of the study area, the Sparta is overlain by rocks of Tertiary age which may provide small amounts of water on the outcrops. The Yegua-Jackson aquifer outcrops over a large area of Angelina County and in recent years has been designated a minor aquifer. Recharge rates for the aquifers in this part of the state are relatively higher than in other regions, because of the higher rainfall and lower evaporation rates.

The Carrizo-Wilcox Aquifer was formed by the hydrologically connected Wilcox Group and the overlying Carrizo Formation of the Claiborne Group. The aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana, providing water to all or parts of 60 Texas counties. The thickness ranges from less than 50 to over 200 feet, but is generally around 100 feet in thickness. The Carrizo-Wilcox aquifer in the region occurs as a major trough caused by the Sabine Uplift near the Texas-Louisiana border. Total groundwater pumpage from the Carrizo-Wilcox in the region averaged 76,607 acre-feet per year during 1995, 1996, 1997. The largest urban areas dependent on groundwater from the Carrizo-Wilcox are located in central and northeast Texas and include the cities of Lufkin, Nacogdoches, and Tyler. Well yields of greater than 500 gallons per minute (gpm) are not uncommon (SPI, 2006).

There has been some historic decline of well levels in the area. Evaluation of 46 Carrizo-Wilcox wells throughout the region that have been monitored since the 1960s to the 1990s indicates that the average decline during this time period was about 51 feet and ranges from 20 feet to 263 feet. Major water-level declines have occurred in the region of Tyler and in the Lufkin-Nacogdoches area. There has been a leveling off of the decline of some wells since 1979 when Nacogdoches began using surface water from Lake Nacogdoches. Much of the heavy pumpage has been from municipal sources, but industrial pumpage is also appreciable.

The Sparta Aquifer extends in a narrow band across the state from the Frio River in South Texas northeastward to the Louisiana border in Sabine County and has a maximum thickness of about 200 feet and averages about 100 feet in thickness. The Sparta Aquifer is part of the Claiborne Group deposited during the Tertiary Period and consists of sand and interbedded clay with more massive sand beds in the basal section. Yields of individual wells are generally low to moderate, although some high capacity wells can average 400 to 500 gpm. Because the Carrizo Aquifer underlies the Sparta, most public

Table 4.4-1 Geologic Units and Their Water Bearing Characteristics

System	Series	Group	Stratigraphic Unit	Hydrologic Name	Water Bearing Properties
		Jackson		Yegua-Jackson (Minor)	May yield small to moderate amounts of useable quality water in isolated area on or near the outcrop
Tertiary	Eocene	Claiborne	Sparta Formation	Sparta Aquifer (Minor)	Yields small to moderate amounts of useable quality water over much of the study area
			Mount Selman: Weches Formation		May yield small amounts of useable quality water over much of the study area
			Mount Selman: Queen City Formation	Queen City Aquifer (Minor)	Yields moderate amounts of useable quality water over much of the study area
			Mount Selman: Reklaw Formation		May yield small amounts of useable quality water in isolated areas on the outcrop.
		Wilcox	Carrizo Formation	Carrizo-Wilcox (Major)	Yields large amounts of useable quality water throughout the study area
		Midway			Not know to yield useable quality water within the study area.
	Cretaceous				

water supply wells are completed in the Carrizo-Wilcox because of better quality water and better production.

The Queen City Aquifer, like the Sparta, extends in a band across most of Texas from the Frio River in South Texas northeastward into Louisiana. The Queen City is composed mainly of sand, loosely cemented sandstone, and interbedded clays and has a maximum thickness of 600 feet and an average thickness ranging from 300 to 400 feet. Well yields are typically low, but a few wells exceed 400 gpm. There is some Queen City Sand outcrop in the proposed reservoir area.

The Yegua-Jackson Aquifer extends in a narrow band from the Rio Grande to Louisiana. In the study area, the aquifer is located in the southern portion of Cherokee and Nacogdoches Counties and in most of Angelina County. Declining water levels and some water quality problems associated with naturally occurring conditions are primary concerns with groundwater in this area. High iron concentrations are a widespread problem (Intera, 2004).

In the 2006 Water Plan for the East Texas Region (Region I Plan), the TWDB well database was used to complete a detailed water quality assessment of the aquifers in the East Texas Region (SPI, 2006). TWDB standard water quality constituent analytical results from wells within the region were compared to primary and secondary drinking water maximum contaminant levels (MCL) when the database contained sufficient data. Based on these analyses, the Carrizo-Wilcox aquifer for the most part was determined to have good quality water, except for high dissolved solids and salinity concentrations in a band along its southern boundary. However, about 24% of iron (Fe) and 10% of manganese (Mn) sample results in the Carrizo-Wilcox aquifer group in the East Texas Region exceeded the secondary MCLs for these constituents (300 µg/L for Fe and 50 µg/L for Mn). The results that exceeded the MCLs were evenly distributed geographically.

The Queen City-Sparta aquifer produces water of excellent quality throughout most of its extent in the region; however, water quality deteriorates with depth in the downdip direction. The confined portions of these aquifers have significantly higher dissolved solids and salinity than the unconfined portions (Intera, 2004). Nitrate (as N) was detected above the primary MCL of 10 mg/L in 4.4% of the results in the Queen City-Sparta aquifer in the East Texas Region. Many of these occurred in Cherokee County. Iron was detected above the secondary MCL in 34% of the results, and manganese was detected above the secondary MCL in 15% (SPI, 2006).

The Yegua-Jackson aquifer produces good water only in a limited area. High iron levels are a problem, and the water from at least one location has been described as sodium bicarbonate water. Iron was detected above the secondary MCL in 33% of the results in the Yegua-Jackson aquifer in the East Texas Region. The results that exceeded the MCLs were evenly distributed geographically. Manganese was detected in 18% of the results above the secondary MCL, with most of the exceedances occurring in Angelina County and some in Nacogdoches County (SPI, 2006).

4.4.2 Environmental Consequences

4.4.2.1 No Action Alternative

Under No Action, there would likely be increased pumping of groundwater, which would result in additional drawdowns, particularly in areas that are already stressed, such as the Tyler and Lufkin-Nacogdoches areas. This could result in reduced well production and decreased water quality as deeper, poorer quality water is withdrawn. Other areas that already have limited capacity wells could experience shortages and inadequate withdrawal rates. The limited capacity of wells in many areas and need for additional supplies is discussed in more detail in Section 2.2, Need for the Project.

4.4.2.2 Proposed Action

Construction

No impacts are expected to groundwater as a result of construction of the proposed Lake Columbia dam. Borrow pits would be located within the proposed reservoir pool area and could potentially be in a Queen City Sands outcrop area. However, this is unlikely, because suitable borrow material for the dam would primarily be low-permeability soil, and not the higher permeability sands associated with the aquifer. Excavation of borrow material and placement of fill is not expected to impact groundwater recharge or discharge.

Operation

The Carrizo-Wilcox and Queen City aquifers lie under the proposed reservoir. The Carrizo-Wilcox is confined, and the reservoir is not expected to result in alteration to the flow conditions in the Carrizo-Wilcox aquifer. However, the Queen City Sands do outcrop in this area. The additional head from the impounded water within the reservoir could result in a small increase in recharge to the formation, and it is likely that the lake would lose some water via seepage. However, based on evaluation of existing data, it appears the existing bottom of Mud Creek in this area exhibits net groundwater discharge (gaining stream), as evidenced by extensive wetlands. The Queen City-Sparta Groundwater Availability Model (GAM) states, “The available gain/loss studies are consistent with our assumption that most major rivers and streams in the northeastern part of the Queen City and Sparta outcrop are gaining from the underlying aquifers.” (Intera, 2004). An analysis of historic naturalized flows similarly showed that streams in this portion of the Neches basin are significantly gaining (RJBCO, 2004).

Regionally, this condition would continue to exist after creation of the proposed reservoir. However, the water lost from the reservoir would likely cause a localized rise in the water table and move down gradient, discharging back into Mud Creek through similar processes as existed at the lake site prior to construction and filling of the reservoir. Consequently, it is unlikely that the reservoir would contribute significant inflows to the confined portions of the aquifer and have an impact on overall water levels in the Queen City aquifer.

Seepage losses from the proposed reservoir would therefore likely provide augmented base flow in Mud Creek downstream of the reservoir. Scouring of sediments and downcutting of the channel bottom resulting from relatively sediment-free releases from the lake (see Section 4.2.2) would tend to increase this condition by exposing more saturated zones along the stream banks. The degree of base-flow augmentation is uncertain, and would depend on factors such as seepage rates versus groundwater levels versus stream levels, soil permeabilities, uptake by phreatophytic vegetation, and available flow pathways.

The construction and operation of Lake Columbia would likely result in some reduction of groundwater withdrawals in the region as a result of conversion from groundwater to surface water sources for the Project participants. This would reduce some of the declining groundwater levels and increase the overall supply available to other groundwater users.

Mitigation

No mitigation for groundwater is anticipated.

4.4.2.3 Toledo Bend Pipeline Alternative

As described above for the Proposed Action, a reduction of groundwater withdrawals would likely occur in the regions as a result of conversion from groundwater to surface water from the pipeline. No other groundwater impacts would be expected to occur as a result of construction of the pipeline.

If the pipeline alternative were to be selected, the site for a terminal reservoir is currently unknown. At the terminal reservoir site, the potential seepage impacts discussed above for Lake Columbia could also apply, although on a much smaller scale because of the smaller size of the terminal reservoir.

4.4.3 Cumulative Effects

The Carrizo-Wilcox aquifer is a major water source across the Five-County Area. This aquifer yields large amounts of groundwater of sufficient quality for domestic usage throughout the pertinent counties. It is a confined aquifer in the Permit Area, while the Queen City Sands aquifer outcrops in a portion of the same area. Current groundwater usage throughout the Five-County Area exceeds 75,000 acre-feet per year. However, in some local areas drawdown is occurring. One large city which uses groundwater as a water supply is Tyler. Southeastern portions of Tyler are located within the northwestern boundary of the upper Mud Creek Watershed. Finally, despite the widespread usage of groundwater, local concerns in the Five-County Area have arisen over decreased quality related to high dissolved solids, salinity, and iron and manganese. Both local drawdowns and quality concerns could be exacerbated if substantial increases occur in usage patterns.

The No Action alternative would lead to substantial increases in groundwater usage throughout the Five-County Area; one specific example is the City of Tyler. These increases could be cumulative over the entire area as well as local areas. Even with such cumulative increases, future water supply needs would not be met.

The Proposed Action alternative would provide a primary source for meeting future water supplies. The availability of this new supply from the proposed Lake Columbia could cause decreases in groundwater usage in certain areas. However, as shown within Table 3.3-5, the past, present, and continued usage of the Carrizo-Wilcox aquifer has and will continue to result in high relative contributions to effects on both groundwater hydrology and quality in the Five-County Area.

The construction of the proposed Lake Columbia should cause no impacts to local groundwater such as the Queen City Sands aquifer. Neither construction nor operation of Lake Columbia would cause impacts on the confined Carrizo-Wilcox aquifer. Some local uses of the Carrizo-Wilcox aquifer are occurring in the Permit Area. Such uses provide only low relative contributions to effects on groundwater hydrology and quality; further, such uses would not continue (Table 3.3-5).

Regarding the Queen Sands aquifer in the Permit Area, some recharge from lake water to the Sands could occur. Such recharge could lead to augmented base flows below the dam.

Based upon this information on effects on groundwater within the Permit Area, no mitigation needs have been identified.

Table 3.3-5 also indicates two other past, present, and continuing actions within the upper and lower Mud Creek Watershed areas that have low relative contributions to effects on groundwater quality, namely, municipal landfills and oil and gas production. No other future actions which would impact groundwater hydrology and quality were identified (Table 3.3-6).

Completion of the Toledo Bend Pipeline alternative could lead to decreased usage of groundwater in certain locales within the Five-County Area. However, no detailed study has been conducted. Further, some water seepage in the Queen City Sand aquifer could occur from a terminal storage area located near Mud Creek.

This review of cumulative effects for the three alternatives has not revealed any major impact concerns regarding groundwater resources in the Five-County Area or the Permit Area.

4.5 SURFACE WATER

4.5.1 Affected Environment

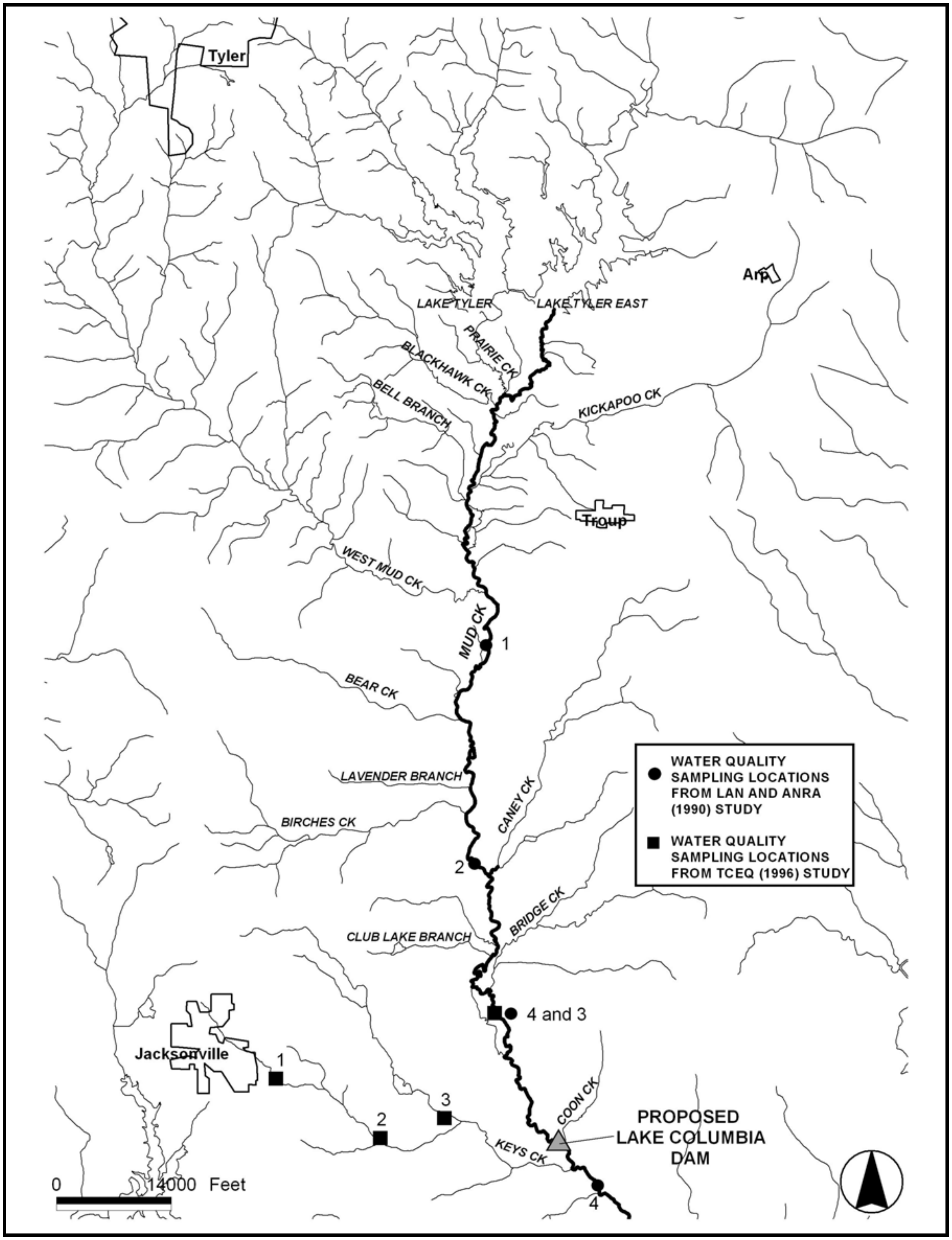
4.5.1.1 Hydrology

The Neches River runs approximately 220 river miles from north central East Texas southeastward to its confluence with the Sabine River near Sabine Lake at the Gulf of Mexico (see Figure 4.2-1). Approximately 150 of those river miles are above the confluence of the Neches River with the Angelina River. Headwaters of these rivers are in southeast Van Zandt County (Neches River) and southwest Rusk County (Angelina River). The Trinity River drainage basin borders the Neches basin on the west and the Sabine River basin lies to the north and east.

The upper Neches River Basin is defined as the portion encompassing the Angelina River and its tributaries upstream of the confluence with the Neches River. Above this point, the two rivers drain a total of approximately 7,400 square miles. This upper basin is about 70 miles wide at its maximum point and narrows to about eight miles near the mouth. Elevations within the upper basin vary in range by about 600 feet with the higher elevations in the headwaters over 700 feet NGVD.

Mud Creek, on which the proposed Lake Columbia would be located, is a tributary of the Angelina River and has a total drainage area of approximately 554 square miles. The headwaters of Mud Creek arise in Smith County east of the City of Tyler (see Figure 1.1-1). The Mud Creek watershed has a dendritic drainage pattern with a broad floodplain. The stream flows in a southerly direction through Smith and most of Cherokee counties until it reaches the confluence with Keys Creek where it begins to make a southeasterly turn towards the Angelina River. This confluence is approximately one mile downstream of the proposed Lake Columbia dam site. There are 13 named tributaries that contribute to the flow of Mud Creek above this confluence. These streams, in order of their confluence points with Mud Creek from north (upstream) to south (downstream), are listed below and are identified on the map in Figure 4.5-1:

- Prairie Creek
- Blackhawk Creek
- Kickapoo Creek
- Bell Branch
- West Mud Creek
- Bear Creek
- Lavender Branch
- Birches Creek
- Caney Creek
- Club Lake Branch
- Bridge Creek
- Coon Creek
- Keys Creek



Source: LAN, 1991b; Bayer, 1996

Figure 4.5-1 Mud Creek Tributaries and Water Quality Sampling Locations

The proposed dam site would be located immediately upstream of the Coon Creek confluence, and the drainage area at this point is approximately 384 square miles. Different channel features and flow characteristics within the proposed Project area portion of the watershed allow the watershed to be appropriately divided into two distinct portions: the northern portion and the southern portion.

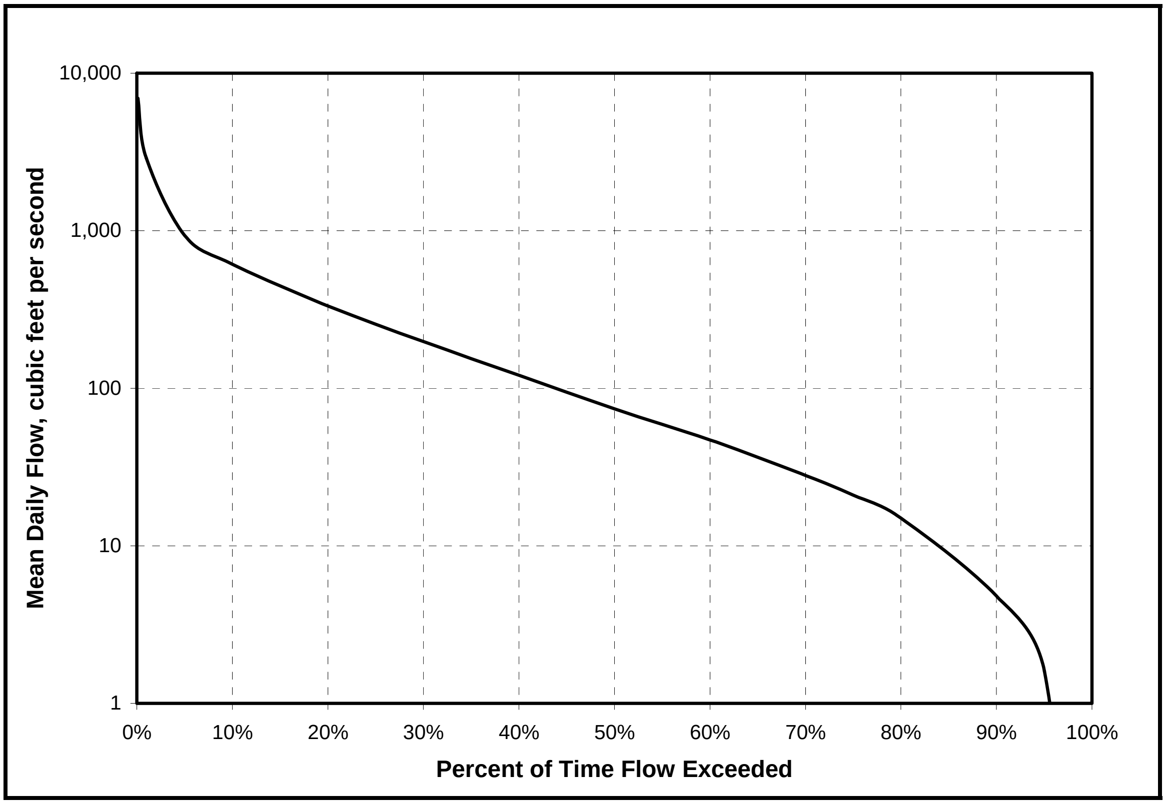
The northern portion extends from the headwaters to the confluence of Caney and Mud Creeks. This portion is controlled by dams on Prairie Creek and Mud Creek that form Lake Tyler and Lake Tyler East, respectively. The reservoirs are joined by a channel built across the divide upstream of the dams. Together, these two reservoirs provide 73,700 acre-feet of conservation storage capacity for the City of Tyler (Bayer, 1996). Tributaries within this northern portion of the Mud Creek watershed are characterized by long, slow-moving reaches with numerous pools and very few riffles and stagnant pools. There is limited channel braiding within this portion of the watershed.

The southern portion of the Mud Creek watershed extends downstream to the confluence with Keys Creek. Unlike the northern portion, the southern portion of Mud Creek is characterized by low gradients and extensive channel braiding. There are multiple meandering sloughs, stagnant pools, and oxbow lakes, as well as alternating patterns of riffles and large backwater pools. The complexity of these systems within the lower portion acts to slow flow movement under normal flow conditions.

The dam for proposed Lake Columbia would be located on Mud Creek within Cherokee County, approximately five miles from the town of Jacksonville and approximately 16 stream miles upstream from the Angelina River. The USGS topographic map of this area shows two channels for Mud Creek at the proposed dam site with marshy areas between the channels and near the edges of the valley. The area was heavily wooded in the past, however in recent years (since 1994), satellite images show that the dam site has been logged and cleared and the channels straightened.

Mud Creek is classified as a fifth-order stream below its confluence with Prairie Creek in Smith County (just below the Tyler Lakes) and remains a fifth-order stream from there downstream to its confluence with the Angelina River. Stream order is a measure of the relative size of streams. When two streams of the same order join, their order is increased by one. Stream sizes range from the smallest, first order, which has no flowing tributaries, to the largest, twelfth order, the Amazon River in South America.

There is one streamflow gaging station on Mud Creek, USGS No. 08034500 (Mud Creek near Jacksonville), that has a period of record from 1939 to 1979 and 2001 to present. The drainage area of Mud Creek and its tributaries above this gage covers 376 square miles. The average mean daily flow for 1940 through 1979 is 258 cubic feet per second (cfs), and the median is 74 cfs. The minimum mean daily flow is 0 cfs and the maximum is 22,700 cfs. Figure 4.5-2 exhibits the flow duration curve for Mud Creek near Jacksonville.



Source of data: http://waterdata.usgs.gov/nwis/. Date Retrieved: 2007-02-05

Figure 4.5-2 Flow Duration Curve, Mud Creek Near Jacksonville, TX USGS Station No. 08034500 (1940-1979, 2001-2006)

4.5.1.2 Water Quality

Water quality regulatory programs in Texas are administered by the Texas Commission on Environmental Quality (TCEQ) with the substantial involvement of local river authorities as well as other state and local groups, and are conducted under the Texas Clean Rivers Program and other relevant legislation. The Texas Administrative Code (TAC), Title 30, Chapter 307 promulgates surface water quality criteria, regulations, and standards. Three general categories of water use for each river segment are identified for Texas surface water quality standards: recreation, aquatic life, and domestic water supply. In addition, TCEQ regulations require certification that a permit allowing the discharge of dredged or fill material will comply with state water quality standards, under Section 401 of the Clean Water Act (CWA). The Railroad Commission of Texas has this authority for permits involving oil and gas production.

The proposed Lake Columbia would be located on Mud Creek, a tributary of the Angelina River. Mud Creek falls within the limits of Water Quality Segment 611, the Angelina River Above Sam Rayburn Reservoir, as delineated by the TCEQ for purposes of administering water quality standards. This segment is listed in the CWA Section

303(d) list of water bodies that do not meet, or are not expected to meet, water quality standards for one or more parameters, which in this case is bacteria levels. Segment 611 is within the 5c Category of the list, meaning that additional data and information will be collected before a Total Maximum Daily Load (TMDL) is scheduled (TCEQ, 2005). Site-specific water quality criteria as listed in 30 TAC 307 also apply to this segment. Site-specific criteria are established by TCEQ because of one or more permitted facilities are discharging to the water body. In this case, in addition to the normal site-specific criteria for chlorides, sulphates, total dissolved solids, dissolved oxygen, pH, bacteria, and temperature, copper standards have been established for Ragsdale Creek and its tributaries in Cherokee County. The City of Jacksonville has two wastewater discharges into Ragsdale Creek, as described below. Ragsdale Creek is a tributary of Keys Creek, which flows into Mud Creek just downstream of the proposed dam site.

Mud Creek is a perennial stream from its confluence with the Angelina River to a point immediately upstream of its confluence with Prairie Creek in Smith County (TNRCC, 2000). Mud Creek experiences periodic low-flow conditions similar to other East Texas streams, and therefore water quality is as much a function of the quantity of flows coming in from contributing streams as the incoming quality of water. Further upstream from the tributaries are Lake Tyler and Lake Tyler East. Figure 4.5-1 illustrates their locations with respect to the proposed Lake Columbia dam downstream.

Point source pollution, defined as occurring from domestic or industrial wastewater that is discharged from outfall sewers or drainage channels, mainly occurs from the wastewater treatment plants in the study area. There are seven domestic wastewater treatment plants that currently discharge into second-order streams that are tributaries of Mud Creek upstream of the proposed Lake Columbia dam site and two plants just downstream. Figure 4.5-3 identifies their locations relative to the proposed dam site. Table 4.5-1 presents information on the permitted wastewater discharges to Mud Creek.

The permits specify limitations on average daily flow, biochemical oxygen demand (BOD), and total suspended solids (TSS). Most plants, including the major ones at Tyler and Jacksonville, now have advanced wastewater treatment capabilities (better than 20 mg/L BOD and 20 mg/L TSS).

Non-point source pollution within the study area, such as agricultural land drainage, soil erosion, and urban storm drainage from industrial and residential land use areas, occurs primarily as agricultural land drainage. This runoff contains sediment, nutrients, organics, and salts. Sandy soils have prevented row crop development efforts; therefore, the dominant agricultural practice is improved pasture. Although this area contains higher levels of these pollutants than under natural conditions, these levels are not considered to be as severe as those subject to cropland runoff, where the soil and cover are extensively disturbed (LAN, 1991b). The majority of the urban runoff occurs from the Tyler area, which includes contaminants such as gasoline, lawn fertilizers, cleaning solvents, sediment, and other debris. Only the southeast part of Tyler is in the Mud Creek watershed, and much of that is controlled by the Lake Tyler and Lake Tyler East, which are upstream of the proposed Lake Columbia. The remainder of Tyler's urban runoff drains

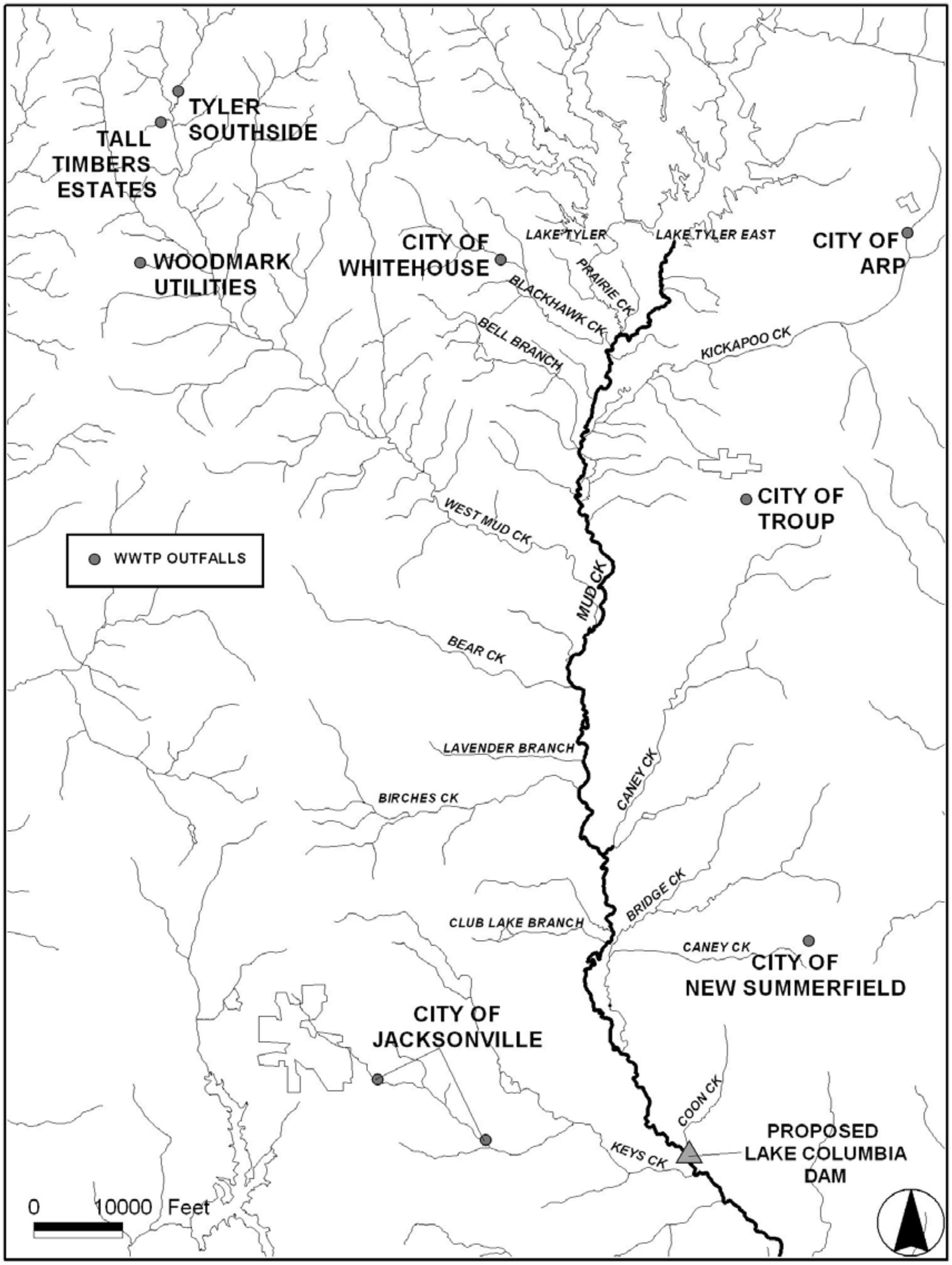


Figure 4.5-3 Wastewater Discharges Into Mud Creek

Table 4.5-1 Wastewater Discharges in the Proposed Project Area

Discharger	Permitted Daily Average			Discharge Route
	Flow (mgd)	BOD (mg/L)	TSS (mg/L)	
City of Arp	0.211	20	20	Kickapoo-Mud Creek
City of Whitehouse	1.50	20	20	Blackhawk-Mud Creek
Tall Timbers Estates	0.445	10	15	West Mud-Mud Creek
Tyler Southside	9.0	10	15	West Mud- Mud Creek
City of Troup	0.308	20	20	Caney-Mud Creek
City of New Summerfield	0.06	30	90	Caney-Bridge-Mud Creek
Woodmark Utilities	0.25	10	15	Henshaw-West Mud-Mud Creek
Jacksonville Canada St*	1.0	10	15	Ragsdale-Keys-Mud Creek
Jacksonville Double Ck*	1.75	10	15	Ragsdale-Keys-Mud Creek

* Downstream of proposed Lake Columbia
Source: TCEQ, 2006

to West Mud Creek, which does not flow into Mud Creek. Tyler has recently developed a Storm Water Management Program (JCB, 2008) to reduce the discharge of non-point source pollutants to the maximum extent practicable.

Currently, the only known source of industrial non-point source pollution stems from a lead-acid battery recycling plant in Tecula, Texas (LAN, 1991b), known as the Poly-Cycle Industries Site, located in Cherokee County at the intersection of FM 2064 and CR 4216. This site is located less than a mile from the proposed Lake Columbia northeast of Jacksonville. TCEQ, as well as the Environmental Protection Agency (EPA) and other parties, have been evaluating this site since 1983 because of the discovery of lead-contaminated soil. In 1984 lead contamination in soils was measured at 281,000 parts per million and in 1986 at 350,000 parts per million. In 1991, the EPA excavated nine acres of soil and covered it with a two-foot soil cap. On February 24, 2000, the Texas Natural Resource Conservation Commission (TNRCC) conducted a soil and sediment sampling survey. Sample analysis results revealed lead contamination ranging from 98 to 290 mg/kg. While these levels are observed releases, they are below the EPA's drainage pathway cleanup level of 500 mg/kg (TNRCC, 2002; TCEQ, 2007). TCEQ and the EPA pursued listing this site as a Superfund site. Previous sampling and analysis in Mud Creek at the proposed Lake Columbia site did not show elevated lead levels that would indicate that Mud Creek has been affected by the discharges from the Poly-Cycle site (LAN, 1991b).

Wilson (1983) conducted a physiochemical conditions study of Lake Tyler and Lake Tyler East in order to relate the differences between the two reservoirs to the land use of their respective drainage areas. He determined that both reservoirs can be considered mesotrophic (having an intermediate level of productivity or nutrient richness) with nitrogen acting as a limiting factor to productivity. He predicted that surface runoff from a portion of Chapel Hill Oil Field located within the Lake Tyler East drainage area may be a contributing factor to increased amounts of sodium chloride in that reservoir.

Intensive water quality monitoring surveys of Segment 611 were completed in 1984 by the Texas Department of Water Resources (currently the TCEQ) from the upper Angelina River in Rusk County to the Paper Mill Creek confluence in Angelina County (TDWR, 1985). Results from this study indicated that Segment 611 had relatively good water quality for the region, however, periodic violations of dissolved oxygen (DO) had been observed in the lower portion of the segment leading it to be classified as water quality limited.

This study acted as a follow-up study to a similar survey conducted by the TDWR in 1977. When comparing the two studies, it shows that water quality improved throughout Segment 611. Two areas of low DO levels in Keys Creek in 1977 were observed; however, in the 1984 study, DO was at an adequate level (LAN, 1991b). Similar findings were shown in the area downstream of Nacogdoches. In 1977, DO concentration was critically low (0.8 mg/L, 9.8 % saturation), whereas in 1984 there were no levels surveyed below 5.9 mg/L or 71 percent saturation. Overall, the water quality levels in 1984 were an improvement in seven of the 11 mainstream stations surveyed indicating a degree of improvement within the region from 1977 (LAN, 1991b), likely the result of improved wastewater treatment.

In 1988 the Texas Water Commission (currently the TCEQ) conducted a water quality survey along West Mud Creek to update a database for water quality management actions. Results from this study indicated that there was a reduction in DO levels for at least 9.4 miles downstream of the Tyler Southside WWTP. Additionally, concentrations of ammonia at levels deemed to be toxic to aquatic life as well as high fecal coliform counts from undetermined sources caused this stream to be classified as unsafe for contact recreation use.

Additional sampling conducted by Lockwood, Andrews & Newnam, Inc. (LAN) and ANRA in 1990 was designed specifically to evaluate the water quality suitability for the proposed Lake Columbia. Four sampling sites were tested on Mud Creek as shown in Figure 4.5-1, with one additional site downstream of Mud Creek on the Angelina River. Both normal flow and wet-weather flow were sampled. Results are summarized in Table 4.5-2a. ANRA has more recently collected some additional data on Mud Creek at U.S. 79, which is in the middle of the proposed reservoir (Site 3 on Figure 4.5-1). These data are summarized in Table 4.5-2b. Water quality is considered to be generally good, with acceptable DO, and low levels of dissolved solids, nutrients, and metals, excluding iron and manganese, which are commonly elevated in East Texas streams. None of the parameters measured exceeded acceptable concentrations for surface water quality (LAN, 1991b). These data are consistent from 1990 to 2008, as they show the improvement in water quality since the mid 1970s, which is largely attributable to improvements in wastewater treatment plants.

Table 4.5-2a Water Quality Data for Mud Creek and Angelina River (1990)

Parameter	Units	Texas Drinking Water Stds*	Mud Creek (4 sites)		Angelina River (1 site)	
			Average	Range	Average	Range
Flow	cfs		233	23.0-599	1,150	550-1,750
Ammonia- N	mg/L		0.07	<0.05-0.15	0.05	<0.05-0.08
Orthophosphate- P	mg/L		0.16	0.07-0.30	0.09	0.05-0.12
Phosphorus	mg/L		0.22	0.09-0.40	0.14	0.08-0.19
BOD_5	mg/L		1.6	<1.7-2.5	1.3	<1.7-1.7
Dissolved Oxygen	mg/L		8.42	7.6-9.29	7.58	6.55-8.6
Fecal Coliform	N/100ml		78**	40-117	256**	142-460
pH	s.u.	>7.0	7.04	6.09-7.50	6.76	6.62-6.89
Chloride	mg/L	300	20	15-23	19	15-22
Sulfate	mg/L	300	30	25-38	33	31-35
TDS	mg/L	1,000	156	127-212	96.2	73.3-119
Alkalinity, $CaCO_3$	mg/L		23	6.0-42	23	14-32
Hardness	mg/L		40	27-51	38	35-40
Arsenic	µg/L	10	n/a	<3.0-<6.0	n/a	<3.0-<6.0
Barium	µg/L	2,000	55	39-82	56	50-63
Cadmium	µg/L	5	n/a	<4.0-<5.0	n/a	<4.0-<5.0
Chromium, hex	µg/L	100	n/a	<0.01	n/a	<0.01
Iron	µg/L	300	1,980	920-4,000	3,300	1,700-4,900
Lead	µg/L	15	<3.0	<3.0-3.4	n/a	<3.0
Manganese	µg/L	50	120	40-370	170	40-300
Mercury	µg/L	2	n/a	<0.2	n/a	<0.2
Selenium	µg/L	50	n/a	<0.2	n/a	<0.2
Silver	µg/L	100	n/a	<5.0-<7.0	n/a	<5.0-<7.0
Zinc	µg/L	5,000	15	6.9-32	7.5	<6.0-12
Turbidity	NTU		31	15-78	41	17-65
Color	CU	15	56	30-100	75	60-90
Temperature	ºF		72.9	57.9-88.2	67.5	55.0-79.9

* 30 TAC 290
** Geometric mean
Source: LAN, 1991b

Table 4.5-2b Water Quality Data for Mud Creek (2006-2008)

Parameter	Units	Mud Creek at U.S. 79	
		Average	Range
Flow	cfs	53	7.8-160
Ammonia- N	mg/L	0.49	<0.1-1.16
Nitrate+Nitrite-N	mg/L	0.72	0.26-2.07
Orthophosphate- P	mg/L	0.06	<0.04-0.15
Total Phosphorus	mg/L	0.18	0.07-0.43
Dissolved Oxygen	mg/L	8.3	5.1-11.2
E. Coli	N/100ml	161*	22-2,420
pH	s.u.	7.5	7.1-7.9
Chloride	mg/L	38.2	11.5-75.5
Sulfate	mg/L	39.5	21.1-60.7
TDS	mg/L	179	115-295
TSS	mg/L	18	3-77
Temperature	ºF	64.8	49.6-80.2

*Geometric mean
Source: ANRA, 2008b

In 1996 the Texas Natural Resource Conservation Commission (currently the TCEQ) conducted a use attainability analysis for sites on Ragsdale Creek, Keys Creek, and Mud Creek. The headwaters of Ragsdale Creek arise within Jacksonville and the stream receives urban runoff from the city in addition to two WWTPs, the Canada Street WWTP and the Double Creek WWTP. Ragsdale Creek is a third order stream from downstream of the Canada Street WWTP until it reaches the confluence of Keys Creek. The headwaters of Keys Creek arise north and northeast of Jacksonville and flow into Mud Creek just downstream of the proposed dam. The study was conducted because the streams were within the potential zone of impact of the city of Jacksonville wastewater discharge (Bayer, 1996). The sampling sites are shown in Figure 4.5-1. Results from Sites 1 and 2 reveal an intermediate level of quality existed within this region. This was due in large part to low percentages of in-stream cover, poor bank stability, and severe flow fluctuations. Site 3 on Ragsdale Creek indicated a high quality exists for aquatic habitat. It did not get an exceptional score, however, because of a low percentage of in-stream cover, lack of deeper pools, and poor bank stability. Perhaps most significantly, Site 4, the gaging station located upstream of the proposed dam on Mud Creek, had an intermediate level of quality for similar reasons to Site 3 with the addition of lack of riffles and gravel or larger sized substrates (Bayer, 1996). Table 4.5-3 shows the results of the stream habitat quality criteria evaluation for Site 4.

Table 4.5-3 Quantitative Criteria for Evaluating Stream Habitat Quality at USGS Gaging Station, Mud Creek Site 4

Metric	Value	Score
1. Instream Cover	18.2% (rare)	2
2. Riffle/Runs	0 (absent)	0
3. Pool Depth	3.3 feet (moderate max. depth)	3
4. Bank Stability	57%/40° (unstable)	0.5
5. Riparian Cover	> 350 feet (extensive)	3
6. Flow Fluctuations	Minor (little or none)	3
7. Channel Sinuosity-bend dev. well/moderate/poor	1/2/0 (moderate)	2
8. Bottom Substrate ≥ gravel sized	0% (unstable)	0
9. Aesthetics	Natural (natural area/trees)	2
Total Points		15.5
Habitat Quality		Intermediate

Source: Use Attainability Analysis for Ragsdale Creek, Keys Creek, and Mud Creek, Cherokee County, Texas (Bayer, 1996)

4.5.1.3 Waters of the United States (U.S.), Including Wetlands

In the context of language contained in the Clean Water Act (CWA) as promulgated in 33 CFR Part 328.3, the term **"waters of the United States"** means:

1. All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
2. All interstate waters including interstate wetlands;
3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:
   i. Which are or could be used by interstate or foreign travelers for recreational or other purposes; or
   ii. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
   iii. Which are used or could be used for industrial purpose by industries in interstate commerce;
4. All impoundments of waters otherwise defined as waters of the United States under the definition;
5. Tributaries of waters identified in paragraphs (1)-(4) of this section;
6. The territorial seas;

7. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (1)-(6) of this section.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 123.11(m) which also meet the criteria of this definition) are not waters of the United States.

Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the CWA, the final authority regarding CWA jurisdiction remains with the EPA.

The term **"wetlands"** means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

The term **"adjacent"** means bordering, contiguous, or neighboring. Wetlands separated from other waters of the United States by man-made dikes or barriers, natural river berms, beach dunes and the like are "adjacent wetlands."

The term **"ordinary high water mark"** means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

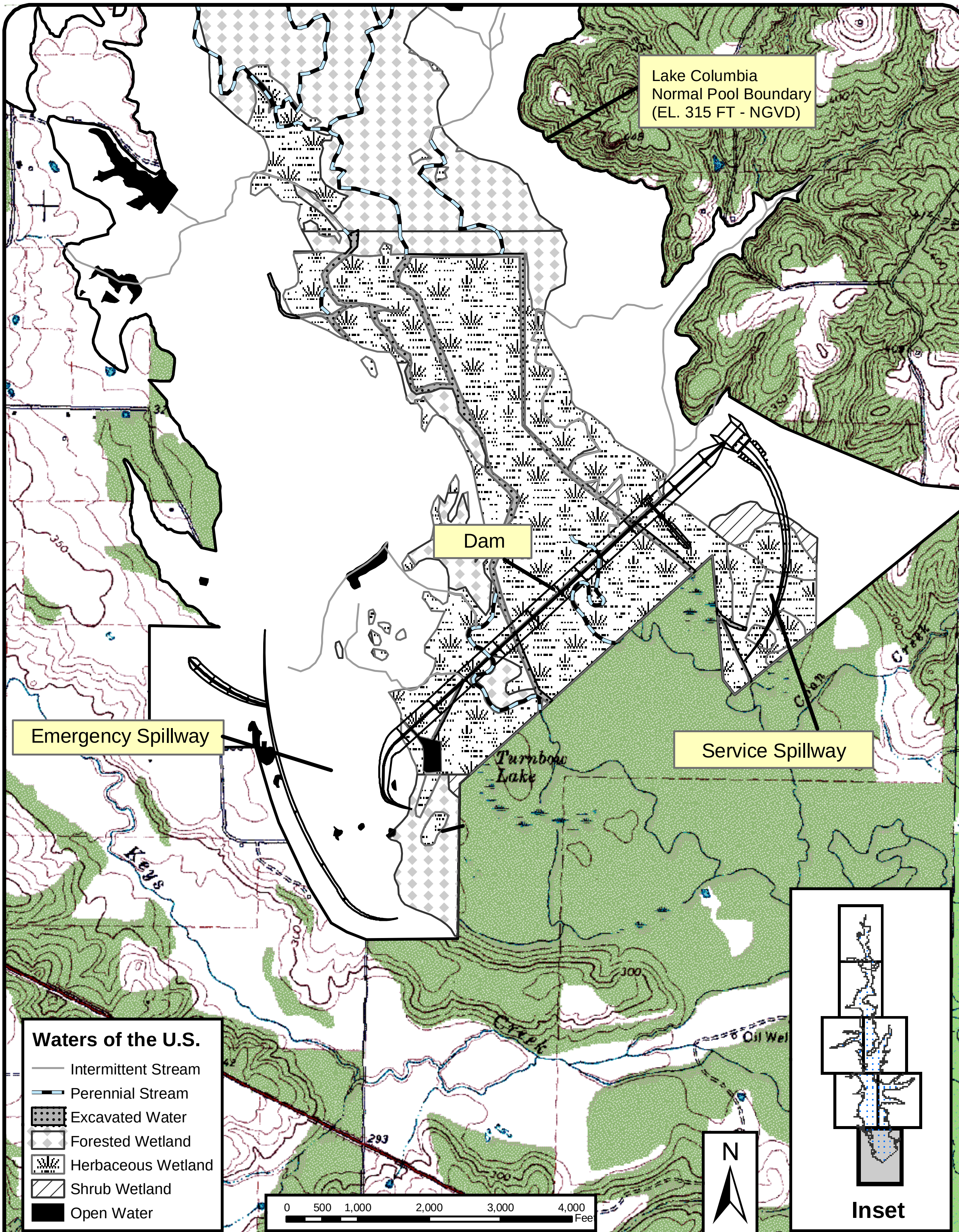
A Section 404 jurisdictional determination within the Permit Area was performed. This determination was based on earlier work by Hicks (1994a and b) and was updated to reflect conditions existing in 2003 (FNI, 2003a). Field reconnaissance, remote sensing, and GIS-based analyses were used by FNI to develop a comprehensive database of vegetation, hydrology, and soil characteristics to define the boundaries of existing wetlands. Changes in land use since the Hicks 1994 wetlands delineation were detected that resulted in updates to various cover types previously identified within the Permit Area along with the mapping of wetland areas not previously mapped. Detailed discussion of wetland habitat types and vegetative composition is presented in Section 4.8.1.1.2. Overall, FNI determined that most of the Permit Area has sustained no disturbance since the 1994 delineation that would appreciably alter the hydrology or topography or change wetland boundaries previously identified (FNI, 2003a). FNI’s exception to their findings focused on approximately 1,000 acres in the vicinity of the proposed dam site. This area was disturbed by the current landowner since 1994. Work in this area included the clearing of forested wetlands, channelization of Mud Creek, and construction of levees that resulted in altered surface drainage and dewatering of some wetlands (FNI, 2003a). A total of approximately 5,746.5 acres of waters of the U.S. are present within the 10,655.5-acre Permit Area (i.e., normal pool at elevation 315NGVD plus dam site), 5,351.5 acres of which are wetlands (FNI, 2003a). The USACE field verified the jurisdictional determination and issued an approved Jurisdictional Determination on 19 May 2003. The water types and their respective acreages within the Permit Area are summarized in Table 4.5-4. Figures 4.5-4a through 4.5-4g identify the areal extent of these features within the Permit Area.

Wetlands perform habitat, hydrologic, and water quality functions. Wetland functions include water quality improvement, floodwater storage, nutrient cycling, groundwater discharge, groundwater exchange, fish and wildlife habitat, aesthetics, and biological productivity. Table 4.5-5 provides a description of wetland functions and relationships. An evaluation of the impacts to these functions and relationships was performed using the Interim Riverine Hydrogeomorphic Model (HGM) (see Section 4.5.2.2).

Table 4.5-4 Waters of the U.S. Within the Permit Area

Category	Linear Feet	Acres	Percent
New Channel	14,256	30	0.52%
Intermittent Stream	204,864	47	0.82%
Perennial Streams	370,128	255	4.44%
Open Water	- -	63	1.10%
Shrub-Scrub Wetlands	- -	144	2.51%
Hillside Bog	- -	0.5	0.01%
Herbaceous Wetlands	- -	1,518	26.41%
Bottomland Forested Wetlands	- -	3,689	64.20%
TOTAL	589,248	5,746.5	100%

Source: FNI, 2003a



Map Source: FNI, 2003.

USACE
Project No.
198700524

Angelina and Neches River Authority
Proposed Lake Columbia

Waters of the U.S.
Within the Normal Pool

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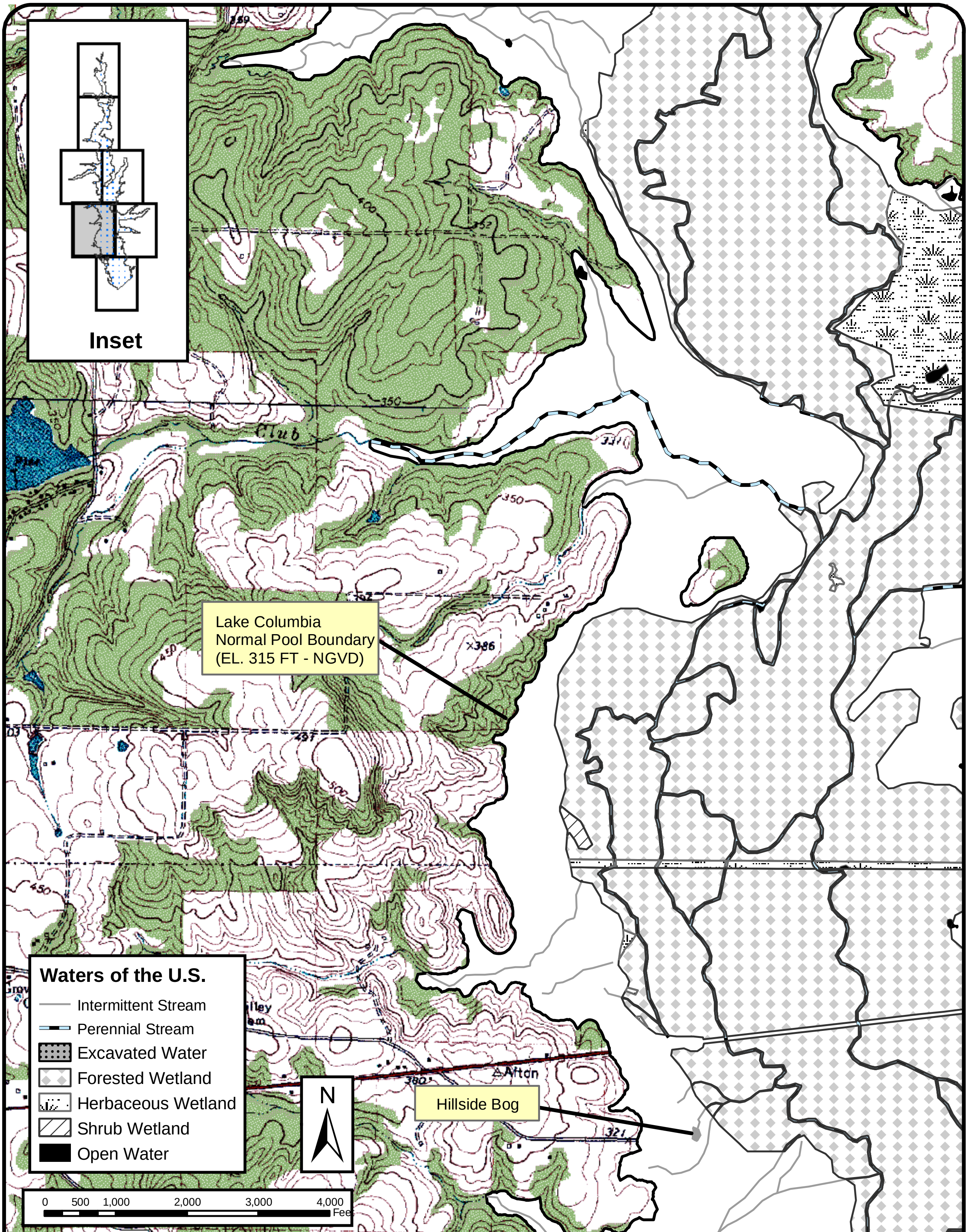
DESIGNED	RH
DRAFTED	BAR

FIGURE
4.5-4a



Map Source: FNI, 2003.

USACE
Project No.
198700524

Angelina and Neches River Authority
Proposed Lake Columbia

Waters of the U.S.
Within the Normal Pool

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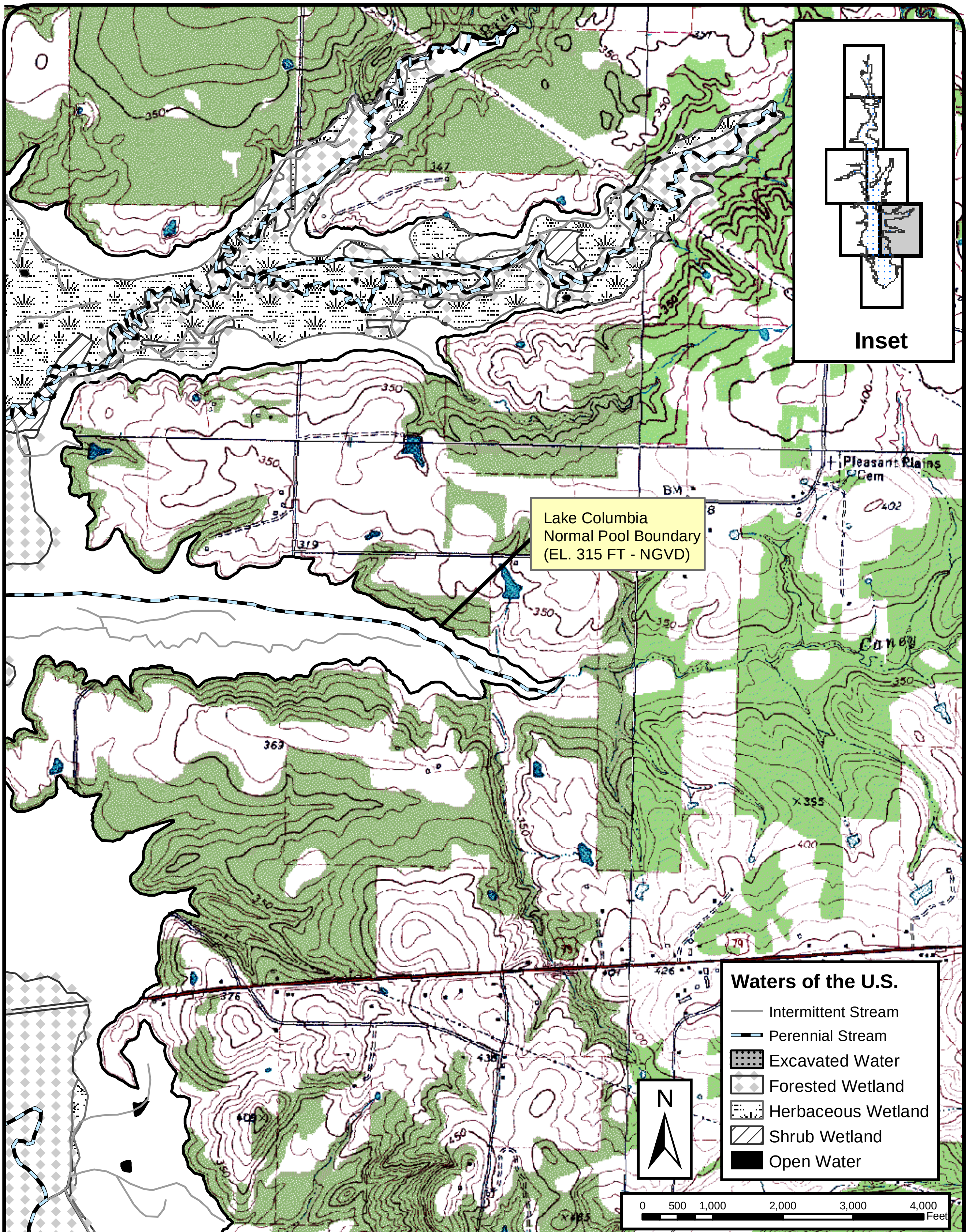
DRAFTED	BAR

FIGURE
4.5-4b



Map Source: FNI, 2003.

USACE
Project No.
198700524

Angelina and Neches River Authority
Proposed Lake Columbia

Waters of the U.S.
Within the Normal Pool

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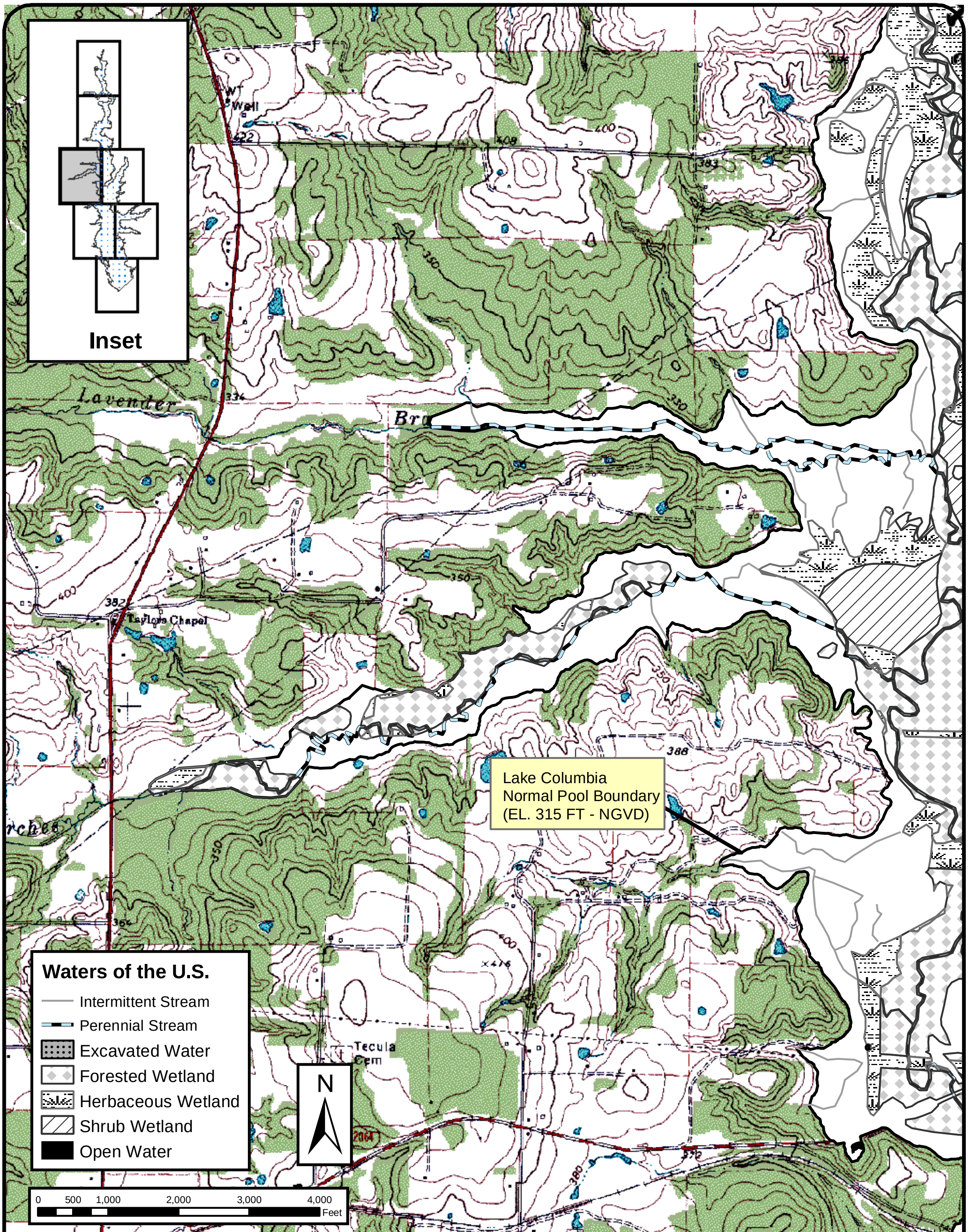
DRAFTED	BAR

FIGURE
4.5-4c



Map Source: FNI, 2003.

USACE Project No. 198700524

Angelina and Neches River Authority
Proposed Lake Columbia

Waters of the U.S. Within the Normal Pool

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DESIGNED	RH
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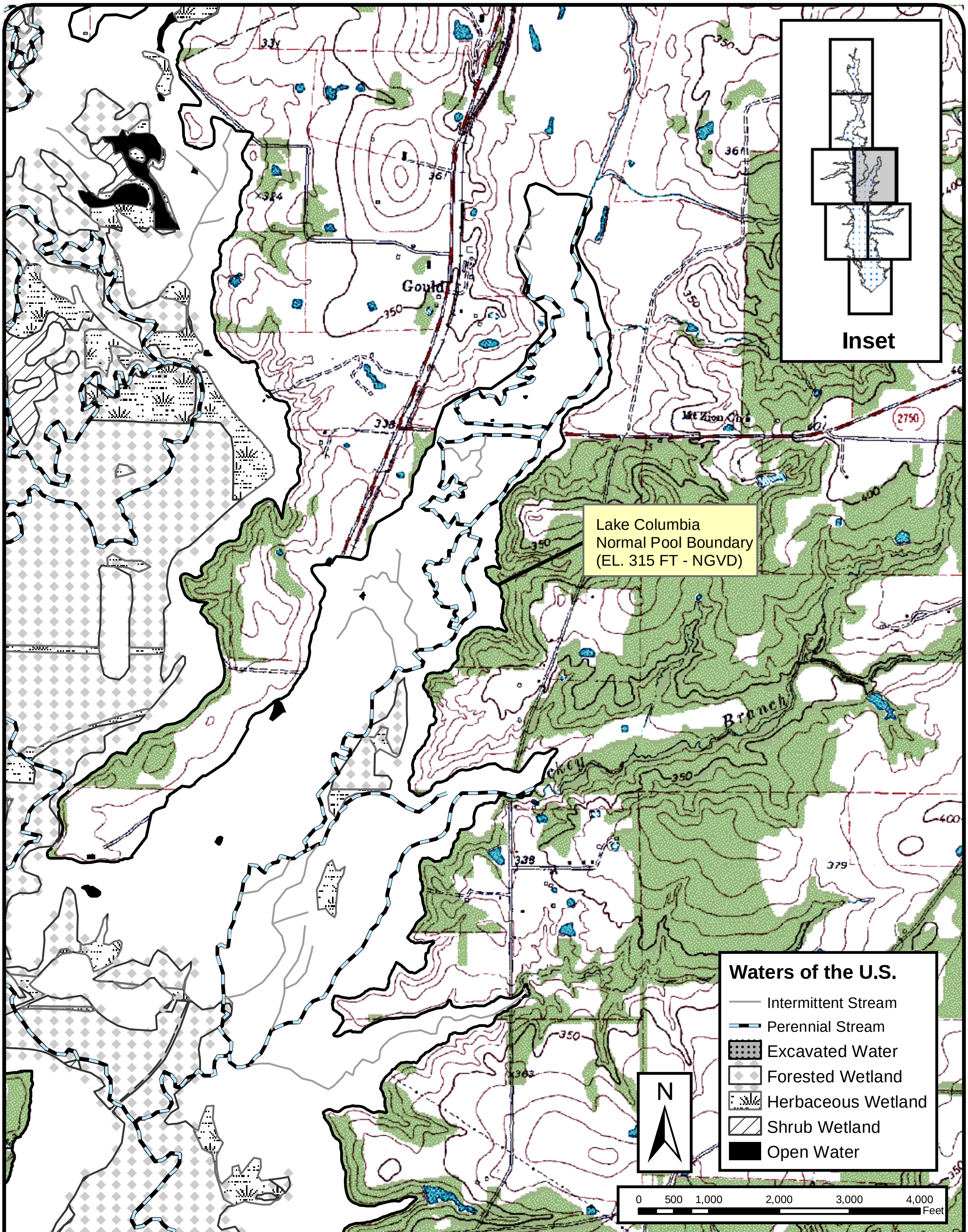
FIGURE 4.5-4d



Map Source: FNI, 2003.

USACE
Project No.
198700524

Angelina and Neches River Authority
Proposed Lake Columbia

Waters of the U.S.
Within the Normal Pool

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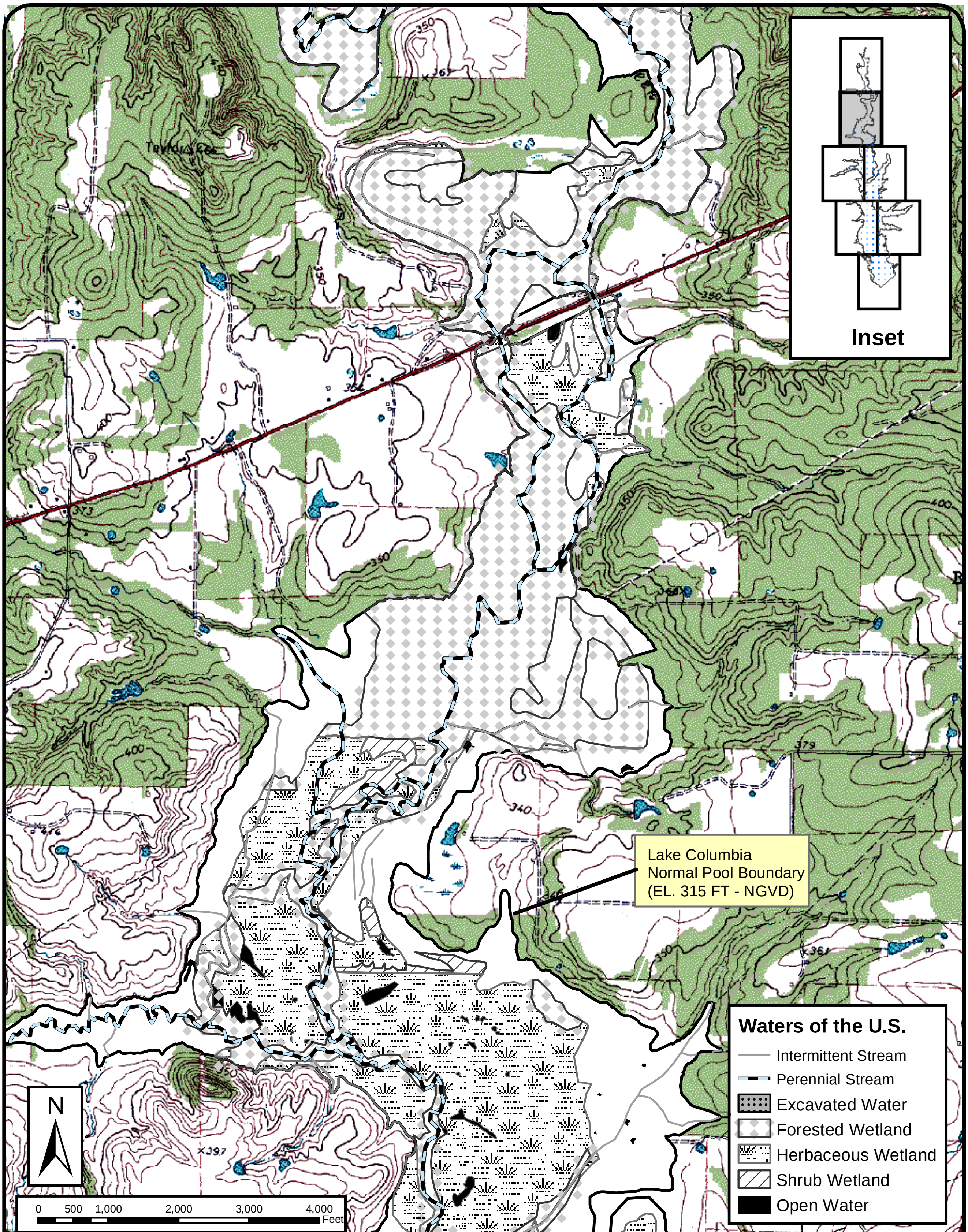
DESIGNED	RH
DRAFTED	BAR

FIGURE
4.5-4e



Map Source: FNI, 2003.

USACE
Project No.
198700524

Angelina and Neches River Authority
Proposed Lake Columbia

Waters of the U.S.
Within the Normal Pool

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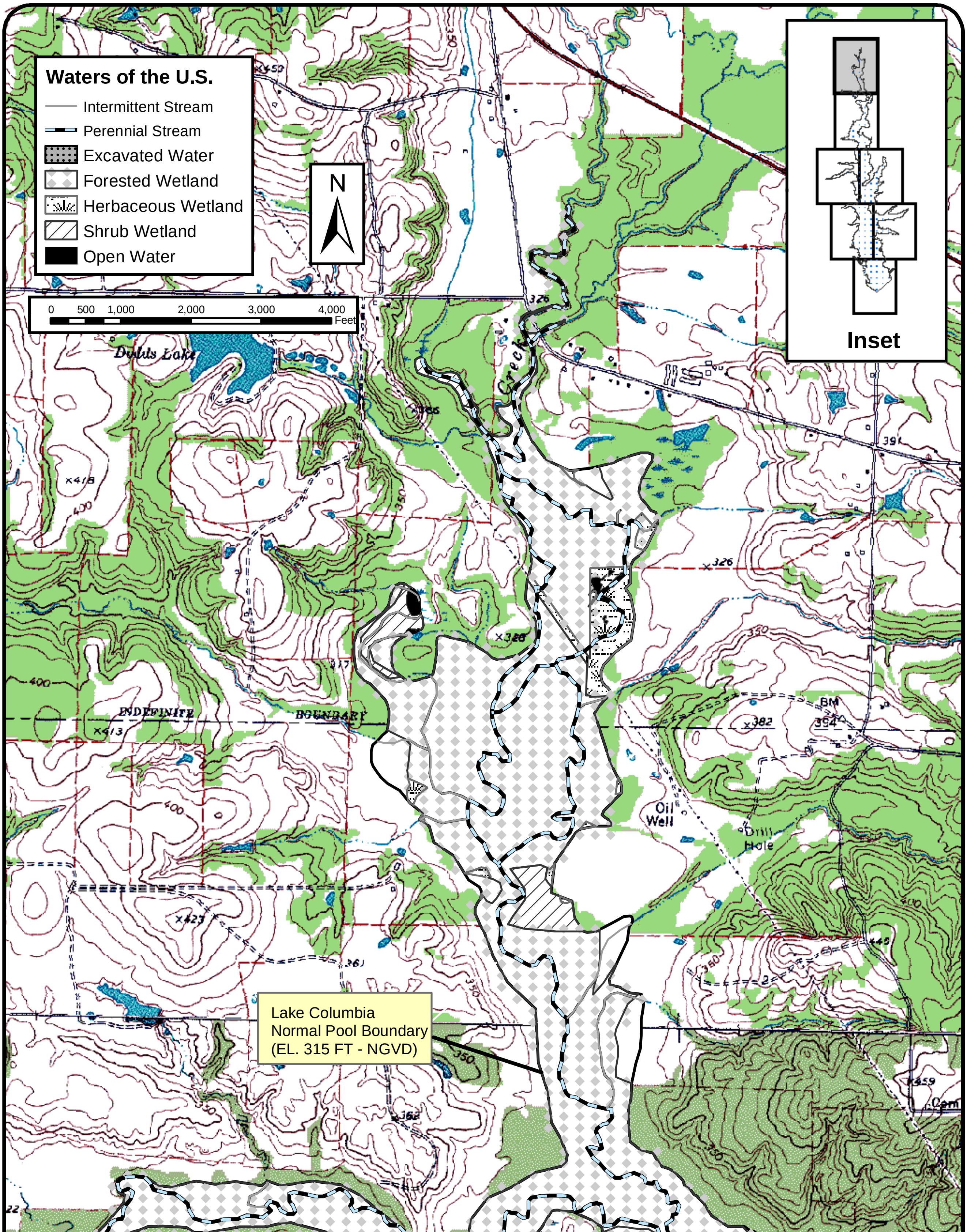
DATE	August 11, 2003
SCALE	1:24,000
DESIGNED	RH
DRAFTED	BAR

FIGURE
4.5-4f



Map Source: FNI, 2003.

USACE Project No. 198700524

Angelina and Neches River Authority
Proposed Lake Columbia

Waters of the U.S. Within the Normal Pool

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DATE	August 11, 2003
SCALE	1:24,000
DESIGNED	RH
DRAFTED	BAR

FIGURE 4.5-4g

Table 4.5-5 Wetland Functions and Relationships

Wetland Function	Concern	How Wetlands Perform Function	Factors Determining Importance of Functions
Flood Conveyance	If flood flows are blocked by fills, dikes, or other structures, increased flood heights and downstream velocities could result, causing damage to adjacent upstream and downstream areas.	Some wetlands (particularly those immediately adjacent to rivers and streams) serve as floodway areas by increasing conveyance for flood flows from upstream to downstream points.	Stream characteristics, wetland topography, size, vegetation, location of wetland in relationship to river or stream, existing encroachment on floodplain (dikes, dams, levees, etc.)
Wave Barriers	Removal of vegetation increases erosion and reduces capacity to moderate wave intensity.	Wetland vegetation, with massive root and rhizome systems, binds and protects soil and acts as wave barriers.	Location of wetland adjacent to coastal waters, lakes, and rivers, wave intensity, type of vegeta-tion, and soil type.
Flood Storage	Fill or dredging of wetlands reduces their flood storage capacity.	Some wetlands store and slowly release flood waters.	Wetland area relative to watershed, wetland position within watershed, surrounding topography, soil infiltration, capacity in watershed, wetland size and depth, stream size and characteristics, outlets (size, depth), vegetation type, substrate type.
Sediment Control	Destruction of wetland topographic contours or vegetation decreases wetland capacity to filter surface runoff and act as sediment traps. This increases water turbidity and siltation of downstream reservoirs, storm drains, and stream channels.	Wetland vegetation binds soil particles and retards the movement of sediment in slowly flowing water.	Depth and extent of wetland, wetland vegetation (including type, condition, density, growth patterns), soil texture type and structure, normal and peak flows, wetland location relative to sediment of vegetated buffer.
Pollution Control	Destruction of wetland contours or vegetation decreases natural pollution control capability, resulting in lowered water quality for downstream lakes, streams, and other waters.	Wetlands act as settling ponds and remove nutrients and other pollutants by filtering and causing chemical breakdown of pollutants.	Type and size of wetland, wetland vegetation (including type, condition, density, growth patterns), source and type of pollutants and water course, size, water volume, streamflow rate, microorganisms, etc.

Wetland Function	Concern	How Wetlands Perform Function	Factors Determining Importance of Functions
Fish and Wildlife Habitat	Fills, dredging, damming, and other alterations destroy and damage flora and fauna and decrease productivity. Dam construction is an impediment to fish movement.	Wetlands provide water, food supply, and nesting and resting areas. Coastal wetlands contribute nutrients needed by fish and shellfish to nearby estuarine and marine waters.	Wetland type and size, dominant wetland vegetation (including diversity of life form), edge effect, location of wetland within watershed, surrounding habitat type, juxtaposition of wetlands, water chemistry, water quality, water depth, existing uses.
Recreation (Water -based)	Fill, dredging or other interference with wetlands would cause loss of area for boating, swimming, bird watching, hunting and fishing.	Wetlands provide wildlife and water for recreational uses.	Wetland vegetation, wildlife, water quality, accessibility to users, size, relative scarcity, facilities provided, surrounding land forms, vegetation, land use, degree of disturbance, availability of similar wetlands, distribution, proximity of uses, vulnerability.
Aquifer Recharge	Fills or drainage may destroy wetland aquifer recharge capability, thereby reducing base flows to streams and ground water supplies for domestic, commercial, or other uses.	Some wetlands store water and release it slowly to ground water deposits. However, many other wetlands are discharge areas for a portion or all of the year.	Location of wetland relative to water table, fluctuations in water table, geology including type and depth of substrate, permeability of substrate, size of wetland, depth, aquifer storage capacity, ground water flow, runoff retention measures.

4.5.2 Environmental Consequences

4.5.2.1 No Action Alternative

Under No Action, the surface water impacts associated with either of the other alternatives would not occur. Existing conditions as described above would remain. It is possible that other sources of water would be pursued by various entities. This could result in interbasin transfers and increased treated wastewater returned in the Mud Creek watershed.

Without the proposed Project, no appreciable loss or alteration of waters of the U.S. including wetlands would be expected within the Permit Area except as might occur from other non-related land use activities (i.e., oil and gas development, highways, pipelines, transmission lines, etc.). Additionally, the vegetative and hydrologic character of various areas could change over time because of forestry operations, clearing or vegetative management for grazing, construction of artificial impoundments, other drainage modifications, and beaver activity. On balance, however, the total area of waters of the U.S. would be expected to remain fairly constant.

4.5.2.2 Proposed Action

Construction

General Construction Effects

At the proposed dam site and borrow area, increases in sedimentation would be expected to occur. Pursuant to the requirements of the TCEQ, a storm water discharge permit would be obtained. This permit requires that a Storm Water Pollution Prevention Plan (SWPPP) be prepared and strictly followed during construction. Surface water runoff from areas disturbed by Project construction activities would be controlled in an effort to minimize adverse affects related to erosion of exposed soils and subsequent sediment transport. Sediment that escapes could accumulate in various places downstream of the dam site. However, areas subject to sediment deposition would likely be scoured over time as discussed below under operation impacts. Borrow sites would be located within the footprint of the reservoir, and disturbances in those areas would be inundated after filling and operation of the reservoir. There is also a potential for fuel spills. However, spill prevention and cleanup is a required component of a SWPPP.

During construction, coffer dams and a short diversion channel would be constructed to divert flow around active construction areas at the dam site. These measures would serve to minimize overall adverse impacts associated with total suspended solids. This diversion would remain in place for the duration of dam construction, estimated at approximately 2-1/2 years, and would be removed upon completion of the dam. The portion of the stream bypassed by the diversion channel would be essentially void of any flow and would remain dry. The diversion channel would convey all streamflow at the dam site, no water would be impounded, and there would be no appreciable change in normal flows downstream.

Effects to Waters of the U.S.

Construction of the dam and reservoir would result in the loss of approximately 5,747 acres of waters of the U.S., approximately 5,352 acres of which are wetlands.

In order to assess the loss of functions and values of wetlands and other waters of the U.S., a functional analysis was conducted utilizing the Hydrogeomorphic Model (HGM) approach. HGM is a somewhat similar modeling procedure to HEP, but focuses on specific functions provided by wetlands. Functions provided by Riverine Wetlands (such as those within the Project area) include the following (Brinson, et. al., 1995):

- Hydrologic
  - Dynamic Surface Water Storage
  - Long-Term Surface Water Storage
  - Energy Dissipation
  - Subsurface Storage of Water
  - Moderation of Groundwater Flow
- Biogeochemical
  - Nutrient Cycling
  - Removal of Imported Elements and Compounds
  - Retention of Particulates
  - Organic Carbon Export
- Plant Habitat
  - Maintain Characteristic Plant Communities
  - Maintain Characteristic Detrital Biomass
- Animal Habitat
  - Maintain Spatial Structure of Habitat
  - Maintain Interspersion and Connectivity
  - Maintain Distribution and Abundance of Invertebrates
  - Maintain Distribution and Abundance of Vertebrates

The full Riverine Wetlands HGM model specific to Texas bottomlands is still under development. Interim, abbreviated models are currently in use in Texas. Two models are applicable to the Project area wetlands: the Riverine Forested HGM Interim and the Riverine Herbaceous/Shrub HGM Interim. These interim models abbreviate wetland functions into three main categories:

- Temporary Storage and Detention of Storage Water
- Maintain Plant and Animal Community
- Removal and Sequestration of Elements and Compounds

These functions are evaluated for a given Wetland Assessment Area (WAA) using a set of physical, chemical, and biological variables. A WAA is a distinct wetland area with common characteristics and common boundaries. The variables used in the interim models include:

V_{dur} – The % of the WAA that is flooded or ponded due to the hydrology of the adjacent waterway (i.e. overbank flooding).

V_{freq} – The frequency that the WAA is flooded or ponded by the nearby waterway.

V_{topo} – The roughness or topography of the WAA.

V_{cwd} – The number of pieces of coarse woody debris > 3" dia. along a 100' transect.

V_{wood} – Percentage of the WAA that is covered by woody vegetation.

V_{tree} – Percentage of the trees in the WAA that are mast producers.

V_{rich} – The diversity of the tree species in the WAA.

V_{basal} – The average/mean basal area of the trees in the WAA per acre.

$V_{density}$ – The average density of trees > 3" dia. in the WAA.

V_{mid} – The average/mean coverage of the midstory (shrub/sapling) layer in the WAA

V_{herb} – The average/mean coverage of the WAA by the herbaceous layer.

$V_{detritus}$ – The amount of detritus on the WAA (determined by presence of A or O soil horizon)

V_{redox} – The amount of the WAA that exhibits redox features as an indication of chemical exchange.

V_{sorpt} – The absorptive properties of the soils as determined by soil type.

$V_{connect}$ – The number of habitat types within 600' of the perimeter of the WAA.

Specific data for each variable is gathered from existing published information and field investigations. The specific data for each of the variables are compared to pre-determined maximum values for an ideal reference wetland to arrive at a subindex for each variable that is between 0 and 1 where 0 is the lowest and 1.0 is optimal. The subindices are then analyzed by specific formulas for each function to arrive at Functional Capacity Indices (FCIs). The FCIs are then multiplied by the area of the WAA to arrive at the Functional Capacity Units (FCUs) for each function in each WAA. This analysis is done for baseline conditions (pre-Project) and one or more post-Project intervals, depending on the type of project and length of time that impacts are likely to occur. The net FCU loss (or gain) is calculated as the difference between the post-Project FCU and the pre-Project FCU for each function.

For this study, most of the field data required for the variables had already been collected as part of the HEP analysis (FNI, 2003a). Since numerous WAAs were present within the footprint of the Project, all WAAs of a similar nature were combined into groups to help streamline the HGM analysis. The groups included (1) forested wetlands, (2) shrub wetlands, (3) herbaceous wetlands/open water. Delineation and acreage determination of these groups were previously performed as part of the jurisdictional delineation for the Project (FNI, 2003a) (see Table 4.8.1-1). Impacts were also analyzed over a 30-year period of time with specific evaluation intervals including Pre-Project, Year 1, Year 5, Year 10, Year 20, and Year 30. For surface water reservoirs, impacts do not occur all at once. Construction of the dam usually takes several years before any water is impounded in the reservoir. In the present analysis, it was assumed that in Year 1 the foot print of the dam and certain other areas in the pool would be land cleared with a sharp reduction in the FCU values.

Once reservoir filling is initiated, it may take several more years to impound water to normal operating level (conservation pool – 315 feet for Lake Columbia), depending on rainfall over that period. A reservoir will usually fluctuate dramatically for several years until it reaches a general equilibrium of fluctuation around its normal operating level. Therefore, impoundment impacts are not usually seen until at least year 5. For this analysis, it was assumed that beginning with Year 5, the pool area below the fringe (discussed below) would be assumed to be completely impacted (all FCUs would equal 0) for the life of the Project).

For reservoirs that are not maintained with a constant pool elevation, establishment of wetlands at the upper fringe, can be difficult to predict. Depending on size of watershed, runoff coefficients, evaporation, water use, downstream bypasses, spillway design, etc, the zone of fluctuation for each reservoir can be highly variable. From observation of other reservoirs in general, it appears the upper fringe may maintain exiting wetland characteristics for some time, and then slowly experience decline then re-development of wetland habitats over a number of years. Most young reservoirs (5 to 10 years) have a fairly barren fringe while older reservoirs (15+ years) typically have a fringe of herbaceous, shrub, and early successional stage forested wetlands, depending on age. The vertical and horizontal dimension of these fringe areas is highly variable depending on many physical and hydrological variables. The typical vertical dimension is usually a few feet, dependent on the frequency and duration of fluctuation. The horizontal dimension is a function of the vertical dimension, shoreline slope, shoreline aspect and exposure to wave energy, and water clarity.

In an effort to predict reasonable patterns of wetlands fringe development for Lake Columbia, USACE personnel conducted a site study of two existing reservoirs of variable age in East Texas – Richland Chambers Reservoir (approximately 20 years old) and Cedar Creek Reservoir (40+ years old). In this study, overall characteristics, spatial distribution, and vertical distribution of fringe wetland vegetation were assessed. At the time of investigation, both reservoirs were at their normal operating levels. Elevations of observed wetlands along the fringes relative to the normal operating levels were determined with the aid of graduated rods.

The field data were then compared to historical reservoir level information for years common to the two reservoirs' existence, 1990 to 1996. A very close relationship between average reservoir fluctuation and the vertical distribution of wetland vegetation in both reservoirs was determined. For Richland Chambers, that range was about 3.5 feet. For Cedar Creek, the range was about 2.5 feet.

That relationship was then evaluated relative to reservoir operation analysis results (predicted daily lake levels) for Lake Columbia based on the same years (1990 – 1996) of rainfall data and full operation of the reservoir. The range of fluctuation was 4.5 feet for Lake Columbia. With additional analysis of frequency and duration of fluctuations, it was decided to usefourfeet as the predicted vertical distribution of a fringe for Lake Columbia. Based on the field observation at Richland Chambers and Cedar Creek, the majority of fringe wetlands were confined to protected coves and backwater areas with very little fringe wetland observed along the open shorelines of the reservoirs.

The predicted fringe for Lake Columbia was thus mapped as the protected cove shorelines and backwater areas with relatively gentle slope and four feet of vertical distribution (1,195 acres). Within that fringe area, the acreage of existing wetland type (herbaceous, shrub, and forested) and uplands was determined from the jurisdictional mapping. Assumptions of wetland impacts and establishment were made for this fringe area based on observations at Richland Chambers and Cedar Creek Reservoirs for the study period intervals.

The HGM analyses were run based on the above described procedures and a set of future assumptions decided upon by USACE. The reservoir impacts and reestablishment of fringe wetlands would likely occur over an extended period of time (30 years) with variable results.

The results of the HGM analyses indicate that the net impact of the reservoir to forested wetlands is a deficit of -3,531.95 FCUs for Temporary Storage, -3,612.15 FCUs for Maintenance of Plant and Animal Communities, and -3,061.87 FCUs for Removal and Sequestration of Elements and Compounds. The net impact to shrub wetlands is a deficit of -134.70 FCUs for Temporary Storage, -108.00 FCUs for Maintenance of Plant and Animal Communities, and -108.48 FCUs for Removal and Sequestration of Elements and Compounds. The net impact to herbaceous wetlands is a deficit of -1,368.31 FCUs for Temporary Storage, -1,012.00 FCUs for Maintenance of Plant and Animal Communities, and -1,027.18 FCUs for Removal and Sequestration of Elements and Compounds. Mitigation in the future would need to at least equal these deficits as a result of gains of FCUs in mitigation lands and the reservoir fringe.

Operation

Hydrology

There are numerous hydrologic effects caused by dams and reservoirs; however, the magnitude of these effects depends greatly on the type of stream, the surrounding environment, the type and size of dam and reservoir, and how they are operated. Some of the common effects are reflected by changes in downstream hydrology, morphology, and water quality. Upstream effects result from the conversion of the flowing stream within the body of the reservoir to a lake.

The Lake Columbia dam is not designed for flood control. Therefore, all inflows into Lake Columbia when the water surface elevation of the reservoir is at or above the conservation pool level of 315 feet NGVD would automatically spill downstream through the service and/or emergency spillways.

The impoundment of streamflows within the reservoir and the capacity of the service and/or emergency spillways would cause the magnitude of peak flood flows to be reduced downstream, while the duration of flood events would likely be extended. Diversions from the reservoir also would affect flood flows. Because of the existing topography and stream geomorphology (shallow, braided channel and wide, flat, alluvial floodplain with abrupt side slopes) that characterize the downstream channel, there would continue to be some level of overbanking with the reservoir in operation, which is necessary to maintain connectivity of channels and wetlands within the floodplain. This would help to minimize the reduction in downstream floodplain width and area that would otherwise occur because of the effects of the dam and reservoir (FNI, 2005). This is discussed further under "Erosion and Sedimentation" below.

Table 4.5-6 presents the reductions in peak flood flows at the dam site and at two downstream highway crossings that are expected with the operation of the dam and reservoir. S.H. 110 is approximately five miles below the proposed dam site and U.S. 84 is further downstream, approximately six miles above where Mud Creek joins the Angelina River. As shown, differences are notably reduced at the downstream locations because of additional contributions of flood inflows from the drainage area below the dam. The drainage area at the proposed dam site is 384 square miles, but increases to 475 square miles at S.H. 110 and to 520 square miles at U.S. 84.

There would also be an eight to 16 percent (1,249 acre) reduction in the floodplain area downstream of the dam for both frequent and less-frequent flood events as shown in Table 4.5-7. These reduced floodplain areas generally are confined to edges of the existing floodplain where the flat alluvial area intersects the abrupt side slopes that form the alluvial valley (FNI, 2005).

Four participants in the proposed Lake Columbia Project are located downstream of the dam. ANRA has stated that deliveries of water to these entities would be made with releases from the reservoir into Mud Creek and downstream through the bed and banks of Mud Creek. This would result in increased instream flows in Mud Creek below the dam. These Project participants and their shares are listed in Table 4.5-8. Although the equivalent constant flow is given for these releases, it is uncertain as to what the actual release schedule would be for these individual participants. It is likely that releases would be variable depending on demand and other available sources of supply. Minimum releases from the reservoir are not required under the water right for the proposed Lake Columbia.

Table 4.5-6 Reductions in Peak Flood Flows with Proposed Lake Columbia

Scenario	Flood Flows (cfs) Corresponding to Different Flood Events		
	2-Year Flood	10-Year Flood	100-Year Flood
Lake Columbia Dam Site			
Existing Conditions (without L. Columbia)	10,079	23,112	42,697
With Lake Columbia, No Diversions	2,296	7,570	15,824
With Lake Columbia, Full Diversions	303	4,563	12,866
S.H. 110			
Existing Conditions (without L. Columbia)	13,205	28,697	48,800
With Lake Columbia, No Diversions	8,204	17,650	30,331
With Lake Columbia, Full Diversions	7,842	16,800	28,175
U.S. 84			
Existing Conditions (without L. Columbia)	13,992	30,349	51,392
With Lake Columbia, No Diversions	9,783	20,998	35,899
With Lake Columbia, Full Diversions	9,467	20,280	34,050

Source: FNI, 2005

Table 4.5-7 Comparison of Floodplain Areas Without and With Proposed Lake Columbia

Flood Frequency	Mud Creek Floodplain Area (acres)			
	Without Lake Columbia	With Lake Columbia	Difference	Percent Diff.
2-year	7,773	6,524	1,249	16%
5-year	8,309	7,648	661	8%
10-year	8,790	8,063	727	8%
25-year	9,273	8,494	779	8%
50-year	9,636	8,724	912	9%
100-year	10,000	9,088	912	9%

Source: FNI, 2005

Table 4.5-8 Proposed Lake Columbia Participants Located Downstream of the Dam

Entity	Share	Ac-Ft/Yr	cfs*
Caro WSC	0.5%	427.5	0.6
Nacogdoches	10.0%	8,550.7	11.8
Alto	0.5%	427.5	0.6
Temple-Inland	10.0%	8,550.7	11.8
Total Releases	21.0%	17,956.5	24.8

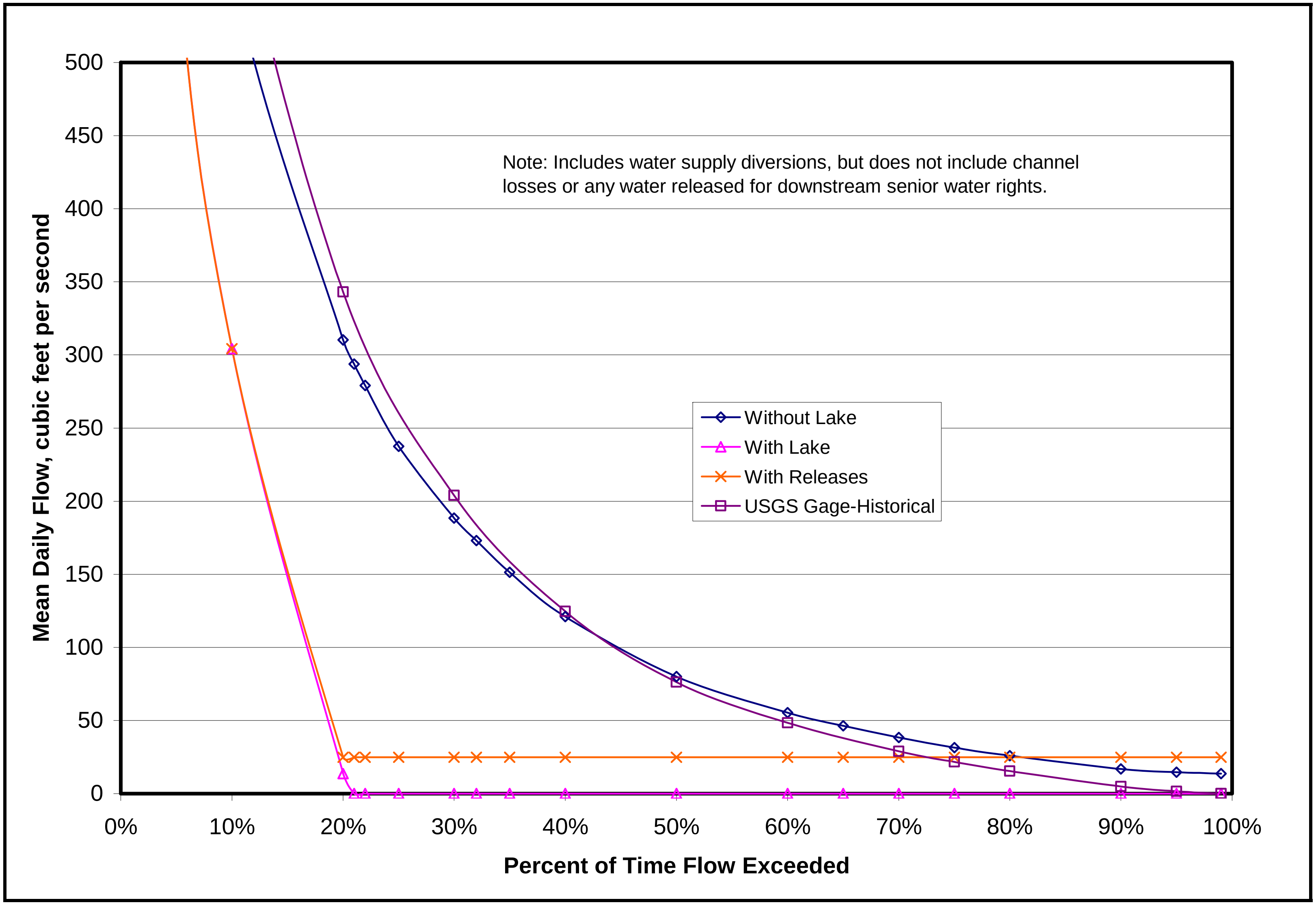
*Assumes constant release

Jacksonville has two wastewater treatment plants (WWTPs) that discharge to Keys Creek, which joins Mud Creek just below the dam site (approximately one mile). ANRA has a long-term contract with Jacksonville to ensure that these return flows will continue to be discharged in the future. The maximum permitted daily flow from these WWTPs is currently 4.3 cubic feet per second (cfs). The sum of the above releases from the reservoir for water supply and these return flows is equivalent to a constant flow in Mud Creek at the confluence with Keys Creek of approximately 29 cfs.

Changes in the overall flow regime downstream of the dam have been predicted by Freese and Nichols based on the results of daily reservoir operation simulations using 1940-1996 historical data from the TCEQ Neches Basin Water Availability Model (WAM). These simulations assumed full withdrawal for water supply, continued upstream return flows of 9.99 mgd, no channel losses, and no releases made for downstream senior water rights. The median daily lake elevation for this scenario was 312.5 feet, or 2.5 feet below the top of the conservation pool. (FNI, 2005) Based on results from these simulations, flow duration curves for Mud Creek immediate below the dam are presented in Figure 4.5-5a. As shown, different curves are presented for various conditions, including without and with Lake Columbia and with water supply releases from Lake Columbia. Similar flow duration curves for Mud Creek below its confluence with Keys Creek, which is approximately twomiles below the dam site, and at Highway 110, which is approximately five miles below the dam site, are presented in Figures 4.5-5b and 4.5-5c, respectively. These downstream flow duration curves take into account the additional inflows from tributaries and the incremental drainage area downstream of the dam. The Keys Creek and Highway 110 curves were generated based on incremental naturalized inflows extracted from the WAM using a ratio of the drainage area at the dam site and the drainage area at these downstream locations. The downstream flow duration curves also include one condition with the Jacksonville return flows (RFs) into Keys Creek accounted for in the Mud Creek flows.

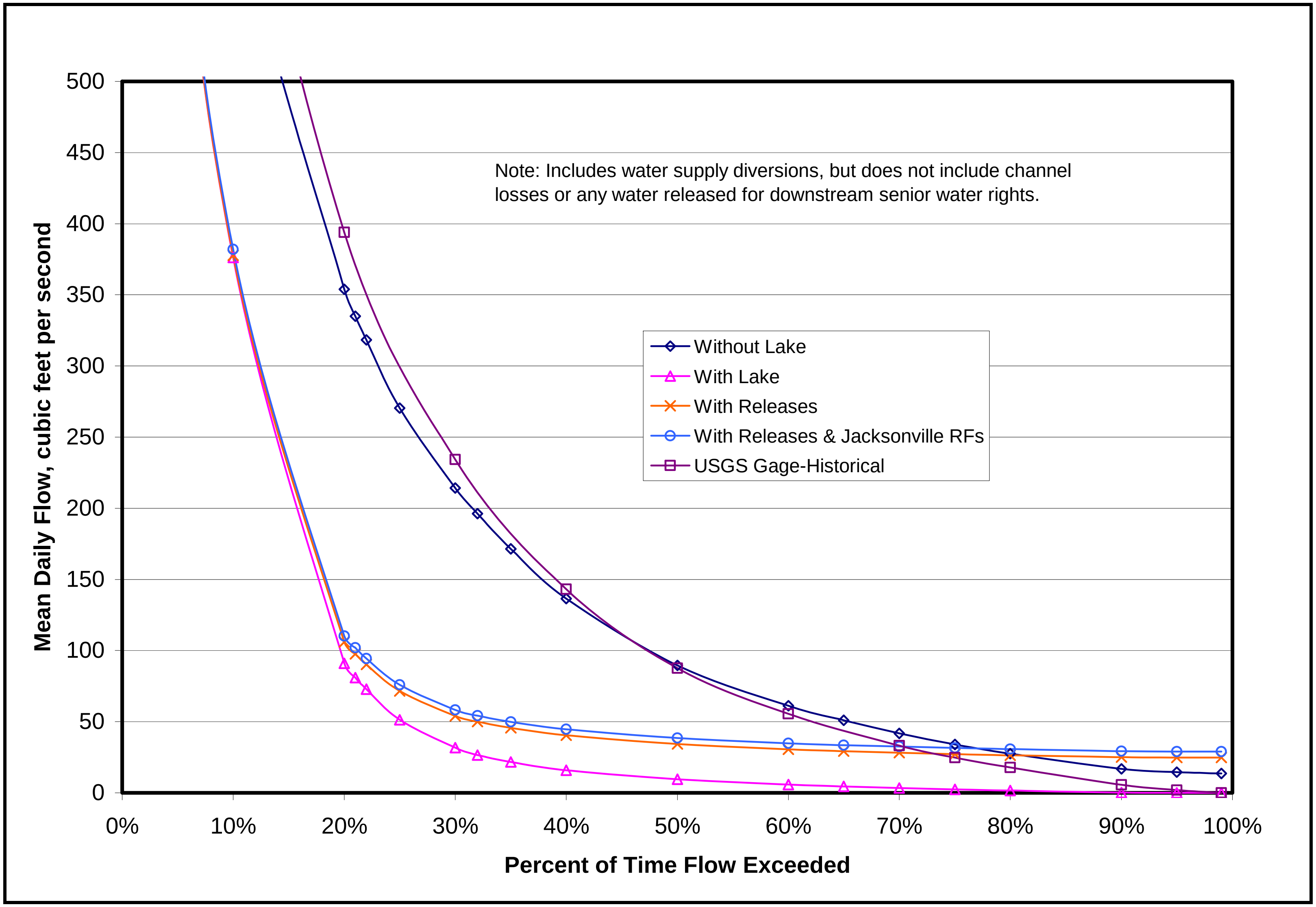
As expected, when compared to existing conditions without Lake Columbia in operation, flows in Mud Creek would be reduced with the proposed reservoir in place, not considering water supply releases and downstream return flows. Zero flow in Mud Creek would be expected approximately 80 percent of the time immediately below the dam, about 10 percent of the time below Keys Creek, and about five percent of the time at Highway 110.

With the constant releases shown in Table 4.5-8, a median (50 percentile) base flow of about 25 cfs would be expected at the dam. The median flow would increase to approximately 39 cfs at Keys Creek with the additional inflows from the incremental drainage area and the 4.3 cfs of return flows from Jacksonville and correspondingly to about 51 cfs at Highway 110. Existing median flows without Lake Columbia in place are approximately 80 cfs at the dam, 90 cfs at Keys Creek, and 102 cfs at Highway 110. With Lake Columbia in operation and delivering water to the downstream participants, low base flows would be increased over existing conditions, and there would essentially be no



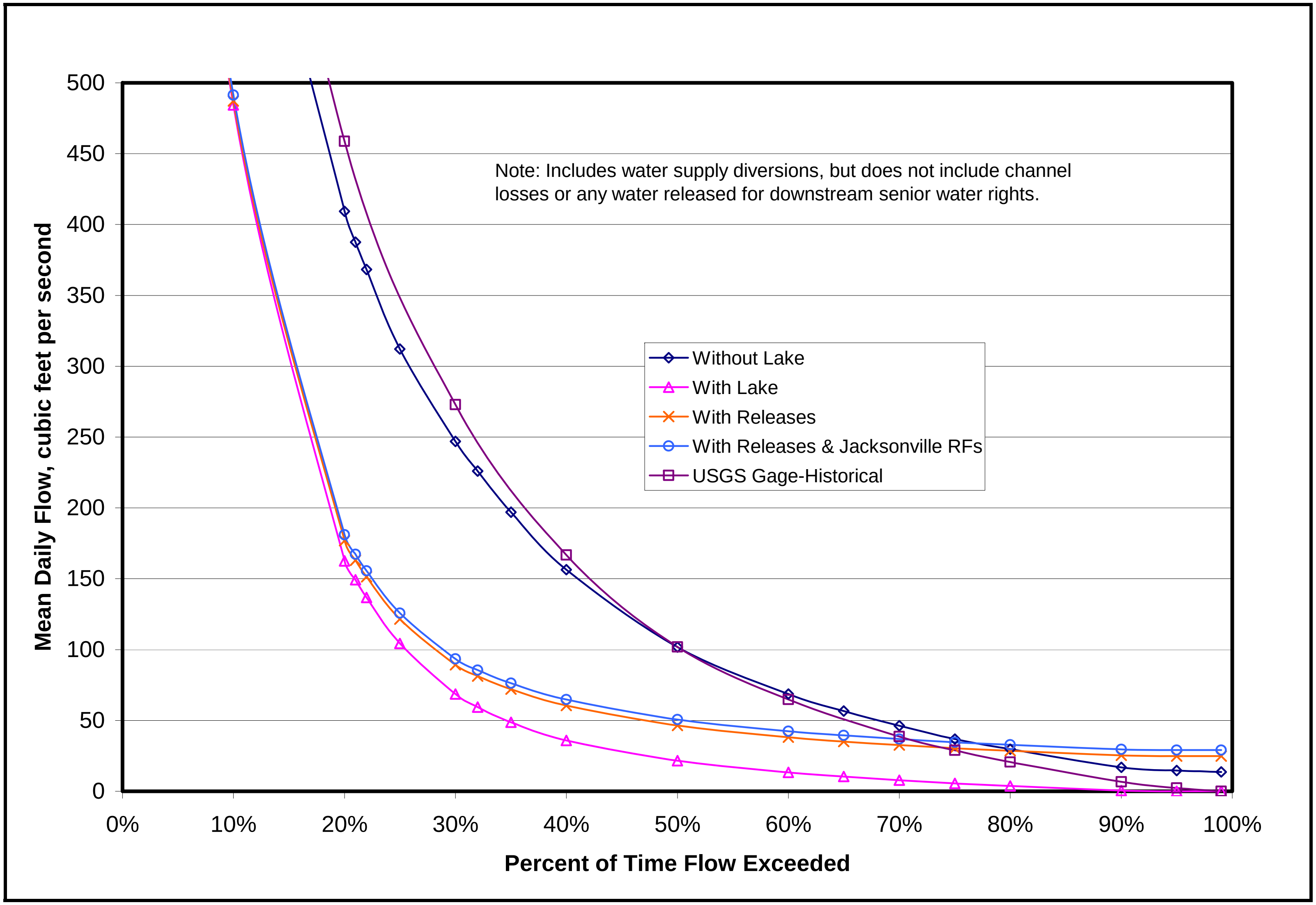
Source: TRC Brandes, 2007a

Figure 4.5-5a Flow Duration Curves Below Proposed Lake Columbia Dam



Source: TRC Brandes, 2007a

Figure 4.5-5b Flow Duration Curves Below Keys Creek



Source: TRC Brandes, 2007a

Figure 4.5-5c Flow Duration Curves at Highway 110

periods of zero flow in Mud Creek below the dam. There would be some changes in geomorphology related to the reduced flows and clear-water releases from the proposed lake. These are discussed below under Erosion and Sedimentation.

Hydropower

During the EIS scoping process, comments were received regarding the impact the operation of Lake Columbia potentially would have on hydropower generation downstream because of reduced flows in the Angelina River, particularly at Lake Sam Rayburn. The impoundment of water in Lake Columbia and diversion of water for municipal and industrial uses under ANRA's water right would reduce the amount of water flowing into Sam Rayburn, and this could possibly result in some reduction in hydropower generation.

However, special conditions contained in the Lower Neches Valley Authority's (LNVA) Lake Sam Rayburn water right (Certificate of Adjudication No. 4411) make it subordinate in priority to upstream municipal water rights, regardless of priority date. Hence, the Lake Columbia water right (Water Use Permit No. 4228) legally is considered to be senior in priority to the Sam Rayburn right, even though its priority date is junior to that of the Sam Rayburn right, and with Lake Columbia in operation, inflows to the reservoir could be impounded without being subject to a priority call from LNRA.

A study was conducted by HDR Engineering, Inc. for ANRA to model the impacts of Lake Columbia on hydropower generation (HDR, 2007). The study used the June 2004 version of the TCEQ Neches Water Availability Model (WAM) with 57 years of continuous monthly flow data (1940-1996). In developing the Neches WAM, the TCEQ modeled the hydropower water right at Lake Sam Rayburn as being junior in priority to all other water rights in the basin. Results from the modeling under full authorized conditions, referred to as Run 3, indicated that there would be differences in hydropower generation at Lake Sam Rayburn in only four of the 57 years simulated, and that the cumulative difference in power generated over the 57 years would be 0.01%.

Based on these results, it is concluded that the impact on hydropower would be negligible.

Water Quality

The low-flow releases from the proposed Lake Columbia dam as described above should provide generally improved water quality in Mud Creek below the dam during base flow conditions. Increased base flows help maintain dissolved oxygen levels, moderate temperatures, and reduce the severity of critical low flows with regard to impacts on aquatic organisms. Maintaining base flows is critical to sustaining a viable and productive aquatic ecosystem. Low base flows generally represent critical conditions for water quality and aquatic organisms.

Turbidity is naturally high in many streams in East Texas, including Mud Creek. The release of clear water from the proposed lake would result in unnaturally clear water for some distance below the dam. Phillips (2001) investigated several sites in Lake Nacogdoches and Bayou Loco, a tributary of the Angelina River. This study area was in Nacogdoches County, which is in the same climatic and physiographic regions as Mud Creek and the proposed Lake Columbia. Because of the proximity and similarities between the sites, it is reasonable to expect similar results with regard to Lake Columbia and its impact on Mud Creek. For the Lake Nacogdoches/Bayou Loco study, sites were instrumented with nephelometer devices to measure turbidity. Although turbidity is influenced by biological factors as well as inorganic suspended solids and sediment loads, the close proximity of the sites to Mud Creek allows the assumption that variation in turbidity is a result of suspended solids. Results from the study show that at a site approximately 10 miles downstream from Lake Nacogdoches, turbidity levels were generally similar to those on Bayou Loco upstream of the lake. Based on these data, it is considered unlikely that the proposed Lake Columbia would cause appreciable impacts to downstream turbidity in Mud Creek for more than a few miles downstream. Dams and reservoirs are sediment traps, so it is likely that the turbidity of the proposed reservoir itself would be less than current instream turbidity. This is discussed further under "Erosion and Sedimentation" below.

Water temperatures in Mud Creek downstream of the proposed Lake Columbia may change because of the different temperature of the water released from the reservoir for downstream users. Water temperatures in reservoirs are known to vary spatially and vertically as they are influenced by atmospheric heating and cooling over long periods of time. Consequently, water released from the reservoir would directly affect water temperatures in Mud Creek below the dam, and temperatures may increase or decrease depending on the time of year and from what depth the water is released. Lake Columbia would have a selective withdrawal tower, and water could be released from near the surface, at mid-depth, or near the bottom, depending on lake level. A bottom release would result in relatively colder-than-normal water during the months of May to September. A surface release in those months could result in slightly warmer water downstream. With a maximum depth of about 50 feet, it is likely that Lake Columbia would be stratified during part of the year, and a thermocline (zone where temperature rapidly decreases with depth) could develop during the period from late spring until September, although it would likely only be in the deepest parts of the lake in late summer. Temperature data at various depths from Lake Travis near Austin, Texas are shown in Figure 4.5-6, and these data demonstrate the formation of a thermocline below about 40 feet in a Texas lake. These data are considered appropriate to compare to the proposed Lake Columbia, as Lake Travis is a Texas reservoir located at roughly the same latitude only about 200 miles away.

Existing water quality in Mud Creek is generally good, and good water quality would be expected in the proposed lake. However, when a reservoir is first filled, vegetation and organic material in the soil decompose and a release of nutrients and depletion of dissolved oxygen (DO) could occur. This is not a long-term problem because once that

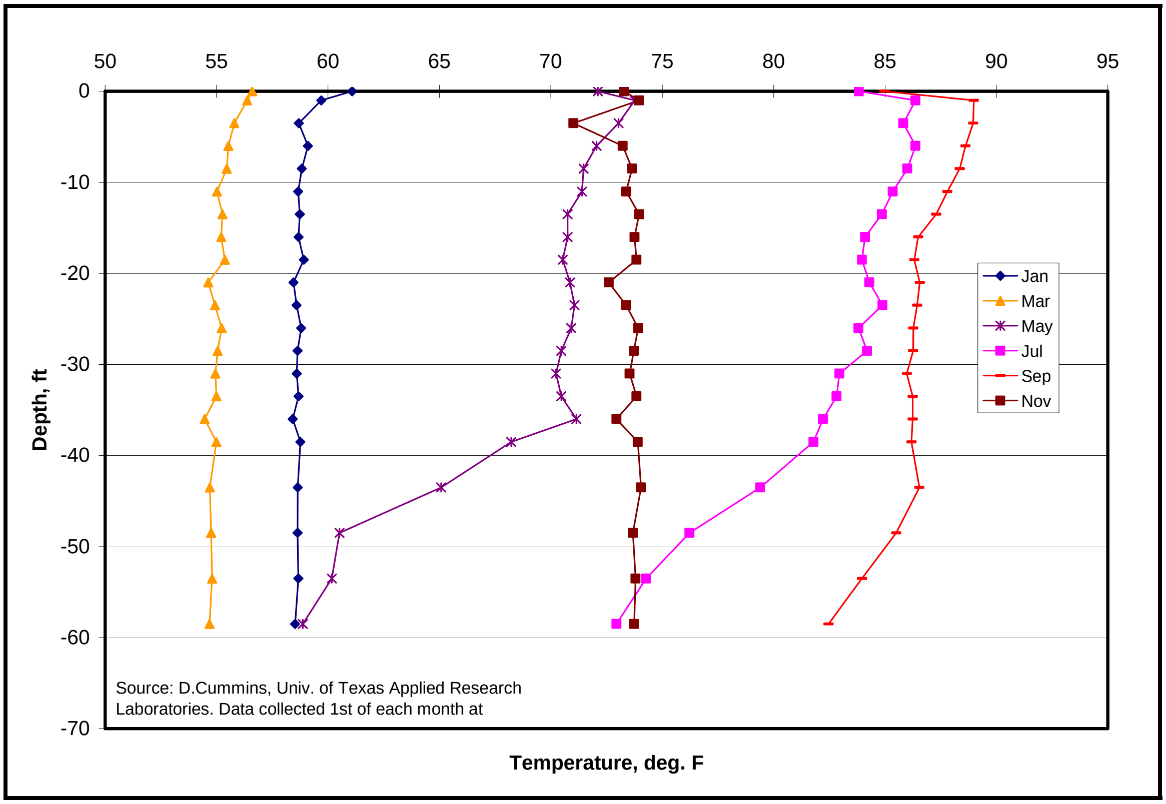


Figure 4.5-6 Lake Travis Temperature Profiles, 2006

material has decomposed, it exerts a lower demand on DO, and the release of nutrients is greatly reduced. The release of nutrients might result in some algal blooms after the reservoir fills, but this would likely decrease after one or two years, depending on inflows. And because the reservoir would not be particularly deep, approximately 50 feet maximum, mixing and reaeration would occur through most of the water column, leaving only a small area of the impoundment in which depleted DO would occur at depth.

Temperature stratification within the reservoir would likely occur during most of the summer, as discussed above. With most lakes in Texas, there can be depressed or anoxic DO levels in the zone below the thermocline, known as the hypolimnion. Mixing and reaeration do not occur in a strongly stratified lake in the hypolimnion. This creates a reducing environment, which can cause the release of odorous sulfides, nutrients (ammonia and phosphorus), and metals from the bottom sediments. In an effort to mitigate these potential conditions in Lake Columbia, a selective withdrawal tower would be constructed within the reservoir to allow releases for downstream users to be made from different depths within the reservoir. With a bottom release, the combination of low-DO water and the presence of these materials could have water quality impacts downstream. With a release from the eplimnion (the zone above the thermocline), as proposed for Lake Columbia, these impacts would largely be avoided. Furthermore, since the maximum depth is only about 50 feet, as shown in Figure 4.5-6 the thermocline would be expected to reach near the bottom of the lake by late summer, which would reduce the duration of any such effects.

Studies have shown that the small increase in water temperature that occurs from releases of water from the eplimnion of impoundments is not detrimental to warm water stream fisheries in the southern U.S. (Robinette, 1978). The study also indicates that water quality was not adversely affected when withdrawal of water was from the epilimnion, and that there may be some increase in biologic productivity because of the higher DO content of the released water. Other studies (USDA, 1979) have shown that benthic populations are much higher and species diversity was improved in streams downstream of impoundments. It was suggested that the moderation of flood flows and prolonged release may be responsible.

Erosion and Sedimentation

Lake Columbia would act as a trap for suspended sediment carried by Mud Creek and its tributaries upstream of the dam. The Mud Creek watershed comprises about 554 square miles, with about 114 square miles, or about 20%, being above and controlled by Lake Tyler and Lake Tyler East. These two lakes inhibit the movement of sediment downstream during normal flow periods. The watershed between the Tyler Lakes and the proposed Lake Columbia dam would encompass about 270 square miles. This leaves about 170 square miles as the primary source area for sediment loadings to Mud Creek downstream of Lake Columbia to its confluence with the Angelina River (FNI, 2005).

Because of the sediment trapping within Lake Columbia, clear water released from the reservoir would have additional capacity to scour and transport sediment within Mud Creek below the dam, likely causing some channel degradation. The stream would not be in a state of dynamic equilibrium if the upstream sediment input is cut off. The ability of a stream to move sediment is a function of the existing sediment load and the velocity. If the sediment load is decreased, such as by trapping within a reservoir, the stream will accumulate more sediment below the reservoir until it is once again in equilibrium. This relationship is described by Lane's Balance, which is described mathematically as:

$$Q \times S \sim Qs \times D50$$

where Q = flow, S = channel slope, Qs = bed material load, and D50 = median size of the bed material. When a channel is in equilibrium, it will have adjusted these four variables such that the volume of sediment being transported into a reach is also transported out, without notable deposition of sediment in the bed (aggradation), or excessive bed scour (degradation). For example, if the bed load Qs is decreased, such as from a clear water release from a reservoir, then the slope S must also decrease, i.e. channel degradation.

This may create a scour hole and depositional bars may form downstream. This is a common impact below dams. In small streams, the impact generally extends to where the stream becomes transport limited. This is expected to be a relatively short distance, because the braiding in Mud Creek and the broad shape of the floodplain indicate a low-gradient system, which has a low transport capacity. Phillips (2001) found similar impacts when studying Lake Nacogdoches, a water supply reservoir on Loco Bayou 30 miles southeast of Lake Columbia with a similar uncontrolled service spillway. He discovered that because of the low-gradient fluvial system, transport of additional sediment and channel degradation was limited to a moderately short distance immediately downstream of the dam. On the Trinity River below Lake Livingston, which is a much larger river, Phillips (2003) found that such impacts extend considerably farther downstream.

On large rivers with a high load of coarse sediments, this impact can be more dramatic. The Brazos River is such a river carrying a very high sediment load, particularly sand. The first major reservoir on the Brazos was Possum Kingdom, constructed in 1941 and controlling 39 percent of the Brazos basin. Today, approximately 76 percent of the Brazos basin is controlled behind reservoirs. Historical changes of water surface elevation at 500 cfs at the Brazos River at Richmond (USGS Gage No. 08114000), which is in the lower basin, from 1931 through 2002 are shown in Figure 4.5-7. These data illustrate that since the mid-1940s, the elevations have steadily lowered over time indicating channel degradation. Trapping of sediments behind dams is the most likely cause of this degradation. Although some of this activity would likely occur with Lake Columbia, it is not likely that there would be as dramatic an effect on Mud Creek, as it is a small stream and does not carry a large sand load. As stated above, scour holes commonly develop below dams, and this would be expected with Lake Columbia, but other than that, major channel degradation downstream is unlikely to occur.

Mitigation

Prior to construction of the Lake Columbia dam and associated facilities, a construction storm water discharge permit must be obtained from the TCEQ, and a Storm Water Pollution Prevention Plan must be prepared and implemented during construction activities. This plan would require the establishment of best management practices to reduce the impact of soil disturbance and sediment delivery to surface waters.

ANRA has adopted Water Quality Regulations for the proposed Lake Columbia. These regulations identify and define various water quality zones with prohibited activities and requirements on certain regulated activities to minimize impacts on water quality and to prevent potential erosional impacts related to future shoreline development. ANRA’s Lake Columbia Water Quality Regulations are attached in Appendix D. Key elements of the regulations are discussed in Section 3.3.4.3.

ANRA has stated that releases would be made from the epilimnion (zone above the thermocline) at times when Lake Columbia is thermally stratified. Under this policy, impacts on downstream temperature and water quality as discussed above would be reduced and minimized. The releases should have no notable impact on water quality in the lake itself.

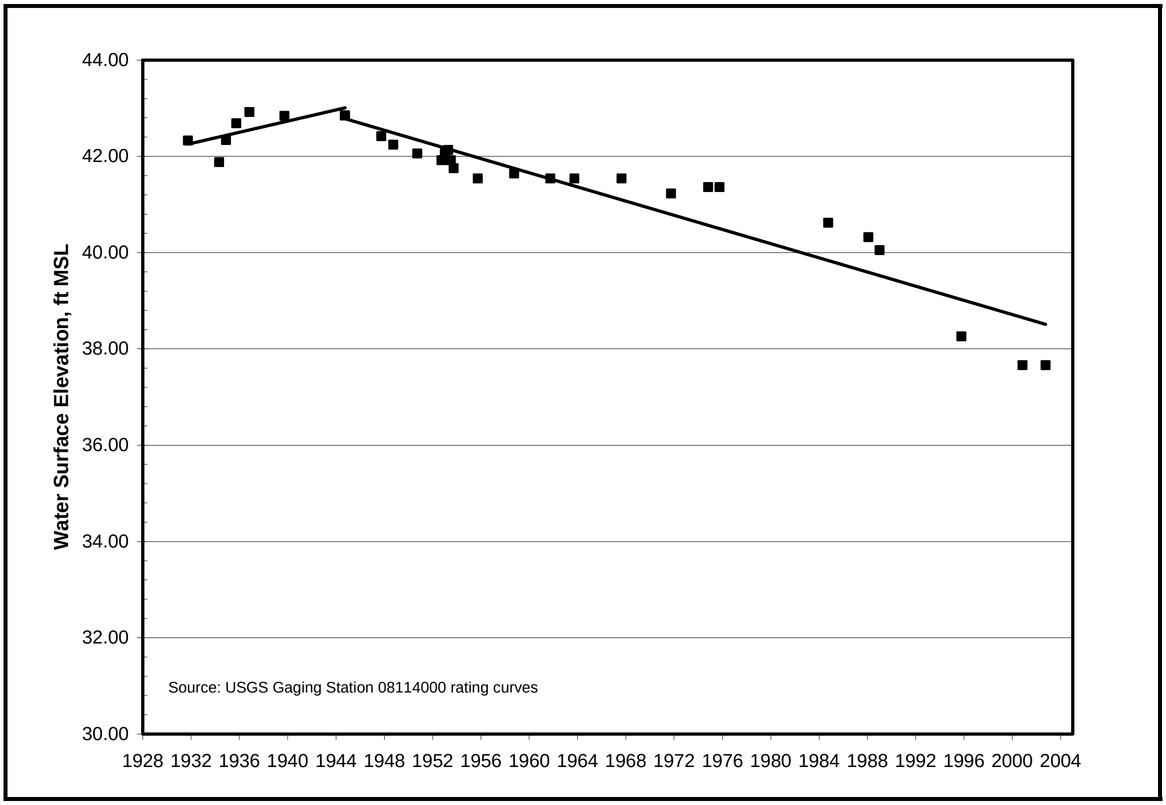


Figure 4.5-7 Change in Elevation for 500 cfs Flow Brazos River at Richmond (1931-2002)

Redevelopment of fringe wetlands around portions of the reservoir over time would offset a portion of the anticipated adverse impacts to wetlands. The extent to which the amount of credit would be considered would depend on the anticipated number of FCU's generated. Ultimately monitoring and performance standards tied back to actual FCU's achieved would serve as the basis for the final determination of offsets. It has been estimated that as much as 1,195 acres of fringe area, primarily in sheltered coves and in the upper portion of the lake, will develop into wetland habitats (see discussion in *Effects to Waters of the U.S.* in this section above). Those wetlands will provide functions that will partially offset lost functions of impacted wetlands

ANRA has proposed a Mitigation Plan (FNI, 2009b). The plan involves replacing impacted waters of the U.S. with functionally equivalent land within the Neches basin, primarily in the area of the Big Thicket National Preserve. The plan is discussed in more detail in Section 3.3.4.3 and attached hereto as Appendix C.

4.5.2.3 Toledo Bend Pipeline Alternative

Under the Toledo Bend Pipeline Alternative, surface waters along the pipeline right-of-way (ROW), at the intake structure on Toledo Bend Reservoir, and in the vicinity of the terminal reservoir at the water delivery point would potentially experience some adverse impacts. Impacts would be primarily construction related, as opposed to operational.

Excavation and disturbances along the 86-mile route from land clearing, trenching, borings, and stream crossings could result in sediment delivery from stormwater discharges. Spills of fuel and other fluids from construction equipment also could impact surface waters. Major crossings would be required for the Angelina River, Attoyac Bayou, and Stryker Creek. A construction storm water discharge permit would have to be obtained, with preparation and implementation of a Storm Water Pollution Prevention Plan. The associated Best Management Practices for controlling runoff and sediment loadings from construction activities should reduce such impacts. Hydrogeomorphic impacts to streams would likely be small and short-lived.

The exact locations of the intake structure site, pump station sites along the pipeline route, and terminal reservoir site are currently unknown. It is likely that the construction of the intake structure and pump station at Toledo Bend Reservoir would adversely impact waters of the U.S. Along the pipeline route, there would be some conversion of forested wetlands to herbaceous. The terminal reservoir could be anywhere near the proposed Lake Columbia site. One possibility would be to construct the terminal reservoir by building a dam on a tributary of Mud Creek, at a smaller scale than Lake Columbia. This action would require an engineered dam capable of passing the probable maximum flood, a new state water right, and a USACE Section 404 permit because of impacts to waters of the U.S. It is most likely that an excavated and diked off-channel reservoir would be constructed on a relatively flat uplands area, which would likely not impact any USACE-jurisdictional features. Except for construction disturbance, there should be little impact to surface waters.

The diversion of water from the Sabine Basin into the Neches Basin would be an inter-basin transfer, requiring special authorization from the TCEQ. This could result in a loss of water right priority and have some impact on the reliability of the water supply. However, Toledo Bend's water right (Certificate of Adjudication No. 4658) has a special condition making it subordinate to all present and future water rights upstream, and there are few junior water rights downstream. Consequently, the probability of a notable impact is low.

The diversion would also result in a slight decrease in flows in the Sabine Basin and a slight increase in flows in the Neches Basin from increased return flows. The amount of water involved is relatively small, and the impacts on hydrology and water quality would not be expected to be appreciable.

4.5.3 Cumulative Effects

Mud Creek, with a total drainage area of about 554 square miles, is a tributary of the Angelina River. The headwaters of Mud Creek arise in Smith County east of Tyler. There are 13 tributaries to upper Mud Creek, with the proposed Lake Columbia dam site being just upstream of Coon Creek and approximately one mile upstream of Keys Creek. The drainage area above the dam site totals 384 square miles. The distance from the proposed dam site to its confluence with the Angelina River is about 16 miles. A streamflow gaging station on Mud Creek near the proposed dam site has been operated from 1940-

1979, and from 2001-2006. During the former period, the average mean daily flow was 258 cfs, and the median was 74 cfs.

Periodic quality water surveys at specific locations in the Mud Creek watershed have been conducted since the 1970s. Improvements in water quality have been recorded in more recent years with such changes probably related to improvements in wastewater treatment plant discharges. At the current time, the water quality in Mud Creek is generally good, with acceptable DO and low levels of dissolved solids, nutrients, and metals in relation to pertinent water quality standards. The exception is iron and manganese, which commonly have elevated concentrations in East Texas streams. These concentrations are likely of geological origin.

As is typical of most streams, point and nonpoint sources of pollution are existent. Table 3.3-5 lists past, present, and continuing actions which are in these two categories. Point source discharges include seven wastewater treatment plants on tributaries to Mud Creek. These plants are expected to be low relative contributors to surface-water quality in the upstream and downstream portions of the Mud Creek Watershed. Nonpoint sources (Table 3.3-5) include the southeasterly urbanization of Tyler; agricultural lands involving pastureland, grazing, and production of hay; timber production via logging; and oil and gas production. Water releases from the upstream Lakes Tyler and Tyler East can also affect both downstream flows (surface water hydrology) and quality. Low relative contributions to surface-water quality are expected from Lakes Tyler and Tyler East, southeasterly urbanization of Tyler, wastewater treatment plant discharges, and oil and gas production. Moderate relative contributions to surface-water quality are expected to be associated with runoff from agricultural lands and timber production via logging operations.

As described above, a total of 5,746.5 acres of waters of the United States are present within the 10,655.5-acre Permit Area for the proposed Lake Columbia Project. Within this total are 5,351.5 acres of wetlands. The wetlands comprise 3,689 acres of bottomland forested wetlands, 1,518 acres of herbaceous wetlands, 144 acres of shrub-scrub wetlands, and 0.5 acres of hillside bog. The wetlands provide functions related to flood conveyance, wave barriers, flood storage, sediment control, pollution control, fish and wildlife habitat, water-based recreation, and aquifer recharge. In relation to past, present, and continuing actions which have or could affect waters of the United States, Table 3.3-5 identifies three such actions in the upper and downstream Mud Creek Watersheds. They include wastewater treatment plant discharges, agricultural lands, and timber production via logging. The latter two actions have moderate relative contributions to cumulative effects, while the first one has low relative contributions.

The No Action alternative would not cause any changes in the flows of Mud Creek, nor would any changes in water quality be expected, other than those resulting from current land use trends. No appreciable loss or alterations of waters of the U.S., including wetlands, would be expected. Accordingly, no detailed studies of cumulative effects from other actions were conducted.

The Proposed Action alternative would have construction phase effects on surface-water hydrology and quality, as well as effects on waters of the U.S. Operational phase effects would also occur, although in a different manner, on surface-water hydrology including downstream flows. Surface-water quality effects could result from evaporation, thermal stratification, and in-lake chemical cycling and interactions. A special water quality issue could be associated with soil erosion in the upper Mud Creek Watershed and the resultant sedimentation within the proposed Lake.

Normal water flows in Mud Creek would be diverted around the dam site and not be disrupted during the 2.5-year construction phase, with no appreciable changes in downstream flows. A stormwater pollution prevention plan would be implemented during the construction phase.

The construction of the dam and filling of the reservoir would result in the loss of approximately 5,747 acres of waters of the U.S., including approximately 5,352 acres of wetlands. Functional losses associated with the wetlands encompass certain hydrologic processes, biogeochemical cycling, and plant and animal habitat. The Corps' Hydrogeomorphic Model (HGM) for Riverine Wetlands was used to quantify the Functional Capacity Units to be lost. This information was then used by ANRA to develop its Mitigation Plan (Appendix C).

The operational phase of the proposed Lake Columbia Project would begin in the 2012 time period and extend to 2060 (the end of the planning period) and beyond. Peak flows would be passed through the spillway, and normal flows would be discharged through a selective withdrawal tower, which allows releases from different water depths. Various reductions in downstream peak flows and floodplain areas are summarized in Tables 4.5-6 and 4.5-7. Flow duration curves for Mud Creek below the dam are shown under various conditions and downstream locations in Figures 4.5-5a, 4.5-5b, and 4.5-5c. In general, downstream flows in Mud Creek would be reduced. Some changes in downstream geomorphology related to reduced flows and clear-water releases would also occur.

Other continuing actions and future actions in the Mud Creek watershed could influence both surface-water hydrology and quality. These would represent contributing actions to cumulative effects on downstream flows and geomorphological consequences. Past and continuing actions which would influence surface-water hydrology include Lakes Tyler and Tyler East, and the southeasterly urbanization of Tyler (as urbanization occurs greater runoff will take place) (Table 3.3-5). One future action which could influence surface-water hydrology includes the widening of U.S. 79 and the completion of a 5,000-foot bridge over the proposed lake and the construction of a smaller bridge for S.H. 135 in the upper part of the proposed lake.

In-reservoir water quality changes are expected to include reductions in turbidity because of settling of suspended solids; water temperature fluctuations as a function of season, depth, and the occurrence of thermal stratification; and dissolved oxygen (DO) changes resulting from organic loadings, temperature changes, and thermal stratification. Low DO levels in the hypolimnion could also influence the dissolution of iron and manganese from bottom sediments. Other continuing actions in the upper Mud Creek watershed that could contribute suspended solids, organic matter, nutrients, and metals to the proposed lake include Lakes Tyler and Tyler East, southerly urbanization of Tyler, wastewater treatment plant discharges, agricultural lands, timber production via logging operations, and oil and gas production (Table 3.3-5). Agricultural lands and timber production are likely to be moderate relative contributors to lake water quality, while the others from the above list would be low relative contributors.

Future actions which could be low relative contributors to suspended solids, organic matter, nutrients, and metals found in the lake include the widening of U.S. 79 and the U.S. 79 and S.H. 135 bridges over the Lake, development and use of public access areas and marinas along the shoreline, shoreline developments around the Lake, and other current or potential land development projects in the upper Mud Creek Watershed (Tables 3.3-6 and 3.3-7). Moderate relative contributions would occur from recreational usage of the proposed Lake and its environs; the other listed actions are expected to be low relative contributors.

Other future actions could lead to reductions in adverse surface water quality effects. For example, and as shown in Table 3.3-6, ANRA regulation of recreational and commercial activities on and surrounding the proposed Lake Columbia (Appendix D) would be expected to reduce pollutant loadings relative to the above water quality parameters. Appendix D also includes several land use controls which would be implemented in association with lake water quality regulations. Further, ANRA has developed a Mitigation Plan for the proposed Lake Columbia (Appendix C). It includes multiple strategies related to compensation for the above effects on waters of the U.S.

Finally, quantitative information on cumulative effects on surface water hydrology and quality is not available. Such information would be needed for both the levels of effects and their significance determinations, as well as for establishing the relative contributions of other actions and the Proposed Action. Accordingly, ANRA would develop a focused monitoring program to establish these levels and contributions. This program could coincide with earlier monitoring programs for soil erosion and land usage in the Permit Area, Shoreline Development Area, and upper Mud Creek watershed.

The Toledo Bend Pipeline alternative would cause some adverse effects to local streamflows and water quality during the construction phases for both the pipeline and the terminal storage reservoir. No detailed review of cumulative effects on surface water was conducted. Further, the interbasin transfer of water would have potential effects on flows and quality in the entire Five-County Area. Again, the cumulative effects of such transfers were not examined.

4.6 CLIMATOLOGY/AIR QUALITY

4.6.1 Affected Environment

4.6.1.1 Climatology

The proposed Lake Columbia is located within the East Texas climatological zone as defined by the National Weather Service. At approximately 32 degrees latitude, the proposed reservoir lies toward the northern end of the sub-tropical zone, which is characterized by hot, humid summers and short, mild winters. Temperature variation is not extreme, although it is enough to create four distinct seasons. In addition, there may be rapid variation in temperature throughout the year with the exception of the summer months. In this region, severe thunderstorms and tornadoes may occur in addition to occasional strong winds. Average annual evaporation is high (52 inches), and the monthly average evaporation typically exceeds rainfall seven months out of the year. Lake Columbia would lie approximately 175 miles from the Gulf of Mexico, which plays a significant role in local climatology; however, continental influences remain the dominant factor for the Permit Area.

Data from the National Oceanic and Atmospheric Administration (NOAA) for the nearby Rusk and Henderson stations indicate that average monthly temperatures in the area range from 82 degrees F in July and August to just under 46 degrees F in January, with an average annual temperature of 65 degrees F. Average summer (July and August) afternoon highs reach the 90 to 95 degree range while average December and January highs reach just over 60 degrees. Average minimum temperatures vary from 75 degrees F in July to about 40 degrees F in December and January. A minimum temperature less than or equal to 32 degrees F occurs about 30 days per year. The record high temperatures for the Rusk and Henderson stations are 110 and 111 degrees F, respectively. Record low temperatures are 0 and -1 degrees F, respectively. Mean monthly relative humidity varies between about 65 and 75 percent. Recorded 6:00 a.m. humidity readings average about 85 percent and noon readings about 60 percent.

Long periods of widespread precipitation characterize the Permit Area and are usually caused by slow moving, cold northern air masses that may force resident warmer air aloft or that otherwise may become stationary, wedging incoming moist, Gulf air upward. Both conditins cause cooling of the moister, warm air resulting in abundant precipitation throughout the area. The Rusk and Henderson stations provide similar records regarding normal monthly and total annual precipitation showing that rainfall typically peaks in the spring months of April and May with a smaller peak occurring in September. Winter rainfall is moderate with the least rainfall occurring in the summer months of July and August. The average annual precipitation is about 45 inches, and one to two inches of snow may fall during the year.

Information from the Climatic Atlas for stations in Dallas and Shreveport indicates that the windiest season is spring, with an average speed of about 10.5 miles per hour (Dept. of Commerce, 1968). The annual prevailing wind direction is from the south to southeast, occurring almost 40 percent of the time. There is, however, a large variation in the monthly distribution of wind occurrences. Winter months experience the most even distribution of winds with a near equal division between north-to-northwest and south-to-southeast winds, each about 45 percent of the time. Summer heavily favors the prevailing south to southeast winds. Calm conditions prevail only about three percent of the time. Potentially damaging winds occur with intense thunderstorms and seasonal tornado activity. Winter cold air is often brought by strong, but usually non-destructive winds.

4.6.1.2 Air Quality

Air quality relates to the concentration of various pollutants and their interactions in the atmosphere. Long-term climates as well as short-term weather fluctuations are considered when testing air quality because they control dispersion and affect concentrations of pollutants. The EPA and TCEQ establish air quality standards and maximum pollutant concentrations through the Federal Clean Air Act and Texas Clean Air Act, respectively. Air quality within the established pollutant standards is considered to not be harmful to public health and welfare. The Clean Air Act of 1990 (CAA) requires the EPA to establish standards for air contaminants in emissions that cause or contribute to air pollution that may endanger public health or welfare. National primary ambient air quality standards are put forth to protect everyone including children, people with asthma, and the elderly from health risk, while the secondary standards prevent unacceptable effects on the public welfare, e.g., unacceptable damage to crops and vegetation, buildings and property, and ecosystems. The EPA has established primary and secondary standards (National Ambient Air Quality Standards, NAAQS) for seven pollutants:

- Particulate matter with an aerodynamic diameter of 10 micrometers (microns) or less (PM_{10})
- Particulate matter with an aerodynamic diameter of 2.5 micrometers or less ($PM_{2.5}$)
- Sulfur dioxide (SO_2)
- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Ozone (O_3)
- Lead (Pb)

Table 4.6-1 presents the ambient air quality standards that are applicable to Texas.

In addition to the NAAQS, Texas imposes additional restrictions on SO_2 concentrations. "No person in the state of Texas may cause, suffer, allow, or permit emissions of SO_2 from a source or sources operated on a property or multiple sources operated on contiguous properties to exceed a net ground level concentration of 0.4 part per million by volume (ppmv) averaged over any 30-minute period" (30 TAC §112.3a).

Table 4.6-1 Primary and Secondary Ambient Air Quality Standards for Texas

Pollutant	Averaging Period	Standard	Primary NAAQS	Secondary NAAQS
Ozone	8-hr	The average of the annual fourth highest daily eight-hour maximum over a three-year period is not to be at or above this level.	76 ppb[1]	76 ppb[1]
Carbon Monoxide	1-hr	Not to be at or above this level more than once per calendar year.	35.5 ppm	35.5 ppm
	8-hr	Not to be at or above this level more than once per calendar year.	9.5 ppm	9.5 ppm
Sulfur Dioxide	3-hr	Not to be at or above this level more than once per calendar year.	–	550 ppb
	24-hr	Not to be at or above this level more than once per calendar year.	145 ppb	–
	Annual	Not to be at or above this level.	35 ppb	–
Nitrogen Dioxide	Annual	Not to be at or above this level.	54 ppb	54 ppb
Respirable Particulate Matter (10 microns or less) (PM_{10})	24-hr	Not to be at or above this level on more than three days over three years with daily sampling.	155 $\mu g/m^3$	155 $\mu g/m^3$
	Annual	The three-year average of annual arithmetic mean concentrations at each monitor within an area is not to be at or above this level.	51 $\mu g/m^3$	51 $\mu g/m^3$
Respirable Particulate Matter (2.5 microns or less) ($PM_{2.5}$)	24-hr	The three-year average of the annual 98th percentile for each population-oriented monitor within an area is not to be at or above this level.	66 $\mu g/m^3$	66 $\mu g/m^3$
	Annual	The three-year average of annual arithmetic mean concentrations from single or multiple community-oriented monitors is not to be at or above this level.	15.1 $\mu g/m^3$	15.1 $\mu g/m^3$
Lead	Quarter	Not to be at or above this level.	1.55 $\mu g/m^3$	1.55 $\mu g/m^3$

[1] Effective May 27, 2008. 1997 standard of 80 ppb remains in place while EPA undertakes rulemaking to address the transition.
ppb = parts per billion by volume
ppm = parts per million by volume
$\mu g/m^3$ = micrograms per cubic meter

Source: TCEQ, 2008.

Within Texas, the TCEQ and other air pollution control agencies operate ambient air quality monitoring across the state, although no air quality monitoring is being conducted in the vicinity of the proposed Lake Columbia. The closest monitoring site, at the Tyler Airport, would not have representative data for the Permit Area. The entire Five-County Area is in attainment with the NAAQS. However, Rusk and Smith counties are within an area previously considered a “near non-attainment area” for ozone. A revised State Implementation Plan for 1-hour ozone in northeast Texas was subsequently prepared. The 1-hour ozone Plan revision enforced significant emissions reductions that were agreed to on a voluntary basis by several local industries. All counties in the area were designated as being in attainment for the 8-hour ozone standard by the EPA on April 15, 2004 (TCEQ, 2004).

4.6.2 Environmental Consequences

4.6.2.1 No Action Alternative

Under No Action, the air quality/climatology impacts associated with either of the other alternatives would not occur. Existing air quality would be unchanged.

4.6.2.2 Proposed Action

Construction

It is expected that construction of the proposed Lake Columbia dam would require approximately 2-1/2 years. During this time, construction of the reservoir would likely result in an increase in fugitive dust emissions during land clearing, excavation, and filling for the dam and appurtenances. This could affect PM_{10} and $PM_{2.5}$ levels during this period. It is expected that standard control measures, such as watering, reduced vehicle speeds, dust suppressants, and reduced activities during high winds, would be employed during construction activities to reduce the airborne emission of particulates. Minor increases in vehicle emissions would also occur. These would not be expected to cause violations of the NAAQS for the region.

Operation

No appreciable impacts to climatology or air quality would be expected to occur during operation of the reservoir. A slight increase in relative humidity and moderation of temperatures in the immediate vicinity of the reservoir could occur, but because of the reservoir's relatively small size, no regional effects would be expected. Boat traffic on the lake and increased vehicle traffic associated with recreation and growth could lead to some increase in vehicle emissions, but this would be expected to be minor. Operation would not be expected to cause violations of the NAAQS for the region.

Mitigation

A plan to control fugitive emissions during construction would be developed and implemented. No other air quality/climatology mitigation measures are anticipated.

4.6.2.3 Toledo Bend Pipeline Alternative

It is unknown how long it would take to construct the Toledo Bend pipeline and terminal reservoir, but it is likely to be on the order of a year or so. During this time, construction impacts to air quality would be similar to those discussed for the proposed Lake Columbia dam construction. PM_{10} and $PM_{2.5}$ levels could be elevated over the length of the pipeline in the areas where construction is occurring. The size of the area disturbed at any one time would be expected to be less than that for the dam construction, although construction of the terminal reservoir would likely disturb a more sizeable area at one time than the pipeline construction. These impacts would be dispersed over a larger area. There would be no appreciable operation impacts. The terminal reservoir would cover an area approximately one percent of the area of the proposed Lake Columbia, and any humidity or temperature effects would be small. Construction and operation would not be expected to cause violations of the NAAQS for the region.

4.6.3 Cumulative Effects

The climatology of this area is characterized by hot, humid summers and short, mild winters. Long periods of precipitation can also characterize the Five-County Area, with annual averages ranging up to about 45 inches. The prevailing wind direction is from the south to southeast. Regarding air quality, the entire Five-County Area is an attainment area with regard to NAAQS for seven criteria pollutants – ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, particulate matter which is 10 microns or less in size, particulate matter which is 2.5 microns or less in size, and lead.

No effects on climatology or air quality are anticipated from the No Action alternative. Therefore, for this alternative there is no need to address cumulative effects on these two atmospheric categories.

The construction phase for the Proposed Action alternative would generate fugitive dust and construction vehicle gaseous emissions. Best practice standard control measures would be used to minimize such emissions. More specifically, ANRA would require that a fugitive dust control plan be implemented. During the operational phase, boat traffic and vehicular traffic would increase in the Permit Area, Shoreline Development Area, and other nearby locations. Pollutant emissions would increase in these localized areas; however, no major effects on climatology or air quality would be anticipated. A review of the past, present, and continuing other actions addressed in Table 3.3-5 did not reveal any actions which would contribute to cumulative effects.

Table 3.3-6 includes three future actions which could contribute to cumulative air quality effects. These actions include widening of U.S. 79 and building an associated bridge about three miles upstream of the proposed dam, construction of a bridge for S.H. 135 over the upper part of the proposed reservoir, recreational usage of the proposed Lake Columbia and its environs (e.g., the Shoreline Development Area), and ANRA regulation of recreation and commercial activities on and surrounding the proposed lake.

Reconstruction of U.S. 79 and the S.H. 135 bridge would produce increased fugitive dust emissions. This could have a short-term cumulative effect with the increased emissions during construction of the proposed Lake Columbia dam, if the timing of the construction was coincident with the construction of the dam. Increased vehicular traffic from the expanded U.S. 79 would result in increased vehicle emissions once the bridge is completed. Recreational usage of the Lake would increase air pollutant emissions in the local area; however, these emissions are not expected to result in violations of the

NAAQS. One reason for this is the ANRA program to regulate the types and levels of recreational and commercial activities on the proposed Lake and within the Shoreline Development Area.

Construction of the Toledo Bend Pipeline alternative would generate local fugitive dust and construction equipment gaseous emissions. No major impacts on air quality would occur, thus the current attainment status should be continued. No cumulative effects on air quality are anticipated.

4.7 NOISE

4.7.1 Affected Environment

As a frame of reference for bridging objective sound levels to subjective impressions, Table 4.7-1 shows the noise levels of sounds measured in common interior and exterior environments relative to their typical subjective impressions. Various entities have established certain allowable noise levels for different land use activities in the vicinity of neighboring properties or developments. The Noise Abatement Criteria (NAC) established by the Federal Highway Administration (FHWA) provide information for allowable noise levels for different types of activities and are presented in Table 4.7-2.

Existing noise levels in the vicinity of the proposed Lake Columbia were field measured on March 9, 1989 and April 12, 1989. Four receptor sites were selected as being representative of different types of land uses which could be impacted by changes in noise levels. Table 4.7-3 shows results of the field monitoring effort. Noise levels shown in the table are the result of 30 minutes of continuous monitoring. Existing noise levels are primarily natural or caused by roadway traffic (LAN, 1991b). Noise levels near the highways are likely to be somewhat higher today than they were when the survey was conducted, but in general, noise levels are not notably different in the largely rural area comprising the proposed Project site.

4.7.2 Environmental Effects

4.7.2.1 No Action Alternative

Under No Action, the noise impacts associated with either of the other alternatives would not occur, and noise would remain similar to existing conditions.

4.7.2.2 Proposed Action

<u>Construction</u>

Construction of the dam and appurtenances would generate noise in the vicinity of the dam site and borrow pit areas. Road relocations would also generate construction noise. Essentially all of the noise produced from these activities would result from operating

Table 4.7-1 Typical Sound Levels

Example Noise Source or Environment	A-Weighted Sound Level, Decibels (dBA)	Subjective Impression
Shotgun (at shooter's ear) or on a carrier flight deck	140	Painfully loud
Civil defense siren (100 feet)	130	
Jet takeoff (200 feet)	120	Threshold of pain
Loud rock music	110	
Pile driver (50 feet)	100	Very loud
Ambulance siren (100 feet) or in a boiler room	90	
Boat with inboard/outboard engine (50 feet)*	85-90	
Police patrol boat with outboard engine(s) (50 feet)*	81-82	
Pneumatic drill (50 feet) or inside a noisy restaurant	80	
Personal watercraft (50 feet)*	76-81	
Busy traffic; hair dryer	70	Moderately loud
Normal conversation (5 feet) or in a data processing center	60	
Light traffic (100 feet); rainfall or in a private business office	50	
Bird calls (distant) or inside an average living room or library	40	Quiet
Soft whisper (5 feet); rustling leaves or inside a quiet bedroom	30	
In a recording studio	20	
Normal breathing	10	Threshold of hearing

Sources: Beranek, 1988.
* Noise Unlimited, Inc. 1995

Table 4.7-2 Noise Abatement Criteria (Federal Highway Administration)

Activity Category	Description of Activity	Criteria Levels -dB Leq(h) - L10(h)
A	Tracts of land in which serenity and quiet are of extraordinary significance and serve an important public need, and where the preservation of those qualities is essential of the area is to continue to serve its intended purpose. Such area could include amphitheaters, particular parks or portions of parks, open spaces, historic districts which are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.	57 - 60 (exterior)
B	Picnic areas, recreation areas, playgrounds, active sports areas, and parks which are not included in Category A and residences, motels, hotels, public meeting rooms, schools, churches, libraries, and hospitals.	67 - 70 (exterior)
C	Developed lands, properties or activities not included in Categories A or B above	72 - 75 (exterior)
D	Undeveloped lands. Predicated noise levels should be provided to local governments by which developers of land can design activities compatible with further noise levels.	-- --
E	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.	52 - 55 (interior)

Source: 22 CFR Part 772 Table 1.

Table 4.7-3 Existing Noise Levels

Date	Monitoring Site	Location	Noise Level (dB)
3/9/1989	1	West End of Dam	50.5
3/9/1989	2	U.S. 79 near Afton	73.4
4/12/1989	3	CR 2138-North End of Proposed Lake	55.7
4/12/1989	4	West of Gould	50.4

Source: LAN, 1991b

heavy construction and earth-moving equipment, including trucks, cranes, dozers, scrapers, backhoes, and concrete mixers. Construction activities would be limited to daytime hours. Table 4.7-4 presents typical construction equipment noise values.

Table 4.7-4 Standard Construction Equipment Aggregate Noise Emissions Values

Construction Phase	Aggregate Equipment Noise Level, Sound Pressure Level At 50 Feet (dBA)
Site Clearing	84
Excavation	89
Foundations	77
Building Construction	84

Source: EPA, 1971

Operation

Operation of the dam and outlet works is not expected to generate any noise above existing ambient conditions. However, boat traffic and marinas on the lake would generate noise that does not currently exist. Texas does not have any standards for noise levels from motor boats, although boat mufflers are required. Noise regulations can be set by local authorities, such as lake operators, cities, or counties. The Society of Automotive Engineers (SAE) has established standards that have been adopted by many states specifying a limit of 90 dBA at a distance of 1.5 meters for an engine at idle, and 75 dBA measured from the shore at a distance of 50 feet during operation. Prediction of future noise levels for the proposed lake at different locations and times is not practicable. Noise levels would be expected to be higher on busy weekends when there is more boat traffic. Noise levels measured for various types of watercraft at 50 feet are included in Table 4.7-1 and range from 76-90 dBA. Noise levels decrease by 3 dBA with a doubling of distance from a line source, such as a boat (Canter, 1996).

Future residences constructed near the proposed lake would also be a source of noise, although likely to a lesser extent. The major receptor for noise would be these future residents, as there are few current receptors in the vicinity of the proposed lake.

Mitigation

There are few receptors in the vicinity of the proposed dam site, since this is a sparsely populated area. Construction activities would be limited to daytime hours to reduce any such impacts. To protect site workers, signs requiring the use of hearing protection devices would be posted in all areas where noise levels commonly exceed guidelines established by the Occupational Safety & Health Administration (OSHA).

4.7.2.3 Toledo Bend Pipeline Alternative

Construction noise impacts would be similar to those discussed for the Lake Columbia construction activities. However, these impacts would be dispersed over a larger area. Noise levels would be elevated over the length of the pipeline in the areas where construction is occurring. Compared to the Proposed Action, these would be smaller and short lived as construction progresses, since the size of the area disturbed at any one time would be less than that associated with the dam construction, and the degree of construction activity would be considerably less. Construction of the terminal reservoir would disturb a more sizeable area at one time than the pipeline construction, and could have a noise impact similar to construction of the dam, although for a shorter time period.

Operation impacts include noise generated by pump stations. These would be limited to the area around the intake structure on Toledo Bend Reservoir and the booster stations along the pipeline route. Exact locations for these are unknown, but it is likely that they would be located in areas away from sensitive receptors. Pump stations would be enclosed in structures, which would effectively reduce any noise generated.

4.7.3 Cumulative Effects

The current ambient noise levels in the Permit Area and the Shoreline Development Area are typical of rural areas and locations near rural highways. No effects on these noise levels are anticipated from the No Action alternative; thus, there is no need to consider cumulative effects on the ambient noise resource.

The construction phase for the Proposed Action alternative would last for about 2.5 years, with the associated ambient noise levels being typical of construction sites. Further, construction would be limited to daytime hours; thus minimizing noise concerns to families currently living in what would become the Shoreline Development Area. Review of Table 3.3-5 reveals that no noise impacts would be anticipated in the Permit Area and Shoreline Development Area from past, present, and continuing actions.

One future noise-generating action which would be anticipated to occur in the Permit Area and Shoreline Development Area includes widening of U.S. Highway 79 and building a 5,000-foot long bridge and construction of a smaller bridge for S.H. 135 over the upper portion of the proposed reservoir (these actions could coincide with the lake construction). Construction-related noise from the U.S. 79/S.H. 135 projects occurring in the same time period as construction of the proposed lake would increase local noise levels. However, such additive noise levels increase on a logarithmic scale rather than arithmetically. For example, noise levels of 70 dBA each at a common distance from the two construction jobs would total 73 dBA. Further, because noise levels are not continuous over time, the disruptive features of noise could be attenuated. Table 3.3-6 indicates that the U.S. Highway 79/S.H. 135 projects would have a low relative contribution to anticipated noise levels in the two study areas.

Table 3.3-6 indicates that another future action would involve the development and use of public access areas and marinas along the proposed Lake Columbia shoreline, and Table 3.3-7 indicates that a significant percentage of the shoreline could be developed in the future. Access areas and boat marinas are widely recognized as noise-generating sources in local areas. However, their widespread distribution suggests a low relative contribution to noise levels in the Permit Area and Shoreline Development Area. Other development could result in an increase in noise levels, although the primarily residential nature of such development would not likely be a major source.

Another future action involves recreational usage of the proposed lake and its environs. Power boats and personal watercraft could generate higher noise levels, but since these sources are mobile, the noise level at a particular location would be constantly changing. Nonetheless, this action would be a moderate contributor to noise levels in the Permit Area and Shoreline Development Area. Finally, the future action indicating that ANRA would regulate recreational and commercial activities in the two areas would aid in mitigating their associated noise levels.

To summarize relative to cumulative noise levels in the two study areas, the noise would increase during both the construction and operational phases of the proposed lake. However, because of the dynamic and variable nature of the identified noise sources, and anticipated mitigation efforts, no significant cumulative noise levels would be anticipated.

The construction and operational phase noise levels associated with the Toledo Bend Pipeline alternative wwould not be excessive. However, other potential noise sources in the vicinity of this alternative were not studied, thus a definitive statement about cumulative noise levels and their effects cannot be made. Accordingly, and to provide a perspective, it should be noted that direct noise levels associated with this alternative would typically be less than comparable levels related to the Proposed Action and other actions in its vicinity.

4.8 ECOLOGY

4.8.1 Vegetation

4.8.1.1 Affected Environment

4.8.1.1.1 Regional Overview

The proposed Project and its associated Five-County Area are largely within the Pineywoods Vegetational Area with the extreme northern portion within the Post Oak Savannah Vegetational Area (Gould, 1975). The Pineywoods Vegetational Area is characterized by pine and mixed upland pine/hardwood forests, which are extensively dissected by bottomland hardwood forests along natural water courses and man-made reservoirs. This vegetational area represents the southwestern limit of the pine hardwood forests of the southeastern United States. Occasional pastureland and crop cultivation is present throughout the area. The vegetational composition at any given location in the area is greatly dependant on climate, soils, geology, topography, and historic land use, particularly related to forestry practices over the past 50 to 100 years.

4.8.1.1.2 Permit Area Vegetation Cover

Table 4.8.1-1 provides a breakdown of vegetation cover types in the Permit Area (FNI, 2003a). The areal extent of each vegetation cover type is shown in Figures 4.8.1-1a through 4.8.1-1g.

Table 4.8.1-1 Vegetation Cover Types Within Permit Area

Cover Type	Acres	Percent
Bottomland Hardwood Forest (Deciduous Forested Wetland)	3,689	34.6%
Herbaceous Wetland	1,518	14.2%
Shrub Wetland	144	1.4%
Hillside Bog	0.5	<0.1%
Open Water (Pond/Lake)	63	0.6%
New Channel (Excavated Water)	30	0.3%
Perennial Streams	255	2.4%
Intermittent Streams	47	4.4%
Upland Forest (Deciduous Upland Forest)	2,247	21.1%
Shrub Upland	235	2.2%
Grassland (Herbaceous Upland)	2,381	22.3%
Urban	14	0.1%
Highways	32	0.3%
TOTAL	10,655.5	100%

Source: FNI, 2003a

Bottomland Hardwood Forest (Deciduous Forested Wetlands)

Bottomland hardwood forest is associated with Mud Creek and its tributaries within the Permit Area (FNI, 2003a). Dominant trees include willow oak (*Quercus phellos*), overcup oak (*Quercus lyrata*), American elm (*Ulmus americana*), sweet gum (*Liquidambar styraciflua*), sugar hackberry (*Celtis laevigata*), and water oak (*Quercus nigra*). Dominant shrubs include small trees of the species previously listed, and black tupelo (Nyssa sylvatica), deciduous holly (*Ilex decidua*), and American beautyberry (*Callicarpa americana*). Common vines include green briar (*Smilax* sp.), poison ivy (*Toxicodendron radicans*), trumpet creeper (*Campsis radicans*), and Japanese honeysuckle (*Lonicera japonica*). Common herbaceous species include lizard's tail (*Saururus cernuus*), various sedge species (*Carex* sp.), goldenrod (*Solidago* sp.), and smartweed (*Polygonum* sp.).

Priority bottomland hardwood sites have been designated by the USFWS (USFWS, 1985). The priority sites identified by the USFWS Texas Bottomland Hardwood Preservation Program in the vicinity of the Permit Area are presented in Figure 4.8.1-2.

Herbaceous Wetland

Herbaceous wetlands within the Permit Area are dominated by wetland obligates such as rushes, sedges, smartweed, and lizard's tail (FNI, 2003a). Common forbs include goldenrod and morning glory (*Ipomoea* sp.). Native grasses such as switch grass (*Panicum virgatum*) and bluestems (*Andropogon* sp.) are common.

Shrub Wetland

Shrub wetlands within the Permit Area are wetlands in successional transition between herbaceous wetlands and forested wetlands (FNI, 2003a). Dominant shrubs include eastern false-willow (*Baccharis halimilifolia*), deciduous holly, and buttonbush (*Cephalanthus occidentalis*). Trees include overcup oak, willow oak, loblolly pine (*Pinus taeda*), and red maple (*Acer rubrum*). Vines include green briar, wisteria (*Wisteria* spp.), blackberry (*Rubus sp.*), and pepper vine (*Ampelopsis arborea*). Soft rush (*Juncus effusus*), American snowbell (*Styrax americana*), lizard's tail, sedges, and smartweed dominated the herbaceous species present.

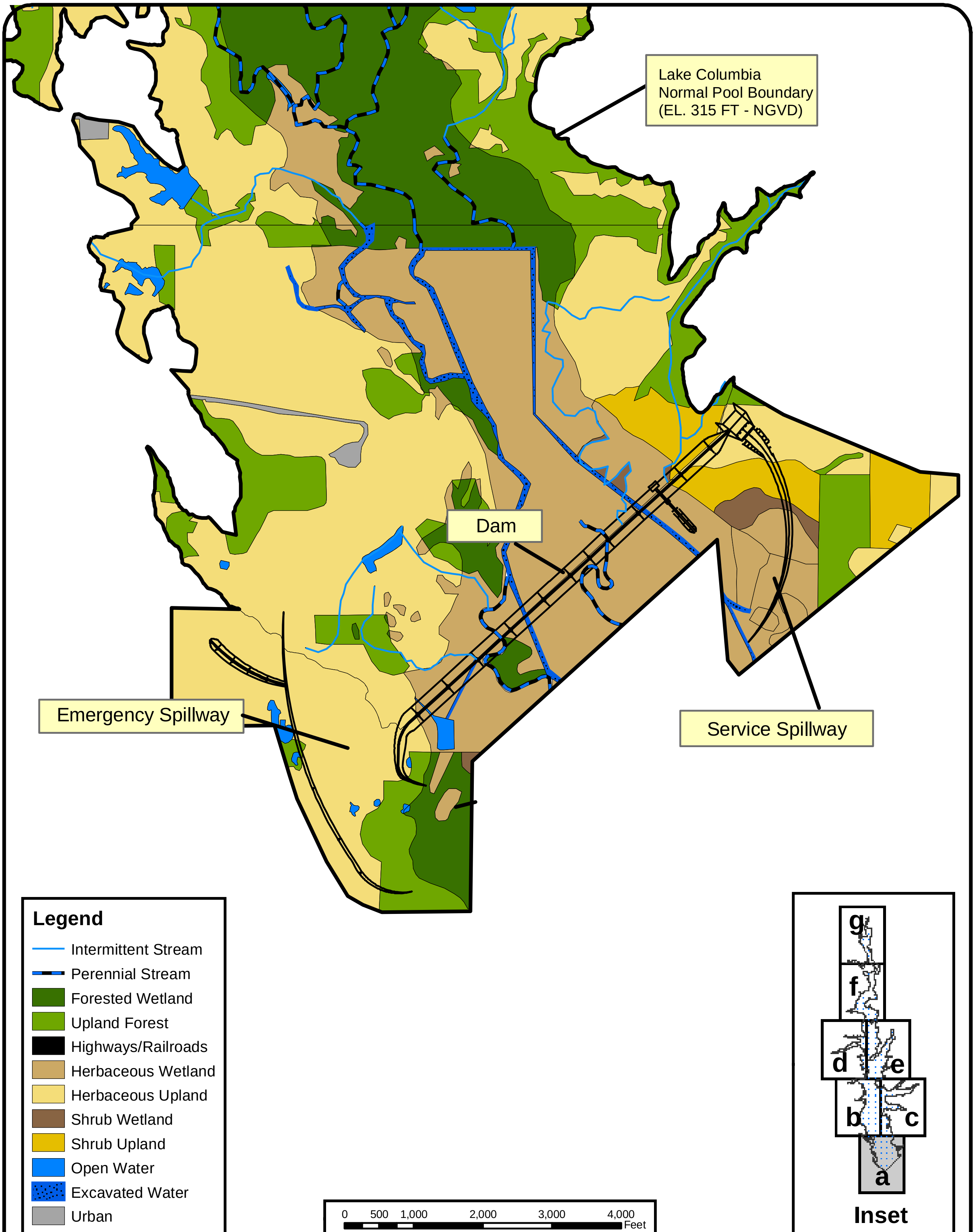
Riverine

Emergent, floating, and submergent aquatic vegetation is noticeably absent from the Mud Creek channel (FNI, 2003a). Vegetation overhanging the stream channel is likely to include herbs and grasses such as sedges, smartweed, and Indian sea-oats (*Chasmanthium latifolia*). Common tree and shrub species include planer-tree (*Planera aquatica),* water oak, swamp privet (*Forestiera acuminata*), and water tupelo (*Nyssa aquatica*).

As noted on Figure 4.8.1-1a, some lengths of Mud Creek are identified as Excavated Water and others as Perennial Stream by FNI, (2003a). Excavated Waters are areas along the Mud Creek channel that have been previously modified by the land owner.

Lacustrine

Lacustrine areas are areas of open water such as ponds, lakes, and reservoirs not dominated by vegetation and are at least 20 surface acres in size. There are no lacustrine areas within the Permit Area (FNI, 2003a).



Map Source: FNI, 2003.

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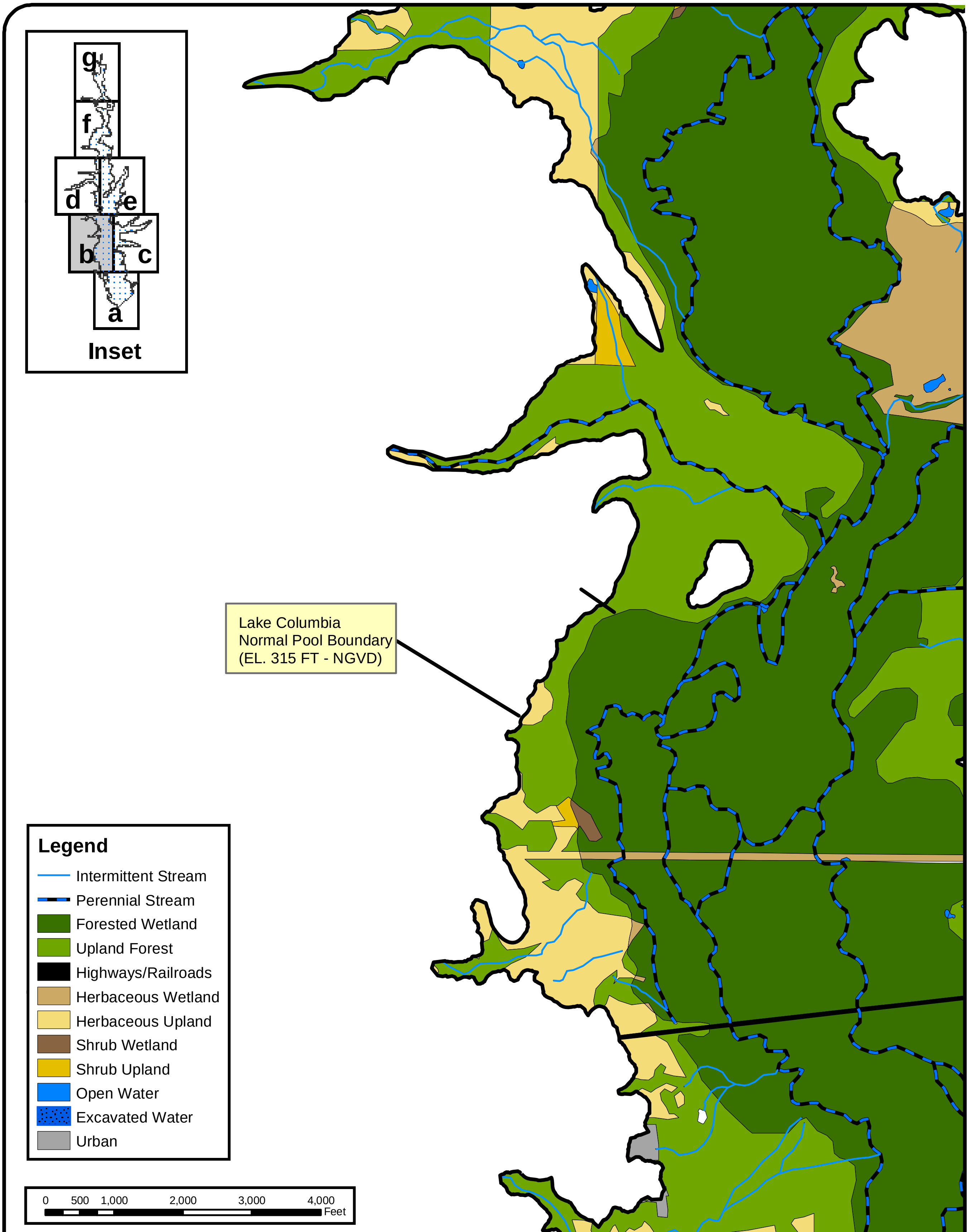
Angelina and Neches River Authority
Proposed Lake Columbia

Vegetation Cover

FN JOB NO	ANR01289
FILE	H:/HEP/ HEP Sites-Cover/8x11/1of7.mxd
DATE	December 6, 2002
SCALE	1:24,000
DESIGNED	BAR
DRAFTED	BAR

FIGURE
4.8.1-1a



Map Source: FNI, 2003.

Angelina and Neches River Authority
Proposed Lake Columbia

Vegetation Cover

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DATE	December 6, 2002
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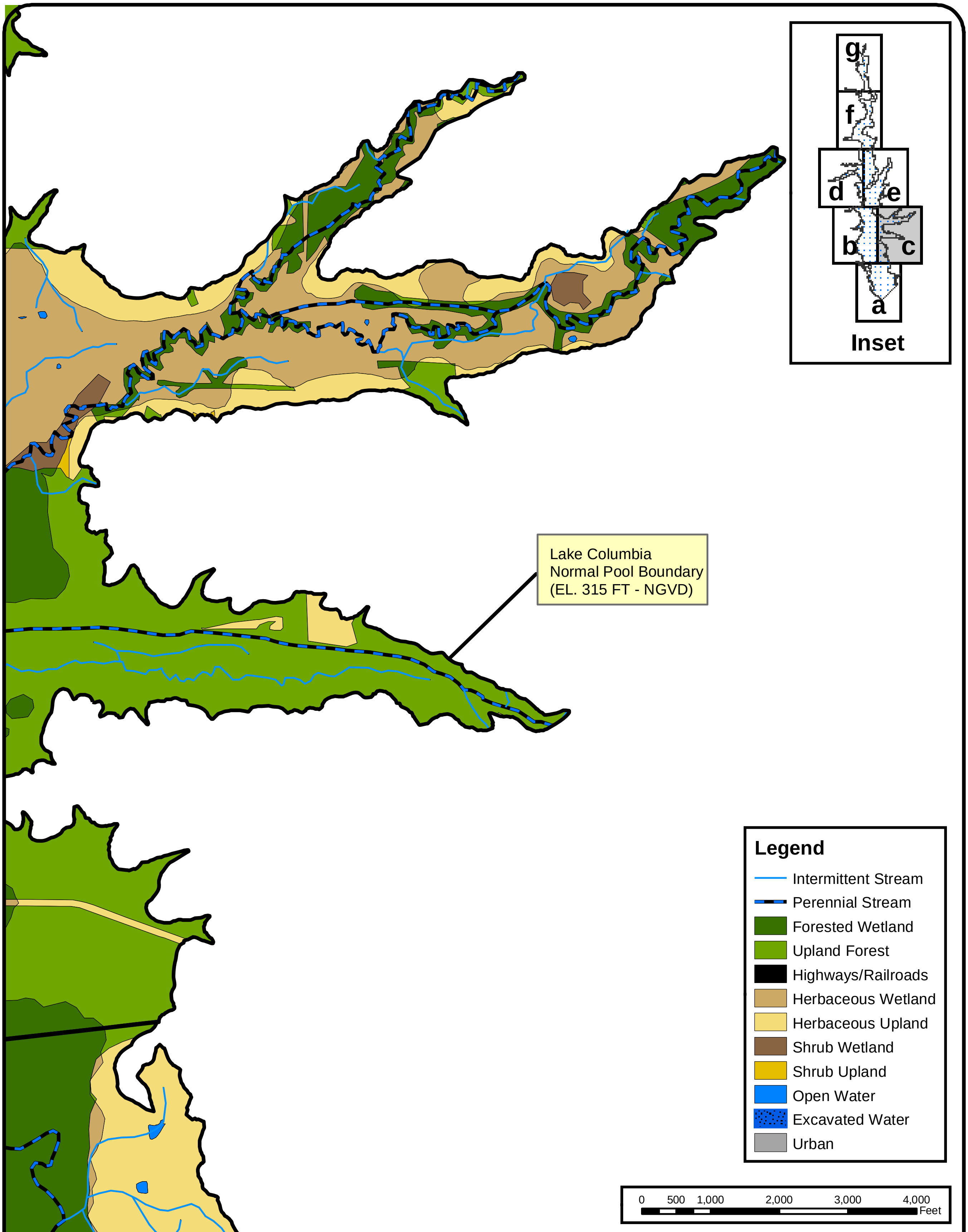
FIGURE 4.8.1-1b



Map Source: FNI, 2003.

Angelina and Neches River Authority
Proposed Lake Columbia

Vegetation Cover

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DATE	December 6, 2002
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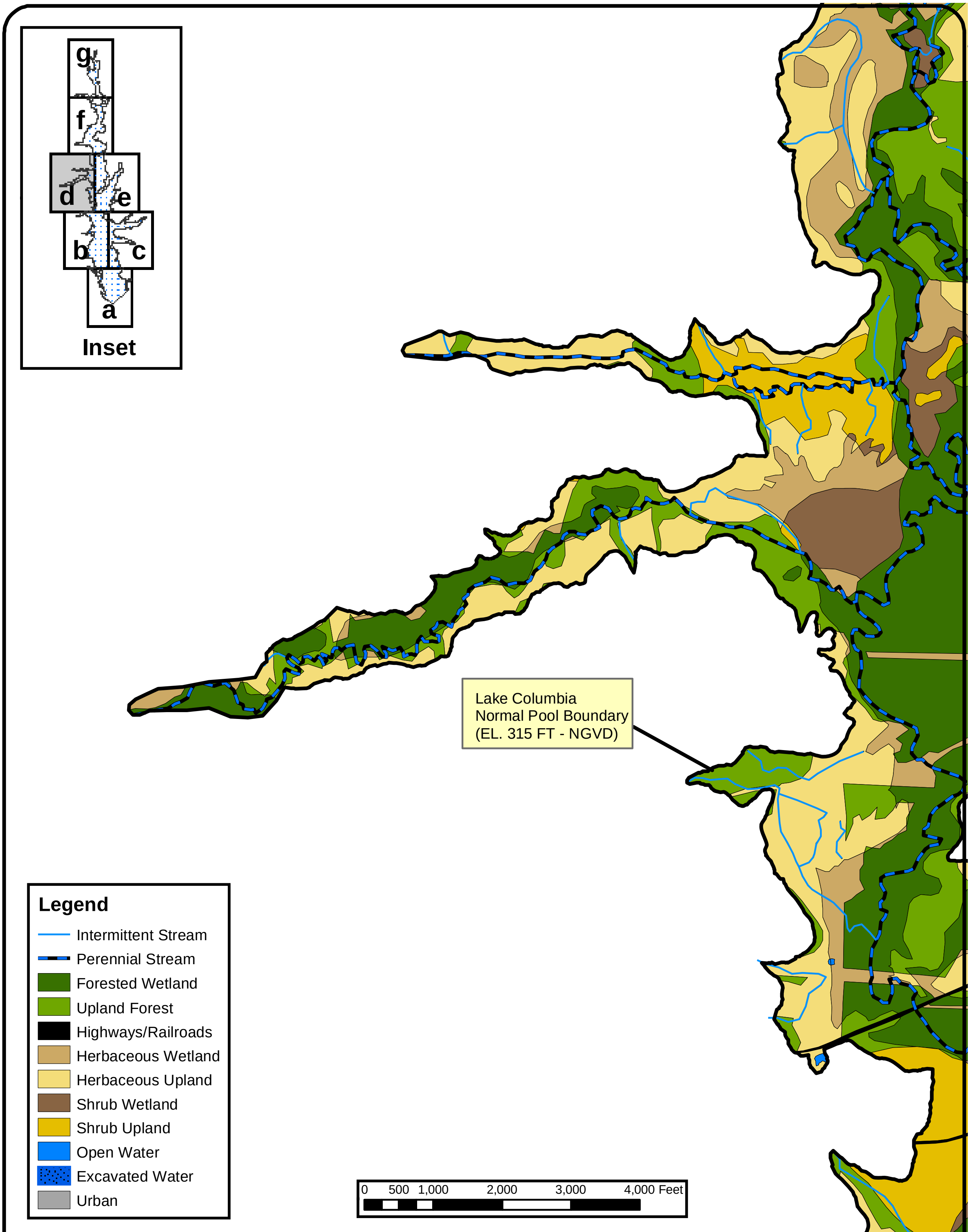
FIGURE
4.8.1-1c



Map Source: FNI, 2003.

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Angelina and Neches River Authority
Proposed Lake Columbia

Vegetation Cover

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DATE	December 6, 2002
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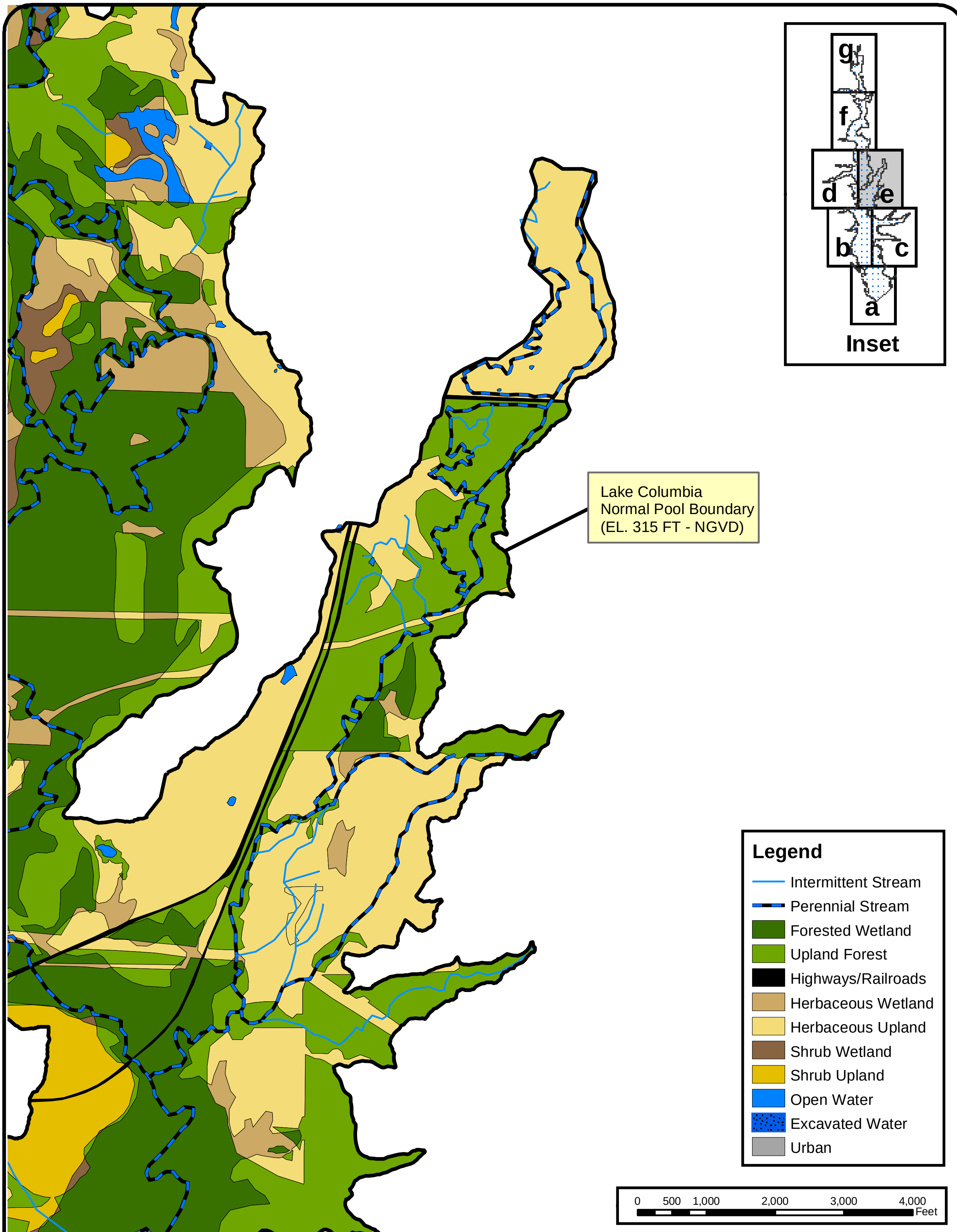
DRAFTED	BAR

FIGURE
4.8.1-1d



Map Source: FNI, 2003.

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Angelina and Neches River Authority
Proposed Lake Columbia

Vegetation Cover

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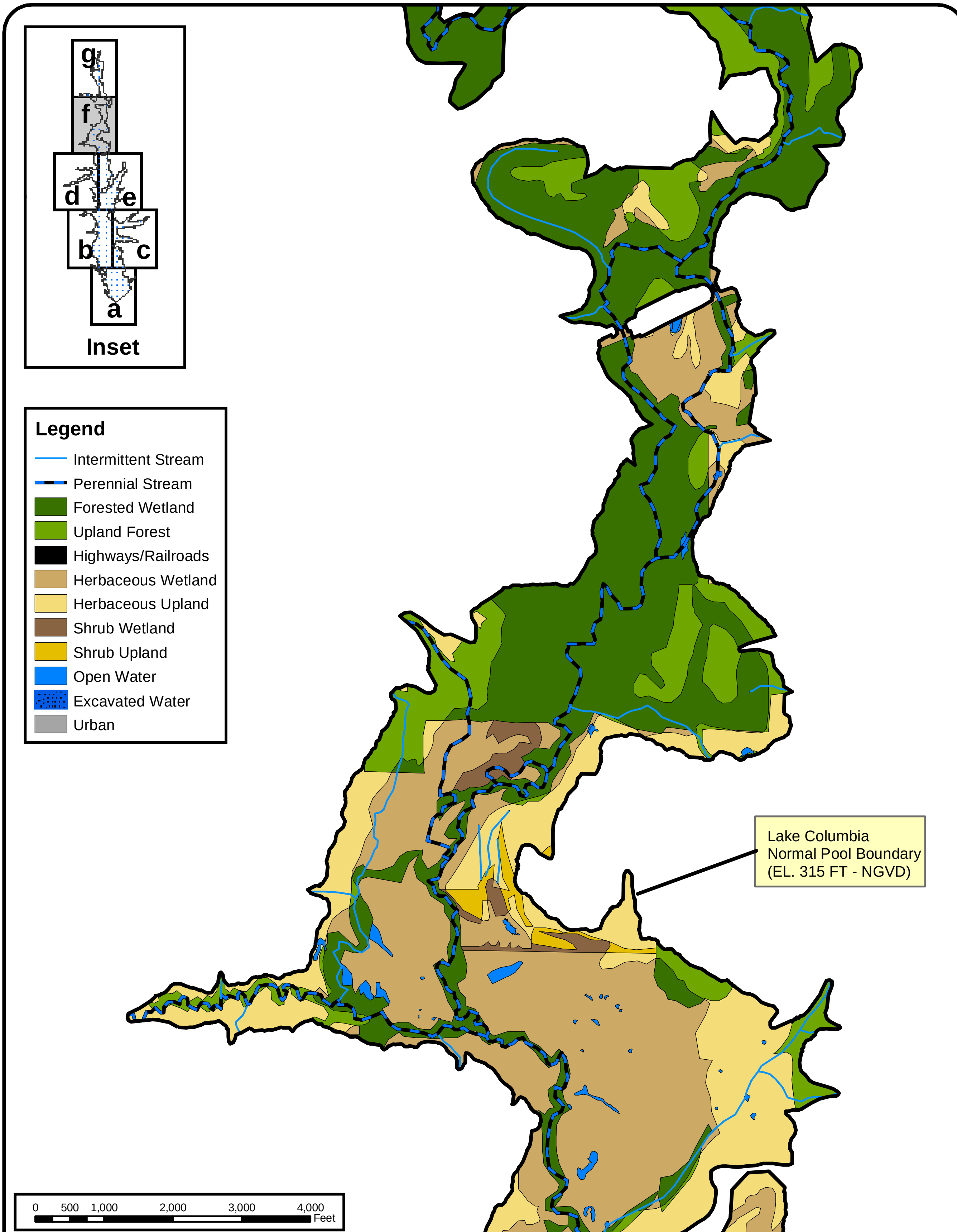
DRAFTED	BAR

FIGURE
4.8.1-1e



Map Source: FNI, 2003.

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Angelina and Neches River Authority
Proposed Lake Columbia

Vegetation Cover

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DATE	December 6, 2002
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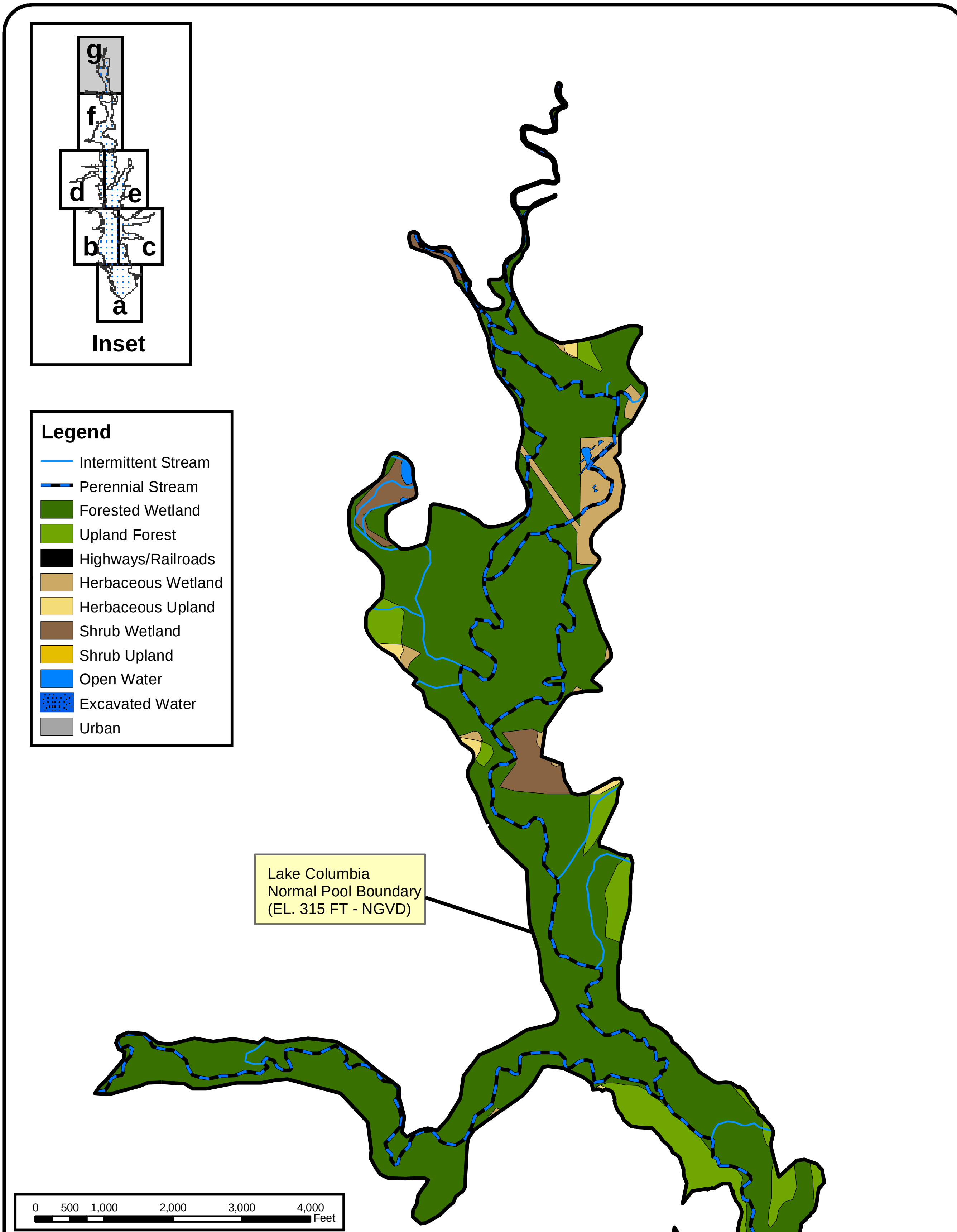
DESIGNED	BAR
DRAFTED	BAR

FIGURE
4.8.1-1f



Map Source: FNI, 2003.

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Angelina and Neches River Authority
Proposed Lake Columbia

Vegetation Cover

FN JOB NO	ANR01289
FILE	H:/HEP/ HEP Sites-Cover/8x11/7of7.mxd
DATE	December 6, 2002
SCALE	1:24,000
DESIGNED	BAR
DRAFTED	BAR

FIGURE
4.8.1-1g

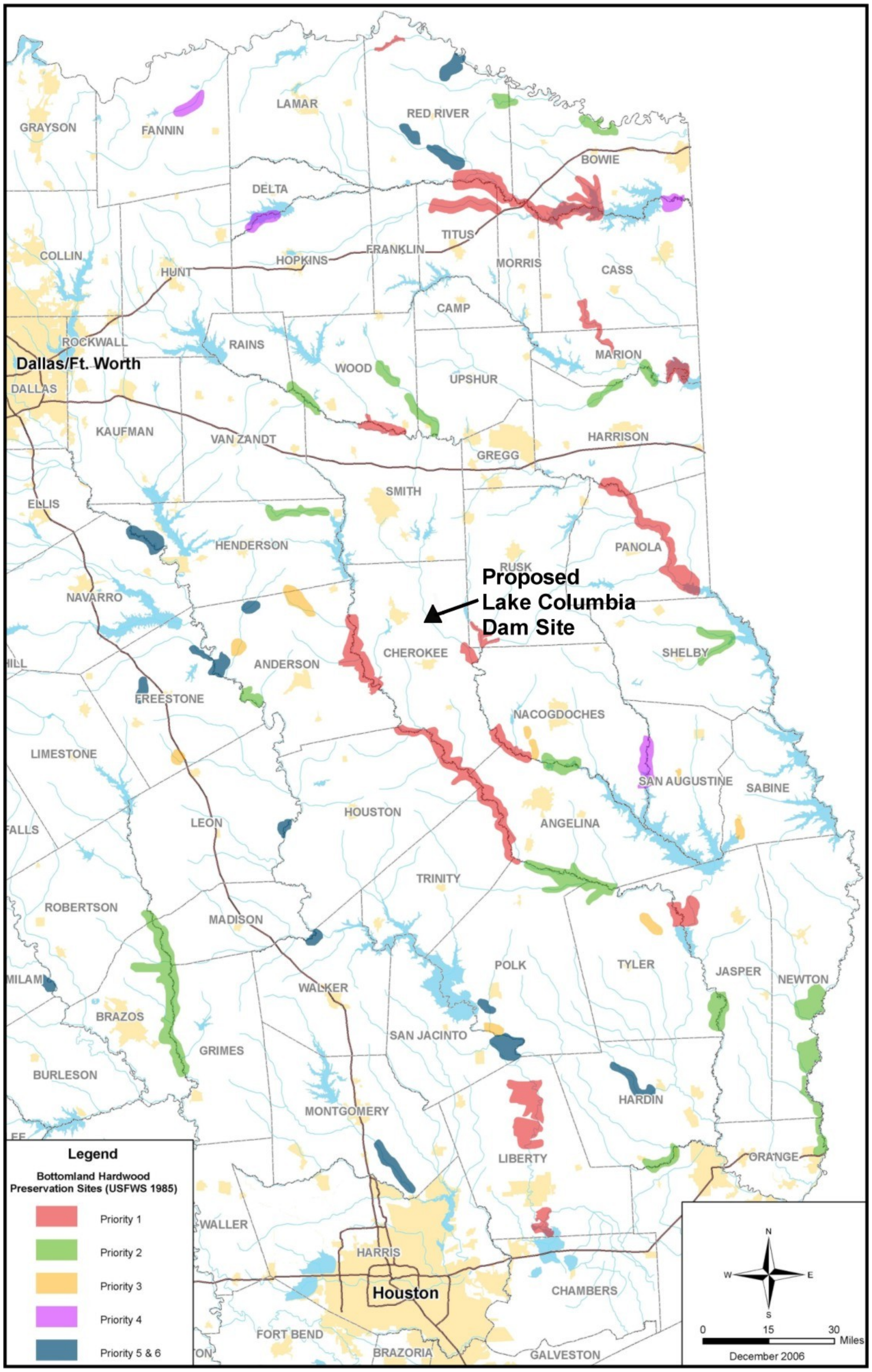


Figure 4.8.1-2 Priority Bottomland Hardwood Sites in Vicinity of the Permit Area

Upland Forest (Deciduous Upland Forest)

Upland forests in the Permit Area are typically mixed hardwood/pine stands with thick sub-canopies of young trees, shrubs, and vines (FNI, 2003a). Dominant tree species include water oak, post oak (*Quercus stellata*), southern red oak (*Quercus falcata*), loblolly pine, short leaf pine (*Pinus echinata*), sweet gum, winged elm (*Ulmus alata*), and eastern red cedar (*Juniperus virginiana*). Common shrub and vine species include common persimmon (*Diospyros virginiana*), American beautyberry, blackberry, Japanese honeysuckle, and green briar. Common herbs include joe-pye weed (*Eupatorium* sp.), corn salad (*Valerianella* sp.), sweet clover (*Melilotus* spp.), and dock (*Rumex* sp.).

Shrubland

Shrubland in the Permit Area represents a midpoint in the successional transition from pasture to forest (FNI, 2003a). Most of the shrub stratum is made up of small trees (e.g., elms, oaks, sweet gum, and pines). Actual shrub species include eastern false-willow (*Baccharis halimilifolia*), sumac (*Rhus coriaria)*, Mexican plum (*Prunus mexicana*), and rusty black-haw (*Viburnum rufidulum*). Common vines include blackberry, honeysuckle, and grape (*Vitis* sp.), and common herbaceous species include sedges, corn salad, rabbit tobacco (*Evax verna*), and sweet clover.

Grassland

Grassland within the Permit Area is generally represented by upland improved Bermuda grass (*Cynodon dactylon*) pastures that have typically followed from forest clearing (FNI, 2003a). Common forbs include nettles (*Solanum* sp.), yankeeweed (*Eupatorium compostifolium*), corn salad, and goldenrod.

Urban

The urban cover type within the Permit Area is associated with private residences and/or support facilities for rural agricultural activities.

4.8.1.1.3 Harmful Invasive Aquatic Plant Species

Several plant species are determined to be potentially harmful due to their invasive nature. These plants are both native and exotic. Some of these species can be particularly harmful in large reservoirs and are difficult to control once established, such as hydrilla, Eurasian watermilfoil, and water hyacinth. It should be noted that these species have been classified as prohibited species by the Texas Parks and Wildlife Department in Texas which regulates the possession and dissemination of these plants. However, these species may be disseminated by non-intentional means such as floods, wildlife, and accidental transport on recreational watercraft and trailers. Table 4.8.1-2 presents a list of the invasive aquatic plant species in Texas.

Table 4.8.1-2 Invasive Aquatic Plant Species in Texas

Common Name	Family	Species
Giant Duckweed	Lemnaceae	*Spirodela oligorhiza*
Salvinia	Salviniaceae	*all species of genus Salvinia*
Giant Salvinia	Salviniaceae	*Molesta spp.*
Water Hyacinth	Pontederiaceae	*Eichhornia crassipes*
Water Lettuce	Araceae	*Pistis stratiotes*
Hydrilla (Florida Elodea)	Hydrocharitaceae	*Hydrilla verticillata*
Lagarosiphon (African Elodea)	Hydrocharitaceae	*Lagarosiphon major*
Eurasian Watermilfoil	Haloragaceae	*Myriophyllum spicatum*
Alligatorweed	Amaranthaceae	*Alternanthera philoxeroides*
Rooted Water Hyacinth	Pontederiaceae	*Eichhornia azurea*
Paperbark	Myrtaceae	*Melaleuca quinquenervia*
Torpedograss	Gramineae	*Panicum repens*
Water Spinach	Convovulaceae	*Ipomoea aquatica*

These species can cause significant economic and ecological problems if they become established. Submergent species such as Eurasian watermilfoil and hydrilla can cause problems with clogging boat motors and water intakes. Floating aquatics such as water hyacinth, water lettuce, and giant salvinia can cause water quality problems by excessive shading of the water column and reduction of dissolved oxygen in addition to clogging water intakes and boat motors.

The control of these species is often very difficult once they become established. The Texas Parks and Wildlife Department has been increasing public awareness of these species and providing education on means of prevention of introduction. Signs at public boat ramps, camping areas, and other lake access points provide useful means of public education. Efforts are also being made in Texas to attempt to eradicate some of these species, such as giant salvinia. Development of triploid grass carps has been aimed at control of submerged aquatics such as hydrilla and Eurasian watermilfoil. ANRA in cooperation with Texas Parks and Wildlife Department would implement a public education program on Lake Columbia at all public boat ramps and lake access points.

These species are individually discussed below.

Giant Duckweed - Spirodela oligorhiza

Giant Duckweed is also called duck-meat, large duckweed, or common duckmeat. Giant duckweed is one of the largest of several types of duckweed. It floats on small ponds and quiet backwaters of bayous and streams. In small ponds giant duckweed may produce dense growths that may block light need by more desirable aquatic plants. It may produce growths thick enough to block access by wildlife and livestock.

Salvinia, Giant Salvinia - all species of genus <u>Salvinia</u> and <u>Molesta</u> spp.

Salvinia, also called water fern, is a small, aquatic fern that floats at the surface with a hairy root-like leaf dangling below. The leaves of young plants lie flat on the water surface; as the plants mature and form mats, the leaves are folded and compressed into upright chains. Salvinias are found in fertile, quiet-water areas in ponds and bayous. Giant salvinia has caused severe economic and ecological problems in many countries including New Zealand, Australia and South Africa. Texas is aggressively working to eradicate Giant Salvinia.

Water Hyacinth, Rooted Water Hyacinth - <u>Eichhornia crassipes, Eichhornia azurea</u>

Water hyacinth has smooth-edged leaves of dark green which project above the water surface. Feathery roots dangle below or are rooted into the substrate. Floating water hyacinth has nearly circular or elliptical leaves that are up to eight inches long. Water hyacinth is often sold for use in ornamental ponds. It can also be used as a component of animal feeds and for natural agricultural fertilization. It has recently been found to absorb a variety of toxins and heavy metals and has come into use for water purification. Water hyacinth is prohibited in Texas, and although exemptions for use in water purification have been incorporated into the Texas Parks & Wildlife regulations, exemptions are not likely to be granted for ornamental ponds.

Water Lettuce - <u>Pistis stratiotes</u>

Water lettuce is also called water bonnet. Water lettuce floats on quiet ponds, lakes and bayous. It prefers soft, acid waters and is cold sensitive. It is occasionally sold in the pet trade. Water lettuce can completely cover ponds, bays and small lakes blocking access and shading out more desirable aquatic plant species. Aquarium plants sold as water lettuce are more likely to be broad-leafed water sprite, *Geratopteris sp.* (unrestricted) than *P. stratiotes*.

Hydrilla (Florida Elodea) - <u>Hydrilla verticillata</u>

Hydrilla, commonly known as Florida elodea, is also called star vine or oxygen plant. It has also been called *Serpicula verticillata, H. alternifolia* and *H. dentate.* The exact number of species in the genus is unclear. Hydrilla often floats at the surface where it forms dense mats. It can survive under a variety of conditions including shade, brackish water, and in either still or flowing water. Hydrilla grows so rapidly that it crowds or shades more desirable aquatic plants. Hydrilla is easily confused with *Elodea spp.* (which is not restricted) and *Egeria densa* (which is restricted).

Lagarosiphon - <u>Lagarosiphon major</u>

Lagarosiphon is also called African elodea. It is sometimes listed as *L. muscoides* var. major and incorrectly as *Elodea crispa.* Lagarosiphon is very similar in appearance to elodea *Elodea spp.* and hydrilla *Hydrilla verticillata.* Lagarosiphon occurs in still-water lakes and ponds or in flowing streams or rivers. It outcompetes native aquatic plants and poses many of the same problems as hydrilla. There are many species of *Lagarosiphon* but only *L. major* is prohibited in Texas. Because the differences between many of these species are unclear, care should be taken in concluding that a specimen in question is actually *L. major.*

Eurasian WatermilFoil - Myriophyllum spicatum

Eurasian watermilfoil is also known as European watermilfoil and fox-tail. It is often confused with parrot's feather, *Myriophyllum aquaticum*, another non-native milfoil introduced through the aquarium plant trade. Unlike some native milfoils, this species tolerates brackish water to about 12-13 ppt salinity (roughly 1/3 sea water). It requires high light levels for good growth. Eurasian watermilfoil was introduced through the pet trade. There are many species of watermilfoils sold in the pet trade, but only *M. spicatum* is prohibited in Texas. Identification of watermilfoil species can be very difficult; plants growing under poor conditions or which are not flowering may be difficult or impossible to identify. Eurasian watermilfoil may be confused with other species of watermilfoil found in Texas.

Alligatorweed - Alternanthera philoxeroides

Alligatorweed is also called chaff-flower. It has also been known as *Achyranthes philoxeroides* and *Thelanthera philoxeroides*. Alligatorweed has long, tangled mats which often root from the joints (nodes). Alligatorweed grows in still lakes or flowing streams or rivers; it grows in fresh or brackish water with more salinity tolerated in flowing water situations. It may grow rooted to the bottom, in floating mats, or on dry land. Alligatorweed may form dense mats that block access to water and boat traffic. Several other emergent aquatic plants that may be mistaken for Alligatorweed include *Ludwigia spp., Lysimachia spp., Lythrum spp., Dianthera spp.* and *Polygonum spp.* These plants are smaller in size and have different flower types.

Paperbark - Melaleuca quinquenervia

Paperbark is an Australian tree that may reach over 50 feet in height, rarely 75 feet, but is often found growing as a shrub or smaller tree. Paperbark seedlings germinate in shallow water or damp ground and can form dense thickets, blocking access to water and wetland areas. Native vegetation may be rapidly displaced by paperbark thickets. Paperbark has been planted as a windbreak to protect agricultural crops as an ornamental tree or shrub. It may be frequently be found for sale at garden centers.

Torpedograss - Panicum repens

Torpedograss is a stemmed (up to 28 inches or more) grass arising from nodes or horizontal rhizomes. Torpedograss grows along stream or lake margins in damp soil. Growth is rapid and invasive, and plants may form floating mats extending out into open water. It may also be found in completely terrestrial settings. Torpedograss grows rapidly and attains noxious levels quickly. It is extremely difficult to eradicate. Torpedograss is commonly confused with other panic grasses, particularly *Panicum hemitomon*.

Water Spinach - Ipomoea aquatica

Water spinach is also called aquatic morning glory. Water spinach is a herbaceous vine, but is not twining or climbing as is typical of most other morning glories. Water spinach may grow in water or soggy soil in low-land marshes and along stream and river banks. The hollow stems may float in water or extend over muddy banks. It grows rapidly and can quickly cover the surface of an entire body of water. Water spinach is not cold-tolerant and unlikely to overwinter in North Texas.

4.8.1.2 Environmental Consequences

4.8.1.2.1 No Action Alternative

Under the No Action alternative, adverse effects to the vegetation and wildlife communities of the Permit Area would not occur. No direct impacts to vegetation would occur in forested areas left unmanaged. Any substantive change would focus on the possibility of other land development projects independent of the proposed surface-water supply Project.

The area would continue to experience changes primarily related to commercial forestry, clearing or vegetative management for cattle ranching, oil and gas development, and local recreation related to hunting and fishing. Trends in other portions of rural eastern Texas are generally cyclic toward conversion from forested land to grazing or improved pasture, and then back to forested land depending on state and national agribusiness trends and opportunities, which is expected to be the same for the Permit Area. As discussed in Section 4.11 Land Use, timber harvests in the Five-County Area have generally increased since 1980. This trend would be expected to continue.

Trends in land management practices toward pine plantations, land clearing, and the introduction of improved grasses and legumes generally results in reductions in plant species diversity and the local abundance of native plant species. These attendant negative effects result in an overall lowering in the species diversity of terrestrial vegetation through time.

4.8.1.2.2 Proposed Action

Construction

During construction, adverse effects to local off-site vegetation may occur as a result of fugitive dust emissions from construction machinery and worker traffic along unpaved roads. Such fugitive dust emission may blanket local vegetation, thereby reducing the photosynthesis capabilities of affected vegetation. Such adverse effects would not be dissimilar to local timbering activities. Measures such as water sprinkling would be employed during construction activities to reduce the airborne emission of particulate matter. Potential adverse effects to vegetation are expected to be localized and of short-term duration.

Surface-water runoff and sediment from areas disturbed by Project construction activities could impact local vegetation related to erosion of exposed soils and subsequent sediment transport off site.

Construction of the proposed Lake Columbia would result in elimination of a variety of vegetation cover types (and wildlife habitat) within the proposed 10,655.5-acre Permit Area through the construction of the dam and/or inundation upon water impoundment. Overall, the most significant of these adverse effects would be upon 5,746.5 acres of waters of the U.S. of which 5,351 acres are wetlands. Of the total waters of the U.S. within the Permit Area, approximately 220 acres would be affected by construction of the dam, and the remaining 5,526 acres would be inundated by water impoundment (FNI, 2003a). The forest resources, which comprise approximately 5,800 acres, would be unavailable for harvest.

Operation

Construction and operation of the proposed reservoir may result in indirect adverse effects to vegetational cover outside of the immediate Permit Area. Potential adverse effects may be brought about by recreational, residential, and/or commercial development along the shoreline of the proposed reservoir.

Mitigation

To minimize potential indirect adverse effects, ANRA has adopted Water Quality Regulations in addition to its Mitigation Plan for the direct loss of vegetation and wildlife habitat. ANRA's Water Quality Regulations are discussed in Section 4.5.2.2 and the full regulations are contained in Appendix D. Detailed descriptions of ANRA's Mitigation Plan are provided in Section 3.3.4.3, and the plan is contained in Appendix C.

Surface-water runoff and sediment from areas disturbed by Project construction activities must be controlled to minimize any adverse affects to local vegetation related to erosion of exposed soils and subsequent sediment transport to local drainages. Pursuant to the requirements of the TCEQ, a Storm Water Pollution Prevention Plan (SWPPP) must be strictly followed during construction (see Section 4.5.2). The SWPPP would designate specific erosion control measures to be employed at various construction sites within the Permit Area as mitigation to control surface water runoff from disturbed areas.

4.8.1.2.3 Toledo Bend Pipeline Alternative

Under the Toledo Bend Pipeline alternative, vegetation along the 86-mile pipeline right-of-way, the intake structure at Toledo Bend Reservoir, the pump stations, and the terminal reservoir at the delivery point would potentially experience varying degrees of adverse impacts. The exact locations of the intake structure site, pump station sites along the pipeline route, and terminal reservoir site are currently unknown. The terminal reservoir could be anywhere near the proposed Lake Columbia site. An approximation of miles of pipeline traversing environmental features and related acreages assuming a 100-foot construction right-of-way as compared to these same features affected by the proposed Lake Columbia Project is provided in Table 3.4-1.

Approximately 73 miles of the pipeline right-of-way from Toledo Bend Reservoir would parallel and/or partially fall within existing state and county roadway rights-of-way while approximately eight miles of the route would pass through cities along its length. Approximately five miles of pipeline would run cross country to the terminal reservoir within the Permit Area.

Assuming a 100-foot construction right-of-way and a 50-foot permanent operation right-of-way, approximately 1,042 acres and 521 acres, respectively, could be adversely impacted by the pipeline. Approximately 10 acres required for the Toledo Bend Reservoir intake structure and pump stations along the pipeline right-of-way, and a few hundred acres for the terminal reservoir at the delivery point would also be directly impacted.

The pipeline would cross through Sabine National Forest. The U.S. Forest Service (USFS) feels significant additional right-of-way would actually be required through Sabine National Forest for a pipeline of that size (Stover, 2007). Assuming a 100-foot wide pipeline construction right-of-way, approximately 160 acres along 13 miles of national forest land would be potentially impacted, including the conversion of some forested wetlands to herbaceous. Moreover, Stover (2007) concluded the construction could result in the removal of more than 60 acres of mature timber, which would require an authorization from the USFS, for which they stated that an EIS would likely be required Mitigation would be required for loss of publilc lands and forested wetlands.

4.8.1.3 Cumulative Effects

The current vegetational composition in the Permit Area is greatly dependent on climatological factors, soil types, topography, and historic land usage, e.g., forestry practices over the past 50 to 100 years. The current vegetational cover types in the Permit Area comprise bottomland hardwood forest (deciduous forested wetlands) 34.6%, herbaceous wetlands 14.2%, shrub wetlands 1.4%, upland forest (deciduous upland forest) 21.1%, shrub upland 2.2%, and grassland 22.3%. Dominant tree species for bottomland hardwood forests and upland forests are identified above, along with wetland obligates, common forbs, dominant shrubs, herbs, vines, and grasses associated with the other vegetative cover types. Information is also included on 13 invasive aquatic plant species in Texas. A modest future monitoring program may be needed to confirm the presence of any of these species in the proposed Lake Columbia. Such a program could become part of an overall aquatic ecosystem monitoring program.

The No Action alternative would not cause any direct adverse effects to the vegetative cover types in the Permit Area. Accordingly, no specific analysis of cumulative effects from other actions was conducted. However, it should be noted that the vegetative types in the Permit Area could change as a function of future land uses.

The construction phase of the Proposed Action would cause the loss of the vegetative cover types in the Permit Area. Adverse effects to nearby cover types could also occur as a consequence of construction dust. These effects would be localized and of short duration.

The operational phase of the Proposed Action could result in additional losses or changes to vegetation in the Shoreline Development Area and in the upper and downstream Mud Creek watersheds. Continuing actions from past and present actions could add to vegetation losses in these areas. Table 3.3-5 includes the following continuing actions which could contribute to such vegetation losses – southeasterly urbanization of Tyler, timber production via logging, and oil and gas production. Conversion of additional lands to agricultural uses could also contribute to vegetation losses. Timber production via logging operations could be a moderate relative contributor to vegetation losses; the other listed continuing actions are considered to be low relative contributors. Although not identified in Table 3.3-6, future shoreline developments around the complete Lake Columbia Project as shown in Table 3.3-7 could also contribute to local area vegetation losses.

ANRA has made commitments to two programs which should in part minimize vegetative losses in the Shoreline Development Area. One involves various land purchases and land use control measures to be accomplished within the adopted Lake Columbia Water Quality Regulations (Appendix D). ANRA’s Mitigation Plan also includes features that would facilitate mitigation (Appendix C).These measures and how they will enhance mitigation are discussed in detail in Section 3.3.4.3.

The Toledo Bend Pipeline alternative would cause adverse effects to, or losses of, vegetation along the 86-mile route and within the terminal storage reservoir area. Pipeline completion procedures, including replanting, would render the vegetative losses as temporary, although it is likely that different vegetation would replace what was lost in many areas. No detailed study of other actions which would contribute to cumulative effects on vegetation was conducted.

4.8.2 Wildlife

The following section describes wildlife species and their associated habitat as reported to occur within the Permit Area. Some wildlife species within the Permit Area utilize both terrestrial and aquatic habitats during their life histories. Animal species which rely solely on aquatic habitat within the Permit Area are described in Section 4.8.3 Aquatic Biology.

4.8.2.1 Affected Environment

4.8.2.1.1 Regional Overview

The proposed Project and its five-county service area are within the Austroriparian Biotic Province (Blair, 1950). This province includes the Gulf Coast Plain from the Atlantic Coast to eastern Texas, corresponding generally with the Pineywoods Vegetational Area (Gould, 1975).

4.8.2.1.2 Permit Area Wildlife by Associated Habitat

Bottomland Hardwood Forest (Deciduous Forested Wetlands)

This habitat type is situated along slopes and lowlands bordering Mud Creek and its tributaries. Cover is young to mature hardwood forest with many mast and fruit producing species. Understory and ground cover habitat structure are usually limited due to the dense overstory. The highly variable hydrologic regime of this habitat ranging from mesic to hydric, along with it being frequently associated with aquatic habitats, provides excellent habitat diversity. Characteristic fauna of bottomland hardwoods are white-tailed deer, (*Odocoileus virginianus*), fox squirrel (*Sciurus niger*), gray squirrel (*Sciurus carolinensis*), swamp rabbit (*Sylvilagus aquaticus*), raccoon (*Procyon lotor*), beaver (*Castor canadensis*), three-toed box turtle (*Terrapene Carolina*), western cottonmouth (*Agkistrodon piscivorus*), ground skink (*Leiolopisma laterale*), green anole (*Anolis carolinensis*), fence lizard (*Sceloporus undulates*), green tree frog (*Hyla cinera*), gray tree frog (*Hyla chrysoscelis*), gulf coast toad (*Bufo valiceps*), barred owl (*Strix varia*), hairy woodpecker (*Dendrocopos villosus*), downy woodpecker (*Dendrocopos pubescens*), wood thrush, (*Hylocichla mustelina*), and wood duck (*Aix sponsa*). Signs of white-tailed deer, bobcats (*Lynx rufus*), and raccoons are common in the bottomlands of the Permit Area, and common avian species include pileated woodpecker (*Dryocopus pileatus*), eastern-tufted titmouse (*Parus bicolor*), wood duck, Carolina wren (*Thryothorus ludovicianus*), red shouldered hawk (*Buteo lineatus*), and yellow-crowned night heron (*Nycticroax violaceus*) (FNI, 2003a).

Herbaceous Wetlands

Herbaceous wetlands (hydric habitats) typically exhibit a relatively high species diversity and habitat structure. These areas may also be associated with aquatic habitats (ponds and streams), thus increasing habitat diversity. Typical wildlife inhabiting herbaceous wetland areas include raccoon, beaver, cricket frog (*Acris crepitans*), spring peeper (*Hyla crucifer*), Strecker's chorus frog (*Pseudacris streckeri*), southern leopard frog (*Rana utricularia*), green anole, western cottonmouth, water snake (*Nerodia erythrogaster*), great blue heron (*Ardea herodias*), snowy egret (*Leucophoyx thula*), and red-winged blackbird (*Agelaius phoeniceus*). Marsh wrens (*Cistothorus palustris*), common yellow throats (*Geothlypis trichas*), and turkey (*Meleagris galopavo*), along with beaver and a variety of frogs, can be found within the herbaceous wetlands of the Permit Area (FNI, 2003a).

Shrub-Scrub Wetlands

Shrub-scrub wetlands are in successional transition between herbaceous wetlands and bottomland hardwood forests. Shrub-scrub wetlands can also be associated with aquatic habitats (ponds and streams), thus increasing habitat diversity. Characteristic wildlife included those occurring in both herbaceous wetlands and bottomland hardwood forests. A variety of songbirds, including yellow-breasted chat (*Icteria virens*), along with evidence of beaver activity have been observed in shrub-scrub wetlands within the Permit Area (FNI, 2003a).

Riverine (Streams and Ponds)

Vegetation communities characterizing streams and ponds are generally distinctive from the other wildlife habitat types (FNI, 2003a). There is typically a combination of woody and herbaceous species of varying structure as well as emergents and submergents. These habitats provide a number of resources for terrestrial wildlife, including watering, feeding, and refugia. They include shallow water and deep water areas of streams and ponds. Ponds may either be man-made or the result of beaver impoundments. A discussion of fish and aquatic invertebrate communities within the Permit Area is provided in Section 4.8.3. Characteristic wildlife associated with streams and ponds are raccoon, opossum (*Didelphis virginiana*), beaver, cricket frog, bullfrog (*Rana catesbeana*), southern leopard frog, red-eared turtle (*Chyrsemys sp.*), snapping turtle (*Chelydra serpentina*), diamond-backed water snake (*Nerodia rhombifera*), western cottonmouth, mallard (*Anas platyrhynchos*), wood duck, great blue heron, and green heron (*Butorides virescens*).

Grassland

The predominant grassland habitat type within the Permit Area consists of improved upland pastures (FNI, 2003a). The improved pastures generally exhibit low species diversity and wildlife habitat structure. Characteristic wildlife of the grassland habitat are nine-banded armadillo (*Dasypus novemcinctus*), eastern cottontail (*Sylvilagus floridanus*), hispid cotton rat (*Sigmodon hispidus*), long-tailed harvest mouse (*Reithrodontomys fulvescens*), plains pocket gopher (*Geomys bursarius*), six-lined racerunner (*Cnemidophorus sexlinatus*), racer (*Coluber constrictor*), painted bunting (*Passerina ciris*), lark sparrow (*Chondestes grammacus*), eastern meadowlark (*Sturnella ma*gna), mockingbird (*Mimus polyglottos*), scissor-tailed flycatcher (*Muscivora forfic*), mourning dove (*Zenaidura macroura)*, bobwhite quail (*Colinus virginianus*), red tailed hawk (*Buteo lineatus*), and turkey vulture (*Cathartes aura*).

Upland Forest (Deciduous Upland Forest)

Upland forests include young to mature forest cover with generally good species diversity and habitat structure. Several hardwood and pine species, shrubs, and herbaceous plants provide cover, forage, mast, and fruit production for wildlife. Characteristic wildlife of the upland hardwood forest habitat type are white-tailed deer, fox squirrel, raccoon, white-footed mouse (*Peromyscus leucopus*), eastern cottontail, three-toed box turtle, green anole, Texas rat snake (*Elaphe obsoleta*), downy woodpecker, red-bellied woodpecker (*Centurus carolinus*), cardinal (*Richmondena cardinalis*), Carolina chickadee (*Parus carolinensis*), Carolina wren (*Thryothorus ludovicianus*), mourning dove, black and white warbler (*Mniotilta varia*), pine warbler (*Dendroica pinus*), and blue jay (*Cyanocitta cristata*). Eastern bluebirds (*Sialia sialis*), pine warblers, tufted-titmouse (*Baeolophus bicolor*), broad-headed and five-lined skinks (*Eumeces laticeps* and *E. faciatus*, respectively), gray tree frogs (*Hyla* sp.), and armadillos (*Dasypus novemcinctus*) have been observed in upland forests within the Permit Area (FNI, 2003a).

Shrub-Scrub Upland

Shrub-scrub uplands represent a successional transition between old field and/or pasture and upland forest. This habitat type may even include recently logged and re-growth forest stands, while in a typically disturbed state, provide a wide variety of habitat conditions for wildlife (FNI, 2003a). The relative openness of the canopy allows for the establishment of shrubs and forbs that provide a large quantity of forage, seeds, and fruits. Characteristic wildlife species inhabiting shrub-scrub uplands include white-tailed deer, raccoon, opossum, eastern cottontail, coyote (*Canis latrans*), six-lined racerunner, green anole, racer, and copperhead (*Akistrodon contortrix*). Bird species observed in this habitat type within the Permit Area included indigo bunting (*Passerina cyanea*), blue grosbeak (*Guiraca caerulea*), red-tailed hawk, cardinal, mourning dove, eastern kingbird (*Tyrannus tyrannus*), and common crow (*Corvus brachyrhynchos*).

Urban

Urban habitat includes areas of intense human development and structural coverage (FNI, 2003a). Urban habitat within the Permit Area is associated with private residences and/or support facilities for rural agricultural activities. Wildlife common to other habitat types in the Permit Area may reside, frequent, and/or pass through this habitat type.

4.8.2.1.3 Recreationally Important Wildlife

Several species of mammals that are of commercial or recreational value within the Permit Area represent a potential economic and recreational resource. Some of these species are considered non-game species by TPWD.

The white-tailed deer is considered by many to be the most important big game mammal in Texas, but within the region of the Permit Area, deer numbers per 1,000 acres exhibited a marked decline from 1984 through 1992, then remained relatively constant through 2003 (TPWD, 2006a).

Bobwhite quail and wild turkey are important game birds over much of Texas, while the mourning dove is the most widespread and abundant game bird in Texas. It is also expected that waterfowl provide a fairly important recreational resource within the Permit Area due to the predominance of bottomland hardwoods.

Fox and gray squirrels are important small game mammals over much of the eastern half of Texas. Rabbits (e.g., cottontail and swamp rabbit), although not strictly defined as game animals, are hunted throughout Texas and are relatively abundant in either upland or bottomland forest habitats.

Furbearers (e.g., raccoon, opossum, gray fox, coyote, striped skunk, beaver, bobcat, and mink) are of some economical and recreational importance in Texas. A very low percentage of the furbearing animals harvested in Texas are taken from the Pineywoods Vegetational Area. Likewise, fur bearers are not expected to be especially numerous within the Permit Area.

The hunting of feral hogs has potential recreational value, but their drastically increasing population also poses a safety risk to both local residents and hunters. Moreover, the relatively uncontrolled growth in their populations has proven to be extremely destructive to both agricultural crops and native wildlife habitats. A large number of feral hogs and evidence of their destructive nature was observed during Horizon's preliminary cultural resources survey of the Permit Area (Owens, 2007). It is unknown if feral hogs provide a recreational hunting resources within the Permit Area.

Local benefits of non-consumptive uses (e.g., photographing wildlife, birding, etc.) are expected to be relatively low due to lack of access to the Permit Area, particularly the more remote areas off of the existing roadways. There are no public lands within the Permit Area, and non-consumptive uses of private land owners within the Permit Area are unknown.

4.8.2.1.4 Habitat Evaluation Procedure (HEP)

A Habitat Evaluation Procedure (HEP) is an analysis tool developed by the USFWS to help quantify the effect of human and naturally caused events on wildlife habitat and document the nonmonetary value of affected wildlife resources. The method relies on being able to measure and quantify species habitat characteristics (e.g. vegetation species composition, height of vegetation, frequency of flooding, etc.) that give a value or suitability of a given area for the selected wildlife species. For this analysis, the life requisites (i.e., what the specific animal needs for cover, reproduction, and food) must be quantified, and the habitat variables that meet those needs must be measurable. This analysis can be used to provide an estimate of the quality and quantity of available habitat for all wildlife in general based on a specific analysis of selected species which represent all species. Two general types of wildlife habitat comparison can be made using HEP:

1) the relative value of wildlife habitats at different locations at the same point in time; and
2) the relative quality of wildlife habitats at the same locations at future points in time.

The habitat quality for selected evaluation species is documented with a Habitat Suitability Index (HSI) on a scale of 0.0 to 1.0, with a ranking of 0.0 being unsuitable and 1.0 being optimal habitat. Optimum conditions are those associated with the highest potential densities of selected evaluation species within a defined area. The HSI value obtained from this comparison becomes an index of carrying capacity for a selected evaluation species.

Again, an HSI ranges from 0.0 to 1.0, and each increment of change must be identical to any other. For example, a change in HSI from 0.1 to 0.2 must represent the same magnitude of change as a change from 0.2 to 0.3, and so forth. Therefore, the HSI must be linearly related to carrying capacity which is an operational restriction imposed by the use of HSI in HEP.

HSI values are obtained for selected evaluation species through use of documented habitat suitability models employing measurable key habitat variables. The HSI values are multiplied by the area of available habitat within a given geographic area of analysis (cover types) to obtain Habitat Units (HUs) for selected evaluation species. HUs are then annualized over the life of the Project (100 years for Lake Columbia) to calculate Average Annual Habitat Units (AAHUs). These values are used in the HEP analysis for comparative purposes.

HEP outputs can be used to assess environmental impacts by comparing the AAHUs available to each selected evaluation species in pre-action and post-action scenarios. Additionally, if the areas of certain habitats are to be created or enhanced through mitigation, the effects of such changes can be compared with an unmitigated scenario.

In summary, a HEP analysis is employed to determine quality of wildlife habitat through a consistent means of assessing the effects of a proposed Project on existing habitat by:

1) assigning an HSI value and determining the equivalent HUs and AAHUs for existing habitat conditions for a selected evaluation species;
2) determining the difference between the AAHUs of existing (pre-Project) conditions and conditions that would result from the development of a proposed Project; and
3) demonstrating by the gain or loss of AAHUs represents the beneficial or adverse effects anticipated as a result of the development of a proposed Project.

For assessing mitigation options, both the specific pre-Project conditions of affected wildlife habitat within the boundary of a proposed Project and the quality of wildlife habitat of proposed mitigation lands can be analyzed. This analysis can also lead to identifying opportunities for enhancing habitat quality. By identifying the habitat variable(s) causing a low HSI value, measures can be taken to enhance the variable(s). For example, if the lack of hard mast trees causes low habitat quality, then tree plantings could help improve that particular habitat.

The generalized process for conducting a HEP analysis involves the following components (USFWS, 1980):

1) determine the applicability of HEP and define the study limits;
2) determine habitat or vegetation cover types;
3) define the relevant species for evaluation;
4) determine each species' life requisites, and measure habitat components for suitability;
5) determine baseline and future HUs and AAHUs; and
6) develop compensation/mitigation plans for the proposed Project.

A HEP was performed by a team led by the USACE and comprising USEPA, USFWS, TPWD, TWDB, TCEQ, and Freese and Nichols, Inc. (FNI, 2003a). The HEP Team had oversight of the tasks that were required for the HEP analysis, including defining the study area, delineating cover types, field sampling, and selecting evaluation species. The vegetational descriptions of the various cover types identified within the Permit Area and their typical wildlife species assemblages have been provided in Sections 4.8.1.1 and 4.8.2.1, respectively.

Evaluation species selected for the proposed Project and HSIs for each cover type existing within the Permit Area are presented in Table 4.8.2-1.

Average Annual Habitat Units for each cover type were calculated that provided the basis for the HEP Team's determination of net adverse effects of the proposed Project on wildlife habitat within the Permit Area shown in Table 4.8.2-2. These net losses of wildlife AAHUs for each cover type provide the basis for planning and estimating potential mitigation requirements for compensating existing proposed Permit-Area wildlife habitat functions adversely affected by development of the proposed Project (FNI, 2003a).

The HEP provided an assessment of upland and lowland wildlife habitat within the entire Permit Area. Wildlife habitat is only one ecological function provided by waters of the U.S. and other natural areas within the Permit Area contributing to its overall ecological character.

Table 4.8.2-1 Habitat Suitability Indices by Cover Type

Species	Cover Type						
	Bottomland Hardwood	Upland Forest	Herbaceous Wetland	Grassland	Shrubland	Shrub Wetland	Riverine
Racer	~	~	~	~	1.00	~	~
Eastern Meadowlark	~	~	~	0.71	~	~	~
Eastern Cottontail	~	0.73	~	0.73	0.73	~	~
Swamp Rabbit	0.51	~	0.50	~	~	0.49	~
Green Heron	0.55	~	0.90	~	~	0.90	0.95
Wood Duck	0.68	~	0.68	~	~	0.68	0.68
Belted Kingfisher	~	~	~	~	~	~	0.34
Fox Squirrel	0.69	0.68	~	~	~	~	~
Gray Squirrel	0.69	0.57	~	~	~	~	~
Downy Woodpecker	0.86	1.00	~	~	~	~	~
Barred Owl	0.70	0.65	~	~	~	~	~
Red-tailed Hawk	~	0.84	~	0.84	0.84	~	~
Average HSI Values	**0.67**	**0.75**	**0.69**	**0.76**	**0.86**	**0.69**	**0.66**

Source: FNI, 2003a

Table 4.8.2-2 Net Impacts to Wildlife Habitat Within the Permit Area

Cover Type	Acres Lost	Net Loss *
Deciduous Forested Wetlands	3,652	-2,342
Herbaceous Wetland	1,349	-315
Shrub-Scrub Wetland	133	-702
Riverine	298	-188
Grassland	2,189	-960
Upland Forest	2,182	-1,420
Shrub-Scrub Upland	190	-864
TOTAL	9,993	-6,791

* Average Annual Habitat Units

Source: FNI, 2003a

4.8.2.2 Environmental Consequences

4.8.2.2.1 No Action Alternative

Under the No Action alternative, adverse effects to the wildlife communities of the Permit Area would occur. Any substantive change would focus on the possibility of other land development projects independent of the proposed surface water supply Project. The area would continue to experience changes primarily related to commercial forestry, cattle ranching operations, oil and gas development, and local recreation related to hunting and fishing. Trends in other portions of rural eastern Texas are generally cyclic toward conversion from forested land to grazing or improved pasture, and then back to forested land depending on state and national agribusiness trends and opportunities which is expected to be the same for the Permit Area. Trends in land management practices toward pine plantations, land clearing, and the introduction of improved grasses and legumes generally results in reductions in plant species diversity and the local abundance of native plant species. These attendant negative effects result in an overall lowering in the species diversity of wildlife communities through time.

4.8.2.2.2 Proposed Action

Construction

Construction of the proposed dam and reservoir would eliminate approximately 4,560 acres of upland habitat with the effect of displacing many terrestrial species of wildlife to similar habitats located beyond the Permit Area. Moreover, at normal water level, the construction of the proposed reservoir would also adversely affect approximately 39 miles of intermittent streams and 70 miles of perennial streams and associated existing aquatic habitats along Mud Creek and its tributaries through inundation; thereby, converting existing stream habitat to reservoir (open water) habitat (see Section 4.8.3.2).

ANRA proposes to limit pre-impoundment clearing to the borrow area near the dam and public access areas (see Figure 3.3-2) plus boat lanes extending into six to eight major tributaries of Mud Creek. Each boat lane would be approximately 100 feet wide. Based on experience with other East Texas reservoirs, current land owners may harvest existing timber within the Permit Area prior to land purchase by ANRA.

Species assemblages of terrestrial wildlife in habitats outside of the Permit Area may be adversely affected as a result of exceeding the current, pre-Project carrying capacity of a given habitat, causing potential population shifts into marginal habitats. However, in the long-term, it is expected that these assemblages would again reach their natural equilibrium. An exception to this prediction would be the feral hog population, which is uncontrolled by natural means and is ever expanding. The displacement of feral hogs occurring within the Permit Area to outlying areas could possibly result in a long-term adverse effect on existing wildlife habitat (and agricultural interests) in the immediate region of the proposed Project.

Operation

Wildlife habitat (and related vegetational communities) outside of the Permit Area would likely experience indirect adverse effects from the presence of the proposed Project. As stated above, species assemblages of terrestrial wildlife in habitats outside of the Permit Area may be adversely affected as a result of exceeding the current, pre-Project carrying capacity of a given habitat, particularly with respect to feral hogs.

Based on development patterns observed at other East Texas reservoirs, the proposed Lake Columbia would also attract various levels of residential, commercial, and recreational development along its shoreline and/or immediate proximity. This is discussed in detail in Section 4.11. Impacts of this would be minimized through implementation of ANRA's approved Lake Columbia Water Quality Regulations (Appendix D), as discussed in Section 3.3.4.3. Local benefits of non-consumptive uses (e.g., photographing wildlife, birding, etc.) are expected to greatly increase along with increased public access to the Permit Area brought about by the existence of the proposed reservoir.

Mitigation

In addition to implementation of ANRA's approved Lake Columbia Water Quality Regulations, ANRA proposes to compensate for the remaining impacts to waters of the U.S. and other wildlife habitat within the Permit Area by offering a Mitigation Plan (FNI, 2009b—see Appendix C). The plan and other proposed mitigation measures are discussed in detail in Section 3.3.4.3.

4.8.2.2.3 Toledo Bend Pipeline Alternative

Under the Toledo Bend Pipeline alternative, wildlife along the 86-mile pipeline right-of-way, the intake structure at Toledo Bend Reservoir, the pump stations, and the terminal reservoir at the delivery point would potentially experience varying degrees of adverse impacts. However, impacts to waters of the U.S. would be substantially less than those associated with ANRA's proposal. The exact locations of the intake structure site, pump station sites along the pipeline route, and terminal reservoir site are currently unknown. The terminal reservoir could be anywhere near the proposed Lake Columbia site. An approximation of miles of pipeline traversing environmental features and related acreages assuming a 100-foot construction right-of-way as compared to these same features affected by the proposed Lake Columbia Project is provided in Table 3.3-2.

Assuming a 100-foot construction right-of-way and a 50-foot permanent operation right-of-way, approximately 1,042 acres and 521 acres, respectively, would be affected by the pipeline. Approximately 95 acres of construction right-of-way would occur in urban areas; the remaining right-of-way represents potential wildlife habitat. Approximately 10 acres required for the Toledo Bend Reservoir intake structure and pump stations along the pipeline right-of-way, and a few hundred acres for the terminal reservoir at the delivery point, would also be directly impacted.

The pipeline would traverse the Sabine National Forest. Assuming a 100-foot wide pipeline construction right-of-way, approximately 160 acres along 13 miles of national forest land would be potentially impacted. Stover (2007) concluded the construction could result in the removal of more than 60 acres of mature timber, which would represent high quality wildlife habitat. This would require authorization from the USFS. The USFS has indicated the project has the potential to significantly affect the quality of the human environment. Therefore, an EIS would be required.

The permanent loss of woodlands in the Sabine National Forest and possibly other areas, and impacts to wetlands and other waters of the U.S., may also result in adverse impacts to wildlife during operation of the pipeline.

4.8.2.3 Cumulative Effects

There are numerous terrestrial wildlife species associated with the various habitat types found in the Permit Area. The species listings are organized by the habitat types discussed in conjunction with vegetation in Section 4.8.1. For example, the wildlife species which could be associated with bottomland hardwood forest (35.9% of the Permit Area) include white-tailed deer, fox squirrel, gray squirrel, swamp rabbit, raccoon, beaver, three-toed box turtle, western cottonmouth, ground skink, green anole, fence lizard, green tree frog, gray tree frog, gulf coast toad, barred owl, hairy woodpecker, downy woodpecker, wood thrush, and wood duck. Signs of white-tailed deer, bobcats, and raccoons are common in the Permit Area.

Similar listings of potential Permit Area wildlife, including songbirds, are included above for herbaceous wetlands, shrub-scrub wetlands, riverine areas, grassland, upland forest, shrub-scrub upland, and urban lands.

Information on recreationally important wildlife in the Permit Area, which is focused on white-tailed deer, bobwhite quail, wild turkey, fox and gray squirrels, and furbearers, is also included above.

The Habitat Evaluation Procedure of the USFWS was used to evaluate the current Habitat Units in the Permit Area. The composite 12 evaluation species for the seven cover types included the racer, eastern meadowlark, eastern cottontail, swamp rabbit, green heron, wood duck, belted kingfisher, fox squirrel, gray squirrel, downy woodpecker, barred owl, and red-tailed hawk. The study determined that the average annual losses totaled 6,791 Habitat Units. This information was used by ANRA in developing their Mitigation Plan for the proposed Lake Columbia Project (Appendix C).

Regarding the No Action alternative, adverse effects could still occur on wildlife in the Permit Area. Such effects would likely occur from land use changes over time in the Permit Area. However, no detailed consideration of such potential changes, or effects from other actions, were evaluated relative to cumulative effects.

Construction of the proposed Lake Columbia Project would eliminate 4,594.5 acres of upland habitat, and 5,746.5 acres of wetlands and streams, thus displacement of many wildlife species to other similar habitats beyond the Permit Area would occur. Land use changes outside the Permit Area could also cause displacement or loss of wildlife species.

One example of a continuing action which could affect wildlife in the upper Mud Creek watershed includes the southeasterly urbanization of Tyler (Table 3.3-5). Local land uses in the Permit Area, and local recreational activities involving hunting and fishing in the Permit Area are also noted as having adverse effects on wildlife; however, neither action would be continuing into the future (Table 3.3-5).

During the operational phase of the Proposed Action, wildlife could be subject to indirect adverse effects resulting from land use changes. The Shoreline Development Area would be an example of where potential local changes in land use could occur. Such development would also lead to wildlife displacement.

ANRA has two programs which would in part mitigate wildlife impacts. One program involves the regulation of recreational and commercial activities on and surrounding the proposed Lake Columbia. This program is a component of the Lake Columbia Water Quality Regulations (Appendix D). The second ANRA program, referred to as the Mitigation Plan includes compensation measures for impacts to wildlife habitat and habitat losses in the Permit Area (Appendix C). Both of these programs would aid in reducing potential cumulative effects on wildlife from the Proposed Action and other actions. Specific details on these measures and their relevance with respect to adverse wildlife effects are discussed in Section 3.3.4.3.

The Toledo Bend Pipeline alternative would also have adverse effects on wildlife along the 86-mile pipeline right-of-way and within the terminal storage area. Pipeline right-of-way restoration would reduce the short-term wildlife impacts. High quality wildlife habitat in the Sabine National Forest corridor for the pipeline would be of concern and possibly require a separate EIS. No comprehensive study of the effects of other actions on wildlife related to this alternative was conducted.

4.8.3 Aquatic Biology

4.8.3.1 Affected Environment

4.8.3.1.1 Aquatic Habitat

Mud Creek contains a variety of habitats within its stream systems. These habitats include runs, riffles, and pools. Runs primarily include areas where flow is more noticeable compared to quiet bodies of water. Riffles are shallow, swift, sections of streams. Pools include long, slow-moving bodies of water or stagnated sections of water. Oxbow lakes are also present within this system. The Permit Area contains 370,128 linear feet (255 acres) of perennial stream, 204,864 linear feet (47 acres) of intermittent streams, 14,256 linear feet (30 acres) of channelized Mud Creek, and 63 acres of open water (ponds, oxbows, etc.) (FNI, 2003a).

The Texas Natural Resource Conservation Commission (TNRCC, now TCEQ) conducted a Use-Attainability Analysis (UAA) on Ragsdale, Keys, and Mud creeks located in Cherokee County, and another UAA on Mud and West Mud creeks in Smith County (TNRCC, 1996 and 1999). These studies on Mud Creek were conducted approximately 6-20 miles downstream of Lake Tyler and Lake Tyler East.

A UAA is conducted on water bodies for which aquatic life uses and dissolved oxygen criteria have been established in the Texas Water Quality Standards. The aquatic life use provides a methodology for a ranking system built upon habitat quality, location in the state (ecoregion), and hydrologic stream order (variously 1^{st}- 8^{th}) which allows the scores to be equated based upon these factors. The ranking results in scores forfourseparate categories (Exceptional, High, Intermediate and Limited) without there being a bias as to stream size or location in the state. As such the aquatic life uses for an area are directly meaningful to other areas of the State. At the time of these studies, such determinations had not been made for the subject streams. Therefore, these use attainability analyses utilized protocols for unclassified streams. Before designating the aquatic life use and dissolved oxygen criteria for the stream segments, an Aquatic Life Assessment had to be performed. The purpose of these assessments was to collect and analyze the data to determine the appropriate aquatic life use and associated dissolved oxygen criteria for these stream segments. The analyses performed included sampling to establish the fish and benthic macroinvertebrate assemblages for the stream reaches, physical habitat assessments, dissolved oxygen and other water chemistry parameter measurements and streamflow discharge measurements.

The observed reach for the UAA in Smith County was characterized by gently sloping stable banks with very little erosion. Riparian widths and natural vegetative buffers were extensive throughout the reach with hardwoods and grasses/forbs dominating the composition. Average tree canopy was 82.4% (TNRCC, 1996 and 1999).

The headwaters of Mud Creek arise in Smith County east of the city of Tyler. The Tyler lakes are located on the upper reach of Mud Creek as depicted in Figure 1.1-1. The stream flows in a generally southerly direction through Smith County and then Cherokee County until the confluence of Keys Creek where the stream turns in a more southeasterly direction to the confluence with the Angelina River.

The TNRCC (1999) reported habitat data for Mud Creek in Smith County, but none for West Mud Creek. Habitat quality for Mud Creek was ranked as high but limited somewhat by instream cover and substrate type. Substrate was dominated by mud and sand.

The hydrology in the area was determined to be fairly stable. Increased channel sinuosity, large pools, and stable flows were factors that increased habitat quality in that area of Mud Creek. TNRCC (1996 and 1999) evaluated stream physical habitat characteristics using the Habitat Quality Index. Table 4.8.3-1 presents some of the habitat quality data presented in those studies.

A more complete data set was provided for the 1996 UAA on Mud Creek, Keys Creek, and Ragsdale Creek in Cherokee County. These samples were collected in the vicinity of the proposed dam and represent typical habitat in the vicinity of the proposed Project. Ragsdale Creek is a tributary of Keys Creek, which is a tributary of Mud Creek. The headwaters of Ragsdale Creek arise in the city of Jacksonville, and the stream receives urban runoff from the city in addition to discharges from two city wastewater treatment plants. The headwaters of Keys Creek arise to the north and northeast of the city of Jacksonville and the stream flows in a generally southeasterly direction to the confluence of Ragsdale Creek and then onward to the confluence with Mud Creek. There were no known point source dischargers in Keys Creek upstream of the confluence of Ragsdale Creek, and urban development was minimal. Silviculture and agriculture were the primary land use activities in the watershed.

The entire Mud Creek watershed within Cherokee County is located in Ecoregion 35 – South Central Plains, as defined by Omernik and Gallant (1987). Stream physical habitat characteristics were evaluated in accordance with the Habitat Quality Index (TNRCC, 1999). Habitat quality characteristics at Sites 1 and 2 on Ragsdale Creek indicate that an intermediate quality existed. Ragsdale Creek data indicated a relatively narrow, shallow stream with a gravel substrate containing numerous riffles but small to moderate pool areas. Dissolved oxygen recorded was high at the one station recorded. The station's channel was moderately sinuous, but the banks had poor stability. The setting was rated as common indicating substantial human activity in the areas along the stream. Overall, the stream contained good habitat for a small stream that is subject to fluctuating flows that periodically cause shoreline erosion and tend to remove in-stream cover, possibly reducing the diversity of microhabitats available. Of the two stations sampled, Station 2 was downstream from the Canada Street WWTP, which, aside from water quality considerations, did provide a more stable base flow to that area of the stream.

Habitat quality characteristics of Keys Creek indicated a high quality rank. Keys Creek did produce a high aquatic life use rank based upon the fish and benthic samples. Its sand and gravel produced more microhabitats than Ragsdale Creek even though subject to the same sort of flow fluctuations, bank erosion, and low amounts of in-stream cover. Keys Creek had less human activity impacting the area sampled than did Ragsdale Creek. The sample area was not subject to wastewater treatment plant flow.

Habitat quality of Mud Creek in Cherokee County at U.S. Highway 79 was ranked as intermediate but the Aquatic Life Use ranked as high. Mud Creek in this area is much wider and deeper than either Keys or Ragsdale creeks. Dissolved oxygen readings were good and the flow at the time of sampling was considerably higher than the other streams sampled. The sample reach had a silt bottom, no riffles, and was primarily composed of moderately sized pools connected by runs. Mud Creek is a perennial stream with a 7-day, 2-year low flow (7Q2) of 5.1 cfs established for the period of 1960 to 1979. The data

Table 4.8.3-1
Mud Creek Drainage Habitat Data and Rankings

	Mud Creek at State Highway 110	West Mud Creek	Mud Creek at U.S. Highway 79	Keys Creek	Ragsdale Creek	
					1	2
Aquatic Life Use Rank	High	Intermediate	High	High	Limited/ Intermediate	Intermediate
Habitat Quality Rank	High	Intermediate	Intermediate	High	Intermediate	Intermediate
Substrate	Mud/Sand	Sand/Mud	Silt	Sand/Gravel	Gravel	Gravel
Flow At Sampling (cfs)	5.6	6.2	20.9	0.35	0.11	1.47
Perennial	Yes	Yes	Yes	Yes	NR	NR
Riffles	Yes (2)	No	No	Yes (6)	Yes (11)	Yes (9)
Pools	Yes	Yes	Moderate Size	Small	Small	Moderate
Dissolved Oxygen (ppm)	4.4 avg	4.9 avg	5.6 avg	4.2	6.46	NR
Avg Depth (feet)	1.64	1.5	2.5	0.69	0.85	0.89
Max Depth (feet)	5.2	5.9	3.3	1.5	1.7	4.7
Avg Stream Width (feet)	17.3	71.5	36	9.9	11.2	11.9
Stream Bends	5	4	3	7	3	6
Length of Creek Sampled (feet)	804	620	1108	620	1320	1320

NR = Not reported

Data compiled from TNRCC, 1996 and 1999.

utilized came from a U.S. Geological Survey (USGS) stream flow gage at U.S. Highway 79. The largely pool/run habitat does contain substantial in-stream cover. The smooth, steep banks are relatively stable. The stream in the areas represented by this station was difficult to access and not heavily impacted by humans at the time of the sampling.

4.8.3.1.2 Fish and Benthos

The entire Permit Area as well as the downstream reach to the confluence with the Angelina River is located within the Austroriparian Biotic Province (Blair, 1950). East Texas lies at the western edge of this biotic province, which extends easterly over the Gulf Coastal Plain to the Atlantic. However, there are numerous fish species whose range includes both the Austroriparian and the transitional Texan Biotic Province to the west. A number of species range throughout several provinces often along major river systems, and some species range across Texas regardless of province or river boundaries. Some of these distributions are explained due to transplanted populations (Hubbs, 1957).

According to Lee et al. (1980) and Hubbs et al. (1991), at least 84 species of fish have habitat ranges that include the Permit Area. Table 4.8.3-2 provides the scientific and common names of those species. Table 4.8.3-2 also lists 46 species listed as collected in the Permit Area by Elottage and Moulton (1998), TNRCC (1996 and 1999), and TWC (1988).

Table 4.8.3-3 presents the list of species and the numbers collected at each station during two TNRCC Use Attainability Analyses (UAAs) performed on the Mud Creek system in the area of the proposed reservoir. The total number of species collected and the numbers of individuals per station are also recorded at the end of the table.

The UAA studies ranked Mud Creek at State Highway 110 as high quality and West Mud Creek as intermediate quality based upon the fish collections reported in Table 4.8.3-3. For Mud Creek, a total of 317 fish from 21 species were collected. Dominant species included the weed shiner (*Notropis texanus*) and longear sunfish (*Lepomis megalotis*). Four pollution tolerant and one intolerant species were taken. An intolerant species is one that has either specific habitat requirements, specific high water quality constituent levels, or a combination of both. Four species of benthic invertivores (darters) and four minnow species were collected. Trophic structure was balanced. The Shannon-Weaver diversity index was high at 3.06 (TNRCC, 1999). West Mud Creek, by comparison, produced only 120 individuals from 12 species. The western mosquitofish (*Gambusia affinis*) and green sunfish (*L. cyanellus*) were the dominant species.

Table 4.8.3-2 Fish Species of Potential Occurrence in the Angelina-Upper Neches River Basins

Scientific Name	Common Name	Species Collected in Permit Area
Petromyzontidae	lampreys	
Ichthyomyzon castaneus	chestnut lamprey	
I. gagei	southern brook lamprey	*
Polyodontidae	paddlefish	
Polyodon spathula	paddlefish	
Lepisosteidae	gars	
Atractosteus spatula	alligator gar	
Lepisosteus occulatus	spotted gar	*
L. osseus	longnose gar	
Amiidae	bowfins	
Amia calva	bowfin	*
Anguillidae	freshwater eels	
Anguilla rostrata	American eel	
Clupeidae	herrings	
Dorosoma cepedianum	gizzard shad	*
D. petenense	threadfin shad	
Esocidae	pikes	
Esox americanus	redfin pickerel	*
Cyprinidae	carps and minnows	
Cyprinella lutrensis	red shiner	*
C. venusta	blacktail shiner	*
Cyprinus carpio	common carp	
Hybognathus nuchalis	Mississippi silvery minnow	
Hybopsis amnis	pallid shiner	*
Lythrurus fumeus	ribbon shiner	*
L. umbratilis	redfin shiner	*
Macrhybopsis aestivalis	speckled chub	
Notemigonus crysoleucas	golden shiner	*
Notropis atherinoides	emerald shiner	*
N. atrocaudalis	blackspot shiner	*
N. buchanani	ghost shiner	
N. sabinae	Sabine shiner	
N. texanus	weed shiner	*
N. volucellus	mimic shiner	
Opsopoeodus emiliae	pugnose minnow	*
Phenacobius mirabilis	suckermouth minnow	*
Pimephales promelas	fathead minnow	

Scientific Name	Common Name	Species Collected in Permit Area
P. vigilax	bullhead minnow	*
Semotilus atromaculatus	creek chub	*
Catostomidae	suckers	
Carpiodes carpio	river carpsucker	
Cycleptus elongates	blue sucker	
Erimyzon sucetta	lake chubsucker	*
E. oblongus	creek chubsucker	
Ictiobus bubalus	smallmouth buffalo	
Minytrema melanops	spotted sucker	*
Moxostoma poecilurum	blacktail redhorse	*
Ictaluridae	North American catfishes	
Amieurus melas	black bullhead	
A. natalis	yellow bullhead	*
Ictalurus furcatus	blue catfish	
I. punctatus	channel catfish	*
Noturus gyrinus	tadpole madtom	
N. nocturnes	freckled madtom	*
Pylodictis olivaris	flathead catfish	
Aphredoderidae	pirate perches	
Aphredoderus sayanus	pirate perch	*
Atherinopsidae	New World silversides	
Labidesthes sicculus	brook silverside	*
Fundulidae	topminnows	
Fundulus chrysotus	golden topminnow	
F. blairae	western starhead topminnow	
F. notatus	blackstripe topminnow	*
F. olivaceus	black spotted topminnow	
Poeciliidae	livebearers	
Gambusia affinis	western mosquitofish	*
Moronidae	temperate basses	
Morone chrysops	white bass	
M. mississippiensis	yellow bass	
Centrarchidae	sunfishes	
Centrarchus macropterus	flier	
Lepomis auritus	redbreast sunfish	
L. cyanellus	green sunfish	*
L. gulosus	warmouth	*
L. humilis	orangespotted sunfish	
L. macrochirus	bluegill	*
L. marginatus	dollar sunfish	

Scientific Name	**Common Name**	**Species Collected in Permit Area**
L. megalotis	longear sunfish	*
L. microlophus	redear sunfish	*
L. punctatus	spotted sunfish	*
L. symmetricus	bantam sunfish	
Micropterus punctulatus	spotted bass	*
M. salmoides	largemouth bass	*
Pomoxis annularis	white crappie	*
P. nigromaculatus	black crappie	*
Percidae	perches	
Ammocrypta clara	western sand darter	*
A. vivax	scaly sand darter	
Etheostoma asprigene	mud darter	*
E. chlorosoma	bluntnose darter	*
E. gracile	slough darter	*
E. histrio	harlequin darter	*
E. parvipinne	goldstripe darter	
E. proeliare	cypress darter	
E. whipplei	redfin darter	*
Percina carbonaria	Texas logperch	
P. macrolepida	bigscale logperch	
P. sciera	dusky darter	*
P. shumardi	river darter	
Sciaenidae	drums and croakers	*
Aplodinotus grunniens	freshwater drum	
Elassomatidae	pygmy sunfishes	
Elassoma zonatum	banded pygmy sunfish	

* = Species collected in the vicinity of the proposed Lake Columbia.

List compiled from Lee et al., 1990; Hubbs et al., 1991. Species listed as collected in Project area as per Elottage and Moulton, 1998; TNRCC, 1996; TWC, 1988.

Nomenclature according to Nelson et al., 2004.

Table 4.8.3-3 Fish Species Collected from Mud Creek and Tributaries

Scientific Name	Common Name	Fish Collected (# of Individuals)					
		Mud Creek SH 110	West Mud Creek	Mud Creek U.S. 79	Keys Creek	Ragsdale Creek	
						1	2
Petromyzontidae	lampreys						
Ichthyomyzon gagei	southern brook lamprey				1		
Lepisosteidae	Gars						
Lepisosteus occulatus	spotted gar	1		6			
Amiidae	Bowfins						
Amia calva	bowfin			1			
Clupeidae	Herrings						
Dorosoma cepedianum	gizzard shad		1				
Esocidae	Pikes						
Esox americanus	redfin pickerel	3			1		
Cyprinidae	carps and minnows						
Cyprinella lutrensis	Red shiner			1			
C. venusta	blacktail shiner	8	3	2	17		
Hybopsis amnis	pallid shiner			12			
Lythrurus fumeus	ribbon shiner		2	10	53		4
L. umbratilis	redfin shiner		2				
Notropis atherinoides	emerald shiner	20					
N. atrocaudalis	blackspot shiner		3	1	17	34	63
N. texanus	weed shiner	126		3	5		
Opsopoeodus emiliae	pugnose minnow			17	1		
Phenacobius mirabilis	suckermouth minnow				1		
Pimephales vigilax	bullhead minnow	1		7	24		
Semotilus atromaculatus	creek chub					33	23
Catostomidae	suckers						
Erimyzon sucetta	lake chubsucker						1

Scientific Name	Common Name	Fish Collected (# of Individuals)					
		Mud Creek SH 110	West Mud Creek	Mud Creek U.S. 79	Keys Creek	Ragsdale Creek	
						1	2
Minytrema melanops	spotted sucker			6			
Moxostoma poecilurum	blacktail redhorse			9			
Ictaluridae	North American catfishes						
Amierus natalis	yellow bullhead	1	2		2	15	8
Ictalurus punctatus	channel catfish			3			
Noturus nocturnus	freckled madtom				17		
Aphredoderidae	pirate perches						
Aphredoderus sayanus	pirate perch	8					
Fundulidae	topminnows						
Fundulus notatus	blackstripe topminnow	8	2	3	14	33	24
Poeciliidae	livebearers						
Gambusia affinis	western mosquitofish	2	71	28	13	47	62
Centrarchidae	sunfishes						
Lepomis cyanellus	green sunfish		20			7	
L. gulosus	warmouth	12		1	4	2	
L. macrochirus	bluegill	19	3	3	8	3	
L. megalotis	longear sunfish	56	7	12	61	10	14
L. microlophus	redear sunfish			1			
L. punctatus	spotted sunfish	5			2		
Micropterus punctulatus	spotted bass	2		1			
M. salmoides	largemouth bass	6	4	4	2	1	
Pomoxis annularis	white crappie			3			
P. nigromaculatus	black crappie	3					
Percidae	perches						
Etheostoma asprigene	mud darter	19			2		
E. chlorosoma	bluntnose darter	1		3	1		
E. gracile	slough darter	14					

Scientific Name	Common Name	Fish Collected (# of Individuals)					
		Mud Creek SH 110	West Mud Creek	Mud Creek U.S. 79	Keys Creek	Ragsdale Creek	
						1	2
E. whipplei	redfin darter						1
Percina sciera	dusky darter	2			12		
Sciaenidae	drums and croakers						
Aplodinotus grunniens	freshwater drum			2			
	Total Number	317	120	139	258	185	200
	Total Species	21	12	24	21	10	9

List compiled from TNRCC, 1996 and 1999.

Nomenclature according to Nelson et al., 2004.

Ragsdale Creek at Site 1 has a limited to intermediate aquatic life use based on the results of the Index of Biotic Integrity (IBI), which is a composite index of the overall condition of a fish community based upon the cumulative score of 12 separate metrics (TNRCC, 1996). Major reasons given for that rating were a lack of certain groups of fishes (darters, suckers, and intolerants), a preponderance of tolerant individuals, and the presence of hybridized fish. Ragsdale Creek at Site 2 had an intermediate aquatic life use based on the results of the IBI. The aquatic life use rating was due to a lower-than-expected fish species variety both on a total and group basis (e.g., darters, sunfish, suckers, and intolerants) and the dominance of tolerant individuals.

The Keys Creek fish sample rated high based on the results of the IBI. There were more than twice as many fish species collected (21) as compared to the Ragsdale Creek site. The Keys Creek sample included several species of darters and intolerant fishes that were lacking in Ragsdale Creek. The Mud Creek fish sample scored lower on the IBI than the Keys Creek sample, but was still in the high aquatic life use range. Although the total number of species was higher in Mud Creek (24), species representing darters or intolerants were fewer than expected. A higher percentage of tolerant individuals were also present (TNRCC, 1996).

According to the TNRCC (1996), the fish communities of both Keys Creek and Mud Creek compare favorably with the fish community found in the nearest Ecoregion site in the Neches River Basin - Piney Creek in Trinity County. The Piney Creek sample consisted of 22 species, with good representation of the major groups, and an IBI score of 54 (exceptional).

4.8.3.1.3 Macroinvertebrates

Although no macroinvertebrate surveys have been conducted on Mud Creek itself, the TWC collected aquatic invertebrates from nearby West Mud Creek and Black Cypress Creek in 1987. Taxa collected during these two surveys are provided in Tables 4.8.3-4 and 4.8.3-5. Most of the invertebrates collected in these two surveys are found in lotic depositional habitats (Merritt and Cummins, 1996). That is, they inhabit the pools or slower-moving portions of streams where the suspended solids in the water column are deposited. As these streams provide habitat comparable to that found in Mud Creek and are in close proximity, the aquatic invertebrate communities are likely to be similar.

The invertebrate community expected in Mud Creek and its associated drainage includes a variety of crustaceans, mollusks, segmented worms, and insects. Aquatic crustaceans common to Texas streams in the Project area include crayfish, freshwater prawns, and planktonic forms such as water fleas (Cladocera). Bivalve mollusks frequently encountered in area waterways include the fingernail clams (Sphaeriidae) and freshwater mussels (Unionidae). Annelid or segmented worms, such as oligochaetes and leeches, are found in most fresh water systems. The aquatic insects generally comprise the most diverse portion of the aquatic invertebrate community. Some aquatic insects remain in the

Table 4.8.3-4 Aquatic Invertebrates Collected from West Mud Creek (August 1987)

Phyllum	Order	Family	Genus
Annelida			
	Oligochaeta		
		Tubificidae	*Limnodrilus* sp.
	Hirudinea		
Mollusca			
	Bivalvia		
		Sphaeriidae	*Pisidium* sp.
			unidentified
Arthropoda -Insecta			
	Ephemeroptera		
		Caenidae	*Brachycercus* sp.
		Ephemeridae	*Hexagenia* sp.
		Heptageniidae	*Stenonema* sp.
	Odonata	Coenagrionidae	*Argia* sp.
		Calopterygidae	*Hetaerina* sp.
		Gomphidae	*Nasiaeschna* sp.
		Libellulidae	*Sympetrum* sp.
	Hemiptera	Corixidae	*Graptocorixa* sp.
			unidentified
	Diptera	Ceratopogonidae	*Beziia* sp.
		Chaoboridae	*Chaoborus* sp.
		Chironomidae	*Tanypus* sp.
			Crytpochironomus sp.
			Polypedilum sp.
			Dicrotendipes sp.
			Microspectra sp.
			Tribelos sp.
			Constempellina sp.
			unidentified

Source: TWC, 1989 (as provided in LAN, 1991b).

Table 4.8.3-5 Aquatic Invertebrates Collected from Black Cypress Creek (November 1987)

Phyllum	Order	Family	Genus
Annelida			
	Oligochaeta		
		Lumbricidae	
		Tubificidae	*Aulodrilus pigueti*
			Limnodrilus hoffmeisteri
			Ilyodrilus templetoni
			Ilyodrilus sp.
			Pristina americana
			Pristina sp.
	Hirudinea		
			Helobdella elongata
Mollusca			
	Pellecypoda	Sphaeriidae	*Pisidium compressum*
			Pisidium nitidum
			Sphaerium transversum
			Eupera cubensis.
	Gastropoda	Hydrobiidae	*Amnicola limosa*
Arthropoda -Insecta			
	Coleoptera	Hydraenidae	*Hydraena* sp.
	Ephemeroptera		
		Caenidae	*Caenis* sp.
		Ephemeridae	*Hexagenia limbata venusta*
	Diptera	Ceratopogonidae	*Probezzia* sp.
		Tipulidae	*Limnophila* sp.
		Chironomidae	*Chironomus riparus*
			Clinotanypus
			Polypedilum scalaenum
			Procladius sp.
			Stenochironomus sp.
			Tanypus sp.
			Tanytarsus guerulus
Arthropoda - Crustacea			
	Decapoda	Palaemonidae	*Palaemonetes kadiakensis*
	Isopoda	Asellidae	*Lirceus* sp.
	Astacidae	Cambaridae	*Cambarellus* sp.

Source: TWC, 1989 (as provided in LAN, 1991b).

water for their entire life-cycle and include the aquatic bugs (Hemiptera) and some beetles (Coleoptera). Others, such as the Ephemeroptera (Mayflies) and Odonata (Dragonflies and Damselflies), have aquatic immature forms before emerging as aerial adults. Since these emergent insects often leave one stream system and colonize another, insects found in West Mud and Black Cypress creeks may also inhabit Mud Creek. However, because of the mobility of aerial adult insects, the species and even genera in a stream may change seasonally.

4.8.3.1.4 Commercial or Recreationally Important Species

There are no known commercially important species found within the Permit Area. The important game fishes throughout the Permit Area consist primarily of channel catfish, largemouth bass, and sunfish (LAN, 1991b).

4.8.3.1.5 Harmful Invasive Aquatic Species

Table 4.8.3-6 presents a list of all the fish species listed as invasive, prohibited, or exotic by the Texas Parks and Wildlife Department (TPWD). According to TPWD, no person may import, possess, sell, or place them in waters of this state except as authorized by rule or permit issued by the department. While the list is extensive and there are legitimate reasons to prohibit these species, the probability of most of these species ever being introduced into Lake Columbia, much less surviving, is very low. TPWD (2009a) indicated that snakeheads, family Channidae, have been collected in Arkansas and efforts at exterminating them there were unsuccessful. Also, the grass carp (*Ctenopharyngodon*) is a possible invader, but since TPWD has tight control over this species, and only allows sterile triploid individuals to be stocked via permit, this species should not be problematic. Since the latitude of Lake Columbia is far enough north to produce cold water temperatures in the late fall through late spring, it is unlikely that tropical species on the list would survive, and this would also include species of the *Tilapia*, *Oreochromis*, and *Saratherodon*. The blue tilapia competes strongly with native fishes in thermally enriched reservoirs. Additionally, TPWD noted that the zebra mussel (*Dreissena* sp.) has been found in Lake Texoma. This invasive species is of great concern should it spread throughout Texas waters.

4.8.3.1.6 Unique or Sensitive Aquatic Communities

While the proposed reservoir site does contain an array of aquatic habitats, no sensitive or unique aquatic resources have been identified by the USFWS, Texas Natural Heritage Program (TNHP), or the TPWD within the Permit Area.

4.8.3.1.7 Bay and Estuary Inflow

The proposed Lake Columbia dam is located over 280 river miles from the Neches estuary at Sabine Lake; consequently, the effects of the reservoir on freshwater inflows to

Table 4.8.3-6 Invasive, Prohibited, and Exotic Fish Species

Common Name	Family	Species
Lampreys	Petromyzontidae	All species except *Ichthyomyzon castaneus* and *I. gagei*
Freshwater Stingrays	Potamotrygonidae	All species
Arapaima	Osteoglossidae	*Arapaima gigas*
South American Pike Characoids	Characidae	All species of genus *Acestrorhyncus*
African Tiger Fishes	Family, Subfamily Alestiidae: Hydrocyninae	All species of genus *Hydrocynus*
Piranhas and Pirambebas	Family Serrasalmideae, Subfamily Serrasalminae	All species except pacus of the genus *Piaractus*
Payara and other wolf or vampire tetras	Family Characidae, Subfamily Rhaphiodontinae	All species of genera *Hydrolycus* and *Rhaphiodon*, including *Cynodon*
Dourados	Family Characidae, Subfamily Bryconinae	All species of genus *Salminus*
South American Tiger Fishes	Erythrinidae	All species
South American Pike Characoids	Ctenolucidae	All species of genera *Ctenolucius* and *Boulengerella*, including *Luciocharax* and *Hydrocinus*
African Pike Characoids	Families Hepsetidae and Ichthyboridae	All species
Carps and Minnows	Cyprinidae	All species and hybrids of species of genera: *Aspius, Pseudoaspius, Aspiolucius* (Asps); *Abramis, Blicca, Megalobrama, Parabramis* (Old World Breams); *Hypophthalmichthys* or *Aristichthys* (Bighead Carp); *Mylopharyngodon* (Black Carp); *Ctenopharyngodon* (Grass Carp); *Cirrhinus* (Mud Carp); *Thynnichthys* (Sandkhol Carp); *Hypophthalmichthys* (Silver Carp); *Catla* (Catla); *Leuciscus* (Old World Chubs, Ide, Orfe, Daces); *Tor*, including the species *Barbus hexiglonolepsis* (Giant Barbs and Mahseers); *Rutilus* (Roaches); *Scardinius* (Rudds); *Elopichthys* (Yellowcheek); *Catlocarpio* (Giant Siamese Carp); All species of the genus *Labeo* (Labeos) except *Labeo chrysophekadion* (Black SharkMinnow)

Common Name	Family	Species
Walking Catfishes	Clariidae	All species
Electric Catfishes	Malapteruridae	All Species
Electric Eels	Electrophoridae	*Electrophorus electricus*
South American Parasitic Candiru Catfishes	Subfamilies Stegophilinae and Vandelliinae	All species
Pike Killifish	Poeciliidae	*Belonesox belizanus*
Marine Stonefishes	Synanceiidae	All species
Tilapia	Cichlidae	All species of genera *Tilapia*, *Oreochromis* and *Saratherodon*
Asian Pikeheads	Luciocephalidae	All species
Snakeheads	Channidae	All species
Old World Pike-Perches	Percidae	All species of the genus *Sander* except *Sander vitreum*
Nile Perch	Centropomidae (also called Latidae)	All species of genera *Lates* and *Luciolates*
Seatrouts and Corvinas	Sciaenidae	All species of genus *Cynoscion* except *Cynoscion nebulosus*, *C. nothus*, and *C. arenarius*
Whale Catfishes	Cetopsidae	All species
Ruffe	Percidae	All species of genus *Gymnocephalus*
Air sac Catfishes	Heteropneustidae	All species
Swamp Eels, Rice Eels or One-Gilled Eel	Synbranchidae	All species
Freshwater Eels	Anguilliidae	All species except *Anguilla rostrata*
Round Gobies	Gobiidae	All species of genus *Neogobius*, including *N. melanostoma*
Temperate Basses	Moronidae	All species except for *Morone saxatilis*, *M. chrysops* and *M. mississippiensis* and hybrids between these three species
Temperate Perches	Percichthyidae	All species, including species of the genus *Siniperca* (Chinese perches)

Source: TPWD, 2009b

this estuarine system are expected to be very minimal, if any. The Texas Water Code (Section 11.147) stipulates that only those water right permits issued for projects located within 200 river miles of the mouth of their associated river at the coast "shall include in the permit, to the extent practicable when considering all public interests and the studies mandated by Section 16.058 as evaluated under Section 11.1491, those conditions considered necessary to maintain beneficial inflows to any affected bay and estuary system." As a result, state Water Use Permit No. 4228, which authorizes the proposed Project, does not contain any requirements for passing flows to provide for freshwater inflows to Sabine Lake or any associated estuarine water body.

4.8.3.2 Environmental Consequences

4.8.3.2.1 No Action Alternative

No impacts to the aquatic resources of the Permit Area would result from the No Action alternative. The aquatic invertebrate and fish communities should remain essentially unchanged from existing conditions. Any substantive change would focus on impacts from the possibility of other land development projects independent of the proposed surface water supply Project.

4.8.3.2.2 Proposed Action

Construction

The proposed reservoir would inundate 10,133 acres of land within the proposed reservoir footprint. The footprint extends roughly 14 miles upstream from the location of the proposed dam. Within this approximately 14-mile upstream reach of Mud Creek there currently exists approximately 70 miles of perennial stream, 39 miles of intermittent stream,three miles of channelized Mud Creek, and 63 acres of ponds. The estimated total acreage for these streams and ponds is approximately 395 acres. The existence of approximately 112 miles of stream over a straight line distance of 14 miles upstream indicates there is an average of eight miles of stream per mile of reservoir length. These values indicate the extreme sinuosity of Mud Creek as well as the existence of braided channels throughout the area within the proposed reservoir. The floodplain in the nine-mile reach immediately above the proposed dam generally varies from 0.8 to 1.6 miles wide, whereas the remaining upstream approximately five-mile reach of the proposed reservoir varies from 0.3 to 0.6 miles in width. A total of approximately 5,747 acres of waters of the U.S. are present in the Permit Area and are situated within the broad, flat floodplain described above.

The complex of channels throughout and the relatively flat, wide floodplain constitute a considerable acreage of aquatic habitat. Overbanking in the area of Highway 79 occurs at a flow of 140 to 150 cfs (see ***Instream Flows*** below). Under existing conditions, that level of flow is exceeded 37% of the time (see Figure 4.5-2). FNI (2005) reports that the 2-year flood flow in the same reach is about 10,124 cfs. That flow produces flooding over a 3,873.84-foot width of floodplain, which is 80% of the width produced by the 100-year flood event. The data indicate overbanking and flooding of floodplain areas occur frequently and can be extreme, which would provide additional fishery habitat in the area beyond the ponds and stream channels. Such flooded areas increase the habitat diversity in the area, provide protected areas for spawning and growth of juvenile fish, increase the volume and availability of nutrient material for the aquatic resources, and replenish the water in small ponds, oxbows, and swales adjacent to the stream channels. Much of the potentially flooded area consists of wooded bottomland, which provides canopy cover over the streams. In addition to forested habitat, emergent wetlands represent approximately 1,350 acres of waters of the U.S. within the Permit Area.

Depending upon the existing streamflows, areas of inundation can vary from approximately 400 acres to more than 5,700 acres. Intermittent streams, swales, oxbows, and small lakes within the Permit Area receive water not only through overbanking but also as direct runoff from the surrounding watershed. This type of flow supports the widespread distribution of aquatic areas throughout the floodplain.

The above described habitat would be inundated by the proposed reservoir. The proposed Lake Columbia would inundate 10,133 surface areas and at the conservation pool elevation of 315 feet NGVD would contain 195,500 acre-feet of water. The lake would have a maximum depth of 50 feet and an average depth of 19 feet. The proposed reservoir has 95 miles of shoreline including the dam and would contain approximately 1,200 acres of wetland fringe along the shoreline. The lake edge quickly drops to near the average depth with the bulk of the bottom being relatively flat except where streams exist. The lake would be expected to stratify from late spring through September annually. Given its relatively shallow average depth, the amount of bottom included by the hypolimnion should be relatively small. Therefore, the volume of the lake in the epilimnion above the thermocline available for occupation by organisms should be quite high. Except where timber may be cleared, the amount of structure available in the proposed reservoir would be relatively high. Primary fish habitat would be located along the shallow margins and up the flooded former stream channels that directly enter the proposed reservoir.

Approximately 8,628 acres of the lake would remain unpopulated by aquatic plants because of deep water or high energy shorelines. However, aquatic vegetation and possibly emergent marsh areas would likely establish along the lake margin, in secluded shallower coves, and in the upper two to three miles of the reservoir where water levels would remain relatively shallow.

Fish

The inundation of Mud Creek would alter the biological community substantially over what exists at present. Stream species would largely be replaced by species that do well in, or at a minimum tolerate, reservoir habitat.

Table 4.8.3-2 lists 84 fish species whose range includes the proposed reservoir area. The table presents 46 species that were listed as collected from the streams in the area of the proposed reservoir in the literature examined for this report. Based upon a review of the habits and habitats of the species listed in Table 4.8.3-2, another 21 species whose range includes the area are likely inhabitants of the proposed reservoir area (Hubbs, 1991; Lee et al., 1980). Therefore, the streams, ponds, and small lakes of the Mud Creek floodplain are likely to contain 69 of the possible 84 species. The other 15 species whose range is included in the reservoir footprint have been considered unlikely to occur due to habitat requirements that are not met by Mud Creek.

Table 4.8.3-7 presents the list of 69 possible fish species relative to the likelihood of occurrence in the proposed reservoir. Overall, of the 69 species, 39 would likely remain while 30 species would likely be eliminated.

Table 4.8.3-8 indicates anticipated changes in fish species assemblages as a result of reservoir construction. Some stream fishes such as lamprey, pirate perch, and silversides that occur in reasonably small numbers and are often represented by a single species could be lost completely. The catfish and sucker families would likely lose some member species while others would remain. While no suckers are likely to be common, catfish species , particularly the channel catfish (*Ictalurus punctatus*) and the flathead (*Pylodictis olivaris*), would likely flourish, while the two madtom species that are stream adapted would decline. Topminnows, minnows, and darter species would likely be the most affected groups by the impoundment of stream habitat. These families are currently represented by numerous species in Mud Creek and would likely lose from 50 to 75% of their species due to impoundment. Those species predicted to remain are generally more tolerant of pond or lake conditions than those that would likely drop out. Minnows, mosquitofish (*Gambusia affinis*), topminnows, and sunfish species were the most abundant species in the TNRCC 1996 and 1999 studies of Mud Creek and associated tributaries.

Whereas the more diverse stream fishery consists of 69 species representing 17 families, the proposed reservoir is expected to contain approximately 30 species representing 14 families of fishes. Therefore, an expected reduction in species of 56.5% (34 species) would be anticipated. Of the 30 species likely to inhabit the reservoir, Table 4.8.3-8 indicates that 8 could be abundant, 20 would be common, 6 would be uncommon, and five would be restricted to shallow, vegetated portions of the proposed reservoir where they could be locally common. The abundant species would likely include the largemouth bass (*Micropterus salmoides*) channel catfish, green sunfish (*L. cyanellis*), bluegill (*L. macrochirus*), redear sunfish (*L. microlophus*), mosquitofish (*Gambusia affinis*), gizzard shad (*Dorosoma cepedianum*), and threadfin shad (*D. petenense*). Thirteen of the 30 species likely to occur in the reservoir are sunfish species, five are catfish species, and only six are minnow species. Whereas habitat diversity characterizes Mud Creek in the area of the reservoir, the aquatic habitat of the proposed reservoir would be less diverse and less dynamic as is typical of a lake with a controlled spillway. The majority of the

Table 4.8.3-7 Fish Species Likely to Occur in the Proposed Reservoir and Those Species from the Current Mud Creek Fishery that Would Likely Not Survive in Reservoir Habitat

Species Likely To Occur	Species Likely To Be Lost
Petromyzontidae (lampreys)	
	I. gagei (southern brook lamprey)
Lepisosteidae (gars)	
Lepisosteus occulatus (spotted gar) *L. osseus* (longnose gar)	
Amiidae (bowfins)	
Amia calva (bowfin)	
Clupeidae (herrings)	
Dorosoma cepedianum (gizzard shad) *D. petenense* (threadfin shad)	
Esocidae (pikes)	
Esox americanus (redfin pickerel)	
Cyprinidae (carps and minnows)	
Cyprinella lutrensis (red shiner) *C. venusta* (blacktail shiner) *Cyprinus carpio* (common carp) *Notemigonus crysoleucas* (golden shiner) *Pimephales promelas* (fathead minnow) *P. vigilax* (bullhead minnow)	*Hybopsis amnis* (pallid shiner) *Lythrurus fumeus* (ribbon shiner) *L. umbratilis* (redfin shiner) *Notropis atherinoides* (emerald shiner) *N. atrocaudalis* (blackspot shiner) *N. buchanani* (ghost shiner) *N. sabinae* (Sabine shiner) *N. texanus* (weed shiner) *N. volucellus* (mimic shiner) *Opsopoeodus emiliae* (pugnose minnow) *Phenacobius mirabilis* (suckermouth minnow) *Semotilus atromaculatus* (creek chub)
Catostomidae (suckers)	
Erimyzon sucetta (lake chubsucker) *Ictiobus bubalus* (smallmouth buffalo)	*Minytrema melanops* (spotted sucker) *Moxostoma poecilurum* (blacktail redhorse)
Ictaluridae (North American catfishes)	
Amieurus melas (black bullhead) *A. natalis* (yellow bullhead) *Ictalurus furcatus* (blue catfish) *I. punctatus* (channel catfish) *Pylodictis olivaris* (flathead catfish)	*Noturus gyrinus* (tadpole madtom) *N. nocturnes* (freckled madtom)
Aphredoderidae (pirate perches)	
	Aphredoderus sayanus (pirate perch)
Atherinopsidae (New World silversides)	
	Labidesthes sicculus (brook silverside)

Species Likely To Occur	**Species Likely To Be Lost**
Fundulidae (topminnows)	
F. notatus (blackstripe topminnow)	*F. chrysotus* (golden topminnow) *F. blairae* (western starhead topminnow) *F. olivaceus* (black spotted topminnow)
Poeciliidae (livebearers)	
Gambusia affinis (western mosquitofish)	
Moronidae (temperate basses)	
Morone chrysops (white bass)	
Centrarchidae (sunfishes)	
Lepomis auritus (redbreast sunfish) *L. cyanellus* (green sunfish) *L. gulosus* (warmouth) *L. humilis* (orangespotted sunfish) *L. macrochirus* (bluegill) *L. marginatus* (dollar sunfish) *L. megalotis* (longear sunfish) *L. microlophus* (redear sunfish) *L. punctatus* (spotted sunfish) *L. symmetricus* (bantam sunfish) *M. salmoides* (largemouth bass) *Pomoxis annularis* (white crappie) *P. nigromaculatus* (black crappie)	*Centrarchus macropterus* (flier) *Micropterus punctulatus* (spotted bass)
Percidae (perches)	
E. chlorosoma (bluntnose darter) *E. gracile* (slough darter)	*Ammocrypta clara* (western sand darter) *Etheostoma asprigene* (mud darter) *E. histrio* (harlequin darter) *E. proeliare* (cypress darter) *E. whipplei* (redfin darter) *P. sciera* (dusky darter)
Sciaenidae drums and croakers	
Aplodinotus grunniens (freshwater drum)	
Elassomatidae (pygmy sunfishes)	
	Elassoma zonatum (banded pygmy sunfish)

List compiled from Lee et al., 1990; Hubbs et al., 1991; Elottage and Moulton, 1998; TNRCC, 1996 and 1999; TWC, 1988.

Nomenclature according to Nelson et al., 2004.

Table 4.8.3-8 List Of Species Lost and Remaining in Proposed Reservoir by Family with Practical Level of Abundance of Those Species Occupying Proposed Reservoir

Family	Species Lost (%)	Species Remaining	Relative Abundance of Remaining Species			
			Abundant	Common	Uncommon	Restricted
Lamprey	1 (100)	0				
Gars	0 (0)	2		2		
Bowfins	0 (0)	1				1
Shad	0 (0)	2	2			
Pikes	0 (0)	1				1
Minnows	12 (67)	6		6		
Suckers	2 (50)	2			2	
Catfish	2 (33)	5*	1	2	2	
Pirate Perch	1 (100)	0				
Silversides	1 (100)	0				
Topminnows	3 (75)	1		1		
Livebearers	0 (0)	1	1			
True Bass	0 (0)	1*		1		
Sunfishes	2 (13)	13	4	7		2
Darters	6 (75)	2			2	
Drums	0 (0)	1		1		
Pygmy Sunfish	0 (0)	1				1
Total	**30**	**39**	**8**	**20**	**6**	**5**

*Blue catfish and white bass likely to be stocked—not likely current residents of Mud Creek.

fishes would occur in areas of greatest cover and forage. These areas would likely be within the first five to 10 feet of depth along the shoreline, which likely represents approximately 3,090 acres (approximately 30 percent) of the proposed10,133-acre reservoir.

Areas of the proposed reservoir where vegetation would not be cleared would provide complex structure with additional cover for species such as bass and sunfish. Channel catfish and flathead catfish would occupy old stream channels, drop-offs, and bars. Due to the lack of topographic relief within the existing floodplain, the proposed lake bed would be relatively flat. Because the proposed reservoir would have a relatively shallow

average depth, some cover may be provided by aquatic plants or stumpage in water 15-18 feet deep.
Depending upon forage species' presence, the large expanses of open water could provide habitat for white bass if they were to be introduced. Pockets of emergent wetlands five to 10 acres in size could develop within the upstream forested wetland. Over the long term, these areas could increase in size as the woody vegetation declines. These areas could provide some habitat for the bowfin (*Amia calva*), the redfin pickerel (*Esox americanus*), the bantam sunfish (*L. symmetricus*), banded pygmy sunfish (*Elassoma zonatum*), bluntnose darter (*Etheostoma chlorosma*), and slough darter (*E. gracile*). Particularly important habitat could develop in coves where existing streams drain into the proposed reservoir. These areas may provide refugia for some of the minnow species still extant in the proposed reservoir.

The Texas Parks and Wildlife Department (TPWD) would develop and manage the fishery resources in the proposed Lake Columbia. The Inland Fisheries Division of TPWD is responsible for managing the fishery resources in approximately 800 public impoundments and about 191,000 miles of rivers and streams together, totaling 1.7 million acres. The proposed Project is located within TPWD Region III, specifically III C (TPWD, 2007). Some of the impoundments in Region III managed by TPWD include Lake Fork, Lake Athens, Lake Bob Sandlin, Gilmer Reservoir, Gladewater City Lake, Lake Jacksonville, Lake O' the Pines, Martin Creek Reservoir, Lake Murvaul, Lake Nacogdoches, Lake Palestine, Lake Quitman, Sam Rayburn Reservoir, Lake Tawakoni, and Toledo Bend Reservoir. These impoundments range from approximately 1,000 acres to over 100,000 acres. Reservoirs such as these are surveyed by TPWD every three to five years under the Statewide Freshwater Fisheries Monitoring and Management Program.

The TPWD establishes a fisheries management plan for each impoundment. For new impoundments such as the proposed reservoir this would likely include the stocking of fish species TPWD deems appropriate for the particular impoundment.

During 2006 the species and numbers of each stocked statewide that could be utilized in the proposed reservoir included the largemouth bass (*M. salmoides salmoides*), 162,310; the Florida largemouth bass (*M. salmoides floridanus*), 5,780,482; channel catfish, 873,490; bluegill, 417,585; white crappie (*Pomoxis annularis*), 856; threadfin shad (*D. petenense*) 900; and blue catfish (*I. furcatus*) 143,727. White bass (*Morone chrysops*) and gizzard shad (*D. cepedianum*) are other species that might be included. The above species are all listed as managed species in the East Texas reservoirs named above. Selection of specific species for stocking, in addition to stocking timeframe, would be dependent on management recommendations made annually by the TPWD scientists. In addition the Lake Survey reports available for these impoundments for 2006 mention fisheries for black crappie (*P. nigromaculutus*), flathead catfish (*P. olivaris*), red ear sunfish (*L. microlophus*), and redbreast sunfish (*L. auritus*), and palmetto bass (white bass [*M. chrysops*] and striped bass [*M. saxatilis*]).

Invertebrates

The aquatic habitat available for invertebrates would be changed in the proposed reservoir pool from a primarily lotic (flowing water) to lentic (still water) habitat. In general, invertebrates that inhabit streams are adapted to make use of the available current as a source of food and dissolved oxygen while securing themselves to the substrate or other surface to avoid being swept away. Those that inhabit riffle zones normally require highly oxygenated water. Organisms that inhabit reservoirs do not usually require highly oxygenated waters. Some are surface dwellers such as whirligig beetles (Gyrinidae). Most, however, are limited to the limnetic zone and emergent plants found there.

Another expected change may be the available substrate. While the lotic depositional areas in a stream generally contain relatively high amounts of detritus and silt, under normal flows they are continually “flushed” by the current. This would not occur in an impoundment and would be limiting for some mussel species. Heavy mussels tend to sink in deep, soft silt. Additionally, most mussel species cannot tolerate overlying silt for more than a short period (Howells, Neck, and Murray, 1996). However, some unionid species, such as the little spectaclecase (*Villosa lienosa*) are known to occur in reservoirs.

The reservoir habitat created could support a productive invertebrate community, although the composition tends to be less diverse than in a flowing system because dynamic hydrologic conditions and microhabitats are typically lacking. The macroinvertebrate communities downstream of the impoundment should not change greatly, if adequate channel flows are maintained.

<u>Operation</u>

Downstream Impacts Analyses

Construction of the proposed reservoir would alter the volume, frequency, duration, and timing of downstream flows. ANRA has funded several planning and engineering studies over time that addressed the effects of the reservoir on downstream flows in regard to overbanking flows to wetland areas and instream channel flows necessary for the maintenance of the Mud Creek fishery.

Downstream Floodplain Effects

The most recent review of the effects of the proposed reservoir on flow was the Freese and Nichols, Inc. 2005 study that addressed the potential downstream area of effect in the Mud Creek floodplain based upon expected reservoir operation conditions (FNI, 2005). Their study area included the entire existing 100-year floodplain from the proposed dam site to the confluence of Mud Creek with the Angelina River (see Figure 1.1-1). The study included computer simulations of proposed reservoir operation and hydraulic and hydrologic modeling to compare with and without reservoir scenarios. Based on USACE evaluation of this study, the conclusions appear to be reasonable and relevant to predicting impacts. The study was intended to define the geographic boundaries of the two scenarios to determine areas of potential impact. The study provides an extensive set of conclusions. The conclusions regarding the volume and extent of floodplain flooding are recounted below:

1. "The area of potentially affected floodplain is relatively small (17 percent or less of the existing, downstream floodplain area) for both frequent (i.e., 2-year and 5-year) and less-frequent (i.e., 10-, 25-, and 100-year) flood events based on the results of simulated reservoir operation scenarios assuming full withdrawal for water supply." This 17% relates to 1,249 acres out of a total floodplain acreage of 7,773 acres for the 2-year flood.

2. "The Mud Creek floodplain is broad and flat with abrupt side slopes in many places along its margin. This topography tends to minimize the reduction in downstream floodplain width and area that might occur due to the Lake Columbia dam."

3. "The passive nature of the operation of Lake Columbia dam, with its uncontrolled service and emergency spillways, would allow normal inflows to pass through the reservoir when its water surface elevation is at or above the normal pool level of 315 feet msl."

4. "The Loco Bayou site downstream of Lake Nacogdoches studied by Phillips (2001) is approximately 30 miles southeast of the Lake Columbia study area. The proposed Lake Columbia is similar to Lake Nacogdoches in that both are water supply reservoirs, they have uncontrolled service spillways, they occur in the same climatic and physiographic regions; and both are situated on alluvial tributaries of the Angelina River. Because of their proximity and similarities, it is expected that the observable downstream impacts of Lake Columbia on Mud Creek channel or floodplain morphology would be limited to a relatively short distance."

5. "The predicted incremental reductions in width of the floodplain for the various flood profiles modeled are not expected to result in a detectable change in forest species composition in the foreseeable future. The change likely would be imperceptible over decades and likely would not affect any forest stands beyond the 100-year floodplain. If there is an effect, it would probably occur as a long-term shift to the next drier species assemblage at the edge of the floodplain."

6. "Because no measurable effect on forest species composition is expected within the limits of the 100-year floodplain due to the Lake Columbia dam, no adverse impacts are expected on the U.S. Fish and Wildlife Service (1985) proposed Priority 1 Bottomland Hardwood site on Mud Creek downstream from the dam."

7. "Hydraulic modeling results indicated that the downstream floodplain area for any given flood event is not overly sensitive to the starting water surface elevation in Lake Columbia."

8. "Using the hydric soils within the 100-year floodplain as an indicator of the extent of wetlands, a maximum of 72 percent of the area (7,187 acres) may be wetlands. … The non-hydric soils, which would indicate non-wetland areas, cover the remaining 28 percent (2,807 acres) of the floodplain. The non-hydric areas … are more prevalent along the right side of the floodplain (facing downstream), which is consistent with the wider floodplain difference between existing and future floodplains on the right side...."

9. "Assuming that wetlands correlate to the hydric soils within the Mud Creek floodplain, wetlands could occur as far out as the edge of the 100-year floodplain along much of the downstream study area. Local conditions such as precipitation or drainage from upland slopes controls wetland hydrology in the Mud Creek floodplain rather than flooding, because such infrequent flooding would not be adequate to sustain wetlands. Therefore, the Lake Columbia dam likely would have negligible impact on wetland hydrology in the downstream corridor."

The above general conclusions Nos. 5 and 6 reached by FNI (2005) regarding minimal expected changes or adverse effects to downstream bottomland hardwood forests are reasonable since vegetative communities, particularly wetlands, that exist near the outer edges of floodplains are not dependent on the infrequent overbanking hydrology associated with the stream. The frequency of occurrence and duration of overbanking events in the outer edges of the floodplain (2- to 100-year event elevations) are not in themselves sufficient to support hydric plant communities that generally require inundation or saturation at frequencies less than one year. Other hydrologic support mechanisms, such as shallow groundwater, runoff from adjacent higher areas, ponding because of flat or depressed topography, and direct precipitation (the area receives approximately 45 inches of rain per year) become increasingly of greater importance to maintain hydric plant communities with higher topographic position in the floodplain where advective (stream) hydrology has less influence. This is in contrast to the more immediate effects expected in water scarce semi-arid or sub-arctic regions where flood hydrology is typically more important (Nilsson and Berggren, 2000). While overbanking floods can provide new sediment enrichment, nutrients, and seed dispersal that help maintain the vigor and species composition of hydric plant communities, even those benefits are of diminishing importance in the higher elevations of the floodplain.

With regard to the USFWS (1985) proposed Mud Creek priority 1 bottomland hardwood site (Conclusion No. 6), a large portion of that site extends beyond the 100-year floodplain of Mud Creek, which should preclude any measurable impacts caused by Lake Columbia in those portions of the site, and indicates hydrologic support from other sources, as discussed above. It is also located approximately 15 river miles downstream of the proposed dam just above the confluence of Mud Creek and the Angelina River where floodplain impacts would be reduced. The USFWS identified the dominant forest species as overcup oak (obligate wetland species), willow oak (facultative wetland species), green ash (facultative wetland minus), and hackberry [sugarberry] (facultative species). According to the USFWS (1988) definition of wetland plant indicator categories, *obligate wetland* species are expected to occur more than 99% of the time under natural conditions in wetlands; *facultative wetland* species are expected to occur in wetlands between 67% and 99% of the time; and *facultative* species are expected to occur in wetlands between 34% and 66% of the time. In addition, the USFWS (1988) further clarifies that "many obligate wetland species occur in permanently or semi-permanently flooded wetlands, but a number of obligates also occur and some are restricted to wetlands which are only temporarily or seasonally flooded." This would be consistent with this site. Thus, none of these bottomland hardwood species are expected to occur or survive only in wetlands. Impacts on the established forest species at the fringe of the floodplain are not expected.

Baseline and with-Project hydrologic information for the area below the proposed reservoir are presented in Section 4.5. As identified in that section, data from the USGS gaging station at Highway 79 near Jacksonville indicate that the median flow in Mud Creek for the period of record was 74 cfs with a minimum mean daily flow of 0 cfs and a maximum of 22,700 cfs. Flow duration curves are presented at the Highway 79 gage (Figure 4.5-1) and at three locations downstream of the dam site (Figures 4.5-5a to 4.5-5c). Each figure includes the without-lake flow duration curve, the with-lake flow duration curve, and the duration curves for lake flow with releases, lake flow with releases and Jacksonville return flows, as well as the USGS gage historical flow curve.

ANRA has indicated that four reservoir participants (Nacogdoches, Caro WSC, Temple-Inland, and Alto) would receive their water through downstream releases. Their share constitutes 21% of the reservoir yield, 17,956.5 acre-feet/year or 24.8 cfs on a continuous basis, and the Jacksonville WWTP currently permitted discharge is equal 4.3 cfs. ANRA has a contract with the City of Jacksonville to assure that the City's return flows will continue to be discharged in the future and not be retained for reuse. Therefore, the total of the permitted WWTP discharge and the releases to downstream users is 29.1 cfs. Additional inflows would also come from Coon and Keys Creeks, which enter Mud Creek near the proposed dam site, as well as other downstream tributaries.

Examination of data for a Mud Creek cross-section near Highway 79 indicates that overbanking occurs in this area at a flow of about 140 to 150 cfs. Under baseline flow conditions, flows of 140 to 150 cfs or greater would occur about 37% of the time (Figure 4.5-1), whereas with the reservoir this frequency would be about 17% in the immediate reach downstream of the dam (Figure 4.5-5a), increasing to about 23% farther downstream (Figure 4.5-5c). Therefore, based upon both studies, the floodplain area below the reservoir would continue to flood about half as frequently as without the dam, but would still continue to flood about 84% of the area formerly flooded. Furthermore, much of this floodplain area (approximately 1,222 acres) that would experience reduced flooding is upland area rather than wetlands (FNI, 2005). FNI (2005) does not elaborate on what actual percentage of the area is wetlands

Instream Flows

In the Lake Eastex (Columbia) Planning Studies, Freese and Nichols, Inc. projected the effect on reservoir yield of upstream return flows and three levels of inflow bypasses (FNI, 2003a). Table 4.8.3-9 provides the results of these analyses for the 12 scenarios studied. In this table, return flows (in MGD – million gallons/day) represent potential discharges from wastewater plants located upstream of the proposed reservoir. The yields presented for each of the three return flow scenarios are for four potential bypass scenarios: no intentional inflow bypass (No Bypass) and intentional inflow bypasses equal to 5 cfs and 10 cfs and those corresponding to what is referred to as the Consensus Planning Criteria (CPC) as used by the TWDB for purposes of regional water supply planning. No flow values are assigned to the CPC bypass because they vary depending upon current hydrologic conditions as depicted by reservoir storage.

Table 4.8.3-9 Reservoir Yield Under Various Upstream Return Flow and Bypass Scenarios

Return Flow (MGD)	Reservoir Yield (ac-ft/yr)			
	No Bypass	up to 5 cfs	up to 10 cfs	Consensus
9.99	91,040	87,360	83,690	76,270
4.66	85,090	81,415	78,600	71,285
0.00	79,880	77,600	75,420	67,600

Source: FNI, 2005

As expected, the worst-case scenario with regard to yield would be the zero return flow case. The FNI (2003a) conclusion was that bypassing inflows up to 5 or 10 cfs would augment local runoff, groundwater, and return flow contributions to the stream below the proposed reservoir while not substantially reducing the Project yield. However, the CPC bypass resulted in larger yield reductions.

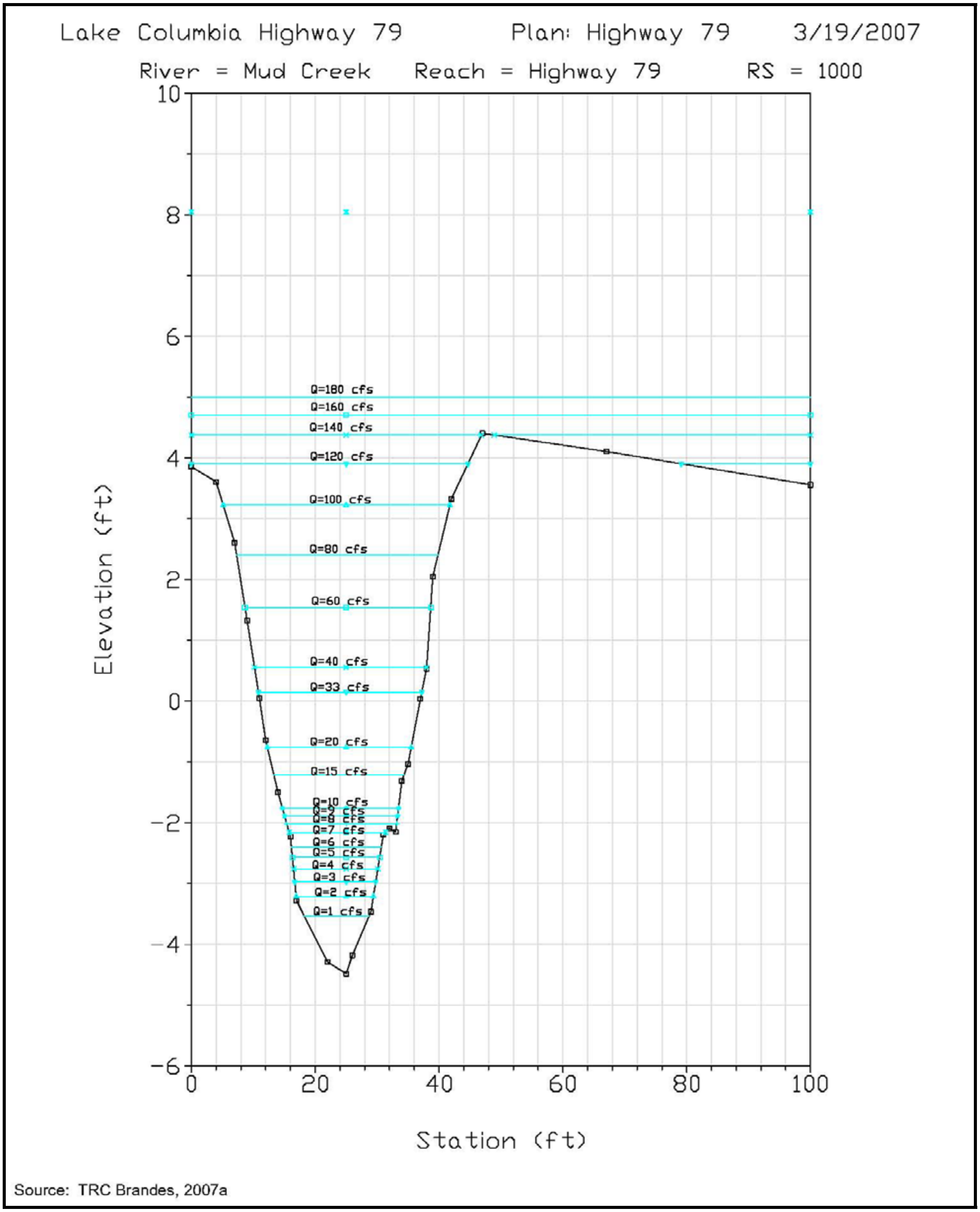
The CPC criteria were developed through collaboration among TWDB, TPWD, TCEQ and other scientists as a potential means for maintaining sufficient streamflows to support instream environmental uses. As discussed in the Texas Water Plan (TWDB, 2007a), the CPC criteria include median, first quartile, and 7-day, 2-year low (7Q2) flow values as bypass flow rates, depending on the reservoir storage level at the time of bypass. Application of these planning criteria resulted in bypass flow rates for the proposed reservoir that generally exceeded 10 cfs and reduced the reservoir yield substantially (Table 4.8.3-9). For instance, the reservoir yield with no return flows or bypasses equals 79,880 acre-feet/year, which is 12,280 acre-feet/year more than the 67,600 acre-feet/year of yield for conditions with no return flows and the CPC bypass criteria in effect.

Based on this evaluation, it appears the reduction in yield at 10 cfs of inflow bypass is approximately 36% less than the yield corresponding to the CPC bypass. ANRA's current plan for reservoir operation presented above would be a continuous release of 24.8 cfs (17,956.5 acre-feet/yr) to meet the demands of four reservoir participants downstream, assuming the participants were using their full amounts at a constant rate (TRC Brandes, 2007b). ANRA's operation plan would therefore release 5,676 acre-feet/year more water than required by the CPC criteria. Since withdrawals of water released from Lake Columbia would occur for over 40 river miles downstream of the proposed dam, instream aquatic habitat along this reach would benefit from the consistent 24.8-cfs release.

Figure 4.8.3-1 shows current water depths and widths of Mud Creek for flows ranging from 1 to 180 cfs as calculated based on a surveyed cross-section of Mud Creek at Highway 79. The channel and floodplains at the USGS gage (Highway 79) are reasonably representative of the stream below the dam site based upon USGS maps and the survey data provided of the stream cross-section (TRC Brandes, 2007). At a flow of 29 cfs, the stream at Highway 79 is roughly 26 feet wide and 4.25 feet deep (the cross-section was actually surveyed at a gage reading of 33 cfs). The width and depth at 29 to 33 cfs is highly consistent with that described in the use attainability analysis (UAA) studies reviewed in Section 4.8.3.1. This width and depth of water is sufficient to support the fisheries and benthos populations described in the UAAs (TNRCC, 1996 and 1999). Another cross-section near Highway 110 several miles downstream produced results consistent with this cross-section.

As depicted by the flow duration curves (Figures 4.5-5a - 4.5-5c), the releases and Jacksonville return flow levels occur 100% of the time. About 20 to 23% of the time the releases and return flows would provide higher flows than would naturally occur in the stream and prevent the flow from falling below 29 cfs down to zero as recorded historically. Eighty percent of the time Mud Creek historically would have had higher flows than with the reservoir present. About 40% of the time those flows would be in the range of 30 to 140 cfs and would result in more instream habitat. The major impact of the proposed reservoir on downstream flows is the reduction of flows capable of overbanking the stream. Flows at 140 cfs or greater create the diverse habitats found throughout the floodplain area of Mud Creek. Such flows, which historically occurred 37% of the time, would occur at a reduced rate ranging from 17% to 23% of the time. This reduction has a greater effect on the total amount of aquatic habitat downstream because of the overbanking and flood filling the slough, ponds, and oxbow areas of the floodplain.

Within the stream itself, the ANRA operating plan coupled with 4.3 cfs of return flows from the Jacksonville WWTP and additional local inflow from streams below the dam and spills from the reservoir would prevent the stream from going completely dry. While not fully offsetting the impact of the lower frequency of overbanking flows, the operating scenario would provide sustained flows during low flow periods and to some extent offset negative effects associated with lowered average streamflows. There should be



Source: TRC Brandes, 2007a

Figure 4.8.3-1 Mud Creek Cross-Section Channel Width and Depth at Various Stream Flows

sufficient aquatic habitat to provide protection for the fish and benthos populations within the stream channel areas; however, much of the adjacent flooded area habitat would be reduced perhaps significantly during dry years. In average flow years, spills from the reservoir would likely support the bulk of habitat adjacent to the stream channel.

Mitigation

ANRA proposes to compensate for the remaining impacts to aquatic biology and waters of the U.S. within the Permit Area by implementing a Mitigation Plan (FNI, 2009b - see Appendix C). The goal of the plan is to replace and/or restore aquatic functions and services associated with waters of the U.S.that are expected to be lost as a result of the construction and operation of the proposed Lake Columbia. ANRA proposes to provide compensatory mitigation through a combination of on-site (within the proposed reservoir footprint), near-site (land immediately surrounding the proposed reservoir and land within the upstream watershed and 100-year floodplain of Mud Creek downstream of the dam), and off-site mitigation. The plan and other proposed mitigation measures are discussed in detail in Section 3.3.4.3.

During construction, a construction storm water discharge permit must be obtained and a Storm Water Pollution Prevention Plan prepared and implemented. This plan would require the establishment of best management practices to reduce the impact of soil disturbance and sediment delivery to surface waters that could impact aquatic biology.

ANRA has adopted Water Quality Regulations for the proposed Lake Columbia. These regulations identify and define various water quality zones with prohibited activities and requirements on certain regulated activities to minimize impacts on water quality and aquatic habitat. These regulations are discussed in detail in Section 3.3.4.3. ANRA's Lake Columbia Water Quality Regulations are attached in Appendix D.

As discussed in Section 4.5, ANRA has stated that releases would be made from the epilimnion (zone above the thermocline) at times when Lake Columbia is thermally stratified. Under this policy, impacts on downstream temperature, water quality, and aquatic habitat would be reduced.

4.8.3.2.3 Toledo Bend Pipeline Alternative

Under the Toledo Bend Pipeline alternative, aquatic communities along the 86-mile pipeline right-of-way and the intake structure at Toledo Bend Reservoir would potentially experience varying degrees of adverse impacts. An approximation of miles of pipeline traversing environmental features (and related acreages assuming a 100-foot construction right-of-way) as compared to these same features affected by the proposed Lake Columbia Reservoir Project is provided in Table 3.4-1.

During pipeline construction, disturbance associated with land clearing, trenching, and directional drilling would be primarily limited to the immediate vicinity of the pipeline right-of-way. There would be numerous stream crossings, including major crossings at the Angelina River, Attoyac Bayou, and Stryker Creek and associated adjacent wetlands. Surface water control structures would be employed as needed during construction to control runoff from disturbed areas in order reduce potential adverse impacts to aquatic biology resulting from sediment transport to local streams during rainfall events.

The exact locations of the intake structure and terminal reservoir site are currently unknown. The terminal reservoir could be anywhere near the proposed Lake Columbia Permit Area. One alternative would involve the construction of a terminal reservoir by building a dam on a tributary of Mud Creek in a similar, but smaller scale to Lake Columbia. This unlikely action would generate additional impacts on aquatic biology, require an engineered dam capable of passing the probable maximum flood, require a new water right, and trigger a USACE Section 404 permit because of impacts to waters of the U.S. It is most likely that an excavated/diked off-channel structure would be constructed on a relatively flat uplands area, which would not impact aquatic biology or any other USACE-jurisdictional features.

4.8.3.3 Cumulative Effects

The affected environment for aquatic biology is primarily focused on the Permit Area with additional evaluation of the downstream impacts area. Several types of studies have been conducted in this area, and they are briefly summarized herein in terms of aquatic habitat, fish and benthos, and macroinvertebrates. Relative to habitat, the Permit Area contains 70 linear miles (255 acres) of perennial stream, 39 linear miles (47 acres) of intermittent streams,threelinear miles (30 acres) of channelized Mud Creek, and 63 acres of open water (ponds). These data apply within an upstream distance of about 14 miles from the proposed dam site; thus it can be noted that Mud Creek is highly meandering in the Permit Area.

Several Use-Attainability Analysis (UAA) studies have been conducted to determine various habitat data and water quality conditions. Such studies by the TCEQ and its precursor agency, the TNRCC, are conducted on water bodies for which aquatic life uses and DO criteria have been or will be established. To date, UAA studies have been conducted on Mud Creek and several tributaries. The following habitat data and rankings were found in Mud Creek at the U.S. Highway 79 crossing: aquatic life use rank – high, habitat quality rank – intermediate, substrate – silt, flow at sampling – 20.9 cfs, DO – 5.6 mg/L, average water depth – 2.5 feet, maximum water depth – 3.3 feet, average stream width – 36 feet, and length of creek sampled – 1,108 feet. In general, this location indicated good conditions for aquatic life and seasonable water quality. At this location Mud Creek is a perennial stream with an estimated 7-day, 2-year low flow (7Q2) of 5.1 cfs (over the time period from 1960 to 1979).

Several historical studies of fish species in the Permit Area have also been conducted. It has been determined that at least 84 species of fish have habitat ranges that include the Permit Area. Four studies conducted from 1988 to 1999 actually collected 46 fish species. In UAA studies of Mud Creek at U.S. Highway 79 in 1996 and 1999, 139 fish comprising 24 species were collected. Downstream on Mud Creek at SH 110, 317 fish representing 21 species were found. These data indicate good fish diversity both within and downstream of the Permit Area. These fish communities compare favorably with the findings from other UAA studies in the Neches River Basin.

In 1987, aquatic invertebrate studies were also conducted in two tributaries of Mud Creek, and the results are applicable to Mud Creek itself. Specifically, the findings indicated that Mud Creek could be expected to include a variety of crustaceans, mollusks, segmented worms, and insects.

There are no known commercially important fish species in the Permit Area; however, recreationally important game fish include channel catfish, largemouth bass, and sunfish. Finally, a list of 32 invasive fish species from the TPWD was considered for relevance to the Permit Area. Following consideration of their habitat requirements, it was determined that the probability of their introduction to Lake Columbia was very low, as was their likelihood of survival.

The No Action alternative would not directly cause any changes to the aquatic habitat, fish and benthos, and macroinvertebrates in the Permit Area. Changes which could occur in the future would be a result of other land use changes and development projects in the upper Mud Creek watershed. Therefore, detailed evaluations of cumulative effects were not conducted.

The construction phase of the Proposed Action would lead to the inundation of the Permit Area. Included within this are approximately 5,947 acres of waters of the U.S., including 5,352 acres of wetlands. Operation of the Proposed Action would involve a 10,133-acre reservoir on Mud Creek rather than the meandering stream prior to construction. The resultant aquatic biological community would be changed from a flowing system to an impounded one. A review of surveys of pre-impoundment fish species and further consideration of species which are associated with reservoirs have resulted in a potential list of 69 possible species in the proposed reservoir. Of these 69 species, further evaluation indicated that 39 would likely remain in Lake Columbia (see Table 4.8.3-7). Some changes in fish species assemblages are also anticipated. For example, the stream fishery had 69 species representing 17 families; while the reservoir fishery is projected to include 30 species representing 14 families (see Table 4.8.3-8).

Invertebrates in the Permit Area would also be impacted by both construction and operation. The basic effects would be associated with the aquatic habitat changing from a flowing water to an impounded water. Invertebrate communities can adapt to such changes; however, the reservoir community is expected to be less diverse because dynamic flow conditions are dampened.

Several continuing actions are anticipated to affect aquatic biology within the proposed reservoir. Such effects could result from direct changes to surface-water quality which in turn affect aquatic habitat, fish, benthos, and macroinvertebrates. These contributing actions from Table 3.3-5, which are listed as affecting both surface-water quality and aquatic biology, include wastewater treatment plant discharges, agricultural lands, and timber production via logging operations. These three actions are located in both the upper and downstream Mud Creek watersheds. Agricultural lands and timber production are listed as causing moderate relative contributions to effects on surface-water quality and aquatic biology. Wastewater treatment plant discharges have low relative contributions.

Future actions could also contribute to surface-water quality impacts and to effects on aquatic biology. Table 3.3-6 includes three future actions, in addition to the three continuing actions above, which could also contribute to cumulative effects. The future actions include development and use of public access areas and marinas along the Lake Columbia shoreline, recreational usage of the proposed Lake Columbia and its environs, and shoreline developments around the proposed Lake Columbia (Table 3.3-7). Recreational usage of the Lake and its environs would be expected to have moderate relative contributions to cumulative effects on aquatic biology in the Permit Area and Shoreline Development Area. The other two future actions would be expected to have low relative contributions.

Table 3.3-6 also includes three future actions which would be expected to yield beneficial effects on surface-water quality and/or aquatic biology. The first one entails ANRA regulation of recreational and commercial activities on and surrounding the proposed Lake Columbia. This action, which involves land use controls, is part of the program associated with Lake Columbia Water Quality Regulations (Appendix D). The second future action involves a fisheries management plan to be prepared by the TPWD. This plan includes fish stocking, periodic monitoring, and various efforts to promote diverse and sustainable fish populations in Lake Columbia. The third action involves ANRA's Mitigation Plan (Appendix C). This plan includes mitigation and improvement elements which are related to aquatic biology, primarily through restoration and enhancement of wetlands and preservation of streams and riparian buffers, resulting in mitigation of impacts at a minimum, and potentially net positive effects for some functions.

Operation of the Lake Columbia Project would also be expected to alter the aquatic biological conditions in the downstream portion of the Mud Creek Watershed. Alterations in the volume, frequency, duration, and timing of downstream flows would occur. Further, the size of the downstream floodplain area would be reduced. It is anticipated that these changed conditions would also influence downstream aquatic habitats, fish and benthos, and invertebrates. However, there are many uncertainties in such effects.

Finally, quantitative information on cumulative effects on aquatic biology in the Permit Area and the downstream Mud Creek watershed is not available and not predictable. Such information is needed for both the levels of effects and their significance determinations, as well as for establishing the relative contributions of other continuing and future actions and the Proposed Action. Accordingly, ANRA would develop a focused monitoring program to establish these levels and contributions. This program should coincide with earlier monitoring programs for soil erosion and land usage in the Permit Area, Shoreline Development Area, and upper Mud Creek watershed; and for surface-water hydrology and quality in the Permit Area and the downstream Mud Creek watershed.

Lastly, the Toledo Bend Pipeline alternative would cause localized adverse effects to aquatic biological communities both along the 86-mile pipeline route and at the terminal storage reservoir. The pipeline route effects would be temporary due to land restoration practices, while the storage reservoir effects would be long term. A comprehensive study of these effects and effects from other actions or the cumulative effects was not conducted.

4.8.4 Threatened or Endangered Species

4.8.4.1 Affected Environment

State and federally listed Threatened or Endangered (T/E) species of potential occurrence in Cherokee and Smith counties are provided in Table 4.8.4-1. Provided below are descriptions of state and federally listed species of potential occurrence (TPWD, 2006a and 2006b, and USFWS, 2006).

Arctic Peregrine Falcon – Status: State Threatened and Federally Delisted

The Arctic peregrine falcons (*Falco peregrinus tundrius)* are considered to be potential fall and spring migrants through the Permit Area between nesting and wintering grounds. Peregrine falcons prefer open areas and often occur near water or wherever smaller birds concentrate. This species also generally avoids developed areas.

Bald Eagle – Status: State Threatened and Federally Delisted

The bald eagle (*Haliaeetus leucocephalus*) is a large fishing species that ranges over much of the U.S. and Canada. In Texas, wintering and nesting activity occur mainly near large freshwater impoundments with standing timber located in or around the water.

Interior Least Tern – Status: State and Federal Endangered

The interior least tern is migratory, breeding along inland river systems of the Missouri, Mississippi, Colorado, Arkansas, Red, and Rio Grande river systems and wintering along the Central American coast and the northern coast of South America from Venezuela to northeastern Brazil. In Texas, interior least terns are found at reservoirs along the Rio Grande, along the Canadian River in the northern Panhandle, along the Prairie Dog Town Fork of the Red River in the eastern Panhandle, and along the Red River (Texas/Oklahoma boundary) into Arkansas. Nesting habitat of the interior least tern includes bare or sparsely vegetated sand, shell, and gravel beaches, sandbars, islands, and

Table 4.8.4-1 State and Federal Listed Threatened or Endangered Species of Cherokee and Smith Counties, Texas

Common Name	Scientific Name	Cherokee County	Smith County	State Status[1]	Federal Status[2]
Birds					
Arctic peregrine falcon	*Falco peregrinus tundrius*	X	X	T	DL
Bachman's sparrow	*Aimophila aestivalis*	X	X	T	NL
Bald eagle	*Haliaeetus leucocephalus*	X	X	T	DM
Interior least tern	*Sterna antillarum athalassos*	X	X	E	E
American Peregrine falcon	*Falco peregrinus anatum*	X	X	E	DL
Red-cockaded woodpecker	*Picoides borealis*	X	X	E	E
Piping Plover	*Charadrius melodus*	X	X	T	T
Wood stork	*Mycteria americana*	X	X	T	NL
Fishes					
Creek chubsucker	*Erimyzon oblongus*	X	X	T	NL
Paddlefish	*Polyodon spathula*	X	X	T	NL
Mammals					
Black bear	*Ursus americanus*	X	X	T	NL, T/SA
Louisiana black bear	*Ursus americanus luteolus*	X	X	T	T
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	X		T	NL
Red wolf	*Canis rufus*	X	X	E	E
Reptiles					
Northern scarlet snake	*Cemophora coccinea copei*	X	X	T	NL
Timber/canebrake rattlesnake	*Crotalus horridus*	X	X	T	NL
Alligator snapping turtle	*Macrochelys temminckii*	X	X	T	NL
Texas horned lizard	*Phrynosoma cornutum*	X	X	T	NL
Louisiana pine snake	*Pituophis ruthveni*	X	X	T	C
Plants					
Neches River rose-mallow	*Hibiscus dasycalyx*	X		NL	C

[1] State Status: E = Endangered; T = Threatened
[2] Federal Status: E = Endangered; T = Threatened; DL = Delisted; DM = Delisted but Monitored; NL = Not Listed ; T/SA = Threatened by Similarity of Appearance; C = Federal Candidate for Listing

Source: TPWD, 2008; USFWS, 2008

salt flats associated with rivers and reservoirs. The birds prefer open habitat, and tend to avoid thick vegetation and narrow beaches. Sand and gravel bars within a wide, unobstructed river channel, or open flats along shorelines of lakes and reservoirs, provide favorable nesting habitat. Nesting locations are often found along higher elevations away from the water's edge, as nesting typically begins when river levels are high and relatively small amounts of sand are exposed. The size of nesting areas depends on water levels and the extent of associated sandbars and beaches. Highly adapted to nesting in disturbed sites, terns may move colony sites annually, depending on landscape disturbance and vegetation growth at established colonies. For feeding, interior least terns need shallow water with an abundance of small fish. Shallow water areas of lakes, ponds, and rivers located close to nesting areas are preferred. Preferred habitat for utilization by the interior least tern has not been reported within the Permit Area; therefore, its occurrence would be highly unlikely.

American Peregrine Falcon – Status: State Endangered and Federally Delisted

The Arctic peregrine falcons (*Falco peregrinus anatum)* are resident of the Trans-Pecos region, including the Chisos, Davis, and Guadalupe mountain ranges. Peregrine falcons prefer open areas and often occur near water or wherever smaller birds concentrate. This species also generally avoids developed areas.

Red-Cockaded Woodpecker – Status: State and Federal Endangered

About the size of the common cardinal, the red-cockaded woodpecker is approximately seven inches long, with a wingspan of about 15 inches. Its back is barred with black and white horizontal stripes. The red-cockaded woodpecker's most distinguishing feature is a black cap and nape that encircle large white cheek patches. Rarely visible, except perhaps during the breeding season and periods of territorial defense, the male has a small red streak on each side of its black cap called a cockade, hence its name. The red-cockaded woodpecker feeds primarily on beetles, ants, roaches, caterpillars, wood-boring insects, and spiders, and occasionally fruits and berries.

The red-cockaded woodpecker makes its home in mature pine forests. Longleaf pines (*Pinus palustris*) are most commonly preferred, but other species of southern pine are also acceptable. While other woodpeckers bore out cavities in dead trees where the wood is rotten and soft, the red-cockaded woodpecker is the only one that excavates cavities exclusively in living pine trees. The older pines favored by the red-cockaded woodpecker often suffer from a fungus called red heart disease which attacks the center of the trunk, causing the inner wood, the heartwood, to become soft. Cavities generally take from one to three years to excavate. Suitable habitat for the red-cockaded woodpecker has not been identified in the Permit Area.

Piping Plover – Status: State and Federal Threatened

The piping plover is a migrant and over-winters on Texas beaches and bay margin mud flats from September to April. Critical Habitat for the piping plover was designated for various areas along the Texas coast. The piping plover has the potential to temporarily occur in the Permit Area during migration. The proposed reservoir Project is not within the area designated as Critical Habitat for the plover and migrating plovers would not be affected by construction or operation of the reservoir.

Wood stork – Status: State Threatened and Federally Not Listed

Wood storks are large, long-legged wading birds, about 50 inches tall, with a wingspan of 60 to 65 inches. The plumage is white except for black primaries and secondaries and a short black tail. The head and neck are largely unfeathered and dark gray in color. The bill is black, thick at the base, and slightly decurved. Immature birds are dingy gray and have a yellowish bill.

Storks are birds of freshwater and estuarine wetlands, primarily nesting in cypress or mangrove swamps. They feed in freshwater marshes, narrow tidal creeks, or flooded tidal pools. Particularly attractive feeding sites are depressions in marshes or swamps where fish become concentrated during periods of falling water levels.

Creek Chubsucker – Status: State Threatened and Federally Not Listed

The creek chubsucker occurs widely from Maine through Georgia along the East Coast and throughout the Mississippi River Basin. It reaches its most westerly extent in Oklahoma and Texas, roughly along the boundary of the Austroriparian Biotic Province. While geographically widespread, it is not a common species in any locale.

In Texas, they occur in tributaries of the Red, Sabine, Neches, Trinity, and San Jacinto rivers; small rivers and creeks of various types; seldom in impoundments; prefers headwaters, but seldom occurs in springs; young typically in headwater rivulets or marshes; spawns in river mouths or pools, riffles, lake outlets, and upstream creeks.

The creek chubsucker is a small sucker possessing a cylindrical, elongate body with a relatively small head. The dorsal color is an olive-bronze with a brassy overcast. The scales have dark pigment on the edges, giving a crosshatched appearance. The sides are lighter, fading to nearly white on the ventral surface. Specimens rarely exceed a total length of 10 inches and are usually less than six inches in length. They feed on small organisms on the stream bottom. Spawning occurs in the spring.

Paddlefish – Status: State Threatened and Federally Not Listed

The native range of paddlefish includes the Mississippi River basin from New York to Montana and south to the Gulf of Mexico. Historically in Texas, paddlefish lived in the Red River's tributaries, Sulphur River, Big Cypress Bayou, Sabine River, Neches River, Angelina River, Trinity River, and San Jacinto River. Paddlefish like to live in slow moving water of large rivers or reservoirs, usually in water deeper than four feet (130cm).

Paddlefish grow up to 87 inches (221 cm) long - over seven feet long. They can weigh as much as 200 pounds, but most are usually between 10-15 pounds. Paddlefish have a gray, shark-like body with a deeply forked tail, and a long, flat blade-like snout (looks like a kitchen spatula) almost one third of its body's entire length. It opens its huge mouth when feeding.

Black Bear – Status: State and Federal Threatened

Black bears have been restricted by the inroads of "civilization" to the more remote, less accessible mountainous areas or to the nearly impenetrable thickets along watercourses. Largely creatures of woodland and forested areas, black bears are more at home on the ground than they are in the trees. They are expert climbers, however, and, especially when young, often seek refuge in trees. Ordinarily they are shy and retiring and seldom are seen. They appear to use definite travel ways or runs, a habit that is frequently taken advantage of by hunters.

Their food is extremely varied as reflected by the crushing type of molar teeth. They are known to feed upon nest contents of wild bees, carpenter ants and other insects, manzanita berries, coffee berries, wild cherry, poison oak, apples, pine nuts, acorns, clover, grass, roots, fish, carrion, and garbage about camps. Occasional animals become killers of livestock and young deer.

Louisiana Black Bear – Status: State and Federal Threatened

The Louisiana black bear is a habitat generalist and often overwinters in hollow cypress trees either in or along sloughs, lakes, or riverbanks in bottomland habitats of the Tensas and Atchafalaya river basins. These bears are mobile, opportunistic, largely herbivorous omnivores that exploit a variety of foods. The distribution and abundance of foods, particularly mast, largely affects their movements. The size of an individual's range or area it traverses annually to secure food and mates and to care for young is probably directly related to the diversity of vegetative cover, or habitats. Constituent elements of black bear habitat include hard and soft mast, escape cover, denning sites, corridor habitats, and some freedom from disturbance by man.

The Louisiana black bear is considered extirpated in Texas. The Louisiana black bear is now restricted primarily to the Tensas and Atchafalaya River Basins in Louisiana. These bears make long-range movements and not uncommonly occur in adjacent Mississippi.

However, it is unknown whether breeding numbers exist outside of Louisiana. The Louisiana black bear's occupied habitat consists primarily of bottomland hardwood timber found in its river basin habitats. Potential habitat for the Louisiana black bear is not abundant in the Permit Area.

<u>Rafinesque's Big-Eared Bat – Status: State and Federal Threatened</u>

Rafinesque's big-eared bat (*Plecotus rafinesquii)* occurs in forested regions largely devoid of natural caves. Its natural roosting places are in hollow trees, crevices behind bark, and under dry leaves. It has been observed most frequently in buildings, both occupied and abandoned. *P. rafinesquii* appears to be a solitary bat although colonies of 2-100 may be encountered in summer. Winter aggregations, usually of both sexes, are more numerous but even then solitary individuals are frequently found. The bats probably do not hibernate in East Texas, but in the northern part of their range they tend to seek out underground retreats and hibernate through the winter.

<u>Red Wolf – Status: State and Federal Endangered</u>

Red wolves have several coat colors including black, brown, gray, and yellow. The reddish coats for which they are named was typical of some Texan populations. Red wolves are smaller and more slender than their gray wolf cousins, but larger than coyotes. Adult males weigh 60 to 80 pounds, and females are smaller and weigh 40 to 60 pounds. Red wolves prefer to live in forests, swamps, and coastal prairies. Dens are often located in hollow trees, stream banks, and sand knolls. The red wolf's diet consists primarily of small mammals such as rabbits and rodents, but also includes insects, berries, and occasionally deer. Shy and secretive, red wolves hunt alone or in small family packs, and are primarily nocturnal. Red wolves are considered extirpated in Texas.

<u>Northern Scarlet Snake – Status: State Threatened and Federally Not Listed</u>

The Northern Scarlet Snake is a medium-sized snake measuring about 15 inches in length with young approximately 7.5 inches long. The snake has red to orange saddles with black edges that are separated by yellow bands that blend with its cream belly. The young have the same pattern except that the red saddles are pink. This snake prefers moist soils in forested areas that are easy to burrow into. Scarlet snakes kill young mice, small lizards, and snakes by constriction. Small eggs are swallowed whole, while larger eggs are punctured and their contents squeezed out.

<u>Timber Rattlesnake – Status: State Threatened and Federally Not Listed</u>

The timber rattlesnake (*Crotalus horridus*) is a state-listed threatened species in Texas. This species inhabits bottomland areas, primarily adjacent to major creeks or rivers where adequate underbrush is present. There is evidence of habitat segregation by sex and stage of maturity, where adult males and immature, or non-gravid females utilize closed canopied areas near the streams while adult females prefer less canopy cover and more ground debris. Additionally, gravid females are often associated with sandy roads when they are located in proximity of streams (Reinert and Zappalorti, 1988). The primary diet of this species is rodents; therefore, an abundant rodent population is an important food resource. It has been determined that the presence of logs within the habitat are an important consideration (Reinert, et.al., 1984). This species hibernates in burrows near the stream course, which in some cases extend to the water table (Reinert and Zappalorti, 1988).

Alligator snapping turtle – Status: State Threatened and Federally Not Listed

The Alligator Snapping Turtle is the largest freshwater turtle in North America. Larger than the Common snapper, it possesses many similar characteristics, such as a large head, a long tail, and a small cross-shaped grayish brown plastron. In its mouth, the Alligator snapper possesses a "lure," a wormlike projection that is moved to attract prey into the turtle's mouth. As well as having an extra row of scutes on each side, the carapace also features prominent dorsal keels that are raised and curved posteriorly. The carapace is generally brown or blackish in color, is very rough and often has algae growing on it. The turtle's skin is dark brownish to grey on top, and lighter on the bottom.

Sticking mostly to river systems that drain into the Gulf of Mexico, the Alligator Snapping Turtle can be found in the north from Kansas, Illinois, and Indiana, to the Gulf; including Florida and eastern Texas. Alligator Snapping Turtles are massive and have been documented as weighing in at well over 200 pounds, with a shell length of 79cm (31 in) and heads as large as 24 cm (9.5 in). They are highly aquatic and prefer large slow-flowing streams or tributaries with large holes and mud at the bottom. They can also be found in canals, lakes, oxbows, swamps, ponds and bayous.

Texas Horned Lizard – Status: State Threatened and Federally Not Listed

The Texas horned lizard (*Phrynosoma cornutum*) prefers open, arid, and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush, or scrubby trees. The decline of the Texas horned lizard is attributed to fire-ant invasion, agricultural practices, and urbanization.

Louisiana Pine Snake – Status: State Threatened and Federal Candidate

The Louisiana pine snake is a relatively large constricting snake that hisses loudly, vibrates its tail, and is apt to strike vigorously when first encountered. Its head appears disproportionately small. This snake is a good burrower and useful in controlling rodents. Their food consists largely of small mammals, but they also prey on birds and their eggs, and lizards. The Louisiana pine snake chiefly occurs on sandy soils in longleaf pine woods in west-central Louisiana and east Texas. Stands of longleaf pines have not been reported to occur in the Permit Area (FNI, 2003, and LAN, 1991b); therefore, the Louisiana pine snake is not expected to occur in the Permit Area.

Neches River Rose-Mallow – Status: State Not Listed and Federal Candidate

The Neches River rose-mallow is found in East Texas Prairie wetlands in areas of open sun. Populations are generally located within floodplains of permanent streams or rivers (e.g., Angelina, Neches, and Trinity Rivers) in East Texas that flood at least once a year. The base of the plants is normally in standing water early in the growing season, with water levels dropping but never drying out completely until late in the growing season. Some populations remain wet throughout much of the year. The Neches River rose-mallow occurs in marshes along the Neches River, borrow pits along highways, and in hydric soils in marshland complexes.

There is a possibility of the occurrence of the Neches River rose-mallow in the Permit Area, if habitat exists. TPWD reported that construction of the proposed reservoir would cause the loss of a site for the Neches River rose-mallow, but the report did not give the location of the site with respect to the proposed reservoir location (TPWD, 1998). During subsequent field work efforts, natural resource agency team members expressed interest in its potential occurrence in the Permit Area and made a conscious effort to look for the species during field efforts, but found none (FNI, 2006a).

Macroinvertebrates

There are no state or federally protected aquatic invertebrate species within the Mud Creek watershed, which includes portions of Smith, Cherokee, Nacogdoches, and Angelina counties. There are 12 mussel species considered to be rare by TPWD (2008) that are of potential or known presence within each of the four counties (Table 4.8.4-2). While the range of occurrence could include the four counties for all 12 species, TPWD's county lists only show the creeper (*Strophitus undulates*) as listed for Cherokee, Nacogdoches, and Smith counties, the fawnsfoot (*Truncilla donaciformis*) as listed for Smith and Cherokee counties, and the little spectacle case (*Villosa lienosa*) as listed in Smith County. The county lists provide a stronger estimate of the likelihood of a specie's presence in that area, probably based upon verified records. The remaining species have been verified as occurring, at least historically, in one or more of the four counties by Howells et al (1996).

4.8.4.2 Environmental Consequences

4.8.4.2.1 No Action Alternative

No direct impacts to threatened or endangered species would result from the No Action alternative. Existing vegetational and aquatic communities are expected to change over time due to forestry, grazing, and/or oil and gas activities, the habitats within which these species may occur may also decrease. The general cyclic trend towards managing for low-diversity pine forest or improved pasture would tend to decrease the habitats preferred by listed species.

Table 4.8.4-2 Mussels Designated "Rare" by TPWD

Common Name	Scientific Name
Creeper (squawfoot)	*Strophitus undulatus*
Fawnsfoot	*Truncilla donaciformis*
Little spectaclecase	*Villosa lienosa*
Louisiana pigtoe	*Pleurobema riddellii*
Pistolgrip	*Tritogonia verrucosa*
Rock-pocketbook	*Arcidens confragosus*
Sandbank pocketbook	*Lampsilis satura*
Southern hickorynut	*Obovaria jacksoniana*
Texas heelsplitter	*Potamilus amphichaenus*
Texas pigtoe	*Fusconaia askewi*
Wabash pigtoe	*Fusconaia flava*
Wartyback	*Quadrula nodulata*

Source: TPWD, 2008

4.8.4.2.2 Proposed Action

Construction

Adverse effects to federally listed T/E species are not expected to occur as a result of construction of the proposed Project. No federally or state listed T/E species have been encountered during Permit Area-specific investigations performed to date (LAN, 1991b, Hicks, 1994 and FNI, 2003a).

The only federally listed T/E species that have been reported to occur by the USFWS in either Smith or Cherokee counties is the red-cockaded woodpecker (RCW). Investigations of potential habitat for the RCW have been performed within and adjacent to the Permit Area (FNI, 2003a). Initial investigations of the Permit Area performed by TPWD in 1993 were evaluated followed by coordination with TPWD and USFWS personnel familiar with the local distribution of the RCW within and around the Permit Area. Based upon an intensive field investigation of potential RCW habitat sites by a qualified biologist after consultation with both TPWD and USFWS personnel, no areas of potential RCW habitat were observed within the Permit Area (FNI, 2003a). Communications with the Texas Forest Service and a local consulting forester also indicated no RCWs or suitable forest stand characteristics occurring within the Permit Area (FNI, 2003a). Based upon these studies and communication with local experts, the proposed reservoir would have no adverse effects on the RCW or RCW habitat.

Operation

Similar to Construction, no adverse effects to T/E species are expected to occur as a result of operation of the proposed reservoir.

4.8.4.2.3 Toledo Bend Pipeline Alternative

Under the Toledo Bend Pipeline alternative, it is possible that threatened or endangered species could be impacted. The pipeline would cross through Sabine National Forest. A large number of both federal (4) and state (19) listed threatened or endangered species have the potential of occurring in counties traversed by the pipeline, particularly in Sabine National Forest in Shelby County, but also Rusk and Cherokee counties.

The U.S. Forest Service (USFS) believes significant additional right-of-way would be required through the Sabine National Forest for a pipeline of that size (Stover, 2007), as shown on Figure 3.3-1. There are known colonies of red-cockaded woodpeckers in the Sabine National Forest, and there is the possibility of other T/E species occurring as well. Assuming a 100-foot wide pipeline construction right-of-way, Table 3.4-1 indicates that approximately 160 acres along 13 miles of national forest land would be potentially impacted. Such impacts would add to habitat fragmentation associated with timber removal that could bisect large areas of contiguous forestland. Moreover, Stover (2007) concludes the construction could result in the removal of more than 60 acres of mature timber which would require an authorization from the USFS, for which they stated that an EIS would likely be required.

4.8.4.3 Cumulative Effects

As the above information describes, there are eight federal and/or state listed bird species in Smith and Cherokee Counties, two state listed fishes, four federal and/or state listed mammals, four state listed reptiles, one federal and state listed reptile, and one federal listed plant species (in Cherokee County only). A total of 20 species are listed for Cherokee County, with 18 listed for Smith County (Table 4.8.4-1). The federal listing includes three endangered species (interior least tern, red-cockaded woodpecker, and red wolf), two threatened species (piping plover and Louisiana black bear), two candidates for listing (Louisiana pine snake and Neches River rose-mallow), two delisted species (Aortic peregrine falcon and American peregrine falcon), and one delisted but monitored species (bald eagle). The state listing includes four endangered species (interior least tern, American peregrine falcon, red-cockaded woodpecker, and red wolf). A total of 15 species is on the state’s threatened species list (Aortic peregrine falcon, Bachman’s sparrow, bald eagle, piping plover, wood stork, creek chubsucker, paddlefish, black bear, Louisiana black bear, Rafinesque’s big-eared bat, northern scarlet snake, timber/canebrake rattlesnake, alligator snapping turtle, Texas horned lizard, and Louisiana pine snake). There are no federally or state protected invertebrate species within the Mud Creek watershed.

Brief summary information is included above on each listed species, and in some cases referral is made to their potential presence in the Permit Area following construction of the proposed Lake Columbia Project. For example, bald eagles, interior least terns, and American peregrine falcons may occur near surface-water reservoirs. Red-cockaded woodpeckers make their home in mature pine forests, and the Permit Area and its vicinity could include such mature trees.

No direct effects to threatened or endangered species would result from the No Action alternative. Accordingly, no examination of cumulative effects was conducted.

Adverse effects to the federal or state listed threatened or endangered species are not expected to occur as a result of the construction and operation of the Proposed Action (the proposed Lake Columbia Project). Accordingly, no examination of cumulative effects associated with other past, present, and future actions were pursued. In addition, ANRA's Mitigation Plan (Appendix C) would aid in precluding adverse effects on listed species.

As noted above, the Toledo Bend Pipeline alternative would likely include the removal of more than 60 acres of mature pine forest which is known habitat for red-cockaded woodpeckers in the Sabine National Forest. This action alone would cause significant impacts on this federal and state-listed endangered species, and the procurement of necessary authorization from the U.S. Forest Service would be problematic. The influence of other actions on this species in this area was not studied in detail. Further, no comprehensive study of direct and cumulative effects on other threatened or endangered species was conducted.

4.9 CULTURAL RESOURCES (PREHISTORIC AND HISTORIC)

4.9.1 Section 106 Consultation

4.9.1.1 Federal and State Regulations

ANRA's Proposed Action to construct the Lake Columbia water supply reservoir would represent a federally permitted undertaking with the potential for damaging or destroying historic properties, such as prehistoric and historic archeological sites and historic structures and districts. According to existing federal laws and guidelines designed to preserve and protect the nation's cultural heritage, including Sections 106 and 110 of the National Historic Preservation Act (NHPA) of 1966 (P.L. 89-665; 16 U.S.C. 470 et seq.), as amended through 2000 (P.L. 91-243, P.L. 93-54, P.L. 94-422, P.L. 94-458, P.L. 96-199, P.L. 96-244, P.L. 96-515, P.L. 98-483, P.L. 99-514, P.L. 100-127, P.L. 102-575, P.L. 103-437, P.L. 104-333, P.L. 106-113, P.L. 106-176, P.L. 106-208, and P.L. 106-355); NEPA of 1969 (P.L. 91-190; 83 Stat. 852; 42 USC §4221 et seq.); and Executive Order Number No. 11593 of 1971, "Protection and Enhancement of the Cultural Environment", the USACE is required to assess the potential of the proposed undertaking to adversely affect historic properties. In addition, ANRA, the Project sponsor, represents a political subdivision of the State of Texas. Consequently, the proposed Project would also fall under the jurisdiction of the Antiquities Code of Texas (Texas Natural Resource Code of 1977 [revised 1987], Title 9, Chapter 191, VACS, Art. 6145-9).

Under existing federal and state regulations, the USACE (under the NHPA) and ANRA (under the Antiquities Code of Texas) are required to provide for an evaluation of the potential impact of the proposed undertaking on significant cultural resources within the Project area. The significance of cultural resources is determined based on their eligibility for inclusion in the National Register of Historic Places (NRHP) under federal law and for designation as Texas State Archeological Landmarks (SALs) under state law. The first step in this process involves developing an inventory of cultural resources present within the Project area, determining the significance of the resources based on their NRHP and SAL eligibility, and assessing the potential effects of the undertaking on significant or potentially significant cultural resources.

4.9.1.2 Memorandum of Agreement/Programmatic Agreement

To comply with Section 106 of the NHPA, the USACE would draft a Memorandum of Agreement (MOA) or Programmatic Agreement (PA) to serve as an agreement document among the USACE, the Advisory Council on Historic Preservation (ACHP), and the Texas Historical Commission (THC) that would include a mitigation plan for avoiding or minimizing adverse effects to historic properties within the proposed Lake Columbia Project area. This document would establish the extent and level of any additional activities necessary to develop a comprehensive inventory of cultural resources located within or potentially affected by the proposed undertaking, to evaluate potential impacts to historic properties eligible for inclusion in the NRHP and for designation as SALs, and to avoid, minimize, or treat any adverse effects to such historic properties.

4.9.1.3 Tribal Coordination

The Project area is located within the traditional homeland of the Caddo Tribe of Oklahoma (Caddo Tribe), and the USACE has invited the Caddo Tribe to comment on all cultural resources work associated with the proposed undertaking. Prior to the beginning of cultural resources investigations, the USACE initiated contact with the Caddo Tribe to develop a strategy for identifying and evaluating any archeological sites and TCPs that may exist within the Project area. The USACE would engage in ongoing consultation with the Caddo Tribe throughout the process of completing the cultural resources inventory, determining the significance of cultural resources, developing a plan to mitigate adverse effects to significant cultural resources, and developing the MOA or PA for the proposed undertaking.

4.9.1.4 Permit Area Description

For purposes of evaluating potential Project impacts on historic properties, the Permit Area of the proposed Lake Columbia Project refers to the area that would be potentially impacted physically, visually, audibly, and/or aesthetically by the proposed undertaking. This includes direct impacts associated with the construction of proposed Project facilities and impoundment of the proposed reservoir as well as indirect impacts associated with ongoing use and maintenance of the proposed reservoir and appurtenant facilities. By definition, the Permit Area includes the entire area associated with the proposed Lake Columbia Project that would be covered under the permit issued by the USACE. Based on discussions completed to date among the USACE, ANRA, and the THC, the Permit Area for cultural resources that has so far been defined includes the proposed normal conservation pool (i.e., the proposed reservoir impoundment delimited by the 315-foot (National Geodetic Vertical Datum [NGVD]) elevation contour, the acreage between the proposed normal conservation pool boundary and ANRA's proposed "purchase line" or "fee line" (demarcated by the 318-foot NGVD contour), and the proposed dam and spillway area. The Permit Area for the Lake Columbia Project, as currently defined for cultural resources, has been divided into three distinct components for purposes of discussion—the proposed normal pool, the proposed "purchase line" management zone, and the proposed dam and spillway area—and covers a total area of 12,370 acres (Owens, 2005).

In addition to these facilities, the Permit Area would include ancillary facilities associated with the construction and ongoing maintenance of the proposed reservoir. Such facilities may include borrow areas, temporary and/or permanent access roads built to facilitate movement of construction equipment and/or future recreational traffic, temporary and/or permanent utility lines (e.g., water pipelines, power transmission lines), temporary construction staging areas, and parks and other recreational facilities. At this time, such ancillary facilities have not yet been defined; consequently, discussion of the Permit Area within this document effectively refers only to the 12,370-acre area encompassed by the proposed normal pool, purchase area, and dam and spillway areas defined above.

4.9.2 Affected Environment

4.9.2.1 Geomorphological Reconnaissance Survey

Geomorphology, the study of landforms and the processes that shape them, seeks to understand why landscapes look the way they do, to understand landform history and dynamics, and to predict future changes through a combination of field observation, physical experimentation, and numerical modeling. Geomorphology is particularly important in archeological investigations because knowledge of the geological, fluvial, and sedimentological processes responsible for formation of the landscapes upon which archeological sites are situated helps to predict where archeological sites would be found, to identify archeological sites, and to evaluate the level of integrity of archeological deposits. Geomorphological studies are especially important in environments such as those that characterize the Permit Area in which many archeological sites may be buried and lack surface expression.

As outlined in the Scope of Work (SOW) for Phase Ia cultural resources investigations developed in consultation with the THC and the Caddo Tribe (Owens, 2005), the geomorphological study was intended to provide preliminary views of late Quaternary deposits and channel evolution processes in the Permit Area as well as a means of identifying areas where more intensive subsurface prospecting may be necessary to identify deeply buried cultural resource sites. Specific objectives of the geomorphic field reconnaissance were as follows:

- Develop a preliminary map of landforms and geomorphic features in the Project area that would serve to enhance and focus archeological survey activities.
- Conduct limited stratigraphic/subsurface examination by soil coring and/or mechanical trenching, possibly combined with limited radiocarbon dating of the landforms identified during geomorphic mapping activities, to form a preliminary impression of the age and depositional history of each feature.
- Identify areas within the Permit Area appropriate to more detailed future research aimed at studying geomorphic processes associated with historic properties that are determined to be significant as the result of the archeological survey.
- Evaluate the deep stratigraphy of the dam axis, where construction-related impacts are likely to be relatively deeper than in other portions of the Project area.

Geomorphology was used to develop a partial survey strategy. The work that was performed principally consisted of a limited subsurface/stratigraphic examination of the late Quaternary deposits of sample locations along Mud Creek in order to form an impression of the temporal activity of the stream and the potential of these deposits to obscure ancient prehistoric archeological sites.

The stratigraphy of Mud Creek was examined by means of subsurface investigations in three distinct areas in the lower, middle, and upper reaches of the Permit Area, and efforts were made to obtain a cross-section of the valley floor deposits in each one of these areas by means of limited backhoe trenching and soil coring. The geomorphic reconnaissance identified three alluvial stratigraphic units within the sampled portions of the Permit Area. Unit 1 consists of a sandy Pleistocene terrace, Unit 2 consists of first terrace fill, and Unit 3 is recent alluvium. Although none of these deposits were directly dated, the field evidence suggests that two of the three units (i.e., Units 2 and 3) are of Holocene age and have a potential for buried archeological sites.

At the present time, the first, second, and third of the above referenced objectives have been partially completed (the fourth objective was not addressed as the property on which the dam axis would be located was not available for study during the geomorphological reconnaissance). More detailed work within the Permit Area may result in discovery of additional alluvial units and allow for mapping of the units already identified, thereby helping to refine expectations about the locations and depths at which cultural resources sites might be encountered in areas outside the high-probability zones identified prior to the initiation of the Phase Ia archeological survey. Future work should include coring to evaluate the deeper deposits in the valley, additional trenching and radiocarbon dating to map and date the alluvial surfaces identified during the initial geomorphic reconnaissance, and additional survey work to identify possible additional alluvial structures in the Mud Creek floodplain.

4.9.2.2 Archival Research

Prior to initiating Phase Ia archeological survey fieldwork, documentation on file at the General Land Office (GLO), the National Park Service's (NPS's) online *National Register Information System* (NRIS), the THC's online *Texas Archeological Sites Atlas*, the THC's hard copy map files, and the Texas Archeological Research Laboratory (TARL) was reviewed. The goal of the archival research was to locate information on previously recorded cultural resource sites within and in the vicinity of the defined Permit Area, as well as to identify any previous cultural resource investigations conducted nearby. Archival research revealed that the segment of Mud Creek in which the proposed reservoir would be built has never been professionally studied by archeologists, architectural historians, or other cultural resource specialists. No cultural resource sites have been previously documented within the Permit Area. No records of any previous cultural resource surveys within the Permit Area were identified. No historic properties within or in the vicinity of the Permit Area have been listed on the NRHP or designated as SALs.

As no data directly pertaining to the potential density of archeological sites in the Permit Area was available, archeological studies of other reservoirs in East Texas were examined, including Lake Gilmer in Upshur County (HESI, 1992) and Lake Naconiche in Nacogdoches County (Perttula 2000, 2002) (Table 4.9-1). At Lake Gilmer in Upshur County, the survey area was 1,900 acres in size, and a total of 29 archeological sites were documented during the survey, including 22 aboriginal prehistoric sites and seven historic-age sites (five of the aboriginal sites also exhibited historic period cultural components). At Lake Gilmer, the density of archeological sites was 0.015 sites per acre surveyed, or one site per 65.5 acres. At Lake Naconiche in Nacogdoches County, the Project area covered a total of 1,254 acres, though only 500 acres of high-probability areas were surveyed. A total of 65 sites, including 62 newly documented sites and three previously recorded sites, were encountered during the survey of the 500 acres of high-probability areas, resulting in a site density of 0.13 sites per acre surveyed, or one site per 7.7 acres.

Table 4.9-1 Archeological Site Densities Recorded During Previous Surveys in East Texas

Name of Project	Counties	Size of Project Area (Acres)	Total Acres Surveyed	No. Sites Recorded	Site Density	Reference
Lake Gilmer	Upshur	1,900	1,900	29	1 site/ 65.5 acres	HESI 1992
Lake Naconiche	Nacogdoches	1,254	500	65	1 site/ 7.7 acres	Perttula 2000, 2002
Troup Mine	Rusk, Smith	35,000	33,200	248	1 site/ 133.9 acres	Skinner 1981

By way of contract, the archeological study of the proposed Troup Mine in Rusk and Smith counties was examined (Skinner, 1981). While the Troup Mine survey area was situated in a predominantly upland environment and is not necessarily comparable to the bottomland environments that characterize much of the Permit Area or the other reservoir studies cited above, the Troup Mine project area is located nearer to the Permit Area than the other reservoir projects. During the Troup Mine survey, a total of 33,200 acres of the overall 35,000-acre project area were surveyed, and 248 archeological sites were documented, resulting in a site density of 0.007 sites per acre surveyed, or one site per 133.9 acres.

The site-density data from these previous studies in East Texas are not directly comparable to each other or to the Permit Area, though they represent the only available data set upon which to extrapolate the number of sites expected to be found in the Permit Area. At Lake Gilmer, for example, the entire 1,900-acre project area was surveyed, while only about 40% of the proposed Lake Naconiche reservoir (i.e., only those areas identified as having a high probability to contain archeological sites) was surveyed. As a result, the overall archeological site density was much higher at Lake Naconiche (one site per 7.7 acres) than at Lake Gilmer (one site per 65.5 acres). Furthermore, the physiographic environment of the Permit Area is not necessarily comparable to the environments of these other East Texas reservoirs. Mud Creek possesses a much wider floodplain than either Lake Gilmer or Lake Naconiche, and most of the lower elevations in the Mud Creek basin have been characterized as having a low-probability for archeological sites; thus, an overall lower site density may be expected in the Permit Area than those documented during previous studies of other reservoirs. Nevertheless, based on the data from these previous studies, the density of archeological sites that may be expected in the 12,370-acre Permit Area may range from as low as 189 sites (projected from Lake Gilmer data) to as many as 1,606 sites (projected from Lake Naconiche data). Projected from the Troup Mine data, the Permit Area would be projected to contain 92 sites.

4.9.2.3 Archeological Survey

Prior to initiating archeological fieldwork, a SOW for Phase Ia cultural resources investigations was developed in consultation with the THC and the Caddo Tribe (Owens, 2005). Under existing federal and state laws, a 100% survey of the Permit Area would be required to identify all historic properties that potentially would be impacted by the proposed undertaking. However, as resources available for the current phase of investigations would not permit a 100% survey of the Permit Area, the intention of the Phase Ia survey was to survey a sample subset of the overall Permit Area that would provide a representative cross-section of the types and density of cultural resources present in the Permit Area. Thus, a "probability model" was developed in consultation with the THC and the Caddo Tribe that was intended to identify a representative cross-section of cultural resources present in the Permit Area that accurately models the complete population of the Permit Area's cultural resources. The archeological survey results reported in this section are the result of this probabilistic survey of a sampled subset of the overall Permit Area and do not represent a 100% survey of the Permit Area's cultural resources. Future survey-level investigations would be necessary to develop a comprehensive inventory of cultural resources present in the Permit Area to comply with the requirements of the NHPA and the Antiquities Code of Texas.

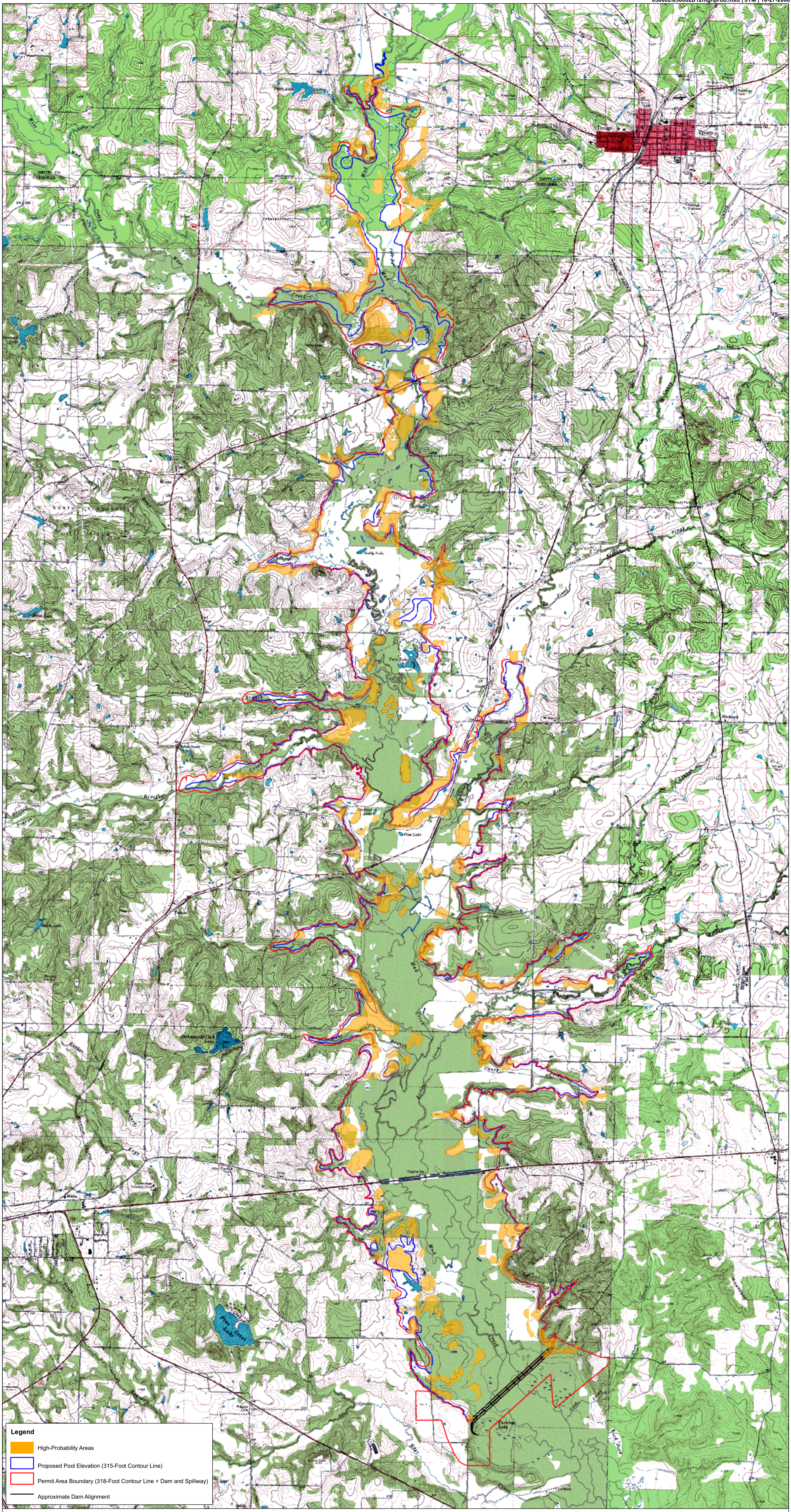
The probability model that was developed to guide Phase Ia cultural resources investigations stratified the Permit Area into physiographic environments with "high," "moderate," and "low" probabilities for containing cultural resources that could be located quickly using basic surveying techniques (i.e., pedestrian walkover and shovel testing). The probability model was designed to maximize the number of sites encountered given the resources available for fieldwork rather than to provide a complete inventory of sites that may be present within the Permit Area. The high-probability landforms identified in the model tend to represent likely locations for later prehistoric (i.e., Caddoan) archeological sites and, to a lesser degree, earlier prehistoric sites. Earlier prehistoric sites may be located on any type of physiographic landform, including those defined as high-, moderate-, and low-probability, but low-probability environments, as defined here, generally consisted of marshy lowlands that are difficult to survey using conventional techniques. By focusing survey activities during the Phase Ia survey on the high-probability landforms, it was anticipated that more archeological sites could be documented for the time and resources allocated. By maximizing the number of sites that could be recorded given the resources available, it was anticipated that the overall number and diversity of site types recorded would be maximized and be representative of the overall population of sites in the Permit Area.

A total of 208 high-probability areas were identified inside and adjacent to the Permit Area that cover a cumulative total of 2,064 acres (Figure 4.9-1). All or portions of 160 of these 208 high-probability areas occur within the defined Permit Area, covering a total area of 1,272 acres, or approximately 10.3% of the 12,370-acre Permit Area. High-probability areas for aboriginal cultural resources included alluvial formations on floodplains, along valley margins, and at the mouths of tributary streams where they discharge into lower-order stream floodplains. In Mud Creek, such areas included sandy ridges bordering stream meander scars on the floodplain; alluvial fans and terraces on the floodplain, along valley margins, and at the mouths of tributary streams; similar landforms along higher-order tributary streams; topographically elevated ridges and rises in otherwise low-lying, partially or totally inundated floodplain settings; alluvial and/or colluvial landforms at the mouths of tributary streams where they discharge into the Mud Creek floodplain; and upland settings near springs or other perennial water sources. During the archeological fieldwork, high-probability landforms located within and immediately beyond the Permit Area were surveyed. While a small fraction (less than 5%) of the high-probability areas were not surveyed due to their relative inaccessibility, the vast majority of these landforms were intensively surveyed for cultural resources.

Moderate-probability areas for aboriginal cultural resources included areas lying between high-probability landforms along valley margins outside of seasonally or permanently inundated floodplains. Moderate-probability areas were not specifically delineated on project maps or quantified by number or acreage; rather, moderate-probability areas were identified during the fieldwork. Moderate-probability areas were judgmentally surveyed for cultural resources based on available time and accessibility, usually while field crews were moving from one high-probability area to another.

Low-probability areas for cultural resources included low-lying, permanently or seasonally inundated floodplain settings; steeply sloping valley margins; some landforms lacking a developed B horizon; and some upland settings. Floodplain settings in general have a low probability for historic-age cultural resources, though elevated alluvial formations may represent suitable historic habitation sites. Steep valley margins (i.e., those with slopes greater than approximately 20%) have a low potential to contain any cultural resources. Low-probability areas also included any landform that has experienced extensive damage from natural (e.g., erosion, animal burrowing) or artificial (e.g., construction, timber clearing, plowing, residential and commercial development) impacts. Low-probability areas also were not specifically delineated prior to the beginning of fieldwork, but were expected to be largely coextensive with the bottomland wetland environments identified during earlier wetland studies (USACE, 2003a). A small sample of low-probability areas was surveyed, though the low-lying portions of the Mud Creek and tributary floodplains near the primary stream channels and channel meanders were not surveyed.

The Phase Ia archeological survey resulted in the documentation of 37 previously unrecorded archeological sites, including 30 aboriginal sites, four historic-age sites, and three sites containing both aboriginal and historic-age cultural components (Table 4.9-2) (Owens et al., 2006). Based on available information, cultural components on aboriginal sites consist of approximately equal numbers of ceramic sherd and lithic artifact scatters that likely represent a range of Caddoan campsites, hamlets, and villages on the one hand,



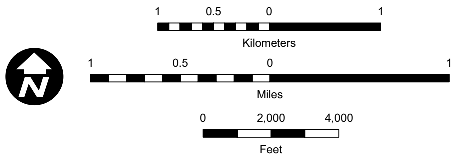
MAP SOURCE:

USGS, 7.5' SERIES, TEXAS QUADRANGLES:
GRIFFIN (1973), JACKSONVILLE EAST (1973), NEW SUMMERFIELD (1973), TECULA (1973), TROUP EAST (1973), TROUP WEST (1973)

USGS, 7.5' SERIES, TEXAS DIGITAL ELEVATION MODEL (DEM):
GRIFFIN (1998), JACKSONVILLE EAST (1998), TECULA (1998)

USGS, 7.5' SERIES, TEXAS DIGITAL LINE GRAPH (DLG):
GRIFFIN (1998), JACKSONVILLE EAST (1998), TECULA (1998)
NEW SUMMERFIELD (1998), TROUP WEST (1998)

Horizon Environmental Services, Inc.



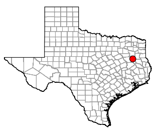


FIGURE 4.9-1
HIGH-PROBABILITY AREA LOCATION MAP
LAKE COLUMBIA WATER SUPPLY PROJECT
CHEROKEE AND SMITH COUNTIES, TEXAS

NOTE: THE 315-FOOT POOL ELEVATION LINE WAS SUPPLIED BY FREESE & NICHOLS, 2005.

THE 318-FOOT ELEVATION LINE WAS DERIVED USING QUICKSURF VERSION 5.1 AND DIGITAL DATA FROM DIGITAL LINE GRAPHS (DLG) AND DIGITAL ELEVATION MODELS (DEM).

Table 4.9-2 Management Summary of Cultural Resources Recorded During Phase Ia Survey

Permanent Trinomial	Temp. Site No.	Cultural/ Chronological Affiliation	Site Type	Potential Project Impacts	NRHP/ SAL Eligibility	Recommendation
Archeological Sites						
41CE367	DD-001/2	Archaic (?); Caddoan (Early?)	Campsite; Caddoan hamlet	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE368	DD-003	Trans. Archaic; Early Ceramic; Late Caddoan	Campsite; Caddoan hamlet	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE369	DD-004	Caddoan hamlet/ Mid-/late 19th to early/mid-20th centuries	Caddoan hamlet; EuroAmerican industrial site	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE370	DD-005	Unknown Caddoan	Caddoan hamlet	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE371	DD-006	Early Ceramic (?); Unknown Caddoan	Campsite; Caddoan hamlet	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE372	DD-007	Unknown prehistoric (Archaic?)	Lithic scatter	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE373	DD-008	Unknown prehistoric (Archaic?)	Lithic scatter	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE374	DD-009	Early to Middle Archaic	Calf Creek projectile point	Shoreline	Potentially Eligible	Avoidance/ Eligibility testing
41CE375	DD-010	Unknown prehistoric; Late 19th to early 20th centuries (?)	Lithic scatter; Historic farmstead (?)	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE376	DD-011	Middle Caddoan	Caddoan hamlet	Inundation/ Shoreline (?)	Potentially Eligible	Avoidance/ Eligibility testing
41CE377	DD-012	Early Ceramic; Middle to Late Caddo Period	Campsite; Caddoan hamlet	Inundation/ Shoreline	Potentially Eligible	Avoidance/ Eligibility testing
41CE378	DD-013	Unknown prehistoric	Lithic scatter	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE379	DD-014	Unknown prehistoric	Lithic scatter	Inundation/ Shoreline	Potentially Eligible	Avoidance/ Eligibility testing

Permanent Trinomial	Temp. Site No.	Cultural/ Chronological Affiliation	Site Type	Potential Project Impacts	NRHP/ SAL Eligibility	Recommendation
41CE380	DD-015	Early Ceramic	Campsite	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE381	DD-016	Unknown prehistoric	Lithic scatter	Inundation/ Shoreline	Potentially Eligible	No further work
41CE382	DD-017	Late 19th to early 20th centuries (?); Unknown prehistoric	EuroAmerican industrial site; Lithic scatter	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE383	DD-018	Early Ceramic; Middle to Late Caddoan	Campsite; Caddoan hamlet	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE384	DD-019	Late 19th to early 20th centuries	Historic farmstead	Shoreline	Potentially Eligible	Avoidance/ Eligibility testing
41CE385	RD-001	Middle to Late Caddoan	Caddoan hamlet	Shoreline/ Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE386	RD-002	Early Ceramic; Middle Caddoan	Campsite; Caddoan hamlet	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE387	RD-003	Historic unknown	Historic farmstead	Spillway Constructio n	Potentially Eligible	Avoidance/ Eligibility testing
41CE388	RD-004	Middle to Late Caddoan; Unknown prehistoric	Caddoan hamlet; Campsite	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE389	RD-005	Middle to Late Caddoan (Frankston Phase?); Early Ceramic	Caddoan hamlet; Campsite	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE390	RD-006	Middle to Late Caddoan; Early Ceramic	Caddoan hamlet/village; Campsite	Shoreline/ Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE391	RD-007	Unknown prehistoric	Lithic scatter	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE392	RD-008	Unknown prehistoric	Lithic scatter	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE393	RD-009	Middle Caddoan	Caddoan hamlet	Shoreline/ Inundation	Potentially Eligible	Avoidance/ Eligibility testing

Permanent Trinomial	Temp. Site No.	Cultural/ Chronological Affiliation	Site Type	Potential Project Impacts	NRHP/ SAL Eligibility	Recommendation
41CE394	RD-010	Historic unknown; Caddoan unknown	EuroAmerican industrial site; Lithic and ceramic scatter	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE395	RD-011	Historic unknown	Historic bridge	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE396	RD-012	Unknown prehistoric	Lithic scatter	Shoreline/ Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE397	RD-013	Unknown prehistoric	Lithic scatter	Shoreline	Potentially Eligible	Avoidance/ Eligibility testing
41CE398	RD-014	Unknown prehistoric	Lithic scatter	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE399	RD-015	Early Ceramic	Campsite	Shoreline/ Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE400	RD-016	Unknown prehistoric	Campsite	Shoreline	Potentially Eligible	Avoidance/ Eligibility testing
41CE401	RD-017	Unknown prehistoric	Lithic scatter	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE402	RD-018	Historic unknown	Historic bridge and elevated roadway	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
41CE403	RD-019	Early Ceramic	Campsite	Inundation	Potentially Eligible	Avoidance/ Eligibility testing
Historic Structures						
N/A	1	ca. 1925	Bungalow and large barn	Shoreline	Potentially Eligible	Avoidance/ Archival research
N/A	2	ca. 1925	Bungalow and agricultural resources	Shoreline	Potentially Eligible	Avoidance/ Archival research
N/A	3	ca. 1925	Bungalow and agricultural resources	Shoreline	Potentially Eligible	Avoidance/ Archival research
N/A	4	ca. 1910	Pyramidal-roofed bungalow	Shoreline	Ineligible	No further work
N/A	5	ca. 1955	Ranch-style house and outbuildings	Shoreline	Ineligible	No further work
N/A	6	ca. 1940; ca. 1955	Bungalow; Side-gabled house	Inundation	Ineligible	No further work

Permanent Trinomial	Temp. Site No.	Cultural/ Chronological Affiliation	Site Type	Potential Project Impacts	NRHP/ SAL Eligibility	Recommendation
41CE384	7	ca. 1890	Hall-parlor house	Shoreline	Potentially Eligible	Avoidance/ Archival research
N/A	8	Pleasant Plains Community	African American Freedman's Village	Shoreline	Potentially Eligible	Avoidance/ Archival research

Eligibility recommendations apply only to the portions of sites and features within the Permit Area and/or that were investigated. Site and feature areas outside the Permit Area and/or beyond documented site boundaries were not evaluated.

and lithic artifact scatters that may represent aceramic Caddoan or earlier PaleoIndian or Archaic period encampments on the other hand. All Late Prehistoric sites are considered to be affiliated with the Caddo based on the identified types of ceramics found on these sites. In addition, pre-Caddoan Woodland period components are suspected to exist on several sites that also have Caddoan components. Based on available data, aboriginal Archaic, Woodland, and Caddoan components are likely represented among the archeological sites, indicating aboriginal occupation in the Mud Creek basin as early as the Middle Archaic period (circa [ca.] 4500 to 3000 B.C.) and extending through the Late Caddoan period (ca. A.D. 1400 to 1680). No obvious cultural components associated with earlier PaleoIndian or Early Archaic periods were documented, though any of the lithic scatter sites may be found to date to these early periods. Similarly, no clear evidence of protohistoric or early historic aboriginal components has been observed to date. Many of the aboriginal sites appear to contain multiple cultural components, but these cannot be separated based on available information. Historic-age components on multiple-component sites and on exclusively historic-age sites include historic farmsteads, machinery mounts (such as sawmill boiler foundations and possible distilleries), and bridges, dating mostly from the late 19th to early 20th centuries.

Recommendations concerning the eligibility of the 37 archeological sites recorded during the Phase Ia survey for inclusion in the NRHP under Section 106 of the NHPA and for designation as SALs under the Antiquities Code of Texas have not yet been formalized. As it is often not possible to establish firm eligibility recommendations based exclusively on the limited data available at the survey level of investigation, it is likely that many of the archeological sites recorded in the Permit Area would be recommended as potentially eligible for inclusion in the NRHP and for designation as SALs and recommended for additional investigations in the future.

In addition to the 37 archeological sites, 25 isolated occurrences (IOs) of artifacts were recorded during the Phase 1a archeological survey. In general, whenever any cultural materials were observed during the survey, the find was delineated to determine the nature, extent, and quantity of the materials. By definition, IOs are cultural resource localities that did not warrant formal designation as archeological sites because cultural resources were present in extremely small numbers and lacked any contextual associations that would help identify the functional or chronological associations of the items. In practice, any occurrence of a single, isolated artifact in either surface or subsurface contexts that lacked any apparent associations with other cultural resources or datable paleosols was designated as an IO, unless exceptional circumstances warranted its designation as a site (this occurred in only one case).

All of the IOs encountered during the Phase Ia archeological survey lack sufficient manifestation of cultural resources to warrant designation as archeological sites. Based on their lack of integrity and/or ephemeral presence, all 25 IOs in the Permit Area are recommended as ineligible for inclusion in the NRHP and for designation as SALs.

At the present time, 37 archeological sites have been documented within the approximately 1,272 acres of high-probability areas surveyed during Phase Ia investigations, resulting in a site density of 0.03 site per acre, or one site per 34.4 acres, of area surveyed. The density of archeological sites documented during the sample survey of the Permit Area is lower than the site density recorded at Lake Naconiche (Perttula 2000, 2002) and higher than the site densities recorded at Lake Gilmer (HESI, 1992) and Troup Mine (Skinner 1981) (Table 4.9-1). Based on the site density projections for the Permit Area based on cultural resources surveys of other reservoir and mine projects in East Texas, the density of archeological sites that may be expected in the 12,370-acre Permit Area may range from as low as 189 sites (projected from Lake Gilmer data) to as many as 1,606 sites (projected from Lake Naconiche data). Based on the Troup Mine data, the Permit Area would be projected to contain 92 sites. Thus, the 37 sites recorded to date in the Permit Area represent as little as 2.3% to as much as 19.6% of the total number of sites that may be expected to exist in the Permit Area based on previous research.

Additional survey would be necessary to develop a 100% inventory of all cultural resources that exist within the Permit Area. At the present time, primarily high-probability areas within the Permit Area have been surveyed; the rest of the Permit Area would need to be surveyed in the future to provide 100% spatial coverage of the Permit Area. In addition, survey methods utilized during the Phase Ia survey consisted only of pedestrian walkover and shovel testing. Shovel testing is capable of detecting cultural resources buried at depths of up to about 40 to 60 centimeters in clayey sediments and up to 100 to 150 centimeters in loose, sandy sediments. The initial geomorphological reconnaissance conducted during Phase Ia investigations determined that Holocene-age sediments deeper than shovel testing is capable of reaching are present in the areas sampled during the initial geomorphic study. In addition, many of the high-probability areas surveyed during the archeological survey were found to contain deep sandy deposits extending deeper than shovel tests could be excavated. In general, it is necessary to conduct soil coring, augering, and/or mechanical trenching operations in areas with deep alluvial sediments to prospect for more deeply buried archeological deposits; in fact, these survey technologies are required under the Antiquities Code of Texas in such environments. However, due to the time constraints, access restrictions, and general remoteness of many of the surveyed portions of the Permit Area, it was not possible to implement survey techniques capable of fully penetrating Holocene-age sediments in all areas surveyed during the Phase Ia survey. Future work would also require coring, augering, and/or mechanical trenching in any previously surveyed area that was found to possess deep Holocene-age sediments that could not be fully penetrated via shovel testing. Additional survey-level activities to provide 100% coverage of the Permit Area would be undertaken in the future to comply with the requirements of federal and state law, including additional survey of the defined Permit Area as well as any ancillary facilities that have not yet been defined, such as borrow areas, temporary and/or permanent access roads built to facilitate movement of construction equipment and/or future recreational traffic, temporary and/or permanent utility lines (e.g., water pipelines, power transmission lines), temporary construction staging areas, and parks and other recreational facilities.

Historic contexts for the cultural resources documented in the Permit Area have not yet been specified. Historic contexts help to provide a cultural and historic background for evaluating the significance of cultural resources and aid in the assessment of NRHP and SAL eligibility for potential historic properties and districts. Samples of historic contexts pertinent to the aboriginal prehistoric and protohistoric past in East Texas are presented in Kenmotsu and Perttula (1993).

4.9.2.4 Historic Structures Survey

As part of the SOW for Phase Ia cultural resource investigations in the Permit Area, a historic structures survey, and accompanying historical and archival research, was conducted. The historic structures survey resulted in a total of seven non-archeological historic resources and one historic structure being recorded. Project architectural historians examined and minimally documented seven historic-age resources identified during archeological field investigations (including one archeological site containing a historic standing structure) (Table 4.9-2). In addition, the architectural historians discovered an eighth historic resource - the African American community of Pleasant Plains - which consists of nine related historic-age sites. The Pleasant Plains resource is not located within the proposed Lake Columbia reservoir footprint. Under the NRHP and the Antiquities Code of Texas, historic-age structures, objects, and districts are those of at least 50 years of age. In practice, historic structures and objects dating to 1960 or earlier (i.e., 45 years old) were recorded, providing a buffer that would enable historic structures investigations to remain up-to-date until 2010.

The historic structures reconnaissance survey entailed minimal documentation of the selected resources, most of which are front- or side-gabled, frame bungalows and associated outbuildings dating to the 1910s and 1920s. The apparent temporal limits of historic development among the sampled population of historic structures are defined by a ca. 1890, L-plan Folk Victorian House and a ca. 1955, Ranch-style house, plus their associated outbuildings. The minimal documentation employed during the survey entailed archival research, a field reconnaissance-level survey, and documentation of salient architectural characteristics of identified sites to a level sufficient to establish the approximate dates of original construction and of any subsequent alterations. Archival and secondary-source research was conducted in Jacksonville, Rusk, and Austin, Texas, to establish historic ownership and use of some sites and their general relationship to the historic development of north-central Cherokee and southern Smith counties. This research was conducted at the Cherokee County Clerk's office, Cherokee County Tax Appraisal District, Cherokee County Historical Commission, Rusk Public Library, Texas State Library and Archives, General Land Office, and the Barker Texas History Collection at the Center for American History of The University of Texas at Austin. Full documentation of any historic-age architectural resources determined to be eligible for inclusion in the NRHP in the future would entail documentation of the properties per Historic American Buildings Survey (HABS) standards.

Historic Site 1 consists of a ca. 1925 frame bungalow and a large horse or dairy barn. Both resources were overgrown with vegetation and no related features, such as wells or cisterns, were found. Historic Sites 2 and 3 are nearly identical, ca. 1925, front-gabled bungalows and associated agricultural buildings, including barns and sheds. A single road accesses the two sites; small two-track lanes peel off the main dirt road in opposite directions to the farmsteads. Historic Site 4 is a ca. 1910, pyramidal-roofed bungalow and chicken house. Historic Site 5 consists of a ca. 1955, Ranch-style house and contemporaneous agricultural outbuildings. Historic Site 6 contains a ca. 1940, front-gabled bungalow and a ca. 1965, side-gabled house. The ca. 1940 house is the newest of the frame bungalows in the Project area and was likely a pre-World War II farm house. Historic Site 7 is a ca. 1890, hall-parlor plan house with a hipped porch and exposed rafter ends more common to bungalows of the early 20th century. Like the other dwellings in the Permit Area, this was probably a farm house.

Historic Site 8, the Pleasant Plains Community, contains the only civic properties and appears to represent a rare example of an African American Freedman's Village constructed after Emancipation. It consists of several farmsteads (Sites 8C, 8D, 8E, 8F, and 8G), with houses dating from ca. 1900 to ca. 1925, a cemetery (Site 8A) with headstones ranging from 1883 to 2004, a ca. 1970 church situated on an earlier church site (Site 8H), and a ca. 1920 school (Site 8I). Barns, sheds, and other agricultural resources dating to the 1920s and 1930s stand near the houses on their 10- to 20-acre plots. From the apparent construction dates, this community appears to have been founded in ca. 1870, peaked in the 1920s, and declined thereafter, though it is still a functioning community today. The only post-World War II construction in the community consists of a single manufactured house erected on Site 8F and a now-vacant church building (Site 8H) constructed in the 1970s.

Historic Site 8, the Pleasant Plains Community, is potentially eligible for listing in the NRHP as a historic district. Historic Sites 1, 2, 3, and 7 are potentially eligible for listing in the NRHP. Further research would be necessary to determine the historic significance of these resources and to make final recommendations regarding NRHP eligibility.

Because of their age, condition, and/or extensive alterations, Historic Sites 4, 5, and 6 are likely ineligible for inclusion in the NRHP.

One historic cemetery was recorded in the Pleasant Plains Community, but it has been determined that this cemetery would be outside of the area of reservoir inundation. No other historic-age cemeteries were observed in the Permit Area during the archeological or historic structures surveys conducted to date.

Historic contexts have not yet been developed for historic-age resources documented in the vicinity of the Permit Area. Historic contexts help to provide a cultural and historic background for evaluating the significance of historic-age resources. Samples of historic contexts pertinent to the aboriginal prehistoric and protohistoric past in East Texas are presented in Kenmotsu and Perttula (1993). Comparable historic contexts for the Anglo-American historic period would need to be developed in the future to aid in the assessment of NRHP and SAL eligibility for potential historic properties and districts documented in the vicinity of the Permit Area.

The reconnaissance-level historic structures survey conducted during Phase Ia investigations targeted a sample of resources that were identified during the archeological survey as being of historic age and potentially meriting further study, thereby providing an estimate of the range of historic-age resources in the vicinity of the Permit Area. Additional reconnaissance-level historic structures survey work would be needed in the future to fully inventory all non-archeological resources of historic-age in the Permit Area that may be impacted as a result of the proposed undertaking, including additional survey of the defined Permit Area as well as any ancillary facilities that have not yet been defined, such as borrow areas, temporary and/or permanent access roads built to facilitate movement of construction equipment and/or future recreational traffic, temporary and/or permanent utility lines (e.g., water pipelines, power transmission lines), temporary construction staging areas, and parks and other recreational facilities. In addition, mitigative measures, such as full documentation per HABS standards, would be required of any historic resources in the Permit Area determined to the eligible for the NRHP that would be adversely affected by the proposed undertaking.

4.9.2.5 Paleontological Resources

Although paleontological resources are often considered to be geological in nature rather than cultural resources, several environmental regulations have been interpreted to include fossils as cultural resources. The Antiquities Act of 1906 refers to historic or prehistoric ruins or any objects of antiquity situated on lands owned or controlled by the government of the United States. In this case, “objects of antiquity” has been interpreted to include fossils by the National Park Service (NPS), the Bureau of Land Management (BLM), the U.S. Forest Service (USFS), and other federal agencies. In the case of Section 106 of the National Historic Preservation Act of 1966 (NHPA), paleontological resources are not applicable unless they are recovered within culturally related contexts (e.g., fossils included within human burial contexts, a mammoth kill site, etc.). Finally, the

National Register of National Landmarks (NRNL) defines a significant National Natural Landmark (NNL) as an area that is one of the best examples of, among other things, fossil evidence of the development of life.

The proposed Lake Columbia reservoir is situated within the Gulf Coastal Plains region. Investigations into the faunal prehistory of the surrounding region have been somewhat less productive in regard to recovery of vertebrate remains as compared to many other parts of the state. Geologic surface deposits become younger as one moves toward the Gulf shore throughout the Texas Gulf Coastal Plains. This trend is due to a tilting of deposits toward the southeast that occurred as a result of upthrust, which, in turn, formed the lower extension of the Appalachian Mountain range. The northeast-to-southwest oriented banding of deposits represents a range of time from the Paleocene (65 to 54.8 million years ago) to the Holocene (10,000 years ago to present). Throughout the Texas Gulf Coastal Plains, few vertebrate remains are found in the few Paleocene outcrops investigated. Likewise, little faunal recovery has been achieved in the Eocene and Oligocene deposits in the area. Miocene deposits have produced megafaunal remains, such as rhinoceros and pachyderm. Eocene deposits located farther to the south and east have yielded whale and crocodile specimens, while Pleistocene deposits, located farther south and east along the coastline, have ceded a wealth of specimens, including extinct horse, camel, mastodon, bison, and giant sloth.

According to the *Geologic Atlas of Texas*, the proposed Lake Columbia reservoir is situated on a combination of Eocene deposits, including Queen City Sand and the Reklaw Formation, as well as Holocene alluvium. With the proposed reservoir located squarely in the traditionally nonproductive Eocene depositional band, the likelihood of significant paleontological specimens existing is considered to be generally low. A transition from Mesozoic to Cenozoic deposit exposures exists about 100 miles west of the proposed Lake Columbia reservoir. Cretaceous deposits to the west have been lucrative as related to faunal specimen recovery.

A review of the NPS's National Natural Landmark Guide indicated that there are no recorded NNL properties on the proposed reservoir site.

4.9.2.6 Summary of Results

A Phase Ia sample cultural resource inventory, including initial archeological, geomorphological, and historic structures surveys, has been completed. The survey has been sufficiently extensive to develop a profile of the types of cultural resources that are likely to exist within the Permit Area or that would be affected by construction of the proposed reservoir. One hundred sixty high-probability landforms, which cover approximately 10.3% of the land area within the Permit Area, were identified prior to initiating Phase Ia archeological survey activities, and most of this land area was intensively surveyed for cultural resources. In addition, some areas within the Permit Area located beyond the designated high-probability zones were surveyed at varying levels of intensity. Many areas within the Permit Area were covered in a deep, sandy mantle that likely dates to the Holocene period and, therefore, potentially contains subsurface cultural resources. Shovel testing was unable to penetrate to the bottom of the sandy Holocene sediments in all areas and backhoe trenching was not conducted during the archeological survey due to landowner permission and accessibility restrictions. In other areas, erosive forces and other natural and artificial factors had removed the overlying sandy mantle, resulting in exposure of more erosion-resistant, pre-Holocene sediments on or near the modern ground surface. These areas could be effectively surveyed with lower shovel testing intensity.

A total of 37 archeological sties, seven historic-age architectural sites (one of which was also documented as an archeological site), one historic-age community composed of nine separate historic-age sites, and 25 IOs were documented as a result of the survey. The sample cultural resource survey was conducted to provide the USACE with sufficient information to characterize the types of cultural resources likely to occur within the Permit Area, though not to develop an exhaustive inventory of all cultural resources located within the Permit Area. Initial survey activities are sufficient to establish the range of cultural resources that can be expected to occur within the Permit Area. A 100% survey of the Permit Area would be necessary to locate all cultural resources that may be potentially affected by proposed Project development.

Determinations of eligibility for inclusion in the NRHP are based on the criteria presented in the Code of Federal Regulations (CFR) in 36 CFR §60.4(a-d). The four criteria of eligibility are applied following the identification of relevant historical themes and related research questions:

> *The quality of significance in American history, architecture, archeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:*
>
> - *that are associated with events that have made a significant contribution to the broad patterns of our history; or,*
> - *that are associated with the lives of persons significant in our past; or,*
> - *that embody the distinctive characteristics of a type, period, or method of construction, or that represent a significant and distinguishable entity whose components may lack individual distinction; or,*
> - *that have yielded, or may be likely to yield, information important in prehistory or history.*

For an archeological resource to be eligible for inclusion in the NRHP, it must meet legal standards of eligibility that are determined by three requirements: (1) properties must possess significance, (2) the significance must satisfy at least one of the four criteria for eligibility listed above, and (3) significance should be derived from an understanding of historic context. As discussed here, historic context refers to the organization of information concerning prehistory and history according to various periods of development in various times and at various places. Thus, the significance of a property can best be understood through knowledge of historic development and the relationship of the resource to other, similar properties within a particular period of development. Most prehistoric sites are usually only eligible for inclusion in the NRHP under Criterion D, which considers their potential to contribute data important to an understanding of prehistory. All four criteria employed for determining NRHP eligibility potentially can be brought to bear for historic sites

The criteria for determining the eligibility of a prehistoric or historic cultural property for designation as an SAL are presented in Chapter 191, Subchapter D, Section 191.092 of the Antiquities Code of Texas. The Antiquities Code of Texas establishes the THC as the legal custodian of all cultural resources, historic and prehistoric, within the public domain of the State of Texas. Under Section 26.8 of Part 2 of Title 13 of the Texas Administrative Code (13 TAC 26), the THC may designate an archeological site as an SAL if the site meets one or more of the following criteria:

1. *The site has the potential to contribute to a better understanding of the prehistory and/or history of Texas by the addition of new and important information.*

2. *The site's archeological deposits and the artifacts within the site are preserved and intact, thereby supporting the research potential or preservation interests of the site.*

3. *The site possesses unique or rare attributes concerning Texas prehistory and/or history.*

4. *The study of the site offers the opportunity to test theories and methods of preservation, thereby contributing to new scientific knowledge.*

5. *The high likelihood that vandalism and relic collecting has occurred or could occur, and official landmark designation is needed to ensure maximum legal protection, or alternatively further investigations are needed to mitigate the effects of vandalism and relic collecting when the site cannot be protected.*

At the present time, NRHP and SAL eligibility have not been determined for the archeological sites recorded during the survey of the Permit Area. It is likely that eligibility testing would be necessary to determine the NRHP eligibility of most, if not all, of the aboriginal and some of the historic-age archeological sites under Criterion D, and at least additional archival research would need to be performed on historic-age sites lacking significant archeological deposits to determine their NRHP eligibility under

Criteria A, B, and C. Additional archeological sites may exist within the Permit Area, and survey and possibly eligibility testing may be necessary to establish the significance of any as-yet undiscovered archeological resources.

All of the IOs encountered during the Phase Ia archeological survey lack sufficient manifestation of cultural resources to warrant designation as archeological sites. Based on their lack of integrity and/or ephemeral presence, all 25 IOs in the Permit Area are recommended as ineligible for inclusion in the NRHP and for designation as SALs.

Historic Site 8, the Pleasant Plains Community, which is outside of the area of inundation of the proposed reservoir, is potentially eligible for listing in the NRHP as a historic district. Historic Sites 1, 2, 3, and 7 are potentially eligible for listing in the NRHP. Further research would be necessary to determine the historic significance of these resources and to make final recommendations regarding NRHP eligibility. Because of their age, condition, and/or extensive alterations, Historic Sites 4, 5, and 6 are recommended as ineligible for inclusion in the NRHP.

4.9.3 Environmental Consequences

4.9.3.1 No Action Alternative

No impacts to cultural resources in the Permit Area, beyond those experienced periodically under existing conditions, would result from the No Action alternative. Any substantive changes would focus on the possibility of other development independent of the proposed water supply Project and increased site looting. The No Action alternative would not result in any new impacts to cultural resources and TCPs beyond those that exist under current conditions.

4.9.3.2 Proposed Action

<u>Construction</u>

Lake Columbia Impoundment

Construction of the proposed reservoir would result in the impoundment of approximately 14 miles of the Mud Creek basin up to the 315-foot NGVD elevation contour. Any cultural resources located at or below this elevation within the Permit Area would be subject to permanent inundation and would experience adverse effects as a result of erosive actions resulting from wave action, wet/dry cycles, erodible soils, and permanent loss of sites from subsurface settling of inundated sediments. Additional impacts to sites would include increased access to exposed sites by increased recreation and threats from future lake development. In addition, any land-clearing activities conducted within the proposed impoundment area, such as tree clearing, may have an adverse effect on any archeological sites present in such areas. Long-term management plans would need to be developed to anticipate and mitigate impacts.

Twenty-three of the 37 recorded archeological sites are situated entirely at elevations lower than 315 feet (NGVD) and would be adversely affected by reservoir impoundment. These 23 sites are potentially eligible for inclusion in the NRHP and for designation as SALs; additional eligibility testing may be necessary to establish their significance. As these sites are located at or below the elevation of proposed reservoir inundation, they would be subject to adverse effects associated with erosive actions resulting from wave action, wet/dry cycles, erodible soils, and permanent loss of sites from subsurface settling of inundated sediments. In addition, any land-clearing activities conducted within the proposed impoundment area, such as tree clearing, may have an adverse effect on any archeological sites present in such areas.

One historic structures site (Historic Site 6) is similarly situated below 315 feet (NGVD); however, this site is likely ineligible for inclusion in the NRHP, so there would be no effect on listed historic properties.

Lake Columbia Shoreline

The proposed normal pool of the proposed reservoir would be established at an elevation of 315 feet (NGVD), and ANRA would maintain additional acreage up to the 318-foot (NGVD) elevation as a proposed management zone. Six archeological sites and six historic structures sites are located above the 315-foot (NGVD) proposed normal pool elevation of the proposed reservoir but would be located on or adjacent to the proposed shoreline. Seven additional archeological sites would be situated partially underwater (i.e., below the 315-foot [NGVD] proposed normal pool elevation) and partially along the shoreline (i.e., above the 315-foot [NGVD] proposed normal pool elevation).

These 13 archeological sites are potentially eligible for inclusion in the NRHP and for designation as SALs; additional eligibility testing may be necessary to establish their significance. Of the six historic structures sites located along the proposed shoreline, two are recommended as ineligible and four are potentially eligible for inclusion in the NRHP.

Being located along proposed shoreline areas may result in adverse impacts to any NRHP-eligible historic properties as a result of erosive actions resulting from wave action, wet/dry cycles, erodible soils, and permanent loss of sites from subsurface settling of inundated sediments. In addition, increased accessibility to the proposed reservoir shoreline may increase the potential for vandalism to cultural resource sites located in proposed shoreline areas. Future lake development may also have adverse effects on historic properties. In addition, any land-clearing activities conducted along the proposed shoreline, such as tree clearing and/or construction of lakeside recreational areas may have an adverse effect on any archeological sites present in such areas. Long-term management plans would need to be developed to anticipate and mitigate impacts.

Dam and Spillway

Construction-related impacts within the proposed dam and spillway area may create adverse effects for one cultural resource site located on the uplands overlooking Mud Creek on the eastern side of the channel. This site is likely not eligible for the NRHP under Criterion D; however, insufficient data are currently available to assess its eligibility under Criteria A, B, or C. At this time, 100% of the upland settings and immediately adjacent sideslopes bordering Mud Creek on which the proposed spillway facilities would be built have been surveyed for cultural resources; however, virtually none of the floodplain settings along the proposed dam axis have been surveyed and it is unknown whether or not any cultural resources exist within the area in which the proposed dam would be constructed. Landscaping activities undertaken by a local landowner have resulted in fairly extensive prior impacts to surface and near-surface sediments across most of the proposed dam axis area, though it is currently unknown how deep these impacts may extend.

Six cultural resource sites, including five archeological sites (one of which is also a historic architecture site) and one additional historic architecture site, are situated within the Permit Area south of U.S. Highway (U.S.) 79, about three miles north of the proposed dam axis. Portions of the Permit Area south of U.S. 79 have been identified as possible sources of fill material to construct the proposed dam. Any proposed borrow acquisition conducted in this area would likely have adverse effects on cultural resources located within proposed borrow excavation areas. Borrow excavations conducted on or near archeological sites would result in the physical removal of archeological deposits via excavation of fill materials, and additional impacts to surrounding areas may result from construction of access roads and associated activities, such as vegetation clearing.

<u>Operation</u>

Lake Columbia Impoundment

The proposed normal pool of the proposed reservoir would be at an elevation of 315 feet (NGVD), and ANRA would maintain additional acreage up to the 318-foot (NGVD) elevation as a proposed management zone. Ongoing erosive forces associated with proposed reservoir impoundment resulting from wave action, wet/dry cycles, erodible soils, and permanent loss of sites from subsurface settling of inundated sediments would have adverse effects on any cultural resource sites located at or below the elevation at which the proposed normal pool would be maintained. Additional impacts to sites would include increased access to exposed sites by increased recreation and threats from future lake development. Long-term management plans would need to be developed to anticipate and mitigate impacts.

Lake Columbia Shoreline

Ongoing erosive actions along the shoreline of the proposed reservoir impoundment resulting from wave action, wet/dry cycles, erodible soils, and permanent loss of sites from subsurface settling of inundated sediments would have adverse effects on any cultural resource sites located in proposed shoreline areas. In addition, increased accessibility to the proposed reservoir shoreline may increase the potential for vandalism to cultural resource sites located in proposed shoreline areas and may result in adverse effects to cultural resources. Any future shoreline development may also result in adverse effects to sites.

Any NRHP- and SAL-eligible historic properties located along the proposed reservoir shoreline may experience cumulative viewshed impacts as a result of proposed reservoir impoundment and future shoreline development. In addition, construction or ongoing use of any proposed ancillary facilities associated with the proposed reservoir located along the shoreline may result in direct or indirect impacts to any historic properties situated in proposed shoreline areas.

Dam and Spillway

Ongoing operation of the proposed dam and spillway facilities would not result in any adverse effects to historic properties beyond the impacts resulting from the original construction of the facilities. Any future maintenance of the dam or spillway may result in adverse effects to historic properties if areas beyond the original dam and spillway construction footprint would be impacted. Furthermore, any changes in existing erosional patterns downstream or upstream of the dam may have adverse effects on historic properties resulting from wave action, wet/dry cycles, erodible soils, and permanent loss of sites from subsurface settling of inundated sediments.

Mitigation

Mitigation would involve the development of a Memorandum of Agreement or Programmatic Agreement (PA) as discussed in Section 4.9.1.2.

4.9.3.3 Toledo Bend Pipeline Alternative

There is the potential for adverse impacts to cultural resources along the approximately 86-mile-long proposed pipeline right-of-way, the highest probability for which would be the area of the proposed intake structure at Toledo Bend Reservoir, the proposed pump stations, the proposed new pipeline right-of-way along the approximately five-mile-long segment to run cross-country to the terminal reservoir, and the area of the terminal reservoir itself. The remaining 81 miles of proposed pipeline right-of-way would follow existing state and county roadways; however, significant additional proposed right-of-way would be disturbed and the possibility of impacting cultural resources also exists there. Cultural resources within existing road rights-of-way may have been previously disturbed to some degree as a result of roadway construction activities, though significant intact archeological deposits may exist even within constructed roadway areas that may be adversely impacted by the deeper excavation from the large proposed pipeline construction.

Construction of the pipeline would have the potential to result in fewer impacts to cultural resources and TCPs than construction of the proposed reservoir. In contrast to proposed reservoir impoundment, greater flexibility is available during the process of designing pipeline rights-of-way to avoid impacts to cultural resources. Pipeline rights-of-way can occasionally be redesigned or rerouted to bypass cultural resources and directional drilling can be employed to install pipelines under cultural resources and/or landforms considered likely to contain intact archeological deposits. While avoidance of cultural resources is not always determined to be a feasible option during development of pipeline projects, thereby requiring the development of other measures to mitigate impacts to historic properties, avoidance options are available to avoid impacts to historic properties that may not be available in connection with proposed reservoir.

4.9.4 Cumulative Effects

As described above, several cultural resources studies have already been completed in the Permit Area and surrounding local area. For purposes of these studies, the areas surveyed included land within the proposed normal pool, the purchase line management zone, the dam and spillway area, and unspecified ancillary construction areas. The total acreage was 12,370 acres, not including the ancillary areas. For the 12,370 acres, several types of studies and surveys have already been completed. They include a geomorphological reconnaissance survey, archival research on other surveys and sites within the 12,370-acre area, development and use of a probability model for estimating the number of potential sites in spatially divided locations, conduction of a Phase Ia survey and application of listing criteria under the NHPA and the Texas SALs, completion of a historic structures survey, and accomplishment of a paleontological survey. The findings from these studies and surveys are summarized above.

The central feature of a program to avoid, minimize, mitigate, or treat adverse impacts on cultural resources would be the above-described multi-agency MOA or PA. The MOA or PA could lead to further inventory studies and eligibility determinations, and to further delineation of response strategies.

The No Action alternative would not cause any impacts on the existing cultural resources in the 12,370-acre area noted above. Hence, there is no need to address cumulative effects on these resources.

The construction phase of the Proposed Action alternative has the potential for causing numerous impacts; however, implementation of the requirements of the MOA or PA would be used to minimize or mitigate the construction impacts. Impoundment of the reservoir could increase shoreline erosion and thus expose previously unknown cultural resources. Again, the MOA or PA would be utilized. The Shoreline Development Area could also be subject to activities, which could expose or destroy cultural resources. But again, the MOA or PA would dictate appropriate protocols.

Table 3.3-5 does not reveal any past, present, or continuing actions that would affect cultural resources, and neither does Table 3.3-6 for future actions.

To summarize cumulative effects on cultural resources from the Proposed Action, the primary contributors to effects are associated with construction and operational practices for the proposed Lake Columbia Project. Such effects would be addressed via the MOA or PA. Other actions in nearby areas are not expected to cause adverse effects on these resources.

The Toledo Bend Pipeline alternative has not been subject to cultural resources studies and surveys. However, if necessary, studies could be conducted and an MOA or PA developed. Further, the effects of construction and operation of the pipeline and the terminal storage area would be expected to be of a lesser nature than those for the Proposed Action.

4.10 SOCIOECONOMICS

4.10.1 Affected Environment

4.10.1.1 Population

<u>Existing</u>

The proposed Lake Columbia reservoir would be located in Cherokee and Smith counties, Texas. The five counties for which water demand and supply is a concern are Angelina, Cherokee, Nacogdoches, Rusk, and Smith (the local area).[1] Much of the local area is rural. The largest cities in each county are Lufkin, Jacksonville, Nacogdoches, Henderson, and Tyler, respectively. These cities also serve as the county seat with the exception that the town of Rusk, rather than Jacksonville, is the county seat for Cherokee County.

The estimated combined population of Cherokee, Smith, Rusk, Nacogdoches and Angelina counties, as of July 1, 2004 was 424,219, a net increase of 16,149 or 3.96% from the 2000 Census of 408,070. As shown in Table 4.10-1, Smith County experienced

[1] As discussed in Section 2.2 of this report, the 2006 Region I (East Texas) Regional Water Plan (SPI, 2006) contains a demand and supply analysis for water in these five counties and demonstrates the need for the Lake Columbia Project. Seven reservoirs now in the local area are Lake Tyler, Lake Tyler East, Lake Jacksonville, Lake Acker, Striker Creek Reservoir, Lake Nacogdoches, and Kurth Reservoir. Four reservoirs near the five counties are Lake Palestine, Lake Cherokee, Martin Lake, and Sam Rayburn Reservoir.

the largest population growth during this period (6.7%). When compared with the population size of all counties in Texas, Smith ranks 22nd out of 254. Smith is the only local area county in the top 30 largest counties by population in Texas in 2004 (Texas Almanac, 2006). Cherokee County experienced lesser, though still positive growth, at

Table 4.10-1 Population Change, April 1, 2000-July 1, 2004

County	Population Estimates				
	2000 Census	**July 1, 2004**	**Numeric Change**	**Percent Change**	**TX Rank**
Angelina	80,130	81,492	1,362	1.70%	41
Cherokee	46,659	48,091	1,432	3.07%	61
Nacogdoches	59,203	60,249	1,046	1.77%	51
Rusk	47,372	47,973	601	1.27%	59
Smith	174,706	186,414	11,708	6.70%	22
Totals	**408,070**	**424,219**	**16,149**	**3.96%**	**n/a**
Texas	20,851,820	22,490,022	1,638,202	7.86%	n/a

Source: PEP, 2005

3.07%, over this same time period. Nacogdoches and Angelina counties had comparable growth at 1.77% and 1.70%, respectively. Rusk had the lowest growth rate at 1.27%.

Statewide population grew from 20,851,820 in the 2000 Census to 22,490,022 in July 1, 2004, a 7.86% increase. All five counties had percentage changes in population that were lower than that of the state of Texas, with an average percentage change of 3.96%.

As can be seen in Table 4.10-2, population in the local area grew by 12.96% between the 1990 and 2000 U.S. Census. Of those counties in the local area, Smith had the highest growth. During that same period the state of Texas population increased by 22.76%. The slower growth for the local area than in the state that occurred from 2000 to mid-2004 is a continuation of a more than a decade trend.

Table 4.10-2 Population Change, 1990-2000 and 2000-July 1, 2004

County	Population Level		Population Change	
	1990 Census	**2000 Census**	**1990-2000**	**2000-July 1, 2004**
Angelina	69,884	80,130	14.66%	1.70%
Cherokee	41,049	46,659	13.67%	3.07%
Nacogdoches	54,753	59,203	8.13%	1.77%
Rusk	43,735	47,372	8.32%	1.27%
Smith	151,309	174,106	15.07%	6.70%
Totals	**360,730**	**407,470**	**12.96%**	**3.96%**
Texas	16,986,510	20,851,792	22.76%	7.86%

Source: U.S. Bureau of the Census. 2006

Projected

The population of Texas is expected to increase from the 2000 U.S. Census level of 20,851,792 to 33,317,744 by 2030, as shown in Table 4.10-3. The local area combined population is expected to grow at a slower pace than the state over the same time span, with Smith County forecasted to be responsible for most of the five counties' growth.

Table 4.10-3 Projected Population by Census Years, 2005-2030

County	Actual	Projected Population Levels			
	2000	2005	2010	2020	2030
Angelina	80,130	84,139	87,572	94,908	101,156
Cherokee	46,659	47,699	48,868	51,008	52,637
Nacogdoches	59,203	61,841	64,120	68,994	73,069
Rusk	47,372	48,564	49,652	51,792	52,789
Smith	174,106	183,638	194,408	225,604	289,875
Totals	**407,470**	**425,881**	**444,620**	**492,306**	**569,526**
Texas	20,851,792	22,859,968	22,802,959	28,634,896	33,317,744

Source: TCPA, 2006c

Smith County is expected to continue growing at a relatively fast pace into the future. As exhibited in Table 4.10-4, Smith County's population is expected to increase by 66.49% from the year 2000 through year 2030, faster than the projected statewide growth at 59.78%. An increase in the Smith County population growth is predicted for the period 2020 through 2030. Currently, the outlook for Smith County growth is at a consistently faster pace than the statewide growth. The other four counties in the local area would likely grow at a substantially slower rate than the statewide population in each decade interval.

Table 4.10-4 Projected Percentage Change in Population

County	Projected Percentage Change			
	2000 to 2010	2010 to 2020	2020 to 2030	2000 to 2030
Angelina	9.29%	8.38%	6.58%	26.24%
Cherokee	4.73%	4.38%	3.19%	12.81%
Nacogdoches	8.31%	7.60%	5.91%	23.42%
Rusk	4.81%	4.31%	1.93%	11.44%
Smith	11.66%	16.05%	28.49%	66.49%
Totals	**9.12%**	**10.73%**	**15.69%**	**39.77%**
Texas	9.36%	25.58%	13.35%	59.78%

Source: TCPA, 2006c

4.10.1.2 Labor

Civilian Labor Force

The size of a county's labor force is measured as the sum total of those currently employed and those actively seeking employment. As can be seen in Table 4.10-5, from 2000 through 2004 the labor force percentage change in Angelina (7.73%), Nacogdoches (9.27%), and Smith (9.10%) counties surpassed the statewide percentage change of 6.47%. Cherokee County has experienced rather slim growth in the size of its labor force, growing by less than 1% from an average monthly size of 20,897 in 2000 to 21,068 in 2004, while Rusk County's percentage change was slightly below that for the state, at 5.44%. The overall percentage change for the local area labor force was 7.58%, higher than the statewide average of 6.47%.

Table 4.10-5 Average Monthly Civilian Labor Force Size

County	Average Monthly Civilian Labor Force					
	2000	2001	2002	2003	2004	Percentage Change 2000-2004
Angelina	37,935	38,565	39,319	40,410	40,869	7.73%
Cherokee	20,897	20,751	21,003	21,834	21,068	0.82%
Nacogdoches	29,070	29,672	30,084	31,045	31,764	9.27%
Rusk	21,063	21,215	21,303	21,690	22,208	5.44%
Smith	86,339	87,261	89,821	92,318	94,195	9.10%
Totals	**195,304**	**197,464**	**201,530**	**207,297**	**210,104**	**7.58%**
Texas	10,364,854	10,530,57 7	10,746,387	10,927,433	11,035,379	6.47%

Source: TWC, 2006

Employment

Table 4.10-6 exhibits the average monthly employment levels in the five counties for the years 2000, 2002, and 2004. Smith County has the largest number of employed with 89,186 in 2004, representing an 8% increase from 82,572 employed in 2000. Nacogdoches County experienced an 8.12% gain in employment over that same period. Employment in Angelina County increased in each two year period. Cherokee and Rusk counties experienced a decline in employment from 2000 to 2002. By 2004 employment in Cherokee County was still below 2000 levels, but unemployment in Rusk County had risen, exhibiting a 4.27% increase from 2000-2004. Angelina, Nacogdoches, and Smith counties all experienced more growth than the state. In contrast, Cherokee and Rusk employment growth fell below the statewide growth of 4.54%.

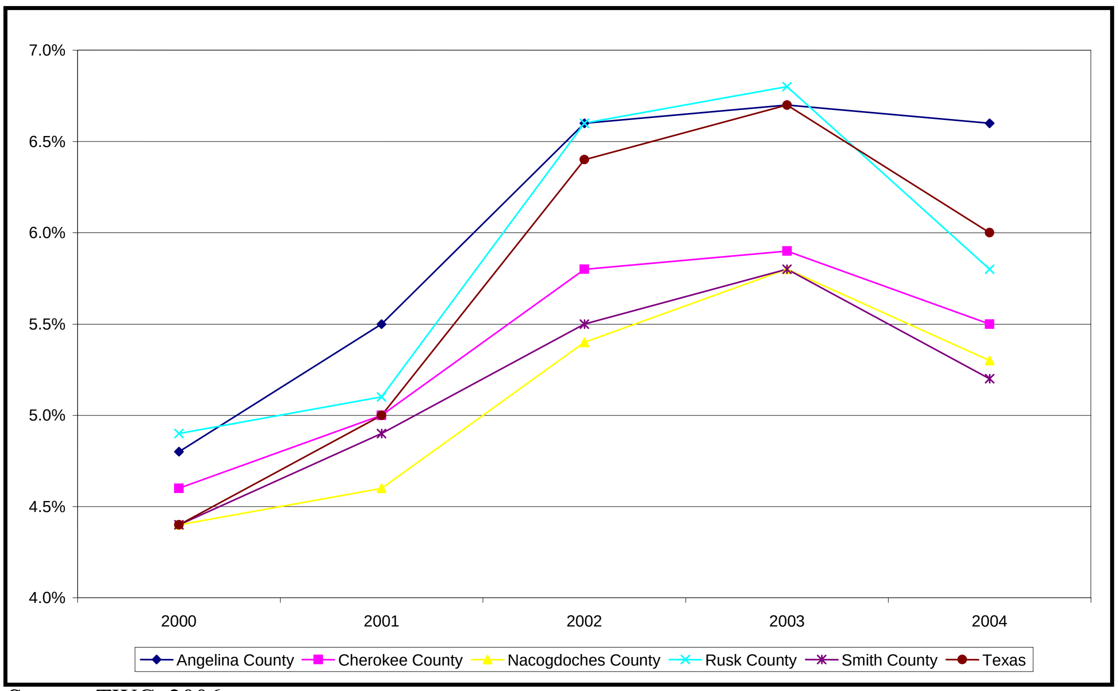
Table 4.10-6 Average Monthly Employment

County	Number in Employment			
	2000	2002	2004	Percentage Change 2000-2004
Angelina	36,120	36,729	38,154	5.63%
Cherokee	19,943	19,787	19,883	-0.30%
Nacogdoches	27,802	28,475	30,060	8.12%
Rusk	20,029	19,904	20,885	4.27%
Smith	82,572	84,890	89,186	8.00%
Totals	**186,466**	**189,785**	**198,168**	**6.28%**
Texas	9,913,119	10,065,924	10,362,982	4.54%

Source: TWC, 2006

Unemployment Rates

The counties of Cherokee, Nacogdoches, and Smith have had annual unemployment rates consistently at or below the statewide averages from 2000 through July 2004. Angelina County has had consistently higher than state rates of unemployment from 2000 to 2004. Rusk County's unemployment rate was higher than that for the state until 2004, when the rate declined below the state rate. Unemployment rates in the local area and for the state are shown in Figure 4.10-1.



Source: TWC, 2006

Figure 4.10-1 Average Annual Unemployment Rate, 2000-2004

4.10.1.3 Earnings

Earnings measures vary. Personal income data are measured and reported for the county of the place of residence. Per capita personal income, then, is the personal income for the county divided by population in the county. Compensation data, however, are measured and reported for the county of work location. Compensation data are typically reported on a per job basis (Confirmed in a telephone conference with an analyst at the Bureau of Economic Analysis, Oct. 2, 2006). Total compensation includes wages and salaries as well as employer contributions for employee retirement funds, social security, health insurance, and life insurance.

Per Capita Personal Income

Personal income is the amount of income people receive during a period. This includes earnings from work received during the period. It also includes interest and dividends received, as well as government transfer payments, such as social security checks.

Table 4.10-7 contains annual per capita personal income for the local area as well as the state of Texas for calendar years 2001 through 2004. For 2004, of the five counties, Smith County has the highest personal income per capita ($29,993), as shown in Table 4.10-7. Angelina County ($27,548), Cherokee County ($24,270) and Rusk County ($23,786) followed, with Nacogdoches County having the smallest per capita personal income ($22,138). All five counties in the local area had a per capita income smaller than that for the statewide average.

Angelina County experienced the largest percentage change in personal income per capita from 2001 through 2004 with an increase of 12.25%. All but Cherokee County had a percentage increase over the period greater than the increase statewide.

Table 4.10-7 Annual Per Capita Personal Income (in $1,000s)

County	Income				
	2001	2002	2003	2004	Percentage Change 2000-2004
Angelina	24,541	24,840	25,576	27,548	12.25%
Cherokee	23,290	23,967	24,341	24,270	4.21%
Nacogdoches	20,214	20,910	21,057	22,138	9.52%
Rusk	21,694	22,086	22,698	23,786	9.64%
Smith	27,872	27,914	28,441	29,993	7.61%
Texas	29,044	28,853	29,453	30,732	5.81%

Source: US DOC, 2006

Total Industry Compensation

What is often termed in economic data as total industry compensation is somewhat of a misnomer, in that a portion of the "industry earnings" stems from government related activity. This will be made clear when the composition of industry compensation is presented. Nevertheless, total industry compensation provides a good picture of the relative sizes of market related economic activity, or business activity, performed in the various counties (Table 4.10-8). Smith County clearly dominates in economic activity, with Angelina County coming in a distant second.

Table 4.10-8 Total Compensation of Employees (in $1,000s)

County	2001	2002	2003	2004
Angelina	1,214,246	1,241,840	1,297,943	1,399,800
Cherokee	471,975	490,441	521,583	508,409
Nacogdoches	679,361	739,210	732,667	763,133
Rusk	466,396	487,775	507,161	530,656
Smith	3,196,258	3,310,178	3,466,779	3,772,830

Source: US DOC, 2006

Income is generated by economic activity in the local area counties through a variety of sectors, including various types of business as well as government. This income is not always received by a person in the county, for a person from a neighboring county may cross county lines to go to work. The employee compensation by industry, however, is a measure of the economic activity generated in the counties.

Compensation for work is broader than salaries and wages. Total compensation also includes employer contributions for employee retirement funds, social security, health insurance, and life insurance. These supplements to income comprise roughly 20% of total compensation. Also, rather than measuring per capita personal income, which includes government transfers to people who are not employed, total compensation measures are presented "per job," meaning in terms of full-time and part-time wage and salary employment. The average compensation per job for 2004 for the local area counties are: Angelina, $36,536; Cherokee, $31,436; Nacogdoches, $31,585; Rusk, $37,780; and Smith, $41,230. Statewide, the average compensation per job is $46,958.

The local area counties display a variety of business activity. The sources of economic activity in the local area counties are individually discussed below.

Angelina County: Compensation by Industry

Angelina County is home to manufacturing, primarily of wood products, iron and steel castings, truck trailers, and mobile homes. In Angelina County manufacturing leads the way for generation of employee compensation. As can be seen in Table 4.10-9, the manufacturing industry accounted for a total of $368,220,000 of the annual compensation of employees in 2004, which amounts to 26% of the total employee compensation generated in the county. Table 4.10-9 also shows the annual compensation of employees for other industries in Angelina County from 2001 through 2004. Government and government enterprises and health care and social assistance are the second and third largest sources of employee compensation. The city of Lufkin, the county seat, is home to Angelina College, to hospitals that serve the area, and to U.S. and Texas forest centers, including the Texas Forestry Museum, as well as a zoo.

Table 4.10-9 Compensation of Employees by Industry in Angelina County (in $1,000s)

Sector	2001	2002	2003	2004
Farm	536	386	490	551
Forestry, Fishing, Related Activities	10,448	10,604	10,174	9,853
Mining	2,139	1,879	1,720	1,860
Construction	52,988	51,229	48,510	49,690
Manufacturing	317,100	305,834	324,445	368,220
Transportation and Warehousing	35,663	32,869	34,111	36,719
Utilities	7,217	7,539	7,948	8,419
Wholesale Trade	44,618	50,401	53,332	57,117
Retail Trade	130,074	133,480	135,883	136,319
Information	40,614	38,794	40,590	40,846
Real Estate & Rental & Leasing	7,728	7,624	7,735	8,503
Finance & Insurance	31,913	34,481	35,567	37,650
Professional/Technical Services	(D)	(D)	(D)	34,665
Management of Companies	(D)	(D)	(D)	10,693
Administrative and Waste Services	28,083	24,181	26,177	29,535
Educational Services	2,806	3,286	3,611	3,792
Health Care and Social Assistance	171,221	184,149	198,381	224,005
Arts, Entertainment, Recreation	3,960	3,980	3,930	4,101
Accommodation & Food Services	36,995	41,951	45,683	47,507
Other Services Except Public Adm.	31,499	33,266	34,416	35,077
Government & Gov't Enterprises	218,846	234,821	244,129	254,678

Source: US DOC, 2006
(D) - Not shown to avoid disclosure of individual confidential information.

Cherokee County: Compensation by Industry

Table 4.10-10 displays compensation of employees by industry for Cherokee County from 2001-2004. The government sectors generate more employee compensation than do the other sectors. This is due partly to two factors unusual to Cherokee County. The city of Rusk, the county seat, is home to a state mental hospital and a prison unit. All in the county is not government dominated, however. The county has a relatively large manufacturing sector, which is the second largest generator of employee compensation. Jacksonville, the county's largest city, is home to bedding plant industries. Health care and social assistance is the third largest compensation generator.

Table 4.10-10 Compensation of Employees by Industry in Cherokee County (in $1,000s)

Sector	2001	2002	2003	2004
Farm	13,976	10,087	12,889	14,389
Forestry, Fishing, Related Activities	3,630	3,713	3,589	(D)
Mining	2,035	1,959	1,716	(D)
Construction	12,020	13,290	14,208	15,460
Manufacturing	102,273	100,803	111,505	121,511
Transportation and Warehousing	5,758	6,698	4,002	3,287
Utilities	11,139	10,718	12,085	11,532
Wholesale Trade	10,423	14,513	13,068	14,139
Retail Trade	60,830	63,664	61,645	36,436
Information	4,709	6,001	5,218	5,689
Real Estate & Rental & Leasing	1,540	1,571	1,678	2,120
Finance & Insurance	19,366	19,491	28,243	21,758
Professional/Technical Services	(D)	(D)	(D)	(D)
Management of Companies	(D)	(D)	(D)	(D)
Administrative and Waste Services	5,534	4,906	4,585	5,331
Educational Services	5,968	6,241	6,723	7,045
Health Care and Social Assistance	44,703	46,470	48,654	50,236
Arts, Entertainment, Recreation	821	2,292	(D)	(D)
Accommodation & Food Services	9,971	10,378	(D)	(D)
Other Services Except Public Adm.	11,052	12,195	13,368	13,754
Government & Gov't Enterprises	140,779	150,324	158,655	159,239

Source: US DOC, 2006
(D) - Not shown in the original source with the explanation "to avoid disclosure of individual confidential information".

Nacogdoches County: Compensation by Industry

The City of Nacogdoches is the county seat of Nacogdoches County, and it is home to Stephen F. Austin State University. As with Cherokee County, the largest generators of compensation for employees in Nacogdoches County are the government sector and the manufacturing sector. The two sectors together account for approximately 51% of the employee compensation generated in the county. Table 4.10-11 displays the earnings, by sector, for industries in Nacogdoches County.

Table 4.10-11 Compensation of Employees by Industry in Nacogdoches County (in $1,000s)

Sector	2001	2002	2003	2004
Farm	4,536	3,269	4,131	4,637
Forestry, Fishing, Related Activities	3,966	4,711	5570	5381
Mining	1,601	1,748	194	119
Construction	38,340	36,076	37,182	39,535
Manufacturing	143,278	151,966	159,203	159,123
Transportation and Warehousing	5,382	6,719	6,685	7,647
Utilities	2,187	2,322	2,582	2,701
Wholesale Trade	25,335	24,470	25,775	25,492
Retail Trade	73,415	76,251	65,504	66,691
Information	10,640	10,694	10,316	8,603
Real Estate & Rental & Leasing	5,779	4,969	4,816	5,025
Finance & Insurance	18,913	20,354	22,372	24,406
Professional/Technical Services	12,316	24,663	27,068	34,605
Management of Companies		(D)	(D)	(D)
Administrative and Waste Services	6,891	(D)	(D)	(D)
Educational Services	1,792	2,030	2,268	2,445
Health Care and Social Assistance	83,102	106,553	87,360	94,115
Arts, Entertainment, Recreation	1,522	1,450	1,572	(D)
Accommodation & Food Services	27,213	26,892	23,634	24,720
Other Services Except Public Adm.	22,960	23,498	23,851	24,686
Government & Gov't Enterprises	190,193	203,166	213,450	222,492

Source: US DOC, 2006
(D) - Not shown to avoid disclosure of individual confidential information.

Rusk County: Compensation by Industry

Rusk County's economy is diversely comprised of mining, forestry, agribusiness, and government services. Table 4.10-12 displays the employee compensation by sector. The county's mining industry consists of production of oil and natural gas, lignite mining, and clay mining. The city of Henderson is the center for the agribusiness and oil activities, but the county has manufacturing, including brick production. The three largest compensation generating sectors, government, mining, and manufacturing, account for 47% of the employee compensation revealed for the county.

Table 4.10-12 Compensation of Employees by Industry in Rusk County (in $1,000s)

Sector	2001	2002	2003	2004
Farm	3,245	2,336	2,933	3,305
Forestry, Fishing, Related Activities	2,817	3,061	4,085	4,724
Mining	64,806	66,539	71,691	81,445
Construction	54,471	71,267	59,535	48,987
Manufacturing	68,750	61,026	65,620	75,384
Transportation and Warehousing	11,241	11,182	12,935	17,338
Utilities	35,351	36,780	40,778	41,344
Wholesale Trade	9,118	8,926	8,824	12,045
Retail Trade	27,735	32,013	37,159	37,376
Information	6,279	6,765	7,552	8,429
Real Estate & Rental & Leasing	1,786	1,643	1,957	2,342
Finance & Insurance	13,771	13,775	15,737	14,714
Professional/Technical Services	(D)	(D)	(D)	(D)
Management of Companies	(D)	(D)	(D)	(D)
Administrative and Waste Services	16,704	17,616	16,680	14,866
Educational Services	(D)	925	1,096	1,180
Health Care and Social Assistance	(D)	30,643	32,870	33,991
Arts, Entertainment, Recreation	1,166	932	1,004	981
Accommodation & Food Services	9,665	10,309	10,502	12,510
Other Services Except Public Adm.	16,287	17,159	18,175	18,444
Government & Gov't Enterprises	79,466	82,027	85,325	87,726

Source: US DOC, 2006
(D) - Not shown to avoid disclosure of individual confidential information.

Smith County: Compensation by Industry

Smith County is home to manufacturing, agribusiness, and petroleum production. Table 4.10-13 shows the annual employee compensation by industry for Smith County from 2001 through 2004, and there are several relatively substantial income generating sectors. Health care and social assistance generate more employee compensation than any other sector. The city of Tyler, the county seat and "Rose Capital of the Nation", is known for its health care and health education facilities, housing the University of Texas Health center, as well as area hospitals and nursing education. While health care is a large sector, manufacturing, government, and retail trade are relatively large, as well. In addition, Tyler is the administrative center for the county's oil production, and it is home to some major educational institutions, including the University of Texas at Tyler and Tyler Junior College.

Table 4.10-13 Compensation of Employees by Industry in Smith County, (in $1,000s)

Sector	2001	2002	2003	2004
Farm	8,696	6,268	7,903	8,881
Forestry, Fishing, Related Activities	4,198	3,771	4,397	4,629
Mining	95,699	48,659	51,626	64,480
Construction	124,227	134,259	146,870	153,240
Manufacturing	543,251	538,115	535,945	586,643
Transportation and Warehousing	67,969	68,983	70,007	148,874
Utilities	17,967	17,700	19,476	21,604
Wholesale Trade	140,646	174,775	174,953	197,173
Retail Trade	400,755	393,282	398,836	357,385
Information	102,549	84,274	94,688	107,277
Real Estate & Rental & Leasing	41,178	41,139	35,857	37,207
Finance & Insurance	150,879	160,466	158,930	166,838
Professional/Technical Services	(D)	161,939	178,657	207,172
Management of Companies	(D)	3,353	7,849	7,467
Administrative and Waste Services	69,819	79,267	80,922	95,288
Educational Services	18,506	23,308	25,704	25,638
Health Care and Social Assistance	593,225	652,600	722,193	789,842
Arts, Entertainment, Recreation	19,019	19,122	17,881	19.015
Accommodation & Food Services	86,319	94,642	103,688	107,500
Other Services Except Public Adm.	94,252	99,293	103,041	109,422
Government & Gov't Enterprises	465,343	504,963	527,356	557,255

Source: US DOC, 2006
(D) Not shown to avoid disclosure of individual confidential information

4.10.1.4 Public Finance

The primary non-federal taxation in the local area is of property and retail sales. Property taxes are dependent upon the appraised value of the property for taxation purposes and on the property tax rates. Retail sales that are qualified for taxation are taxed at a state sales tax plus potential county and city tax rates. Part of these taxes helps fund schools in the local area.

Property Taxation

Cherokee County has the highest property tax rate out of the five counties, with a rate of $0.6000 of tax per $100 of a property's assessed value (see Table 4.10-14). The next highest property tax rate, for Rusk County, is $0.4524 per $100, which is more than $0.14 less per $100 in assessed property value.

Table 4.10-14 Total Appraised Property Values

County	Total Appraised Property Value, 2004 (Dollars)	Tax Rate per $100 of Assessed Value, 2004
Angelina	2,508,510,168	0.3825
Cherokee	1,360,603,372	0.6000
Nacogdoches	1,886,119,810	0.4312
Rusk	2,522,609,070	0.4524
Smith	8,686,720,755	0.2545

Source: TAC, 2006

Retail Sales Taxation

The State of Texas retail sales tax stands at 6.25%. Local sales taxes vary by county and by city. As displayed in Table 4.10-15 all five counties in the local area have a retail sales tax rate of .50%. In addition, as is common in Texas, most cities and towns in the local area impose additional tax rates on retail sales. Common for the larger cities is at least a 1.50% or 2.00% additional sales tax.

Taxable Sales and Local Sales Tax Dollars Returned

Table 4.10-16 shows taxable sales in the local area from 2001 through 2005. Smith County leads the way in sales that are subject to state and local sales taxes, with $2,166,912,255 in such sales in 2005. The next highest amount of taxable sales is $811,381,824 in Angelina County 2005, which is only 37.44% of Smith County's total.

As one would expect, Smith County was also the leader in local sales tax dollars received from taxable retail sales in 2005, as can be seen in Table 4.10-17. In Rusk County all local sales taxes that were returned by the Texas State Comptroller's Office were returned to the city of Henderson.

Table 4.10-15 Retail Sales Tax Rates

County	City	Retail Sales Tax Rate	Total
Angelina		0.50%	
	Lufkin	1.50%	8.25%
	Zavalla	1.50%	8.25%
	Huntington	1.50%	8.25%
	Diboll	1.50%	8.25%
	Burke	0.00%	6.75%
	Hudson	1.50%	8.25%
Cherokee		0.50%	
	Reklaw	1.00%	7.75%
	Cuney	1.50%	8.25%
	Wells	1.00%	7.75%
	Troup	1.50%	8.25%
	Rusk	1.50%	8.25%
	Alto	1.00%	7.75%
	Gallatin	0.00%	6.75%
	New Summerfield	1.00%	7.75%
	Bullard	1.00%	7.75%
	Jacksonville	1.50%	8.25%
Nacogdoches		0.50%	
	Garrison	2.00%	8.75%
	Cushing	2.00%	8.75%
	Chireno	2.00%	8.75%
	Nacogdoches	2.00%	8.75%
	Appleby	1.00%	7.75%
Rusk		0.50%	
	Reklaw	1.00%	7.75%
	Overton	2.00%	8.75%
	New London	No information	No information
	Mount Enterprise	1.50%	8.25%
	Kilgore	1.50%	8.25%
	Easton	1.00%	7.75%
	Tatum	1.75%	8.50%
	Henderson	2.00%	8.75%
Smith		0.50%	
	Bullard	1.00%	7.75%
	Hideaway	0.00%	6.75%
	Lindale	1.50%	8.25%
	New Chapel Hill	1.00%	7.75%
	Noonday	1.00%	7.75%
	Overton	1.50%	8.25%
	Troup	1.50%	8.25%
	Tyler	1.50%	8.25%
	Whitehouse	1.50%	8.25%
	Winona	1.00%	7.75%
	Arp	1.00%	7.75%

Source: TAC, 2006 & TCPA, 2005 & 2006

Table 4.10-16 Taxable Sales (in $1,000s)

County	2001	2002	2003	2004	2005
Angelina	703,409	696,969	699,786	742,173	811,382
Cherokee	170,621	158,993	164,836	176,542	187,604
Nacogdoches	359,540	365,480	374,687	397,089	421,227
Rusk	191,915	184,907	190,549	239,010	250,971
Smith	1,826,881	1,87,017	1,896,420	2,040,555	2,166,912

Source: TCPA, 2006a

Table 4.10-17 Local Sales Taxes Returned to the County by the Texas State Comptroller's Office (Dollars)

County	2001	2002	2003	2004	2005
Angelina	3,616,250	3,282,804	3,441,963	3,699,124	4,134,944
Cherokee	1,080,893	1,026,831	1,083,723	1,134,381	1,320,521
Nacogdoches	4,505,042	4,539,819	4,551,605	4,913,078	5,033,797
Rusk	0	0	0	0	0
Smith	10,055,490	10,144,811	10,459,286	11,397,768	12,341,870

Source: TCPA, 2006b

School District Financing

Table 4.10-18 shows the total revenue for each school district comprises locally collected taxes, revenues from the state, and, if applicable, federal revenues. The total revenue per student and the percentage of total school funding from local taxes are shown in the table. The tax rate adopted by the boards of the independent school districts and applicable to the 2004-2005 school year is in the table, as well. This tax rates are applied to property values in the respective school districts to generate funding for the schools.

As shown in Table 4.10-18, Smith County has the largest number of school districts with ten independent school districts. Smith County also has the largest total revenue, at $198,206,708, from which to provide support to their respective schools. Even though Nacogdoches County has the second highest number of school districts with nine, Angelina County has the second highest total revenue at $103,744,913 for its seven districts.

Table 4.10-18 School District Funding Received

School District	Total Revenue (Dollars) 2004-2005	Total Revenue Per Student (Dollars) 2004-2005	Adopted Total Tax Rate Applicable to the 2004-2005 School Year	Percentage of School Revenue Received from Local Tax 2004-2005
Angelina				
Diboll ISD	12,654,959	6,608	1.555	29.41%
Huntington ISD	10,376,098	6,281	1.64	19.50%
Central ISD	11,260,654	6,711	1.48	21.06%
Hudson ISD	14,197,953	6,029	1.515	21.84%
Lufkin ISD	50,812,639	6,001	1.58	51.39%
Pineywoods Community Academy	1,106,085	5,369	0	00.00%
Zavalla ISD	3,336,525	7,145	1.464	25.51%
Total	103,744,913			
Cherokee				
Alto ISD	5,099,057	7,622	1.517	31.55%
Jacksonville ISD	29,316,009	5,948	1.545	33.67%
New Summerfield ISD	3,558,630	8,238	1.47	12.84%
Rusk ISD	12,037,268	6,372	1.543	31.69%
Wells ISD	2,521,493	7,664	1.40	18.04%
Total	52,532,457			
Nacogdoches				
Chireno ISD	2,490,277	8,033	1.573	20.26%
Cushing ISD	4,331,880	8,734	1.50	68.42%
Douglas ISD	2,699,119	7,690	1.50	48.39%
Etoile ISD	1,014,419	6,996	1.50	50.24%
Garrison ISD	5,341,301	7,809	1.432	31.40%
Martinsville ISD	2,605,082	8,066	1.624	15.66%
Central Heights ISD	4,953,888	6,650	1.552	17.15%
Nacogdoches ISD	36,105,346	5,679	1.713	53.35%
Woden ISD	6,462,705	7,506	1.49	17.57%
Total	66,004,017			
Rusk				
Henderson ISD	22,690,949	6,564	1.60	61.00%
Laneville ISD	1,671,696	10,070	1.50	35.69%
Mount Enterprise ISD	3,061,746	7,055	1.45	17.29%
West Rusk ISD	5,952,425	8,033	1.50	54.72%
Leveretts Chapel ISD	1,957,713	7,769	1.652	18.11%
Overton ISD	3,919,939	7,286	1.61	17.85%
Carlisle ISD	4,212,607	7,496	1.576	16.04%
Tatum ISD	9,182,552	7,490	1.47	84.54%
Total	52,649,627			

School District	Total Revenue (Dollars) 2004-2005	Total Revenue Per Student (Dollars) 2004-2005	Adopted Total Tax Rate Applicable to the 2004-2005 School Year	Percentage of School Revenue Received from Local Tax 2004-2005
Smith				
Arp ISD	9,994,932	10,759	1.763	64.92%
Bullard ISD	10,041,805	6,071	1.59	59.39%
Eagle Academy of Tyler	967,956	5,408	0	00.00%
Lindale ISD	19,391,259	6.048	1.539	51.22%
Troup ISD	7,234,246	7,065	1.522	36.14%
Azleway Charter School	1,479,452	16,258	0	00.00%
Chapel Hill ISD	19,307,434	6,340	1.59	53.17%
Cumberland Academy	1,250,496	6,479	0	00.00%
Tyler ISD	105,565,096	6,036	1.47	70.15%
Whitehouse ISD	22,974,032	5,563	1.503	64.20%
Total	198,206,708			

Source: TEA, 2006

Debt Ratings

The rating of county debt by an independent rating service provides insight into how the credit markets view the economic and financial health of that county. As can be seen in Table 4.10-19, the debts of the local area counties are viewed favorably. The debts of all local area counties in 2006 are classified as AAA, meaning that the outstanding bonds are regarded as having adequate coverage, or, equivalently, that the counties are expected to have adequate capacity to pay principal and interest. Credit ratings are from Fitch Ratings, Ltd. is an international credit rating agency recognized by the U.S. Securities and Exchange Commission.

Table 4.10-19 Public Debt Ratings

County	Latest Debt Ratings Fitch Ratings Ltd
Angelina	AAA
Cherokee	AAA
Nacogdoches	AAA
Rusk	AAA
Smith	AAA

Source: Fitch Ratings, 2006

4.10.2 Environmental Consequences

This section describes potential impacts to output, labor income, employment, and taxes in the Angelina, Cherokee, Nacogdoches, Rusk and Smith Counties. It also provides estimates of the economic value of the reservoir.

4.10.2.1 No Action Alternative

With no action to remedy the water deficits, there would be several main socioeconomic impacts. The job and income creation and other economic impacts connected with the construction and operation of the dam and reservoir would not take place, as the dam would not be built. With no action, there would be shortages of water in the Five-County Area.

With shortages of water, the population projections for the five counties (see Table 4.10-3) may not materialize. According to the Northeast Texas Municipal Water District (NETMWD), population growth and water availability in northeast Texas are positively correlated (NETMWD, 2005). They attribute growth to persons wanting to live near a lake and also a growth in industry and jobs because of additional available water. From 1960 to 2000 the 19 counties in northeast Texas grew by 66.5 percent. Every county that at least doubled its population during that time contains a major reservoir (at least 10,000 acre-feet of water capacity). Every county that decreased in population did not have a reservoir in it for at least part of the 40 years. In counties where reservoirs were constructed, growth rates either reversed (if declining) or increased after completion of the reservoir.

4.10.2.2 Proposed Action

<u>Economic Value</u>

The primary purpose of Lake Columbia is water supply. Lake Columbia would provide a surface water supply with a dependable yield of 85,507 acre-feet/year. As discussed in Section 2.2, projected deficits in 2060 total about 68,000 acre-feet/year for water user groups (WUGs) in the Five-County Area with projected shortages.

Timing of water demands is difficult to predict. Dallas Water Utilities has identified Lake Columbia as a potential water source, and they may in the future want water from the proposed reservoir. Experience from other reservoirs in Texas indicates that all users are not identified before the reservoir is built. After Lake O' the Pines was completed, water from the reservoir was sought by WUGs not identified before the reservoir was constructed. "The use by Harleton WSC, Diana SUD, Glenwood WSC, and Tryon Road SUD of water from Lake O' the Pines followed completion of Lake O' the Pines by several decades and those entities were not included in the original planning for Lake O' the Pines." (NETMWD, 2005) Many of these surface water demands stemmed from population growth and decreased ability to rely on groundwater.

The experience of Trinity River Authority was similar. "The Trinity River Authority conversely entered into the development of Lake Livingston with no immediate customer base or potential water user scenarios identified…Cities such as Livingston and Huntsville by the late 1970s had approached the authority to meet their needs through surface water development, having recognized the limitations of groundwater expansion…Other major user groups emerged including two power generation facilities." (TRA, 2005)

Before calculating the economic impacts of some of the specific types of spending that the proposed reservoir would bring to the Five-County Area, the primary economic value of the reservoir deserves some assessment. This analysis takes as a given the need for the 85,507 acre-feet/year of water for the local area as discussed in Section 2.2. Lake Columbia has been proposed as the least expensive source for obtaining 85,507 acre-feet/year of water.

Based on the most recent Freese & Nichols analysis, raw water from Lake Columbia would cost $0.53 per thousand gallons. (FNI, 2007a) This cost per thousand gallons is derived as follows. The probable total construction cost is $191,059,800. The components of this cost are shown in Table 4.10-20. The annual debt payment on this amount, assuming 30 years of payments at six percent interest, is $13,880,286.50. The annual operating and maintenance cost (O&M) is estimated to be 1.5 percent of the dam construction costs (including 20 percent for contingencies) of $51,977,700, which equals $779,666. The sum of the annual debt payment and the annual O&M is $14,659,952. Based on Lake Columbia's permitted yield of 85,507 acre-feet/year, the estimated total cost of debt and O&M is $171.45 per acre-foot of water, which equates to $0.53 per thousand gallons.

The amount by which the cost of water from the next cheapest additional water source exceeds the cost of the Lake Columbia water is a measure of the efficiency of using Lake Columbia as a water source versus the next best alternative. This valuation is discussed in Section 4.10.2.3, Toledo Bend Pipeline Alternative.

Input-Output Model

Expenditures related to the proposed Lake Columbia in the local area that would be generated from outside the area represent net expenditure injections into the area economies. These expenditures have multiplier effects on total expenditures in the counties. Expenditures on Lake Columbia that are made with resources within the local area are largely made at the expense of other types of expenditures within the local area, and, while they are important to a healthy economy, the expenditures do not have as large a positive net effect as expenditures originating outside the counties. The expenditures on the Lake Columbia Project would be of both types.

Table 4.10-20 Estimated Reservoir Construction Costs, 2006

Description	Amount
Dam and Reservoir Construction	
Embankment	$25,797,900
Internal Drainage	$521,900
Soil Cement Slope Protection	$2,804,900
Service Spillway	$5,132,300
Outlet Works	$1,057,500
Miscellaneous Items	$2,804,200
Engineering and Contingencies	$13,341,500
Geotechnical Investigations	$517,500
Subtotal for Dam	$51,977,700
Conflict Resolution	
Communications	$2,306,700
Electric Utilities	$13,927,600
Oil and Gas	$3,529,800
Water Utilities	$149,100
State and County Roads	$33,114,200
Railroad	$26,547,400
Road and Railroad Erosion Protection	$2,768,200
Engineering and Contingencies	$25,833,100
Subtotal for Conflicts	$108,176,100
Land	$23,856,000
Environmental Mitigation	$7,050,000
Total Cost for Financing	**$191,059,800**

Source: FNI, 2006b

Income that is generated outside the local area and spent within includes the tax dollars that the State would contribute to the Lake Columbia Project. These dollars are collected throughout the state and then are spent on construction and other dam related expenses within the local area. Local expenditures would include money that is spent by those working on the dam who live locally, or purchase goods related to the construction and maintenance, including labor and services. Expenditures outside the local area would include, but are not limited to, materials for the construction that are not produced locally. Not all services are purchased locally.

The following analysis utilizes information about the costs of building and maintaining the proposed dam and reservoir. The analysis also assesses and incorporates the expenditures generated by recreational visitors to the reservoir and the net change in tax revenues for the local area. The analysis of the economic impacts of expenditures related to the planned reservoir uses the IMPLAN input-output model. The model directly incorporates operation and maintenance expenditures, which are explained later in the report, and indirectly incorporates secondary expenditures for law enforcement and local services, power, and other productions and services related to economic activity.

Input-output models were first developed by Wassily Leontieff, for which he won the Nobel Prize in Economics in 1973. Leontieff (1976, 1986) The models describe the spending interrelationships between, among other things, businesses, government, household spending, and exports from and imports to a region. The interrelationships identify, for any particular industry, where all inputs come from and where industry output goes. Input-output models are available for a region, such as the local area.

The model identifies the inputs originating within the county that contribute to each industry and the amount of inputs coming from outside the county that contribute to each industry's production. Similarly, the model demonstrates the output of industries that go to other industries within the region and the output sold outside the region.

Input-output models are not just descriptive. By utilizing regional data and assuming stability of the structure of the industry interrelationships and production techniques, the model becomes an analytical tool for predicting the effects of changes in these industry outputs. The analytical tool provides coefficients, or multipliers, for determining the effect of changes in an industry's output on the regional output, income, and employment.

Economic activity is measured in terms of income and employment generated (or lost) by the impact. With increased spending, many different sectors of the economy benefit – not only the directly impacted sector, but many sectors indirectly. The analysis performed by an input-output model helps account for changes that may occur due to construction. There are many costs associated with construction and maintenance. All sides of the cost-benefit analysis are analyzed including the costs to the local community and surrounding area as well as benefits that the reservoir would bring. In this analysis the IMPLAN input-output model is used to solely assess economic impacts.

The IMPLAN model is an outgrowth of the National Forest Management Act (1976) which required the USDA Forest Service to create 5-year management plans. The plans were to look at alternative land management options as well as socio-economic impacts in local communities due to Forest Service projects. Much of the modeling of the time focused on a national or federal level. It was necessary to develop a model that measured more closely with local communities.

The USDA Forest Service in cooperation with the Federal Emergency Management Agency (FEMA) helped develop IMPLAN which was a regional model of economic impacts. In 1988, the Agricultural Economics Department of the University of Minnesota took responsibility for providing IMPLAN software, data, and technical support for all non Forest Service users on a fee basis. The IMPLAN model is especially suited to local and regional impact studies.[2]

Dam Construction Costs

Expenditures can be either short term or long term. Short-term expenditures terminate after the initial outlay. Short-term expenditures on the proposed Lake Columbia Project include construction of the dam and construction of recreation facilities. The dam and water delivery system constructions are estimated to take approximately three years. The recreation facilities construction would take a year or less, and they are minimal compared to other expenditures, involving such items as boat ramps and picnic tables.

Long-term expenditures recur over time and are primarily for maintenance and operations of those items built with the short-term expenditures. Dam operations and maintenance would be recurring annually and persist over the life of the dam. Recreation facilities would also have to be maintained. The categories of expenditures and their term are shown in Table 4.10-21.

**Table 4.10-21 Dam & Water Supply Construction:
Short- and Long-Term Expenditures**

Expenditures	Term of Expenditures
Dam and Basin Construction	3 Years
Water Delivery System Construction	3 Years
Recreation Facilities Construction	1 Year
Dam Operation and Maintenance	Lifetime
Water Delivery System Operation and Maintenance	Lifetime
Recreation Facilities Operation and Maintenance	Lifetime

Table 4.10-20 provides a detailed breakdown of all estimated construction costs. As seen in the table, the total cost of the Project is estimated to be approximately $191 million in 2006 dollars. In September 2006, the cost for only the construction of the dam and reservoir was estimated at $51,977,700 (FNI, 2006b).

Conflict resolution refers to moving county roads, electric power lines, railroad tracks, oil and gas pipelines and wells, and telephone cables (FNI, 2006b). The costs include

2 The USDA and other federal agencies continue to rely on the IMPLAN model for regional and local economic impact studies. See USDA literature. One example is the National Resources Conservation Service with the USDA: http://www.economics.nrcs.usda.gov/technical/implan/implanmodel.html.

engineering and labor. The conflict resolution costs for the Lake Columbia Project are estimated at $108,176,100 in September 2006 dollars. These are “one-time” costs without persistent economic impacts over the life of the reservoir.

The September 2006 cost estimate for land acquisition is $23,856,000. This cost covers purchasing approximately 11,150 acres of land in Cherokee and Smith counties. Land acquisition area was updated to 11,500 acres by ANRA in April 2007. Environmental mitigation costs are estimated in 2006 dollars at $7,050,000 (FNI 2006b). Actual mitigation costs are unknown at this time, and this estimate is included as a placeholder pending final development and refinement of the mitigation requirements for the Project.

Delivery System and Financing Costs

Delivery systems consist of pipelines to carry water to users, pumping facilities, including booster pumping stations, and treatment facilities. The delivery systems would not be developed at the same time, but in accordance with estimated demand needs. Potential customers have not incurred the costs to assess the water delivery systems, as these are only relevant if proposed Lake Columbia is approved. Costs to end users would be partly determined by the technology available at that time for water treatment.

The lack of precision at this time in delivery system costs is not a major hindrance to this analysis, and a good case can be made that they are irrelevant at this stage. The delivery system costs are not a factor in the comparison of the cost per thousand gallons of water from Lake Columbia versus Toledo Bend (see Section 4.10.2.3). That comparison assesses the efficient means of getting water to the location of Lake Columbia. Delivery systems would eventually be required, but they would be essentially the same cost regardless of which of those alternatives is chosen.

Delivery systems costs are discussed and roughly partially estimated in this report to acknowledge their existence, but all of these costs and their impacts would have to be eventually revisited if Lake Columbia is approved. For this report, these costs, in terms of November 2006 dollars, are $17,406,688, the composition and derivation of which is presented below.

Financing costs are paid by the users of the water. The Lake Columbia costs, including land acquisition, construction, and transmission and treatment facilities, along with any other costs, would be expected to be financed with contract revenue bonds and by resources from the Texas Water Development Board (TWDB). Initially the TWDB would provide the money for the Project. ANRA would pay back the money to TWDB with revenue received from the Project participants. The Project participants would be paying ANRA for water and other utility services. ANRA would issue contract revenue bonds and use the proceeds to pay the Project costs. The maturity durations, which would be at least 30 years, and bond coupon rates have yet to be determined. The participant share is estimated to be 63% of the total financing for the Project. (ANRA) The remaining 37% of financing would come from the TWDB. However, over time the percentage devoted to participants in the local area is expected to increase. The percentage of financing by each participant's percentages are: Afton Grove WSC, 1%; City of Arp, 0.5%; Blackjack WSC, 1%; Caro WSC, 0.5%; Cherokee County, 3%; Jackson WSC, 1%; City of Jacksonville, 5%; City of Nacogdoches, 10%; City of New London, 1%; City of New Summerfield, 3%; North Cherokee WSC, 5%; City of Alto, 0.5%; City of Rusk, 5%; Rusk Rural WSC, 1%; Stryker Lake WSC, 0.5%; Temple-inland, Corp., 10%; City of Troup, 5%; and City of Whitehouse, 10% (ANRA, 2009a).

The initial Project money would come from TWDB, and this money would represent an inflow of funds into the local area. The participants would over time pay back 63% of Project costs, with interest, to TWDB, and these repayments would represent an outflow of funds from the area.

Most of Lake Columbia would be located in Cherokee County. Lake Columbia is proposed to partially or wholly meet the water demands (including net water demands in excess of supply) of the local area for a 100-year period. The deficits are most pronounced in Cherokee County and Rusk County.[3] Cherokee County would be the main recreational economic benefactor of the water in proposed Lake Columbia, as development around the reservoir would be located in that county. The impacts of Lake Columbia, however, are not necessarily confined to the local area.

Southern Smith and northern Cherokee Counties are experiencing rapid growth. The likely development around Lake Columbia could consume between 10,000 and 20,000 acre-feet/year (EPA, 2003). Potentially all of the water from the reservoir could be consumed within the area, but that cannot be foretold currently with any accuracy.

Recurring Maintenance and Operating Expenditures

Estimates for recurring maintenance and operating expenditures for the proposed Lake Columbia dam were calculated by Freese & Nichols (FNI, 2007a). Recurring costs were estimated by Freese & Nichols to be 1.5% of the overall cost of construction. The estimated cost of construction for the Lake Columbia dam is $51,977,700, resulting in an estimated maintenance and operating expense of $780,000. The same ratio of 1.5% of construction costs was applied to estimate the water delivery and supply maintenance costs. These annual costs are estimated to be $261,100 per year, which is 1.5% of the estimated construction cost of water delivery systems ($17,406,688).

Delivery Systems

The only formal delivery systems analysis for Lake Columbia was performed in 1991.[4] After examination of this document, and in discussion with ANRA, it is clear that this analysis is significantly out of date. The plans for additional infrastructure for delivery would be dictated by the final water users, and these plans would be determined

3 See EPA, 2003, pp. 14-15 for tables showing projections of net water shortages by counties.
4 LAN, 1991a, pp. IV-10 to IV-18.

subsequent to approval and building of the reservoir. The earlier analysis does not take into account the existing treatment plants and the areas interconnected with the treatment plants. In discussion with ANRA, the reasonable parts of that analysis that can be used currently are portions of the delivery costs for the northern distribution system and the delivery system to Nacogdoches, but even then these are very rough estimates.

Since the costs were in 1990 dollars, these were inflated to 2006 dollars using the Bureau of Reclamation Construction Cost Indexes for Field Work Only.[5] The cost of pumping plants (structures and improvements, equipment) increased at approximately a 3.01% annual rate over the 16 year period 1990-2006. Steel pipeline costs increased at a 3.15% annual rate over that same period. To convert delivery costs to 2006 dollars from 1990 dollars, the average of these two rates was used, or 3.07%. Table 4.10-22 shows the delivery costs taken into account in this analysis.[6]

Table 4.10-22 Delivery System Costs Currently Identifiable

Description	2006 Dollars
Northern Distribution System, Intake and Pumping Facilities.	$9,728,603
Capital Costs for Water Delivery System to Nacogdoches.	$7,678,085
TOTAL	$17,406,688

Impact on Timber and Agriculture Production

Data reported by the Cherokee and Smith county appraisal districts include valuations of the annual agricultural and timber production capacity for lands approved for agricultural/timber-based tax exemptions.[7] In Smith County, 96 percent of the acreage in the vicinity of the proposed reservoir is designated as agricultural or timber use land.[8] In

5 USBR, 2006.

6 According to a 1991 study, the delivery systems costs, in 1990 dollars, were estimated to be $5,997,000 for the northern distribution system and $4,733,000 in capital costs for the water delivery system to Nacogdoches. See LAN, 1991a), p. IV-18. .

7 General information regarding the valuation of properties approved for agricultural/timber-based tax exemptions was obtained from the Smith and Cherokee county appraisal districts by telephone interviews on November 29, 2006. According to the Smith County Appraisal District (CAD), if land is devoted to agricultural (hay, cattle, etc.) or timber production, then an application for an agricultural valuation may be submitted. If the application is approved, then the land value is based on the agricultural/timber product produced on that land. According to the Cherokee CAD, timber use values are estimated by the state comptroller along with the Texas Forest Service, which provide those estimates to the local CAD. The local CAD estimates agricultural values. The timber use value is a measure of the annual timber production capacity of the land rather than the actual timber on the land. For example, land with 25-year old pine trees has the same timber production capacity as land which has pine seedlings but is otherwise the same.

8 Acreage in the vicinity of the proposed reservoir is identified in a list of properties provided by ANRA. The list of properties was compiled for purposes of public notification concerning the Lake Columbia

Cherokee County, 97 percent of the acreage in the vicinity of the proposed reservoir is designated as either agricultural or timber use land.

Land that would be submerged by the reservoir has a total estimated agricultural and timber annual production capacity of approximately $1.29 million in Cherokee County (just over $661,000 timber use and $632,000 agricultural use) and approximately $42,000 in Smith County.[9] The value placed on all future timber and agricultural production is determined by the price of the land. That is, the purchase price of the land is the market's present valuation of the future profitability of timber and agricultural production. The higher the profitability of this future production, the higher the price of the land. The money set aside for purchases of land for the proposed Lake Columbia is based on recent assessments of market value of the land. The amount set aside for purchases is shown in Table 4.10-20 and totals $23,856,000. Lake Columbia would eliminate the agricultural and timber production on these particular properties, but substitute production from other properties in the local area could arise in response to elimination of the production on the properties covered by the reservoir. Any substitutions are ignored in this analysis. The $23,856,000 is the best assessment of the value of agricultural and timber production that would be lost due to the purchase of land for the Lake Columbia reservoir.

Recreation and Business Development

If constructed and impounded, Lake Columbia would attract new recreational spending to the lake area and to surrounding areas. In order to assess recreational spending, several types of analyses of recreational visits to USACE reservoirs were considered. These analyses also contained information about expenditures by visitors to the reservoirs (Stynes, Chang, and Probst, 2006). Specific expenditure categories were available for reservoir visitors (Propst, Stynes, Lee, and Jackson, 1992a).

A sample of USACE lakes in Texas provided visit and expenditure data on annual users of lakes. These data were used in conjunction with the surface acreage of the lakes in

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project and includes properties which are touched by the proposed reservoir (including a water quality zone). The property list from ANRA covers an estimated 27,981 acres, whereas only 11,150 of those acres are anticipated to be acquired by ANRA for Lake Columbia. The reason for the difference in acreage is that many of the properties are only partially covered by the proposed reservoir and water quality zone. Acreage data for a few of the properties are not available, so the total acreage for the ANRA list is somewhat higher than 27,981. Those additional acres are expected to be few in number and thus immaterial to the analysis, so the ANRA list is considered to comprise 27,981 acres for purposes of this analysis.

9 The Cherokee CAD reports separately the timber and agricultural land values, whereas the Smith CAD reports a single "agricultural" value which includes both agricultural and timber use. (SCAD, CCAD) Because the properties in the ANRA list cover 27,981 acres, whereas the amount of land to be purchased for the reservoir would total approximately 11,150 acres, the total agricultural and timber use value of $3.35 million for the 27,981 acres is multiplied by 39.85 percent (11,150/27,981) to obtain the value of $1.34 million applicable to the 11,150-acre area which would be purchased. To the extent that the average agricultural and timber use value of the 27,981 acres exceeds the average agricultural and timber use value of the 11,150 acres to be acquired for Lake Columbia, this calculation overstates the loss in agricultural and timber production due to submersion of the land.

order to estimate the future number of users for the proposed Lake Columbia. USACE data are shown in Table 4.10-23. The data are for 25 reservoirs in Texas (Propst, Stynes, Lee, and Jackson, 1992b). For each reservoir there are data on the total annual users of the Project. The "users" are broken down into four categories: Boaters that are Campers, Non-boaters that are Campers, Day Users (including overnight visitors (OVN)) that are Boaters, and Day Users (including other OVN) that are Non-boaters. The surface area for each of the lakes was obtained from the Texas Parks and Wildlife (TPWD 2006d).

Table 4.10-23 Annual Visits by Segments (in person trips, 1,000s)

	Camper		Day Users (inc. OVN)			
Project	**Boater**	**Nonboater**	**Boater**	**Nonboater**	**Total**	**Surface Acres**
Aquilla Dam & Lake	0.0	0.0	17.5	47.4	64.9	3,020
Bardwell Lake	1.4	8.6	68.3	419.6	498.0	3,138
Belton Lake	5.4	21.5	449.9	1,799.5	2,276.3	12,385
Benbrook Lake	1.3	11.7	120.3	1,082.8	1,216.1	3,635
Canyon Lake	5.9	23.5	246.6	986.3	1,262.2	8,308
Cooper Lake	2.5	9.0	48.7	172.6	232.8	19,305
Ferrells Bridge Dam Lake O' The Pines	6.9	16.9	276.0	675.6	975.4	16,919
Granger Lake	1.4	7.2	54.8	287.4	350.8	4,064
Grapevine Lake	3.3	15.1	280.5	1,277.8	1,576.7	6,892
Hords Creek Lake	0.9	13.6	28.8	451.2	494.5	510
Joe Pool Lake	14.5	18.5	310.7	395.4	739.0	7,470
Lake Georgetown	7.5	23.7	118.9	376.6	526.7	1,297
Lavon Lake	3.1	9.3	407.8	1,223.3	1,643.4	21,400
Lewisville Lake	7.3	26.0	675.5	2,394.9	3,103.7	29,592
Navarro Mills Lake	1.6	10.7	69.2	463.3	544.8	5,070
O.C. Fisher Lake	0.1	5.4	9.8	965.1	980.2	5,440
Proctor Lake	2.8	8.9	74.3	235.2	321.2	4,537
Ray Roberts Lake	9.6	16.4	816.7	1,390.6	2,233.3	25,600
Sam Rayburn Reservoir	13.6	20.4	645.1	967.6	1,646.7	114,500
Somerville Lake	13.3	47.3	276.6	980.6	1,317.8	11,456
Stillhouse Hollow Reservoir	0.7	2.3	99.1	331.7	433.8	6,429
Town Bluff Dam B.A. Steinhagen Lake	3.3	11.0	73.9	247.5	335.6	10,687
Waco Lake	2.2	18.1	192.5	1,557.6	1,770.4	7,194
Whitney Lake	7.0	29.8	217.0	924.9	1,178.7	23,500
Wright Patman Dam and Lake	4.7	28.6	155.6	955.7	1,144.5	18,994
Lake Columbia	**4.3**	**15.6**	**199.5**	**791.1**	**1010.6**	**10,133**

Twenty-five observations were available for the USACE Fort Worth District. After investigation, one outlier was removed from the sample due to its large size when compared to other lakes in the sample. The remaining 24 observations were then used to estimate the number of users by segment for Lake Columbia as reported at the bottom of Table 4.10-23. The number of users for Lake Columbia was derived using simple linear regressions based on the relationship between surface area of water and the number of users in each of the four categories.[10]

Spending profiles are total lake visitor spending for purchases on services and goods distributed over separate spending categories. The lake visitors were grouped into six market segments: Day use Boater, Day use Non-boater, Camp Boater, Camp Non-Boater, Other overnight Boater, and Other overnight Non-Boater. The spending profiles for Lake Columbia visitors shown in Table 4.10-24 were calculated using the estimated number of visitors from Table 4.10-23 and spending data from a 1999/2000 survey of 16 USACE projects.[11] The number of visitors in the "day user" (boater and nonboater) categories was first separated into "day user" and "other overnight" categories in order to be equivalent to the groupings in the spending profiles. The disaggregation was based on the ratio of the number of cases for each of the categories in the spending profiles. The spending profiles, per person-trip, were then multiplied by the number of visitor days to reach a dollar value for spending in the Lake Columbia Project area. Finally, the spending information, originally in 1999 dollars, was converted to 2006 dollars based on the Consumer Price Index (US DOL, 2006).

As can be seen in the table, average annual total trip spending by visitors over the life of the reservoir exceeds $36 million. However, only $26,211,212 is expected to be spent within 30 miles of the reservoir. Some portion of the visitors would originate outside of the local area, and some portion of the visitors would live within the local area.

To assess the likely portions, a study conducted by the Department of Wildlife and Fisheries Science at Texas A&M University for the Texas Parks and Wildlife Department was used.[12] The study surveyed anglers at Sam Rayburn Reservoir and found that about half of the respondents were non-local residents that were visiting the area for recreational use. This ratio was used in determining the impact to the Lake Columbia area when determining the influx of outside money into the economy. Also, the total dollars spent within 30 miles of the reservoir, or $26,211,212, is the amount assumed to be spent annually in the local area. The impact of this spending is assessed below.

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10 Variables other than surface area of the lake were considered for possible inclusion in the analysis. Maximum depth and age of the lake were found to be insignificant. Other possible variables such as quality of fishing and water level fluctuation were not adequately reported to be of use in this analysis at this time.

11 Table 2. Summary of CE Visitor Spending Profiles, 1999, (per person-trip, six segments), from Recreation Visitors Spending Profiles for 16 Corps of Engineers Lakes (per person-trip), from 1999/2000 Survey, available http://msu.edu/user/changwe4/spend/16lake2.htm.

12 Anderson, Ditton, and Oh, 2002.

Table 4.10-24 Summary of Lake Columbia Visitor Spending by Type of Visitor: Average Annual Spending Over the Life of the Reservoir, 2006 Dollars

Spending Category	Camper		Day User		Other Overnight		Total
	Boater	Non-Boater	Boater	Non-Boater	Boater	Non-Boater	
Spending within 30 miles							
Hotel, motels, cabins, B&B and rental homes	3,797	2,075	0	0	855,871	2,717,879	3,579,622
Camp fee	70,991	266,415	0	0	4,985	4,583	346,974
Restaurants, bars, etc.	36,718	152,830	441,938	2,334,949	621,590	2,134,276	5,722,301
Groceries and take out food	93,614	276,604	727,787	3,084,046	647,012	850,961	5,680,024
Gas & oil	57,885	144,906	1,154,680	1,936,494	675,425	996,097	4,965,487
Other auto expenses	4,473	25,094	282,088	215,166	267,678	0	794,499
Other boat expenses	22,779	0	353,550	0	535,854	0	912,183
Entertainment and recreation fees	10,714	48,491	161,730	366,579	191,412	223,052	1,001,978
Sporting goods and boat equipment	21,843	25,094	513,400	605,652	217,831	319,301	1,703,121
Other expenses	15,342	98,868	82,746	932,386	148,045	227,636	1,505,023
Total (within 30 miles)	338,156	1,040,377	3,717,919	9,475,272	4,165,703	7,473,785	26,211,212
Total trip spending							
Hotel, motels, cabins, B&B and rental homes	6,241	24,151	0	0	977,497	4,369,385	5,377,274
Camp fee	78,272	340,189	0	0	9,471	4,583	432,515
Restaurants, bars, etc.	45,767	230,944	19,042	2,669,652	836,929	3,680,366	7,482,700
Groceries and take out food	124,871	398,302	953,457	3,458,594	958,555	1,159,567	7,053,346
Gas & oil	83,108	300,944	1,534,558	2,581,992	953,072	2,129,693	7,583,367
Other auto expenses	9,517	42,264	293,371	310,795	280,139	0	936,086
Other boat expenses	28,292	0	377,998	0	659,972	0	1,066,262
Entertainment and recreation fees	12,430	88,302	163,611	446,270	214,341	366,662	1,291,616
Sporting goods and boat equipment	30,945	43,585	771,040	701,282	278,644	485,827	2,311,323
Other expenses	21,947	150,944	101,552	1,840,864	181,941	346,801	2,644,049
Total trip spending	**441,390**	**1,619,625**	**4,714,629**	**12,009,449**	**5,350,561**	**12,542,884**	**36,178,538**

Property Tax and Government Operations

New construction would increase economic activity in the area by creating jobs for construction, maintenance and operation of the proposed dam and reservoir. These jobs would create additional sales tax revenue, and new residents would pay property taxes that would benefit government operations. It should be noted that increased population also creates a need for more services, so it is not clear if the increased tax revenue would deliver increased services per person or simply accommodate the increased population. As the population grows, through economic development, construction and maintenance of the dam and reservoir, the tax base would also increase. The resulting taxes surrounding the increase would enable the cities and counties to build more roads, increase the number of schools and teachers, and provide community services to the increased population. The net effect on the current population, as far as community services, may be negligible in the long run. It is expected in the short run that the infusion of new tax revenue would provide funding for currently unfunded projects. The cities and counties would need to prepare for the increases in future services requirements and plan their long term budgets accordingly.

Some tax revenue would also be lost due to the submersion of land by the lake. Property taxes would no longer be paid on properties covered by the reservoir. Taxable values, tax rates, and estimated taxes reported by the Cherokee and Smith county appraisal districts can be used to determine the estimated total taxes currently levied on these properties by counties, cities, and school districts.

Table 4.10-25 reports the appraisal districts' assessment of market values, taxable values, tax rates, and estimated taxes in year 2006 for the 27,981-acre land area in the vicinity of the proposed reservoir.[13]

ANRA plans to acquire only 11,150 of these 27,981 acres for Lake Columbia, so not all of the property reported in Table 4.10-25 would be removed from the tax base because of the reservoir. Assuming that the subset of 11,150 acres has the same characteristics as the 27,981 acres from which it is drawn – in terms of appraised value, taxable value, and division among taxing entities – then the values in Table 4.10-25 which are applicable to the full 27,981-acre area, can be converted to values applicable to the 11,150-acre area to be removed from the tax base by multiplying by 39.85 percent (11,150 / 27,981 = 0.3985).[14] Using this methodology, the total year 2006 market value of the 11,150-acre

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13 The 27,981-acre area includes the properties which are touched to any extent by the reservoir, as described above. The properties are identified in the ANRA public notification property list. Other sources for Table 4.10-25 include the Cherokee CAD website at http://clientdb.trueautomation.com/clientdb/main.asp?id=2, the Smith CAD website at http://www.smithcad.org/scadarc/viewer_temp.htm, and year 2006 tax rate tables provided by the two appraisal districts.

14 Though the division of land across taxing entities differs somewhat for the 11,150-acre area compared to the full 27,981-acre area, any difference in the estimates of market value, taxable value, and tax amount for the 11,150-acre area resulting from the incorporation of the difference in tax rates into the calculation would likely be immaterial.

proposed acquisition area, as appraised by the Cherokee and Smith county appraisal districts, is approximately $17.61 million.[15] Because most of the property in the proposed area is designated for agricultural/timber use tax exemptions, the tax revenue from the properties is relatively low. The estimated total annual property tax revenue that would be lost due to the acquisition of 11,150 acres for Lake Columbia is approximately $88,000.[16]

Table 4.10-25 Estimated Values and Property Taxes for Properties in the Vicinity of the Proposed Reservoir, 2006

Taxing Entity	CAD Market Value	Taxable Value	Tax Rate	Estimated Tax	Alternative Estimated Tax*
Arp ISD	$12,400	$4,515	0.01555000	$70	$70
Bullard ISD	$329,110	$0			
Jacksonville ISD	$18,166,990	$5,375,273	0.01410000	$75,791	$75,791
New Summerfield ISD	$4,867,530	$909,284	0.01343000	$12,212	$12,212
Troup ISD	$19,204,254	$4,510,356	0.01285000	$57,958	$57,958
Whitehouse ISD	$1,622,000	$128,734	0.01445000	$1,860	$1,362
Smith County	$2,300,290	$444,587	0.00268275	$1,193	$1,072
Cherokee County	$41,901,994	$11,664,986	0.00475000	$55,409	$55,409
Cherokee County-Lateral Road		$11,553,652	0.00145000	$16,753	$16,753
****Total**	**$44,202,284**	**$34,591,387**		**$221,246**	**$220,627**

** Using Smith CAD estimated taxes for Smith County, Arp ISD, and Whitehouse ISD.*
*** Due to redundancy of ISD and county values in the case of market values, the Total CAD Market Value is not the sum of the individual figures.*

15 This is equal to 39.85 percent of $44,202,284.

16 This is approximately equal to 39.85 percent of $221,246 or 39.85 percent of $220,627. To the extent that the property to be submerged is of lesser taxable value than the average taxable value for the 27,981 acres, these tax losses are overestimated. Some of the land is currently swamp land and is of lesser value for tax purposes. The United States Army Corps of Engineers and the United States Environmental Protection Agency jointly define wetlands as: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. See: Ullah, S; Faulkner, SP. 2006. Denitrification potential of different land-use types in an agricultural watershed, lower Mississippi valley. *Ecological Engineering* 28 (2): 131-140.

Using the IMPLAN Input-Output Model

Direct, Indirect, and Induced Effects

The above discussion describes the impact that the Proposed Action would have on the local communities. Costs and benefits are modeled using the IMPLAN[17] input-output model, which measures the impact of expenditures for construction and maintenance of the dam and other facilities. Some of the impacts are economic benefits to the communities, such as increased recreational spending, potential for construction of new homes and associated infrastructure, and construction and operation of new businesses, and others are reductions such as increased cost of services and lost tax revenues.

Substantial financial investments are required to build and maintain a reservoir and associated infrastructure. Other spending, such as recreational spending, results in new direct increases in employee compensation, goods and services purchased locally, and payments to land owners. However, these direct increases do not represent the full impact of this spending. Expenditures into the local area that originate from outside the area typically have a larger impact on the economy. They are an infusion of money into the local economy and are spent by employee households, suppliers, and governments as they demand goods and services. The secondary, or indirect, effect of spending by any industry is a significant addition to the amount of direct spending. This occurs because money received by businesses and governments is re-spent several times in any given year for items used in households or goods and services production. The key to determining the size of an indirect effect is a model that accounts for the inter-relationships among industries and between industries and the government. Such a model exists in the form of an input-output model that represents the structure of industries. This model uses local data to help determine impacts to this specific local area. A third, or induced effect, results from the increase that households experience in their household incomes and the subsequent change in the household's expenditures in the local area.

The methodology employed in this study was the use of output, income, and employment coefficients to estimate the indirect and total effects of the Lake Columbia spending on the local area economy. These coefficients are derived specifically for the local area by utilization of the IMPLAN model combined with the area input-output tables.

The IMPLAN coefficients utilized in this analysis are derived using 2004 data representing the economic linkages between the various industrial sectors in the local area economy. A sector is defined as a type of economic activity. An example would be the Dairy Farm Sector. The 2004 data is the most current available, and it is assumed that the coefficients used in this model are relevant for the current year. The model is applied to the most current data available.

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17 IMPLAN Professional 2.0. Minnesota IMPLAN Group, Inc., 1725 Tower Drive West Suite 140 Stillwater, MN 55082 USA. The USDA and other federal agencies continue to rely on the IMPLAN model for regional and local economic impact studies. One example is the National Resources Conservation Service with the USDA: http://www.economics.nrcs.usda.gov/technical/implan/implanmodel.html.

The IMPLAN model uses these coefficients to estimate the effects on output, income, and employment in the local area of specified dollar amounts of expenditures that come from without the local area. For instance, a total effects coefficient of 1.26 (hypothetical) in the output (sales) category implies that every dollar of sales from that business would generate a total of $1.26 in local area sales among all industrial sectors. Income in this analysis refers to wages, profits, and investment income accruing to employees and entrepreneurs.

The IMPLAN model predicts Direct, Indirect, and Induced impacts to the region of interest. (See Table 4.10-26)

Table 4.10-26 Definitions: IMPLAN

Impact	Definition
Direct Effects	Represent the impacts (e.g. change in employment) for the expenditures and/or Production values specified as direct final demand changes.
Indirect Effects	Represent the impacts (e.g. change in employment) caused by the iteration of industries purchasing from industries resulting from direct final demand changes.
Induced Effects	Represent the impacts (e.g. change in employment) on all local industries caused by the expenditures of new household income generated by the direct and indirect effects of direct final demand changes.

Choice of IMPLAN Sectors

A key part of assessing the economic impacts is to determine in what sectors within the IMPLAN model the spending impacts are to be imposed. In such determinations, the analyst is restricted to choosing among IMPLAN's available categories, many of which are aggregations of several types of spending.[18] There is some judgment involved as to which categories are the most appropriate for assessing the expenditure impact. Tables 4.10-27 through 4.10-30 list the sectors for which expenditure impacts were imposed to assess the total impact of the reservoir spending on the local area.

18 A list of the IMPLAN model sectors are available in *IMPLAN Pro (2004),* pp. 291-301.

Table 4.10-27 IMPLAN Sectors Used for Analysis of Dam and Water Delivery Construction and Conflict Resolutions

Description	IMPLAN Sector	IMPLAN Description	Amount 2006 $
Dam Construction	39	Highway, street, and bridge construction	$51,977,700
Communications	41	Other new construction	$2,306,700
Electric Utilities	498	State and local government electric utilities	$13,927,600
Oil and Gas	28	Support activity for oil and gas operations	$3,529,800
Water Utilities	498	State and local government electric utilities	$149,100
State and County Roads	39	Highway, street, bridge and tunnel construction	$33,114,200
Railroad	41	Other new construction	$26,547,400
Road/Railroad Erosion Protection	41	Other new construction	$2,768,200
Engineering/Contingencies	41	Other new construction	$25,833,100
Water Supply Construction	40	Water, sewer and pipeline construction	$17,406,688
Land	431	Real estate	$23,856,000
Environmental/Mitigation	431	Real estate	$7,050,000
TOTAL			**$208,466,488**

Table 4.10-28 IMPLAN Sectors Used for Analysis of Lost Timber and Agriculture

Description	IMPLAN Sector	IMPLAN Description	Amount 2006 $
Lost Timber Production	15	Forest nurseries, forest products, and timber tracts	-$661,493
Lost Other Agriculture Production	11	Cattle ranching and farming	-$674,933
TOTAL			**-$1,336,426**

Table 4.10-29 IMPLAN Sectors Used for Analysis of Annual Recreation Impact

Description	IMPLAN Sector	IMPLAN Description	Amount 2006 $
Hotel, motels, cabins, B&B and rental homes	479	Hotels & motels	$3,579,622
Camp fee	478	Recreation industries	$346,974
Restaurants, bars, etc.	481	Food services and drinking places	$5,722,301
Groceries and take out food	481	Food services and drinking places	$5,680,023
Gas & oil	407	Gasoline stations	$4,965,486
Other auto expenses	483	Automotive repair and maintenance	$794,499
Other boat expenses	401	Motor vehicle and parts dealers	$912,183
Entertainment and recreation fees	478	Recreation industries	$1,001,978
Sporting goods and boat equipment	409	Sporting goods, hobby, book, and music stores	$1,703,122
Other expenses	411	Miscellaneous store retailers	$1,505,023
TOTAL			**$26,211,211**

Table 4.10-30 IMPLAN Sectors Used for Analysis of Annual Operations and Maintenance

Description	IMPLAN Sector	IMPLAN Description	Amount 2006 $
Water Delivery Supply Operations and Maintenance	45	Other Maintenance and repair construction	$139,254
Dam Operations and Maintenance	44	Maintenance and repair of highways, streets, and bridges	$1,528,478
Recreation Facilities Operation and Maintenance	45	Other Maintenance and repair construction	$50,000
TOTAL			**$1,717,732**

Economic Impact Calculations

Using the IMPLAN model to assess the expenditure impacts in the magnitude and sectors shown above, we find the following economic impacts to the five-county region.

The economic impacts of construction expenditures, conflict resolution expenditures, and others shown in Table 4.10-27 are presented in Table 4.10-31. The figures were calculated using the IMPLAN input/output model. These expenditures only occur at the outset of the Project, say, over approximately a three-year period.[19] The impacts shown in Table 4.10-31 also occur over a three-year period. As can be seen in Table 4.10-31 the direct expenditure on goods and services of $208,466,488, which corresponds to the total shown in Table 4.10-27, results in $286,610,713 total expenditures.

Labor income and employment would increase as a result of the dam construction and related spending. Employment on the dam construction and the related activities result in labor income of nearly $73 million over the approximately three-year construction period and on average, more than 675 new jobs that would be created and maintained each year over the construction period.

Table 4.10-32 shows the loss of annual timber and agriculture production due to the purchase of land for the Lake Columbia reservoir. Output and labor income would experience a permanent decrease in annual values of $2,173,039 and $324,381, respectively. The decline in labor income is larger for indirect spending than for direct spending because labor is a higher component of total value in the economic activities

19 This assumes that the delivery systems would be built at the outset. This is a good assumption for the delivery systems considered. Over time, additional delivery systems may be built to respond to new demand, but these delivery systems are not incorporated into this analysis.

other than timber and agricultural production in these counties. Employment would experience a one time, but permanent, decrease of 20.9 jobs due to the land acquisition.

Table 4.10-31 Economic Impact: Construction, Conflict Resolution, and Land Purchase, 2006 Dollars

Impact	Output	Labor Income	Employment (Number of New Full Time Jobs Created and Annually Maintained Over a 3-Year Period)
Direct	$208,466,488	$48,516,523	431
Indirect	$38,893,773	$12,350,567	107
Induced	$39,250,452	$12,061,000	137
Total	**$286,610,713**	**$72,928,090**	**675**

Table 4.10-32 Annual Economic Impact: Lost Timber and Agriculture Production, 2006 Dollars

Impact	Output	Labor Income	Employment (Number of Full Time Jobs)
Direct	-$1,336,426	-$74,214	-10.4
Indirect	-$657,593	-$195,157	-8.6
Induced	-$179,020	-$55,010	-1.9
Total	**-$2,173,039**	**-$324,381**	**-20.9**

Table 4.10-33 shows the average annual economic impact of the dam and reservoir on employment and income stemming from the recreational spending prompted by Lake Columbia should it become available for recreational use. These annual expenditures would continue for the life of the reservoir. The per-year net effects of this spending are shown in the table. Annual output and labor income would be increased by $33,733,186 and $7,290,998, respectively. Annual employment in the local area, much of which is in industries that sell products contributing to recreation, would experience a permanent increase of approximately 360 jobs throughout the life of the reservoir.

Table 4.10-34 shows the annual economic impact of the dam and reservoir operation and maintenance for the life of the reservoir. The net effects are shown in the table. Annual output and labor income would be increased by $3,028,189 and $1,156,338, respectively. Annual employment in these industries would experience an increase of approximately 30 jobs.

Table 4.10-33 Annual Economic Impact: Recreation, 2006 Dollars

Impact	Output	Labor Income	Employment
Direct	$26,211,211	$5,034,462	289.0
Indirect	$3,616,214	$1,056,363	31.5
Induced	$3,905,761	$1,200,173	40.8
Total	**$33,733,186**	**$7,290,998**	**361.3**

Table 4.10-34 Annual Economic Impact: Operations and Maintenance for the Dam, Water Delivery, and Recreation Facilities, 2006 Dollars

Impact	Output	Labor Income	Employment
Direct	$1,717,732	$771,012	20.5
Indirect	$687,590	$193,929	4.9
Induced	$622,867	$191,397	6.5
Total	**$3,028,189**	**$1,156,338**	**31.9**

Table 4.10-35 summarizes the net ongoing annual economic impact to the area. This impact would result after the effects of the construction of the dam and does not include the annual cost savings due to a cheaper water source. The net impact would be additional annual expenditures on goods and services of $34.6 million and approximately 372 new permanent jobs to the area.

Table 4.10-35 Summary of Net Annual Economic Impact, 2006 Dollars

Impact	Output	Labor Income	Employment
Direct	$26,592,517	$5,731,260	299.1
Indirect	$3,646,211	$1,055,135	27.8
Induced	$4,349,608	$1,336,560	45.4
Total	**$34,588,336**	**$8,122,955**	**372.3**

Table 4.10-36 presents the economic impact on taxes from all types of businesses, including services, as a result of the proposed construction and operation of Lake Columbia. Over the three year construction period the federal taxes generated total more than $15 million. Additional state and local taxes total $7.3 million. Post construction,

Table 4.10-36 Economic Impact: Taxes, 2006 Dollars

Impact	Federal Government	State/Local Government	Total
Construction and Related Exp.	$15,044,658	$7,300,918	$22,220,504
Total Taxes Generated over 3-Year Construction Period	**$15,044,658**	**$7,300,918**	**$22,220,504**
Operations and Maintenance	$221,830	$84,831	$306,661
Lost Timber and Agriculture Production	-$77,491	-$73,305	-$150,796
Recreation	$1,637,086	$1,724,047	$3,361,133
Total Taxes Generated Annually Post-Construction	**$1,781,425**	**$1,735,573**	**$3,516,998**

despite the fact that there are negative impacts on taxes because of the loss of the agriculture and timber value on the land to be purchased for the reservoir, the net impact on annual taxes generated over the life of the reservoir total $1.78 million for the federal government and $1.74 million for state and local governments.

The federal government taxes primarily comprise personal income taxes, corporate income taxes, and social insurance taxes. The state and local government taxes are primarily property and sales taxes, along with additional smaller tax receipts for items such as motor vehicle licenses and fishing and hunting licenses, among others.

Conclusions

Using current estimates of the costs of alternative sources of water, the local area would save approximately $31.2 million per year on water supply costs by using Lake Columbia as a water source compared to the next best alternative. The cost/benefit analysis results in more than a $1.019 billion net present value benefit of Lake Columbia compared to the next best alternative. That is, without the Lake Columbia reservoir, water would have to be brought into the area at greater expense, the $1.019 billion net benefit would not be realized, and the local area would necessarily develop at a slower pace, if at all. This saving is a direct net wealth benefit to the local area.

The construction and operation of the proposed dam and other spending connected with the proposed reservoir would have some negative and positive effects. Some timber land and agricultural land would be submerged. With the loss of this land is loss of some local tax revenue. The building and operation of the dam would accompany an inflow of funds that would have direct and indirect spending impacts on the local economy. These impacts would generate new incomes and permanent jobs in the area. The associated economic growth would require new government services, but also the growth would generate additional tax revenue. The evidence from other reservoirs indicates that, if built, the Lake Columbia reservoir would attract recreational visitors throughout its anticipated life. These visitors would bring spending to the local area and induce income, job, and local tax revenue increases. When one calculates the negative and positive effects from an economic standpoint, the positive effects dominate. The expenditures made to build the reservoir would have positive economic impacts on the local area. Some economic impacts are temporary in nature for the construction period, whereas some are recurring annual benefits over the life of the reservoir.

Impact of the dam and water delivery construction and conflict resolution would be approximately $287 million with an additional 675 jobs created and maintained for approximately three years to facilitate the construction project. After the construction period, the net additional annual expenditures on goods and services to the area would be about $34.6 million, inducing an additional 372 jobs created in the area. These net positive impacts are attributable to expenditures on recreation and dam operation and maintenance being greater than timber and agricultural value lost to submersion.The state and local governments would also see an increase in tax revenues of approximately $1.7 million annually with an additional one-time infusion of $7.3 million in tax revenues over approximately three years because of construction expenditures.

4.10.2.3 Toledo Bend Pipeline Alternative

The estimated cost of raw water from Toledo Bend to be $1.65 per thousand gallons, which exceeds the Lake Columbia cost of $0.53 per thousand gallons by $1.12 per thousand gallons (FNI, 2007b, and reproduced in Appendix B). This analysis also indicated that the EPA Alternatives Analysis (EPA, 2003, and reproduced in Appendix A) understated the costs for alternative sources because of some key factors being left out of the EPA cost assessments. The current estimated capital project costs for the Toledo Bend Pipeline alternative total $398,473,190, with recurring annual costs of $45,948,010, which includes costs for debt service, water purchase, energy, and operation and maintenance. These costs underlie the estimated $1.65 per thousand gallons cost of transferring Toledo Bend water to the local area.

4.10.2.4 Valuation of the Lake Columbia Versus Toledo Bend Alternatives

The cost of Lake Columbia water versus water from Toledo Bend can be calculated by applying the estimates of per unit costs from each source to the quantity of 85,507 acre-feet/year. Lake Columbia would cost less by $31,206,087 annually ($1.12 savings per thousand gallons multiplied by 325.851427 thousand gallons per acre foot multiplied by 85,507 acre-feet/year equals $31,206,087 savings per year). Assuming a 100-year life to the reservoir, the present value of this annual savings over the 100-year period beginning with year 2010, in 2007 dollars, is equal to $1,019,479,379, or approximately $1 billion.[20] This would be the estimated net monetary benefit of Lake Columbia compared to the Toledo Bend Pipeline Alternative.

In addition to valuing the water cost from proposed Lake Columbia versus Toledo Bend, there are different socioeconomic impacts on the local area of the two alternatives. Because Toledo Bend water is a higher cost alternative and the State of Texas, or the TWDB, has no commitment to this higher cost alternative, pursuing the Toledo Bend alternative may not even be possible. But assuming that it is, most expenditures for the construction, operation, and maintenance of the Toledo Bend alternative would be made outside the local area. Impacts of these expenditures on the local area would be much less than with Lake Columbia. Significant initial construction and recurring operational and maintenance expenditure impacts would occur to other areas, but these would be at the expense of residents in the local area.

The key issues from an economic impact standpoint are that with the Toledo Bend Pipeline alternative, the residents in the local area would be paying more for water than with the Lake Columbia alternative. These higher payments would mainly flow out of the local area. To get a sense of the magnitude, and to facilitate comparison with the Lake Columbia alternative, assume that payments are for 85,507 acre-feet per year, that they are at cost, and ignore inflation to keep measures in current dollars. Since an acre foot is 325.851 thousand gallons, the annual outflow of wealth from the local area connected only with purchases of water would be approximately $46 million per year throughout the life of the reservoir (85,507 x 325.851 x $1.65). Based on average per capita water consumption in the East Texas region, a typical household of four people would save approximately $173 per year from having Lake Columbia water rather than water obtained from Toledo Bend.[21]

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20 The present value of water cost savings was calculated using a discount rate of 2.7 percent, which represents a real interest rate. This rate is the difference between the arithmetic mean of the long-term government rate over the period 1926-2005 (5.8 percent) and the arithmetic mean of the inflation rate over the same period (3.1 percent), taken from Ibbotson Associates (2006). The long-term government rate was used since Lake Columbia is a long-term project. The long-term inflation rate in conjunction with the long-term interest rate was used to obtain a long-term measure of the real interest rate. The real interest rate is the appropriate discount rate since relative costs are viewed as correct and no inflation in the costs is incorporated into the analysis. Also, the 100-year period and annual yield are viewed as parameters. To the extent that there is quantifiable risk in these assessments, the risk could be added to the existing discount rate. The likely effect of incorporating all risks would be a reduction in the measure of the present value of the water from Lake Columbia versus Toledo Bend. However, incorporating risks would not change the fact of Lake Columbia being the cheaper source of water.

21 As discussed above, a savings of $1.12 per thousand gallons per year results from Lake Columbia. A recent study prepared for the East Texas Regional Water Planning Group (Region I) indicates that average residential water use in this region is 106 gallons per capita per day (APAI, 2009). Therefore, a typical four person household uses 424 gallons per day. Annual savings per household would be 0.424 thousand gal/da x 365 da/yr x $1.12/1000 gal = $173.33 per year in household savings.

The loss to the local area of these higher payments for water would directly induce declines in economic activity in the local area compared to the Lake Columbia alternative. But indirect secondary impacts would cause additional declines in economic activity in the local area. The higher cost of water from Toledo Bend would impair some of the forecasted population growth, income growth, taxes, support for schools, and other aspects of socioeconomic activity in the area.

4.10.3 Cumulative Effects

Selected indicators of socioeconomic characteristics in the Five County Area have been used to provide a cumulative context for the current situation (2004-2006), with some projections included out to 2060. Composite data are typically presented for the Five County Area as well as the individual counties. In some instances, current data for the cities in each county are included. The specific indicators included the human population from 2005 to 2030, labor force size (2004), employment levels and unemployment rates (2004), earnings per capita and total compensation of employees (2004), and compensation by employment sectors for each of the five counties (2004). Public finance information for the Five County Area was also provided on property taxes (2004), retail tax rates (2006), school district financing (2005), and public debt ratings by county in 2006.

The No Action alternative does not address the potential future water deficits in the Five County Area. Water deficits could lead to reductions in human population, employment rates, earnings per capita, total compensation of employees, and compensation by various employment sectors. Economic resources for financing public projects and school systems could also decline over the future time period (2010-2060). These indicators are cumulative over both space and time; hence they are reflective of adverse cumulative effects from the No Action alternative.

The economic value of the proposed Lake Columbia Project is included for the Proposed Action alternative. Further, an input-output model called IMPLAN was used to delineate local area expenditures related to lake construction and operation, delivery system costs, and recurring maintenance and operating expenses. Revenue losses from timber and agricultural production in the Permit Area and Shoreline Development Area were provided, along with projections of recreation increases and expenditures. Expenditures for business development in areas within and near Lake Columbia were also included. Further, increases in property taxes and government operational taxes were also provided. All of the included information for the proposed Lake Columbia and related items are cumulative over space and time. All of these indicators provide evidence that the proposed Lake Columbia Project would provide substantial positive benefits to the human population and socioeconomic characteristics of both the Five County Area and Smith and Cherokee counties. Table 3.3-6 also indicates that these population increases and economic developments in the Five County Area would facilitate the provision of beneficial effects to labor, earnings, and public finance.

An additional beneficial impact of the proposed Lake Columbia Project is that a Texas Department of Transportation project (widening of U.S. 79, and a bridge across the lake, as shown in Table 3.3-6) would also occur aboutthreemiles upstream from the proposed dam. This project would create additional jobs and income for the Five County Area. U.S. 79 would play a key role in providing access to both sides of the lake for recreational visitors to the reservoir area. Shoreline development would likely increase with the proposed reservoir, and the highway could also eventually provide a key access route for any additional development project or new recreational facilities that could materialize in the future. The area traffic volume in general and on U.S. 79 in particular is likely to be increased.

The Toledo Bend Pipeline alternative has a total cumulative cost estimate of $1.65 per thousand gallons. This estimate can be compared to the cumulative cost of $0.53 per thousand gallons for the Proposed Action alternative. Accordingly, the Toledo Bend Pipeline alternative would cost the water users in the Five County Area more than three times as much as Lake Columbia water. This could have a cumulative detrimental effect on future economic developments and population growth in the Five County Area.

4.11 LAND USE AND RECREATION

4.11.1 Affected Environment

This section discusses existing land use in the five-county region surrounding the proposed reservoir, existing land use and recreation for acreage in the immediate vicinity of the proposed reservoir, and plans for mitigation of various impacts which the proposed reservoir would have on existing land use. This section reports findings from both earlier research and current research.

4.11.1.1 Regional Land Use

Land use in the Five-County Area surrounding the proposed reservoir is largely rural. It was described by Lockwood, Andrews & Newnam (LAN, 1991b) as follows:

> The five-county region surrounding the proposed Lake Eastex project is rural in nature with few, but well-defined urban centers scattered throughout.
>
> The region is predominantly forested, with pasture/grazing lands interspersed in an irregular manner. The land is gently rolling to hilly, with well-drained elevated areas and low-lying stream floodplain valleys subject to periodic flooding. Streams generally flow to the southeast, the floodplain valleys are generally 100 to 150 feet lower in elevation than the adjacent uplands, and are from one to ten miles wide. The soils are clayey and poorly suited for row crops.
>
> Changes in land use have historically been slow in the region with urbanization being incremental and largely adjunctive to existing urban centers. Classically

rural "suburbanization" is found throughout the region, with "ranchette" development on small-acreage (5-20 acres) tracts along all-weather roads and not necessarily related to urban centers.

Forested Areas – These areas are found throughout the region, with a total acreage of approximately 1,745,000 (about 56 percent of the study area, Table 4.11-1). Forest cover is predominantly non-deciduous, chiefly southern pine, but with mixed hardwoods in bottomlands near perennial streams. Much of the pine is utilized as a cash crop, so that mature stands are regularly harvested, then allowed to recover and regenerate. Because of this, the pattern of heavily forested and cut-over forest land is continually changing, although the total amount of forested land remains relatively stable throughout the region.

Agricultural Areas – Primarily agricultural land use involves pastureland, grazing, and production of hay. The incidence of these open lands is greater in the more northern portion of the region (Smith County and the northern half of Rusk and Cherokee counties). The land becomes more heavily forested in the southern parts of Rusk and Cherokee counties, and in Angelina and Nacogdoches counties. Due to the erodibility of the soils and depletion of nutrients, very little of the lands are utilized for row crops. However, there are numbers of enclosed nursery operations ("plant farms") located throughout the middle portions of the region. The raising of beef cattle and timber production have consistently been the major long-term sustainable agricultural activities.

Urbanized Areas – The four larger (over 12,000 population) urban centers in the region evolved as "focal points" for a convergence of railroads and radially oriented highways. Originally agricultural-trade centers, and later affected by nearby oil and gas deposits, they have evolved into a more balanced urban center status with manufacturing and processing as major economic entities. The smaller urban centers remain basically rural/agricultural trade centers.

The land use patterns of the urban centers of all sizes have evolved in the traditional manner, outward from the original crossroads center. In the smaller more rural centers the patterns are generally static. Growth has been slow or even reversed. The larger centers have grown steadily but also slowly, and with commercial/industrial growth related directly to transportation arteries, rail and highway. The latter-day development of beltline highways has generated commercial/industrial growth adjacent to their corridors, representing, in many cases, "independent" new growth beyond older urban development. Thus many large undeveloped tracts are left between the older growth areas and the newer beltline growth corridors.

Residential land uses within the corporate boundaries of urban centers have also developed in the traditional manner, but beyond these centers two other patterns are apparent. The first is the increasing "ranchette" small acreage residential developments of five to 20 acres, possibly with part devoted to a pasture and/or garden plot. This type of development is common throughout the region along improved roads and is definitely not limited to close proximity to urban centers.

The second notable non-urban residential pattern in the region is in conjunction with reservoirs and impounded lakes. Residential development in small clusters is common on and adjacent to lakes and reservoirs throughout the region. Much of this development consists of weekend/vacation structures and is generally confined to locations on or near existing all-weather roads. In the Tyler area (Smith County), however, larger homesite developments on the larger lakes is common. The cost of the homes and the security measures provided the developments are directly proportional to their distance from Tyler. High-cost homes (many are year-round residences) and high-security compounds are closest to Tyler.[22]

Table II.46 from the LAN report is reproduced as Table 4.11-1 below.[23]

Table 4.11-1 Land Use / Land Cover Statistics for the Five-County Study Area

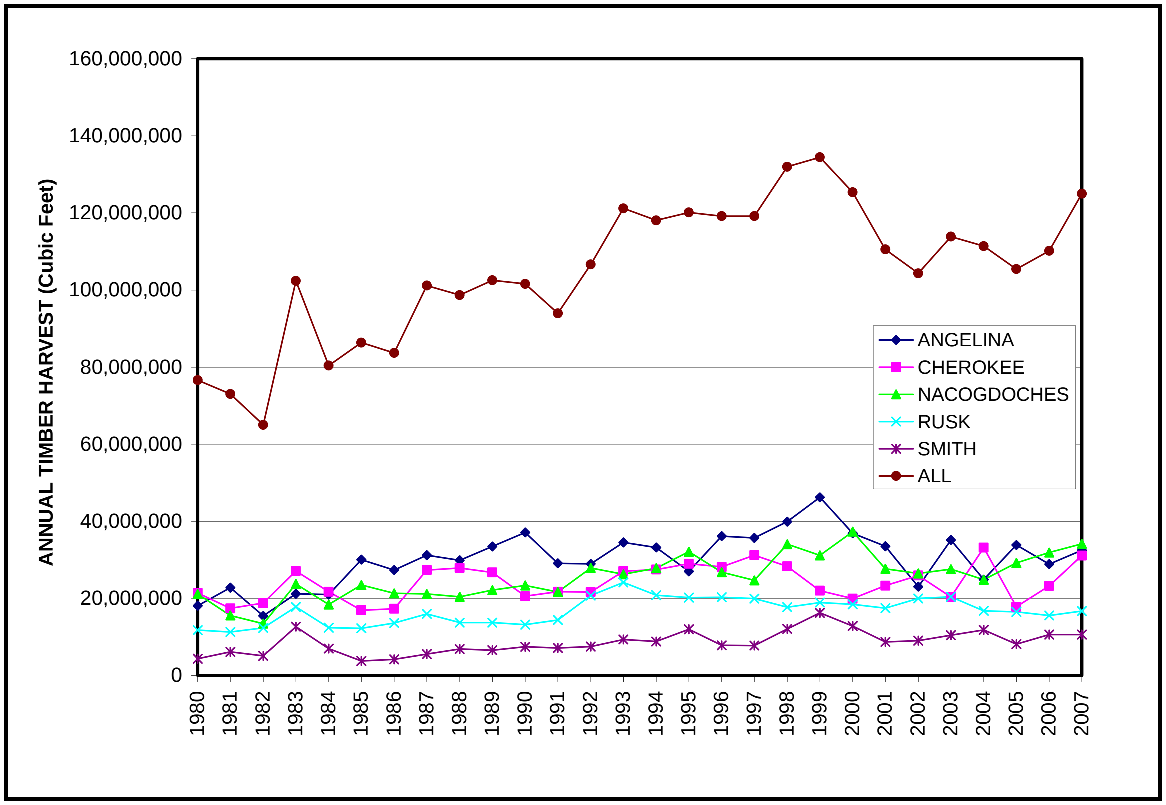
Use/Cover	County					Total
	Angelina	Cherokee	Nacogdoches	Rusk	Smith	
Forest Land	69.9%	58.1%	59.0%	49.0%	42.2%	55.5%
Agricultural Land	21.4%	36.6%	33.6%	46.9%	40.6%	36.0%
Urban/Built-up	1.9%	2.6%	5.1%	2.3%	15.4%	5.5%
Water	6.8%	2.7%	2.3%	1.8%	1.8%	3.0%

Source: LAN, 1991b

More current data on timber production is available from the Texas Forest Service. The total land area covering the Five-County Area is approximately three million acres. Forest land covers 1.8 million acres over the region, or roughly 60% of the land area, which is still consistent with the older data reported by LAN in Table 4.11-1. Timber in the area is a mixture of hardwoods and softwoods, mostly pine, oak, poplar, and mixed hardwoods. Figure 4.11-1 shows the annual harvested timber volume in cubic feet for each of the five counties over the time period 1980 through 2007. Angelina County generally has the highest annual harvest, while Smith County has the lowest volume of harvested timber. The summation of harvested timber for the Five-County Area demonstrates an overall increasing trend over the 28-year period. (TFS, 1980-2007).

Table 4.11-2 presents data from the year 2000 U.S. census concerning the amount of land area and water area for each of the five counties. Total water area is similar to that reported in the LAN report. As can be seen in Table 4.11-2, Cherokee County has the smallest water area. The reservoir would add approximately 10,133 acres of water, or more than 15 square miles. The vast majority of the water in the planned reservoir would be in Cherokee County. The values in Table 4.11-2 also indicate that water area in the

22 Lockwood, Andrews & Newnam (1991c), pp. II-130 through II-134.
23 Lockwood, Andrews & Newnam (1991c), pp. II-133.



Source: TFS, 1980-2007

Figure 4.11-1 Total Harvested Timber by County

Table 4.11-2 Water and Land Area

County	Water Area Square Miles	Land Area Square Miles	Water Area as % of Total Area
Angelina	62.9	801.6	7.3%
Cherokee	9.7	1,052.2	0.9%
Nacogdoches	34.6	946.8	3.5%
Rusk	15.1	923.6	1.6%
Smith	21.1	928.4	2.2%
Total	143.3	4,652.5	3.0%

Source: Texas Almanac, 2006.

five-county region as a percentage of total area in the region remains at the three-percent level reported by LAN (1991b) and shown in Table 4.11-1. However, the percentage water area seems to have changed some at the county level. The water area in Cherokee County, for example, is now reported to be 0.9 percent, down from the 2.7% reported in 1991.

Property appraisal data for year 2003 indicate that 78 percent of property in the five-county region was appraised with an agricultural valuation for year 2003 (TAMU IRNS, 2003). The portion of property appraised with an agricultural valuation for year 2003 ranges from 69 percent in Angelina County to 90 percent in Nacogdoches County and is 77 percent in Cherokee County. Property appraised with an agricultural valuation in the region consists primarily of timber land and pasture (including both native pasture and, to a lesser extent, introduced pasture).

Table 4.11-3 shows some information about the value of agricultural products per farm in the local area. It also provides information about the activities on the farms. Nacogdoches County has the largest average size farms, with Angelina County having the smallest average size farms. Nacogdoches County also leads the five counties in the average value of agricultural products sold per farm. Agricultural products are plant and animal products, and Nacogdoches County specializes mainly in animal related products (cattle, poultry), as it has a very low percentage (less than 1%) of its agricultural products in plant products. Nacogdoches County is a leading poultry producing county.[24] Cherokee County has the highest average value of crops sold per acre of harvested cropland. Cherokee County has nurseries and a significant amount of commercial hay production.[25]

Table 4.11-3 Farms and Value of Production, 2006 Dollars

County	Average Size of Farms in Acres	Average Value of Agricultural Products Sold Per Farm	Percentage of Agricultural Products in Plant Products	Harvested Cropland as a Percentage of Land In Farms
Angelina	125	$19,801	1.06%	12.03%
Cherokee	190	$81,684	68.13%	18.29%
Nacogdoches	212	$153,466	0.55%	10.83%
Rusk	196	$28,288	64.48%	12.03%
Smith	127	$28,051	67.51%	19.31%

Source: www.city-data.com/county for each county, accessed December 5, 2006.

In Cherokee and Smith counties, where the proposed Lake Columbia would be located, interesting supplemental information is available from 2003.[26] Freese and Nichols, Inc. interviewed a panel of four individuals knowledgeable about land use and land use trends: Mike McEwen, Cherokee Real Estate; Joe Daniel, Texas A&M University Extension Service and member of the Farm Bureau's Board of Directors; Larry Morgan,

24 *Texas Almanac* (2006), p. 282.
25 *Texas Almanac* (2006), p. 193.
26 Freese and Nichols, Inc., 2003c. Project No. ANR01289.

President of Jacksonville Chamber of Commerce, and Greg Atwood, Texas Forest Service. They agreed that without Lake Columbia there would not be much change in land use, and this opinion they considered valid for many years into the future, for population growth would be very slow.

The panel noted that land use has changed little. Population growth has been slow, and there has been no notable population exodus from the cities over the last ten years. There has been little change in the Mud Creek watershed in the last ten years, and they do not expect any change in the Mud Creek area over the next 10 years. Some dairy farms and row crops have converted to timber plantations, and the panel expected more conversion of land to timber areas. Any shifts to residential development outside the towns are expected to be slow and toward small parcel ranchettes.

4.11.1.2 Lake-Specific Land Use

There are no towns or cities and no occupied residences that would need to be relocated within the proposed reservoir area. Land use in the area that would be directly impacted by the proposed reservoir was described by LAN (1991b) as follows:

> The actual area(s), which would be inundated by the proposed reservoir, consists mainly of bottomland surrounding the numerous channels of Mud Creek and its tributaries. As such, it is currently subject to regular and frequent flooding. Very few (33 homesteads, 19 barns) permanent or occupied structures are located in the area below elevation 330.4 as a result. The land within this area is generally used for pasture or timber growth.
>
> The primary impact area above elevation 330.4 is also largely devoted to agricultural or timber uses. It does contain scattered individual farm structures and some clusters of homes along with limited commercial and industrial development. There are a few large tracts of land offering individual homesites in anticipation of the reservoir but no development as yet.
>
> There are no urbanized areas within the primary impact area, but several are located within three miles of it. These include Jacksonville, New Summerfield, Troup and Whitehouse. Several small rural clusters with place names are located within or partially within the primary impact area. These include Mixon, Tecula, Gould Community, Jacksonville Club Lake, Bolling Chapel, Earls Chapel, Taylors Chapel and Sweet Zion. Small rural cemeteries within the area are located near Bolling Chapel, New Summerfield and Troup.
>
> Forested areas form approximately 51 percent of the land within the primary impact area. Much of the forest cover is located on land with slopes in excess of 15 percent. Some timbering operations are conducted in level and/or

> upland areas but replanting and regeneration following harvest has in past years kept the total acreage of timber at a relatively constant level.
>
> Cleared agricultural areas in the bottomland as well as the uplands beyond the proposed lakesite are used for pasture or hay production. These areas form about 49 percent of the land within the primary impact area.[27]

This 1991 description has been supplemented, and its continuing relevance confirmed, by more current research. Freese and Nichols (2003a) states, "While some of the Lake Eastex site has been harvested for timber since the 1994 delineation, most of the approximately 10,000-acre site has sustained no disturbance that would appreciably alter hydrology or topography or change wetland boundaries."[28] Based on data reported in Freese & Nichols (2003a), approximately 51 percent of the area that would be submerged under the reservoir is wetland, and the remainder of the area is mainly grassland or upland forest. A summary of the cover types in the 10,655.5-acre Lake Columbia Permit Area is shown in Table 4.8.1-1.[29]

Data obtained from the Cherokee and Smith county appraisal districts further confirm that the area which would be directly affected by the proposed reservoir is rural land used primarily for agricultural or timber use. Data obtained in year 2007 from the Cherokee and Smith county appraisal districts indicate that 97 percent of the acreage in the proposed reservoir area is currently designated for agricultural or timber use.[30]

While the proposed reservoir would be located within both Smith and Cherokee counties, more than 95 percent of its normal pool surface would be located in Cherokee County.[31] Land descriptions available from the Cherokee County Appraisal District confirm the rural nature of the property within the proposed reservoir area. Land descriptions for Cherokee County properties in the vicinity of the proposed reservoir are shown in Figure 4.11-2.[32]

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27 Lockwood, Andrews & Newnam (1991c), pp. II-134, II-135. This description is also quoted in Schaumburg & Polk (2003).
28 Freese & Nichols (2003a), p. 4-12. This statement is also quoted in Schaumburg & Polk (2003).
29 Freese & Nichols (2003a), Table 5-1, p. 5-1.
30 The land in the reservoir area is identified on maps obtained from ANRA as blocks of land with smaller tract designations within each block. More than 40 maps were obtained showing each tract and the outline of the proposed reservoir, and a list of tracts covered or intersected by the reservoir was compiled from these maps. In addition, the ANRA list of properties in the vicinity of the reservoir – as described above – was compared with the list compiled from the maps. After comparing the two lists to ensure consistency, the ANRA list was used to obtain property identification data which in turn could be used to access tract information from the Cherokee and Smith county appraisal district websites.
31 Lockwood, Andrews & Newnam (1991c), p. II-134. Aerial photos with reservoir delineations that were created within the last few years confirm that the vast majority of the proposed reservoir is in Cherokee County.
32 The chart is based on the property list from ANRA and land description and acreage data from the Cherokee County Appraisal District.

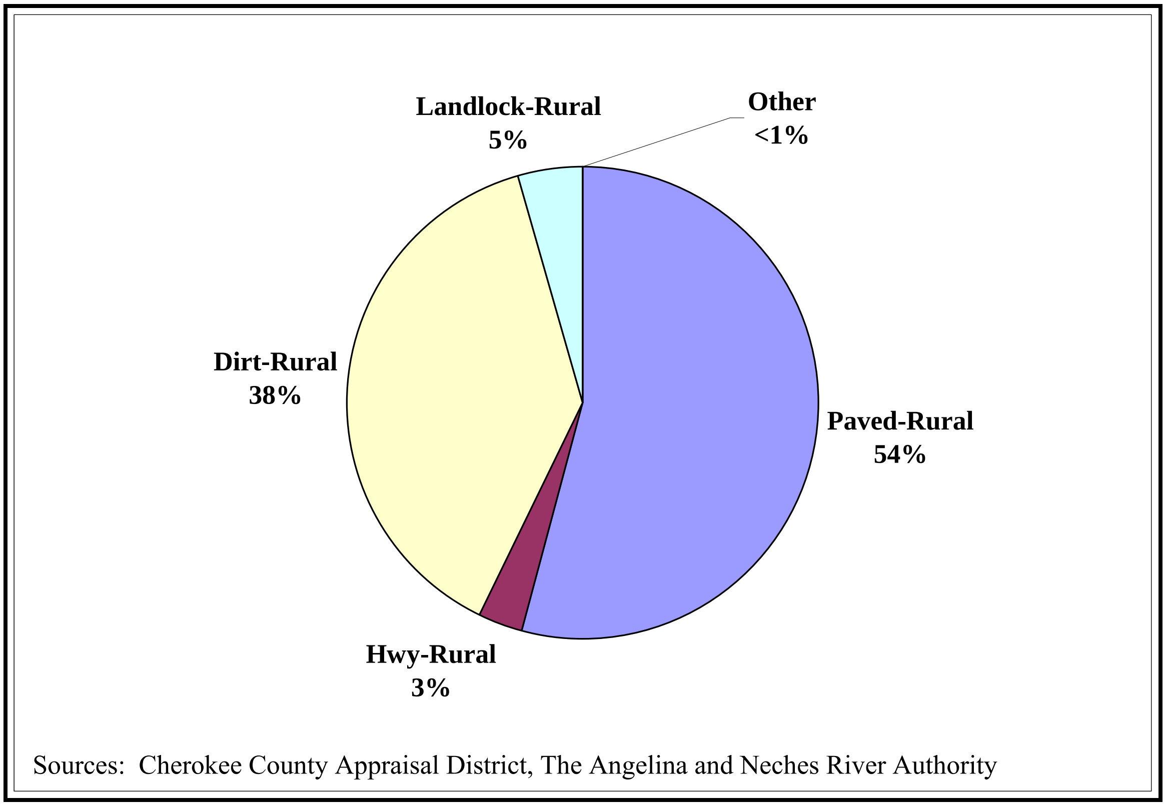

Figure 4.11-2 Land Description for Lake Columbia Properties in Cherokee County, 2006

Not all forest land in the area of the proposed reservoir is economically viable for timber production because many of the trees are not suitable for timber production. However, pine trees in the area are commercially attractive for timber production. Calculations of the economic losses due to submersion of agricultural and timber lands by the proposed reservoir are reported in Section 4.10.10.

Some land in the area of the proposed reservoir is involved in a broader commercial use. Specifically, railroad tracks are located in the area, and these are in use for rail transport. Natural gas lines, a crude oil line, a natural gas well, and electric transmission and distribution lines are also located in the area of the planned reservoir. Even though at the time of this writing a final resolution of issues with these commercial structures has not been determined, they are budgeted in the Lake Columbia Project as "conflict resolutions." In other words, it is planned that these commercial activities would continue, albeit at different nearby locations. Mitigation would minimize disruption in these activities, but some temporary disruption would likely occur. Electric transmission and distribution lines could be relocated. Railroad tracks could continue on the same general route with bridge provisions. Natural gas lines and crude oil lines could likely be relocated to other nearby routes.[33]

4.11.1.3 Recreation

The land that would be purchased for the proposed reservoir is currently privately owned. Public recreational facilities are not present within the Permit Area. If there are recreational activities, such as hunting and hiking in the area, the activities are restricted to the present owners of the properties and their guests.

4.11.2 Environmental Consequences

4.11.2.1 No Action Alternative

Under the No Action alternative the land use would remain as it is. The existing land identified for the proposed Lake Columbia would not be submerged. No recreational opportunities would be provided for this area. This would result in fewer people moving into and visiting Smith and Cherokee counties, with declines in population possible. The predicted shortages of water could impair continued growth and economic activity in this area.

4.11.2.2 Proposed Action

Land Use

Under the Proposed Action, a reservoir would be built resulting in an altered land use. Approximately 11,150 acres would be directly and indirectly affected as a result of the proposed dam and reservoir construction. The estimated reservoir life would be approximately 100 years. Consequently, the Proposed Action is long term and would permanently alter and eliminate existing land uses as a result of inundation. Approximately 15,500 acres of land bordering the reservoir would be regulated in use to protect the integrity of water quality. The loss in the value of agricultural and timber production is shown in Table 4.10-32, and the accompanying loss in property taxes is shown in Table 4.10-36. Some existing utilities, oil and gas production, and transportation infrastructure would also be inundated by the proposed reservoir. Planned mitigation involves moving the utilities and proper abandonment of the oil and gas wells.

Land uses associated with transportation would also be affected as a result of submerging parts of FM 2064 and FM 2750. The Texas Transportation Commission has ordered that the segments of these roads that would be affected by the proposed Project are to be removed from the state highway system, contingent upon construction of the proposed Lake Columbia (TxDOT, 2005). Existing traffic on these roads is light, and alternative routes not causing undue increases in travel time for the traveling public currently exist. Traffic studies indicate that closure of both roads would only cause approximately 200

33 See Freese & Nichols (2003b), section 6.5 for more on conflict resolution.

vehicles per day to take longer routes to common destinations. The longest delay a motorist would experience would be less than 10 minutes (SPI, 2003a). It is possible that these roads would not be relocated, but they would be designed to terminate near the proposed Project. Proper notices about the non-thoroughfare would be placed on the roads, and turn around areas would be constructed. Boat ramps could be constructed at these termination points providing lake access to the public seeking recreation at Lake Columbia.

Historically, residential developments are common on land near and adjacent to reservoirs throughout Texas and typically result in increased property values.

Recreation

Land identified for the proposed Lake Columbia is currently privately owned. Agricultural and forestry practices would be substantially impacted with construction and operation of the proposed reservoir. However, the proposed reservoir would provide opportunities for water sports and camping activities. At the reservoir site, boating, fishing, swimming, camping, hiking, bird watching, and other outdoor activities would be available to the public. Estimated data relative to lake visitation are shown in Table 4.10-23.

Mitigation

ANRA has adopted Lake Columbia Water Quality Regulations that would regulate land use around the proposed lake. These are discussed in Section 3.3.4.3 and are contained in Appendix D.

4.11.2.3 Toledo Bend Pipeline Alternative

A major portion of the pipeline route parallels existing roadways, although routes through towns and cities are uncertain. In most areas, additional right-of-way would be required for the large-diameter line and also for the intake and pump stations. It is anticipated that several hundred acres would be required for the terminal reservoir. These lands would be converted from existing forest or grassland, and in some cases streams and wetlands, into a grass-covered right-of-way, with the terminal reservoir site becoming open water. The impact could be more pronounced in the Sabine National Forest where forested areas would need to be cleared, thus resulting in habitat fragmentation and associated adverse visual effects.

4.11.3 Cumulative Effects

Land usage patterns in the upper and downstream Mud Creek watersheds and the Five County Area are similar in both type and influencing factors causing changes in such usage. Changes in usage patterns over time are a function of forestry management and logging practices in specific areas; agricultural land usage transitioning from grazing to pastureland to crop production, often as a function of economic forces; varying levels of oil and gas production which are often the result of national and international policies and practices; and new development projects and population growth in towns and cities.

Similar patterns and forces related to forestry, agriculture, and oil and gas production also influence land use changes in the Permit Area and the Shoreline Development Area. Further, these two areas also include several linear infrastructure projects which would need to be closed or relocated. Finally, some modest hunting and fishing practices currently take place in the Permit Area and the Shoreline Development Area.

The No Action alternative would not cause any effects on the above types and patterns of land usage. However, if there is an absence of an adequate water supply to meet future needs in the Five County Area, it could cause large-scale changes in the patterns. No specific cumulative effects resulting from the No Action alternative were examined in detail.

The Proposed Action alternative would cause complete losses of the current land use practices in the Permit Area, and likely land use changes in the Shoreline Development Area. As shown in Table 3.3-5, the local recreational activities, and the local land uses in the Permit Area would not continue into the future time period (2010-2060). Table 3.3-6 lists four future actions that would influence land usage in the Permit Area and the Shoreline Development Area. Land use and recreational changes are reflected in the following three future actions: 1) development and use of public access areas and marinas along the Lake Columbia Shoreline, 2) recreational usage of the proposed Lake Columbia and environs, and 3) shoreline developments around the proposed Lake Columbia. Estimated increases in shoreline development are shown in Table 3.3-7. The consequences of the first and third of these three actions are reflected by low relative contributions to declines in surface-water quality and aquatic biology. Recreational usage is depicted as causing moderate relative contributions to declines in surface-water quality, aquatic biology, and local noise levels and air quality. Additional information on cumulative effects on these resources is presented in the sections for the specific resources.

The fourth future action, ANRA regulation of recreational and commercial activities on and surrounding the proposed Lake Columbia, would likely result in beneficial effects on surface-water quality, aquatic biology, waters of the U.S., noise, and air quality (Table 3.3-6). Despite these positive effects, uncertainties still exist relative to the actual cumulative effects levels for these resources. Accordingly, ANRA would develop a focused monitoring program to establish these levels. This program could coincide with the recommended program related to soil erosion (Section 4.3.3).

Regarding land use and recreation in the vicinity of the Toledo Bend Pipeline alternative, no specific survey of land usage near the pipeline route or the terminal storage area has been conducted. However, the linear nature of this alternative would probably have a low likelihood of influencing land use and recreational changes, thus further analyses of cumulative effects is not warranted at this time.

4.12 AESTHETICS

4.12.1 Affected Environment

The Permit Area of the proposed reservoir would be located in Mud Creek, its tributaries, wetlands, ponds, and floodplain, approximately five to 10 miles east and northeast of Jacksonville, Texas. There are no major towns or cities within or adjacent to the Permit Area. The area is characterized as rural and sparsely populated. Viewsheds are restricted to the floodplain and surrounding hills, which rise steeply a few hundred feet above the stream bottom. The area is mostly forested, with approximately 20% grasslands (see Section 4.8.1). The area is primarily designated for agricultural or timber use (see Section 4.11).

4.12.2 Environmental Consequences

4.12.2.1 No Action Alternative

The only impacts to aesthetics under the No Action alternative would be associated with minor residential and commercial development activities, in addition to oil and gas exploration and timber harvesting. These activities would occur irrespective of the proposed action and would be relatively limited in nature.

4.12.2.2 Proposed Action

Construction

During construction, the viewshed would be impacted by clearing for portions of the reservoir pool area, construction of the dam itself, and excavation from the borrow area. Since the area is sparsely populated, the main impact locations would be from highway bridges, such as U.S. 79; however, the dam site is three miles downstream from the bridge and the visual impact would be limited. Six houses and nine out-buildings near the proposed dam and spillway would be impacted and would be acquired by ANRA.

Operation

The largely forested floodplain would become a vast area of open water. The relative aesthetics of forest versus open water are subjective. The dam would be a permanent structure, although as above, access to view the dam itself would be somewhat limited.

Mitigation

No mitigation is proposed for aesthetics.

4.12.2.3 Toledo Bend Reservoir Alternative

The intake station, 86-mile pipeline route, and terminal reservoir site would be impacted by clearing, trenching, and pipe laying. Most of the pipeline route parallels existing rights-of-way and is highly visible, resulting in a significant aesthetic impact during construction. The terminal reservoir would likely be more remote and less visible. During operation, only the intake, pump stations, and terminal reservoir would be visible. However, additional cleared right-of-way, particularly in Sabine National Forest, would experience aesthetic impacts in changing from forested to a cleared corridor.

4.12.3 Cumulative Effects

The aesthetic (visual quality) features of the Permit Area and the Shoreline Development Area are routine and typical of many land areas in the Five-County Area. The local viewsheds are restricted to the floodplain of Mud Creek and terrain involving hills which rise a few hundred feet above the floodplain. No distant vistas or expansive viewsheds are in the above two local study areas.

The No Action alternative would not cause any changes in the local viewsheds, thus no effects on aesthetics would occur. Accordingly, there is no need to address cumulative effects.

The Proposed Action alternative would cause changes in the local viewsheds; with the primary change being from landscape features to water features. Some persons would consider this change to be desirable, and others would not. The other categories of actions as displayed in Tables 3.3-5 and 3.3-6 would not cause any major changes in the local visual quality. No mitigation is planned for any changes in aesthetics resulting from the Proposed Action.

The Toledo Bend Pipeline alternative would involve 86 miles of pipeline and a terminal storage reservoir. The pipeline route is in flatter terrain and hence more expansive viewsheds would be expected. However, construction-related disruptions in viewsheds along the pipeline route would be reduced upon pipeline completion. Other local viewshed impacts around pump stations, the Toledo Bend Reservoir intake, and the terminal storage reservoir are also expected to be minimal, thus no cumulative effects need to be explored.

4.13 ENVIRONMENTAL JUSTICE AND EXECUTIVE ORDERS

4.13.1 Environmental Justice

Executive Order No. 12898 promotes nondiscrimination in Federal programs that substantially affect human health and the environment. The Order promotes access to public information for minority and low-income groups and promotes the participation of these groups in matters relating to human health and the environment.

Environmental justice is defined by the U.S. Environmental Protection Agency as the fair and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulation, and policies. This goal of "fair treatment" is not to shift risks among populations, but to identify potential disproportionately high adverse impacts on minority and low-income communities and identify alternatives to mitigate any adverse impacts.

Council on Environmental Quality guidelines (CEQ, 1998) require identification of minority populations when either: 1) a minority population exceeds 50 percent of the population of the affected area, or 2) a minority population represents a meaningfully greater increment of the affected population than of the population of some other appropriate geographic unit, as a whole. Neither of these circumstances is relevant for the proposed Lake Columbia reservoir.

The population in 2005 was a mixture of ethnicities, as Table 4.13-1 illustrates. Compared with the statewide ethnic mix, the local area had relatively more Anglos and Blacks and smaller percentages of Hispanics, American Indians, and Asians. The Hispanic percentages of the population of each of the five counties vary from 10.5% to 16.8%, and each is less than the 35.1% for the state as a whole. In three of the counties shown, Blacks comprised the largest majority, and Hispanics comprised the largest majority in the other two. The percentages of the populations in each of the five counties that are American Indian range from 0.3% to 0.7%, and each is less than the 0.7% American Indian composition for the state. Similarly, each county has a percentage Asian population that is less than for the state. These minority populations are neither greater than 50% of the populations in the counties nor are they a substantially greater percentage than in the state as a whole.

As shown in Table 4.13-1, the percentage of Black population varied from 14.7% to 18.6% in the five counties, which is greater than the 11.7% Black population composition for the state. However, this difference does not indicate that the proposed Project would

Table 4.13-1 Race/Ethnicity, 2005

County	%Anglo	%Black	%Hispanic	%American Indian	%Asian	%Other
Angelina	67.0	14.9	16.8	0.4	0.7	0
Cherokee	67.2	14.7	16.8	0.5	0.5	0.1
Nacogdoches	67.8	16.4	14.3	0.5	0.8	0.1
Rusk	70.2	18.5	10.5	0.3	0.3	0
Smith	65.1	18.6	14.3	0.5	0.9	0.1
Texas	49.2	11.7	35.1	0.7	3.3	0.1

Source: USCB, 2007

disproportionately affect Black populations. Additionally, even though Hispanics comprise the largest group in Cherokee County, they would not be adversely more affected as a group by the reservoir. Additional investigation revealed that the county-wide percentages of Blacks and Hispanics are not representative of the racial mix of property owners that would sell a portion of their land for Lake Columbia to be realized.

The vast portion of the land to be directly affected by the reservoir is in Cherokee County, with a much smaller portion in Smith County. To determine if Blacks, Hispanics, or any other minority group might be disproportionately involved in land sales for the reservoir, several analyses were conducted.

County appraisal district records were examined. However, in the county appraisal district records there is no identification of the race of the owners of the tracts of land that would be purchased if the Lake Columbia Project goes forward. It is evident from those records, however, that land proposed to be purchased is rural land. There is no dense housing directly affected by the proposed Project and, in fact, relatively few people are involved with the tracts of land that would be purchased for the reservoir site.

To further examine racial mix in the immediate vicinity of the reservoir, all census tracts within a five-mile radius of the center of the reservoir were identified. From census information race could be identified for people within those census tracts, whether they were owners of property that could possibly be sold for the reservoir, owners of property that would not be sold for the reservoir, or renters of property. The five-mile radius encompasses approximately 75% of tracts impacted by the reservoir. The data revealed an approximately 8% Black population and a 13.9% Hispanic population in this defined area. The data also revealed that the Black and Hispanic populations are more concentrated in the towns and cities rather than the rural area in the immediate vicinity of the proposed Lake Columbia.

Given the rural nature of the land and the relatively small percentage of minorities in the immediate vicinity of the proposed Lake Columbia, there is no evidence that minority populations would be disproportionately adversely affected if the proposed Lake Columbia Project would become a reality.

From an economic standpoint a key factor of environmental justice in land purchases is that they be at prices reflecting fair market value, irrespective of race or income levels of the sellers or buyers. From the price standpoint there are no apparent "justice" issues regarding the economics of the land purchases to be addressed. No purchases have taken place.

Table 4.13-2 provides some measures relevant to assessing the importance of low-income families in the areas affected by the proposed Project. The data demonstrate that median household income is lower in all of the counties than for Texas as a whole. This is not atypical given larger population concentration and higher incomes in the large metropolitan areas in Texas, none of which are located in these counties. The percentage of people considered in poverty is lower in two of the five counties than for Texas, so there is not a disproportionate concentration of low-income people in this region. Moreover, homeownership rates are higher in four of the five counties, and as is typical of the less-populated counties in Texas, there is a greater percentage of population that is age 65 or older compared with Texas as a whole. This reflects more retired persons with assets (homes) rather than people living in poverty.

Table 4.13-2 Income, Poverty, Homeownership Rates, and Age

County	Median Household Income, 2007	Persons Below Poverty, 2007	Homeownership Rate, 2000	Persons 65 Years Old and Over, 2008
Angelina	$37,953	19.3%	72.4%	14.1%
Cherokee	$35,413	18.6%	73.8%	14.5%
Nacogdoches	$32,774	21.1%	61.6%	12%
Rusk	$41,906	13.1%	79.9%	14.8%
Smith	$44,699	14.3%	69.7%	14.7%
Texas	$47,563	16.3%	63.8%	10.2%

Source: USCB, 2009

If the proposed Project is built, the price of water would be lower than it would have been without the Project, an advantage for low-income groups as well as others.

The Permit Area is very sparsely populated. There are only six houses in or close to the Permit Area, so there is little potential direct impact on any groups, including low-income or minority groups. There is no apparent adverse effect on low-income groups attributable to the proposed Lake Columbia Project.

All populations have been afforded opportunities to express their views about the proposed Lake Columbia Project. ANRA has, and is, engaged in an intensive public awareness campaign, ensuring public access to information about the proposed Project and providing avenues for everyone to express their views.

ANRA has provided information to newspapers. Newspaper articles have made the general public aware of proposed Lake Columbia, initially discussed as Lake Eastex, for many years. Numerous newspaper articles have been published about the Project since at least 1985. Additionally, ANRA's Lake Columbia web site has been available to the public since 2001. This web site provides a comprehensive level of information regarding the Project.

Prior to 2001, ANRA published newsletters, which were mailed out to local, county, state, and federal elected officials in Angelina, Cherokee, Nacogdoches, Rusk, and Smith counties. These officials represented all populations in the areas. ANRA newsletters were sent to chambers of commerce and news media, and they were provided to individuals who asked to receive a copy. Newspapers were handed out to attendees of civic clubs where ANRA representatives made presentations about the proposed Lake Columbia Project. ANRA representatives also have spoken to a large number of service clubs in Cherokee County and Smith County over the years, as well as to city councils. ANRA began publishing newsletters again in 2007, which are also posted on ANRA's web site.

For owners of property that might be directly affected by the proposed Lake Columbia Project, ANRA sent letters to every landowner of record asking permission for environmental and archeological investigative teams to have access their property, and inviting the landowner to accompany the researchers. Copies of these letters and responses are in ANRA files. No discrimination was involved in this process, or any other notification process.

Minorities, non-minorities, and all income groups are represented through the customer base of the 18 entities who have contracted for water from the proposed Lake Columbia should the Project become a reality. Their elected leaders have been kept informed of important developments regarding the Project.

In response to these efforts, ANRA and others have received hundreds of written responses from the public. The efforts at informing the public have been made in a non-discriminatory manner, and the written evidence indicates that these efforts have been successful.

There are no adverse environmental justice issues involved with the proposed Lake Columbia Project.

4.13.2 Other Executive Orders

Executive Order No. 13112 "Invasive Species" includes a direction to federal agencies to prevent the introduction of invasive species through their actions. Invasive species are discussed in detail in Sections 4.8.1.1.2, 4.8.3.1.5, and Public Education and Involvement is addressed in Section 3.3.4.3. Invasive species are unlikely to be introduced through the construction of Lake Columbia.

Executive Order 13175 "Consultation and Coordination With Indian Tribal Governments" requires agencies to have an accountable process to ensure meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications. The proposed Lake Columbia could impact areas of significance to the Caddo Tribe. As discussed in Section 4.9.1.3, the Permit Area is located within the traditional homeland of the Caddo Tribe of Oklahoma (Caddo Tribe), and the USACE has invited the Caddo Tribe to comment on all cultural resources work associated with the proposed undertaking. Prior to the beginning of cultural resources investigations, the USACE initiated contact with the Caddo Tribe to develop a strategy for identifying and evaluating any archeological sites and Traditional Cultural Properties that may exist within the Project area. Should the Project proceed, the USACE would engage in ongoing consultation with the Caddo Tribe throughout the process of completing the cultural resources inventory, determining the significance of cultural resources, developing a plan to mitigate adverse effects to significant cultural resources, and developing the MOA or PA for the proposed undertaking.

Executive Order 11990 "Protection of Wetlands" requires agencies to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. However, this order does not apply to the issuance by federal agencies of permits, licenses, or allocations to private parties for activities involving wetlands on non-federal property, such as the proposed Lake Columbia. The proposed Lake Columbia would impact 5,746.5 acres of waters of the U.S., including wetlands. Mitigation for impacts to wetlands and other waters of the U.S. have been addressed in detail by ANRA's proposed Mitigation Plan, which is attached in Appendix C. This is discussed in detail in Section 3.3.4.3.

Executive Order 11988 "Floodplain Management" requires agencies to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains. The goal is to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development. The proposed Lake Columbia would not involve occupancy or development of floodplains, other than the impoundment of water within the floodplain of Mud Creek. Analyses presented in Section 4.5.2.2 address impacts to the downstream floodplain and also indicate that flood peaks would be reduced downstream of the proposed dam.

4.13.3 Cumulative Effects

Based upon reviews of U.S. Bureau of Census data relative to minority and economically disadvantaged populations in the Permit Area, Shoreline Development Area, and the Five-County Area, no disproportionate conditions or effects were identified in relation to the Proposed Action alternative. Further, ANRA has communicated Project-related information to all populations in these areas. Accordingly, no cumulative effects to environmental justice from other actions (Tables 3.3-5 and 3.3-6) were explored.

Regarding the No Action alternative, no environmental justice effects are anticipated to occur. No specific environmental justice issues or effects were explored for the Toledo Bend Pipeline alternative.

No issues were identified with respect to other Executive Orders that have not been discussed in other sections.

4.14 SUMMARY OF CUMULATIVE EFFECTS ASSESSMENT

The cumulative effects assessment (CEA) for the proposed Lake Columbia Project (the Proposed Action) is addressed herein in three parts. The first part, which is included as Section 3.3.6, provides the cumulative effects context. The first subsection (3.3.6.1) contains definitions and a synopsis of how CEQ's 11-step CEA was applied. Section 3.3.6.2 delineates five spatial boundaries and their supporting rationale. The five boundaries include the Permit Area, the Shoreline Development Area, the Upper Mud Creek Watershed, the Downstream Mud Creek Watershed, and the Five-County Area. The primary study area boundaries for the 13 resources are delineated in Table 3.3.6-1.

Temporal boundaries are addressed in Section 3.3.6.3. The historical to current time period was selected as 1960 to 2010. The earlier date coincides with the completion of some early reservoirs in the Mud Creek Watershed. The future time period was chosen as 2010 to 2060. The latter date coincides with the end of the planning period for water supply needs in the Five-County Area.

Section 3.3.6.4 contains an analysis of the contributing effects of past and present actions to the status of the resources addressed herein. A total of 15 past and present actions are described, and their relative contributions to cumulative effects on pertinent resources are delineated. Table 3.3-5 highlights the relative contributions. Finally, nine of the 15 actions are projected to continue during the future time boundary (2010-2060) of the Proposed Action.

Section 3.3.6.5 has an analysis of the contributing effects of future actions to the resources addressed herein. A total of 13 future actions are described, with only one having a low likelihood of occurrence. Table 3.3-6 highlights the relative contributions of these future actions to cumulative effects on the pertinent resources. Six of the future actions would have beneficial effects on the specified resources.

Section 3.3.6.6 highlights the findings from the analyses of other actions. The key findings were that the most affected resources included surface-water quality, waters of the U.S., vegetation, and aquatic biology. Agricultural land usage and logging operations were identified as having moderate relative contributions to cumulative effects on these resources.

The second part of the CEA comprises summary cumulative effects subsections for each of the 13 resources addressed above and is distributed within Section 4. Since the ecology resource had four summaries (one each for vegetation, wildlife, aquatic biology, and threatened or endangered species), a total of 16 summaries is included. Each summary provided brief information related to the cumulative effects of the No Action alternative and the Toledo Bend Pipeline alternative. Cumulative effects associated with the No Action alternative were essentially non-existent. The cumulative effects related to other actions in the vicinity of the Toledo Bend Pipeline alternative were not studied in detail.

The third part of the CEA summarizes the cumulative effects findings for each of the 13 resources. Table 4.14-1 is used to summarize the CEA for the resources that were addressed for the Proposed Action (the Lake Columbia Project). Seven of the studied resources were placed in Category 1 relative to their cumulative effects findings. Category 1 denotes that no concerns related to adverse cumulative effects have been identified. Category 1 resources include physiography and topography, geology, groundwater, threatened or endangered species, socioeconomics (beneficial effects), aesthetics, and environmental justice.

Five resources in Table 4.14-1 are included in Category 2. This category denotes that no potentially significant concerns related to cumulative effects have been identified at this time. The resources in Category 2 include climatology/air quality, noise, vegetation, wildlife, and cultural resources.

Four resources in Category 3 are identified in Table 4.14-1. Category 3 denotes that some potentially significant cumulative effects concerns have been identified. Accordingly, a focused monitoring program would be used to establish the levels of cumulative effects and their significance, to reduce uncertainties, and to identify adaptive management measures which could be used to reduce cumulative effects. The four resources in this category include soil (soil erosion); surface-water hydrology, quality, and waters of the U.S.; aquatic biology; and land use and recreation. The focused monitoring program by ANRA for these four resources could be integrated both across the resources and with the Mitigation Plan described in Appendix C.

4.15 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

The Proposed Action (Lake Columbia) and the Toledo Bend Pipeline alternative could result in the irreversible commitment of resources (i.e. the loss of future options for resource development or management, especially of non-renewable resources such as minerals and cultural resources) or the irretrievable commitment of resources (e.g. the lost production or use of natural resources during the life of the Project). Irreversible and irretrievable impacts of the alternatives are summarized in Table 4.15-1.

Table 4.14-1 Summary of Findings of CEA for the Proposed Lake Columbia Project

Section Addressing Cumulative Effects	Category of Findings		
	Category 1[a]	Category 2[b]	Category 3[c]
Physiography and Topography (4.1.3)	X		
Geology (4.2.3)	X		
Soils (4.3.3)			X[d]
Groundwater (4.4.3)	X		
Surface Water – hydrology, quality, and waters of the U.S. (4.5.3)			X
Climatology/Air Quality (4.6.3)		X	
Noise (4.7.3)		X	
Ecology – vegetation (4.8.1.3)		X	
Ecology – wildlife (4.8.2.3)		X	
Ecology – aquatic biology (4.8.3.3)			X
Ecology – threatened or endangered species (4.8.4.3)	X		
Cultural Resources – prehistoric and historic (4.9.4)		X	
Socioeconomics (4.10.3)	X[e]		
Land Use and Recreation (4.11.3)			X
Aesthetics (4.12.3)	X		
Environmental Justice (4.13.3)	X		

Notes:

a: No direct or indirect effects from the proposed Lake Columbia Project are expected; no specific mitigation plans are delineated; no detailed analysis was conducted on contributed effects from continuing past and present actions or from future actions; no concerns related to cumulative effects have been identified.

b: Some direct or indirect effects are expected from the proposed Lake Columbia Project; no mitigation may be needed, or identified mitigation could be used to reduce effects; low relative contributions to cumulative effects from other contributing and future actions have been identified; no potentially significant concerns related to cumulative effects have been identified at this time.

c: Some direct or indirect effects are expected from the proposed Lake Columbia Project; some mitigation measures would be utilized to reduce effects; moderate relative contributions to cumulative effects from other contributing and future actions have been identified; some potentially significant cumulative effects concerns have been identified, thus a focused monitoring program would be used to reduce uncertainties and adapt management as appropriate.

d: The effects of soil erosion could be manifested in associated effects on surface water quality and aquatic biology.

e: The direct and indirect effects provided from an adequate water supply would be beneficial relative to labor, earnings, and public finance.

Table 4.15-1 Irreversible or Irretrievable Commitment of Resources

Resource/Alternative	Irreversible Impacts	Irretrievable Impacts	Description
Physiography and Topography			
Lake Columbia	Yes	Yes	Topography would be irreversibly altered by construction of dam and inundation of valley.
Toledo Bend Pipeline	Yes	Yes	Construction of intake structure and pump station at Toledo Bend. Construction of approximate several hundred-acre terminal reservoir near proposed reservoir site. Removal of habitat particularly in national forest.
Geology and Mineral Resources			
Lake Columbia	No	Yes	Oil and gas resources still in place, but direct drilling eliminated in Permit Area during the life of the Project. Off-site horizontal drilling under the reservoir or in-situ deep lignite gasification could continue.
Toledo Bend Pipeline	Yes	Yes	Shallow lignite deposits in southern Rusk County could not be extracted where pipeline runs. Direct oil and gas drilling eliminated at terminal reservoir except that off-site horizontal drilling under the reservoir could continue.
Soils			
Lake Columbia	Yes	Yes	135 acres of prime farmland soils would be lost.
Toledo Bend Pipeline	Yes	Yes	If prime farmland soils lie in the pipeline route or terminal reservoir site, they would be lost.
Groundwater			
Lake Columbia	No	No	No adverse impacts to groundwater.
Toledo Bend Pipeline	No	No	No adverse impacts to groundwater.

Resource/Alternative	Irreversible Impacts	Irretrievable Impacts	Description
Surface Water			
Lake Columbia	Yes	Yes	5,746.5 acres of waters of U.S. would be impacted. To be compensated by mitigation plan. Approximate 16 percent decrease in floodplain size below the dam with potential loss of some waters.
Toledo Bend Pipeline	Yes	No	Irreversible loss of waters of U.S. at pump station/intake at Toledo Bend and possibly at terminal reservoir. Some conversion of forested wetlands along pipeline route, which could potentially be retrieved.
Climatology/Air Quality			
Lake Columbia	No	No	No irreversible impacts to air quality/climatology. Standards would not be violated.
Toledo Bend Pipeline	No	No	No irreversible impacts to air quality/climatology. Standards would not be violated.
Noise			
Lake Columbia	No	Yes	Boat traffic would generate noise on the lake for the life of the Project.
Toledo Bend Pipeline	No	Yes	Pump stations would generate noise during operation throughout their life.
Vegetation			
Lake Columbia	Yes	Yes	10,655.5-acre Permit Area would comprise an irreversible commitment of vegetation resources. Includes 5,351 acres of wetlands to be compensated by Mitigation Plan. 1,195 acres of wetlands established around water's edge. Development around lake would impact vegetation—to be addressed by Water Quality Regulations.

Resource/Alternative	Irreversible Impacts	Irretrievable Impacts	Description
Toledo Bend Pipeline	Yes	Yes	Vegetation irreversibly impacted at terminal reservoir site and irretrievably along entire ROW, including approximately 160 acres through Sabine National Forest. Wetland vegetation impacted primarily at stream crossings and intake pump station.
Wildlife			
Lake Columbia	Yes	Yes	Terrestrial habitat converted to open water habitat.
Toledo Bend Pipeline	Yes	Yes	Habitat cleared at intake/pump stations, along pipeline route, and terminal reservoir.
Aquatic Biology			
Lake Columbia	Yes	Yes	There would be an irreversible loss of 5,746.5 acres of waters of U.S. and associated aquatic habitat. Existing riverine aquatic habitat would be converted to lacustrine habitat.
Toledo Bend Pipeline	No	Yes	Temporary loss of aquatic resources at stream crossings. Potential impacts at intake/pump station and terminal reservoir for the life of the Project.
Threatened or Endangered Species			
Lake Columbia	No	No	No T&E species known to exist in Permit Area.
Toledo Bend Pipeline	No	Yes	T&E species may exist within counties traversed by pipeline and be displaced, particularly red-cockaded woodpeckers in Sabine National Forest.

Resource/Alternative	Irreversible Impacts	Irretrievable Impacts	Description
Cultural Resources			
Lake Columbia	Yes	Yes	1,272 acres of high probability areas for cultural resources within Permit Area. Inundation of 23 known archaeological sites; 13 sites located on or adjacent to shoreline. Eight historic structures potentially impacted. NRHP eligibility unknown.
Toledo Bend Pipeline	Yes	Yes	No surveys conducted, but approximately 70 miles of high probability areas for cultural resources could be impacted, plus several hundred-acre terminal reservoir site. No surveys conducted, but historic structures unlikely, except potentially in cities.
Socioeconomics			
Lake Columbia	No	Yes	Socioeconomic effects of the proposed Lake Columbia would be predominantly beneficial, but reversible.
Toledo Bend Pipeline	No	Yes	Socioeconomic effects of the Toledo Bend Pipeline would be less beneficial, but reversible.
Land Use and Recreation			
Lake Columbia	Yes	Yes	Changes in land use to lake and residential use would be irreversible. Increased recreational opportunities would be reversible.
Toledo Bend Pipeline	Yes	Yes	Changes in land use along the pipeline route and terminal reservoir would be irreversible. No impact on recreation.

Resource/Alternative	Irreversible Impacts	Irretrievable Impacts	Description
Aesthetics			
Lake Columbia	Yes	Yes	Change from forested and agricultural area to lake view would be irreversible.
Toledo Bend Pipeline	Yes	Yes	Change in Sabine National Forest from forested to open view and at terminal reservoir to water view would be irreversible. Loss of vegetation in non-forested areas of pipeline route would be reversible.
Environmental Justice			
Lake Columbia	No	No	No impact.
Toledo Bend Pipeline	No	No	No impact.

5.0 CONSULTATION AND COORDINATION

5.1 PUBLIC AND AGENCY SCOPING

One of the required activities associated with preparation of an EIS is the solicitation and review of public and agency input as a component of the identification and analysis of potential environmental impacts and alternatives. This process of determining the key environmental issues to be addressed in the EIS document is termed “scoping.”

On August 18, 2005, the USACE conducted an EIS public scoping meeting in Jacksonville, Texas. It is estimated that over 50 people attended. Information was provided describing the proposed action, questions from participants were addressed, and comments were solicited from the interested public. Both written and oral comments were received and recorded.

An agency scoping meeting was held in Jacksonville, Texas on August 19, 2005 to provide information regarding key aspects of the project and to solicit agency input regarding the scope and analyses for the EIS from appropriate state and federal agencies.

Details of the scoping process and comments received are presented in Section 1.4.

5.2 EAST TEXAS REGIONAL WATER PLANNING GROUP

The East Texas Regional Water Planning Group (Region I) was formed pursuant to provisions in Senate Bill 1 (75^{th} Texas Legislature). This planning group includes stakeholders representing broad interests in counties encompassing the Neches River basin and the lower portion of the Sabine River basin, and it is charged with conducting water supply planning studies and developing water supply plans, often referred to as regional plans, to address all future needs for water in the region. This group meets several times each year to coordinate local and regional planning strategies and efforts, and sometimes meets monthly when important water planning activities require discussion and/or decisions. The meetings are open to the public and proper notice is provided. As part of the planning process, the Region I Group has made special efforts to contact water suppliers and providers in the region and obtain their input on available supplies and water needs. In its deliberations to develop the latest 2006 Region I Water Plan, the East Texas Regional Water Planning Group considered a number of strategies to meet future water supply shortages, including water conservation, wastewater reuse, expanded use of existing supplies, and Lake Columbia.

The studies and planning conducted by regional planning groups such as the East Texas Regional Planning Group are considered to be the official source for establishing future water supply needs within the state and for identifying strategies to meet those needs. It is the results from these regional planning efforts that form the basis for the State Water Plan that is developed by the Texas Water Development Board (TWDB) every five years pursuant to the requirements of Senate Bill 1. Hence, to a large extent, the information compiled and evaluated by the East Texas Regional Planning Group in preparing the Region I regional plan has provided the foundation for establishing the need for the proposed Lake Columbia project.

5.3 LIST OF AGENCY CONTACTS

In preparing the EIS for the proposed Lake Columbia project, the USACE communicated with and received input from various federal and state agencies. These are listed below.

5.3.1 Federal Agencies

- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S.D.A. Forest Service
- U.S. Department of Energy/Southwestern Power Administration
- Caddo Tribe of Oklahoma

5.3.2 State Agencies

- Texas Commission on Environmental Quality
- Texas Parks and Wildlife Department
- Texas Water Development Board
- Texas Historical Commission

5.4 LIST OF AGENCIES AND PARTIES TO WHOM COPIES OF THE DRAFT EIS WERE SENT

5.4.1 Federal Agencies

- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S.D.A. Forest Service
- U.S. Army Corps of Engineers (Little Rock District, Tulsa District, and Galveston District)
- U.S. Army Corps of Engineers, Ft. Worth District
- National Park Service
- Caddo Tribe of Oklahoma

5.4.2 State Agencies

- Texas Commission on Environmental Quality
- Texas Parks and Wildlife Department
- Texas Water Development Board
- Texas Historical Commission

- Railroad Commission of Texas
- Texas Department of Transportation
- Texas Forest Service
- Texas General Land Office

5.4.3 County and Local Agencies

- East Texas Council of Governments
- Angelina County
- Cherokee County
- Nacogdoches County
- Smith County
- Rusk County

5.4.4 Libraries and Local Repositories

- Jacksonville Public Library
- Kurth Memorial Library
- Nacogdoches Public Library
- Rusk County Library
- Tyler Public Library
- Henderson City Hall
- Jacksonville City Hall
- Lufkin City Hall
- Nacogdoches City Hall
- Rusk City Hall
- Tyler City Hall

5.4.5 Other Organizations

- Big Thicket Association

5.4.6 Industry/Business

- Union Pacific Railroad Company
- Cherokee County Electrical Cooperative Association
- Oncor Electric Transmission Engineering
- Oncor Electric Delivery Engineering
- Verizon Engineering
- Embarq
- Dale Resources
- El Paso Field Services
- Enbridge Pipeline (East Texas), LP
- Seminole Creek Pipeline, SEMPIPE, L.P.
- MAP Production Company, Inc.
- Gulf South Pipeline Company, LP

- Windsor Energy Group, LLC
- Hyperion Energy, LP
- Texas Eastman Division, Eastman Chemical Co.
- Cherokee Gathering Co., LLC
- Southwestern Energy Production Co.
- Valence Operating Company
- Forest Oil Corporation
- Enterprise Products Operator LP

5.5 LIST OF AGENCIES AND PARTIES TO WHOM COPIES OF THE NOTICE OF PUBLICATION OF THE DRAFT EIS WERE SENT

5.5.1 Newspapers

- The Nacogdoches Daily Sentinel
- The Cherokeean Herald
- The Lufkin Daily News
- The Jacksonville Daily Progress
- Tyler Morning Telegraph

5.5.2 Other Organizations

- Sierra Club
- The Nature Conservancy
- The Conservation Fund
- Texas Land Conservancy
- Friends of the Neches River

5.5.3 Industry/Business

- Temple Inland Building Products
- Tyler Pipe
- Afton Grove WSC
- North Cherokee WSC

5.5.4 Elected Officials

- County Judge, Angelina County
- County Judge, Cherokee County
- County Judge, Nacogdoches County
- County Judge, Rusk County
- County Judge, Smith County
- State Senator, District 1 Texas Senate
- State Senator, District 2 Texas Senate
- State Senator, District 3 Texas Senate

- State Representative, District 6 Texas House of Representatives
- State Representative, District 9 Texas House of Representatives
- State Representative, District 11 Texas House of Representatives
- State Representative, District 12 Texas House of Representatives
- Office of the Governor
- Office of the Lieutenant Governor
- Speaker of the House, Texas House of Representatives
- United States Senator John Cornyn
- United States Senator Kay Bailey Hutchison
- U.S. Representative, First District U.S. House of Representatives
- U.S. Representative, Fifth District U.S. House of Representatives

6.0 LIST OF PREPARERS

RESPONSIBILITY	NAME	DEGREES, EXPERIENCE
U.S. Army Corps of Engineers EIS Team		
EIS Project Manager	Brent J. Jasper	BS, Forestry 16 years experience
Chief, Regulatory Branch	Stephen L Brooks	BS, Civil Engineering ME, Civil Engineering 25 years experience
Chief, Permits Section	Jennifer R. Walker	BS, Environmental Science / Biology 23 years experience
Cultural Resources	Skipper Scott	BS, Anthropology 34 years experience
TRC EIS Team (Third-Party Consultant To USACE)		
EIS Project Manager Purpose & Need, Surface Water	James L. Machin, P.E. TRC	BSE, Engineering MBA, Business MS, Environmental/Water Resources Engineering 33 years experience
Principal	Robert J. Brandes, P.E. TRC	BS, Civil Engineering MS, Civil Engineering PhD, Water Resources Engineering 35 years experience
Geology, Soils, Landforms, Groundwater, Air Quality, Sound	Vicky L. Kennedy TRC	BS, Geology MS, Geology 21 years experience
Surface Water	Jane B. Atha TRC	BA, Geography MS, Geography/Fluvial Geomorphology 11 years experience
EIS Review	Larry W. Canter Environmental Impact Training	BE, Civil Engineering MS, Sanitary Engineering PhD, Environmental Health Engineering 35 years experience
Terrestrial Ecology	George L. Vaught Horizon	BA, Biology MS, Biology 36 years experience
Aquatic Ecology	James M. Wiersema Horizon	BS, Biology MS, Zoology 39 years experience
Wetlands, Hydrogeomorphic Model	C. Lee Sherrod Horizon	BS, Forestry MA, Botany 30 years experience
Cultural Resources	Jeffrey D. Owens Horizon	BA, Anthropology MA, Anthropology 18 years experience
Socioeconomics, Land Use, Environmental Justice	Clifford L. Fry RRC, Inc.	BA, Economics PhD, Economics 21 years experience
Socioeconomics, Land Use, Environmental Justice	Michael P. Lang RRC, Inc.	BS, Economics MS, Economics 5 years experience
Socioeconomics, Land Use, Environmental Justice	Blaine T. Buenger RRC, Inc.	BS, Economics 9 years experience
Quantitative Socioeconomics Impact Analysis	Chad R. Wade RRC, Inc.	BA, Economics PhD, Economics 2 years experience

7.0 REFERENCES

Anderson, David, Robert B. Ditton, and Chi-Ok Oh. 2002. Characteristics, Participation Patterns, Management Preferences, Expenditures, and Economic Impacts of Sam Rayburn Reservoir Anglers. Department of Wildlife and Fisheries Sciences, Texas A&M University, prepared for Inland Fisheries Division, Texas Parks and Wildlife, December 2002.

Andrews, Claude. 2009. East Texas Council of Governments, Director of Area Agency on Ageing. Personal communication with J. Machin, TRC. February 23, 2009

(ANRA) Angelina & Neches River Authority. 2007. Personal Communication between Kenneth Reneau (ANRA) and George Vaught (Horizon) pursuant to features of ANRA's Lake Columbia Shoreline Development Plan. October 31, 2007.

(ANRA) Angelina & Neches River Authority. 2007a. Letter from Kelly Holcomb, ANRA, to James Machin, TRC Brandes, February 16, 2007.

(ANRA) Angelina & Neches River Authority. 2008b. Water quality database received from Matt Romig, Clean Rivers Project Manager. September 2, 2008.

(ANRA) Angelina & Neches River Authority. 2009a. General Project Information for Lake Columbia. http://www.lakeeastex.org/Info. February 14, 2009.

(APAI) Alan Plummer & Associates, Inc. 2009. East Texas Regional Water Planning Group, 2007-2009 Regional Water Planning Study No. 3, Study of Municipal Water Uses to Improve Water Conservation Strategies and Projections. April 2009.

Bayer, C.W. 1996. Use Attainability Analysis for Ragsdale Creek, Keys Creek and Mud Creek, Cherokee County, Texas, Segment 0611 – Angelina River. Texas Natural Resource Conservation Commission.

Beranek, Leo. 1988. Noise and Vibration Control. Revised Edition. Institute of Noise Control Engineering. Washington, D.C.

Blair, W.F. 1950. The Biotic Provinces of Texas. Texas Journal of Science 2:93-117.

Boyd, J. Anthony. 2009. Vice President, Lockwood Andrews & Newnam, Inc. Personal communication with J. Machin, TRC. February 26, 2009.

Brancel, Celeste. 2006. Personal communication. Texas Parks and Wildlife Department, Austin. November 8, 2006.

Brinson, Mark M., Richard D. Rheinhardt, F. Richard Hauer, Lyndon C. Lee, Wade L. Nutter, Daniel Smith, Dennis Whigham. 1995. A Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands. Operational Draft, December 1995. Wetlands Research Program Technical Report WRP-DE-11. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

(BTA) Big Thicket Association. 2006. A Big Thicket Association Strategic Plan for the Stewardship of the Big Thicket National Preserve. Saratoga, Texas.

(BTA) Big Thicket Association. 2007a. Minutes of Board of Directors Meeting, Saratoga, TX. March 3, 2007.

(BTA) Big Thicket Association. 2007b. Letter to Brent Jasper, USACE, from Bruce Drury, BTA, July 11, 2007.

Bureau of Economic Geology. 1968. Geologic Atlas of Texas, Palestine Sheet. University of Texas at Austin. February 1968.

Canter, L.W. 1996. Environmental Impact Assessment, Second Edition. McGraw-Hill Book Company, Inc. New York, New York.

(CCAD) Cherokee County Appraisal District. 2006. 107 East Sixth Street, Rusk, Texas 75785, http://www.cherokeecad.com/.

Center for Plant Conservation. 2006. <http://www.centerforplantconservation.org/ASP/CPC_ViewProfile.asp?CPCNum=2258>. August 2006.

(CIP) County Information Project. 2006. Texas Association of Counties http://www.txcip.org/tac/census/CountyProfiles.php, accessed August 2006.

Council on Environmental Quality. 1978. National Environmental Policy Act – Regulations. Federal Register, Vol. 43, No. 230, November 29, 1978, pp. 55978-56007.

Council on Environmental Quality. 1997. Considering Cumulative Effects Under the National Environmental Policy Act. Executive Office of the President, Washington, D.C.

Department of Commerce. 1968. Climatic Atlas of the United States. Washington, DC.

Edgar, T.F., and J.T. Richardson. 1974. A Report to the Governor's Energy Advisory Council, Resources and Utilization of Texas Lignite. University of Texas and University of Houston. November 1974.

Elottage and Moulton. 1998. As cited in LAN, 1991b (Volume 2).

(EPA) U.S. Environmental Protection Agency. 1971. Noise from Construction Equipment and Operations, U.S. Building Equipment, and Home Appliances. Prepared by Bolt Beranek and Newman for USEPA Office of Noise Abatement and Control, Washington, DC.

(EPA) U.S. Environmental Protection Agency. 2003. Lake Eastex Needs Analysis and Alternatives Evaluation. Prepared by G.E.C., Inc. July 2003.

Falkenberg, Lisa. 2006a. East Texas Aims To Be A New Retirement Haven, Houston Chronicle, Nov. 11, 2006, www.MYSA.com.

Falkenberg, Lisa. 2006b. Ready to Retire? East Texas Wants You. at www.chron.com, Nov. 25, 2006.

Fitch Ratings. 2006. http://www.fitchibca.com/sectors/issuers_list_pub.cfm?mm_id=flag=&marketsector=3&body-content=issr_list&m_mode=&start_alpha=N. Accessed August 2006.

(FNI) Freese & Nichols, Inc. 2003a. Lake Eastex Planning Studies, Final Report, May 2003.

(FNI) Freese & Nichols, Inc. 2003b. Alternatives to Lake Eastex (LAN, 1991 & 1992). Sheet 11 of 14, USACE Project No. 198700524, August 12, 2003.

(FNI) Freese and Nichols, Inc. 2003c. Lake Eastex Area Land Use Trend Questionnaire. Project No. ANR01289.

(FNI) Freese & Nichols, Inc. 2005. Lake Columbia Downstream Impacts Analysis. September 2005.

(FNI) Freese and Nichols, Inc. 2005a. Letter from Tom Gooch, Freese & Nichols, Inc., to Barney Austin, TWDB, February 14, 2005.

(FNI) Freese & Nichols, Inc. 2006a. E-mail communication from Steve Watters (FNI) to George Vaught (Horizon). November 29, 2006.

(FNI) Freese & Nichols, Inc. 2006b. September 2006 cost estimates, provided in an email to Dr. Clifford Fry (RRC), from ANRA, November 7, 2006.

(FNI) Freese & Nichols, Inc., *et al*. 2006c. 2006 Region C Water Plan. January 2006.

(FNI) Freese & Nichols, Inc. 2007a. Subject: Estimated Cost of Raw Water, Lake Columbia, email from Steven P. Watters, FNI, to Clifford Fry, RRC, March 9, 2007.

(FNI) Freese & Nichols. 2007b. EPA Alternatives Analysis – Updated Review. Memorandum from Simone Kiel, P.E. of Freese & Nichols to ANRA, File, ANR00164, February 8, 2007.

(FNI) Freese and Nichols, Inc. 2009a. Lake Columbia Facts. February 13, 2009.

(FNI) Freese and Nichols, Inc. 2009b. Mitigation Plan for the Angelina and Neches River Authority's Lake Columbia Regional Water Supply Reservoir Project. December 3, 2009.

G.E.C., Inc. 2003. Lake Eastex Needs Analysis and Alternatives Evaluation. Prepared for the U.S. Environmental Protection Agency, July 2003.

Gould, F.W. 1975. Texas Plants: A Checklist and Ecological Summary. Texas A&M University, Texas Agricultural Experiment Station, College Station, Texas.

(HDR) HDR Engineering, Inc. 2007. Letter and modeling results from Ken Choffel, P.E. and Cory Shockley, P.E. to John Stover. July 9, 2007.

(HESI) Horizon Environmental Services, Inc. 1992. Cultural Resources of the Proposed Lake Gilmer Project, Upshur County, Texas. Austin, Texas.

(HESI) Horizon Environmental Services, Inc. 2008. Hydrogeomorphic Model Analysis of the Proposed Lake Columbia, Smith and Cherokee Counties, Texas. Austin, Texas.

(Hicks) Hicks and Company. 1994a. Guidance Plan for Wetland Delineation at the Proposed Lake Eastex, Cherokee and Smith Counties, Texas. Austin, Texas.

(Hicks) Hicks and Company. 1994b. Draft Report of Investigations Section, 404 Wetland Delineation of the Proposed Lake Eastex, Cherokee and Smith Counties, Texas. Austin, Texas.

Howells, R. G., R. W. Neck, and H. D. Murray. 1996. Freshwater Mussels of Texas. Texas Parks and Wildlife Press, Austin. 218 pp.

Hubbs, C. 1957. Distributional Patterns of Texas Freshwater Fishes. The Southwestern Naturalist 2 (2-3):89-104.

Hubbs, C., R. J. Edwards, and G. P. Garrett. 1991. An Annotated Checklist of the Freshwater Fishes of Texas, with Keys to Identification of Species. Texas Journal of Science. Volume 43 No. 4 supplement.

Ibbotson Associates. 2006. 2006 Yearbook: Market Results for 1926-2005, Stocks, Bonds, Bills, and Inflation. p. 31.

IMPLAN Pro. 2004. User's Guide, Analysis Guide, and Data Guide, Version 2.0. MIG, Inc. 2004.

Institute for Geophysics. 2009. Northeast Texas Earthquakes of Magnitude 3 or Greater. University of Texas Jackson School of Geosciences. http://www.ig.utexas.edu/research/projects/eq/compendium/DEM_Northeast.htm, accessed May 12, 2009.

Intera, Inc. 2004. Groundwater Availability Models for the Queen City and Sparta Aquifers. Prepared for Texas Water Development Board. October 2004.

Jackson, M.P.A. 1982. Fault Tectonics of the East Texas Basin. Geology Circular 82-4. Bureau of Economic Geology, University of Texas at Austin.

(JCB) Jacobs Carter Burgess. 2008. Storm Water Management Program. Prepared for City of Tyler. January 2008.

(JEDC) Jacksonville Economic Development Corporation. 2009. http://www.jacksonvilleedc.com/norman.htm. Accessed February 20, 2009.

Kaiser, W.R. 1974. Texas Lignite: Near-Surface and Deep-Basin Resources. Bureau of Economic Geology *Report of Investigations*, No. 79

Kaiser, W.R., Johnston, J.E., and Bach, W.N. 1978. Sand-Body Geometry and the Occurrence of Lignite in the Eocene of Texas. Bureau of Economic Geology *Geological Circular 78-4*.

Kenmotsu, N.A., and T.K. Perttula (eds.). 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Cultural Resource Management Report No. 3. Department of Antiquities Protection, Texas Historical Commission. Austin, Texas.

Kimbrough, Luke. 2009. East Texas Council of Governments, Director of Public Information and Regional Services. Personal communication with J. Machin, TRC. February 23, 2009

(LAN) Lockwood, Andrews & Newnam, et al. 1991a. Lake Eastex Regional Water Supply Planning Study Volume 1, Engineering and Financial Analysis. August 1991.

(LAN) Lockwood, Andrews & Newnam, et al. 1991b. Lake Eastex Regional Water Supply Planning Study Volume 2, Environmental Inventory and Issues. August 1991.

(LAN) Lockwood, Andrews & Newnam, et al. 1991c. Lake Eastex Regional Water Supply Planning Study Volume 2, Lake Specific Land Use. August 1991.

Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister and J. R. Stauffer, Jr. 1980. Atlas of North American Freshwater Fishes. North Carolina State Museum of Natural History.

Leontieff, Wassily W. 1976. Studies in the Structure of the American Economy: Theoretical and Empirical Explorations in Input-Output Analysis. M.E. Sharpe, 1976.

Leontieff, Wassily W. 1986. Input - Output Economics, Oxford University Press, April 1986.

Mandelker, D.R. 2007. NEPA Law and Litigation, Second Edition. Thompson/West Publishers, St. Paul, Minnesota, pp. 10-119 to 10-146. July 2007.

Merritt, R. W. and K. W. Cummins. 1996. An Introduction to the Aquatic Insects of North America. 3rd Edition. Kendall/Hunt Publishing Co., Dubuque, Iowa. 862 pp.

Morgan, Greg. 2009. City of Tyler Public Works Director. Personal communication with J. Machin, TRC. February 20, 2009.

National Parks Conservation Association. 2006. http://www.npca.org/wildlife_protection/wildlife_facts/redwolf.html. August 14, 2006.

Nelson, J.S., E.J. Crossman, H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R. N. Lea, and J.D. Williams. 2004. Common and Scientific Names of Fishes from the United States, Canada and Mexico. Sixth Edition. American Fisheries Society Special Publication 29. 386 pp.

(NETMWD) Northeast Texas Municipal Water District. 2005. Water Use Planning In Relation to Reservoirs in East Texas. Letter from Walt Sears Jr. to Bob Brandes. June 27, 2005.

Nilsson, C., and K. Berggren. 2000. Alterations of Riparian Ecosystems Caused by River Regulation. BioScience, Vol. 50(9):783-792.

Noise Unlimited, Inc. 1995. Boat Noise Tests Using Static and Full-Throttle Measurement Methods: a Report to the New Jersey Department of Law and Public Safety, Marine Law Enforcement Bureau. NUI Report No. 8077.1. Annadale, NJ.

(NRCS) Natural Resources Conservation Service. 2007. U.S. Department of Agriculture. Soil Survey Geographic (SSURGO) Database for Cherokee and Smith Counties, Texas. http://soildatamart.nrcs.usda.gov. Accessed 11/16/2007.

Omernik, J.M. and A.L. Gallant. 1987. Ecoregions of the south central states. EPA/600/D-87/315. U.S. Environmental Protection Agency, ERL, Corvallis, Oregon.

Owens, J.D. 2005. Scope of Work: Cultural Resource Inventory Survey, Lake Columbia Water Supply Project, Cherokee and Smith Counties, Texas. Horizon Environmental Services, Inc. Austin, Texas.

Owens, J.D., T. Myers, C.D. Frederick, R. Clark, A. Peyton, and A.E. Butman. 2006. Interim Report: Phase Ia Cultural Resource Inventory Survey, Lake Columbia Water Supply Project, Cherokee and Smith Counties, Texas. Horizon Environmental Services, Inc. Austin, Texas. November 2006.

Owens, J.D. 2007. Personal communication between J.D. Owens and G.L. Vaught about the occurrence of feral hogs within the Lake Columbia proposed permit area during field efforts related to the Preliminary Cultural Resources Survey. 24 October 2007.

(PEP) Population Estimates Program. 2005. Population Division, U.S. Bureau of the Census, obtained from http://www.census.gov/popest/counties/tables/CO-EST2005-01-48.xls., November 2005.

Perttula, T.K. (ed.). 2000. An Archeological Survey of the Proposed Lake Naconiche, Nacogdoches County, Texas. Report of Investigations No. 35. Archeological and Environmental Consultants. Austin, Texas.

Perttula, T.K. (ed.). 2002. Archeological Investigations at the Proposed Lake Naconiche, Nacogdoches County, Texas, Vols. I & II. Report of Investigations No. 42, Vols. I and II. Archeological and Environmental Consultants. Austin, Texas.

Phillips, J.D. 2001. Sedimentation in Bottomland Hardwoods Downstream of an East Texas Dam. Environmental Geology, Vol. 40:860-868.

Phillips, J.D. 2003. Interim Report--Year 1, Sediment Retention in Stream Corridors of the Lower Trinity River Basin, Texas. Southern Landscape Systems Research Program, Department of Geography, University of Kentucky. February 2003.

Phillips, Rusty. 2009. Deep East Texas Council of Governments, Regional Services Director. Personal communication with J. Machin, TRC. February 23, 2009.

Propst, D. B., D. J. Stynes, J. H. Lee, and R. S. Jackson. 1992a. Development of Spending Profiles for Recreation Visitors to Corps of Engineers Projects, Technical Report R-92-4, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS., NTIS No. AD A255206, obtained from http://el.erdc.usace.army.mil/publications.cfm?Topic=techreport&Code=nrrp, accessed December 7, 2006

Propst, D. B., D. J. Stynes, J. H. Lee, and R. S. Jackson. 1992b. Table E1, Appendix E. Summary Results for all Corps of Engineers Projects in the U.S. Army Corps of

Engineers report, Estimating the Local Economic Impacts of Recreation at Corps of Engineers Projects – 1996.

Radbruch-Hall, D.H., R.B. Colton, W.E. Davies, I. Lucchitta, B.A. Skipp, D.J. Varnes. 1982. Landslide Overview Map of the Conterminous United States. Geological Survey Professional Paper 1183, U.S. Geological Survey, Washington, DC.

Railroad Commission of Texas. 2009. Oil and Gas Well Records. http://rrc.state.tx.us/data/wells/wellrecords.php. Accessed April 28, 2009.

Reid, L. M. 1993. Research and Cumulative Watershed Effects. General Technical Report PSW-GTR-141. U.S. Forest Service, Pacific Southwest Research Station, Albany, CA. March 1993.

(RJBCO) R. J. Brandes Company. 2004. Groundwater-Surface Water Interaction, Queen City-Sparta Aquifer Groundwater Availability Study. June 2004.

Robinette, H.R., S. Cates, T. Boyd, R. Bibbs, and E. Berg. 1978. An Evaluation of Water Quality and Related Biological Parameters of Four Reservoirs and their Inflowing and Receiving Perennial Streams. Department of Wildlife and Fisheries, Mississippi Agricultural and Forestry Experiment Station and Mississippi State University. February 28, 1978.

Rumrill, J.N., and Canter, L.W. 1997. Addressing Future Actions in Cumulative Effects Assessment. Project Appraisal, Vol. 12, No. 4, pp. 1-12. December 1997.

Russell, J.E., E.R Hoskins, D. Becker, C. Forster, Y.J. Wang. 1985. Geotechnical Studies Related to In Situ Lignite Gasification Trials. Department of Energy Report No. DOE/PC/30221-2006. December 1985.

(SCWOSG) State Comptroller's Window on State Government. 2006. http://www.window.state.tx.us/taxinfo/sales/index.html, November 2005 and August 2006.

(USACE) U. S. Army Corps of Engineers Representative. 2009. Lake Sam Rayburn Project Office.

Skinner, S.A. 1981. Cultural Resources Survey of the Troup Mine, Cherokee, Smith, and Rusk Counties, Texas. Investigative Report No. 81-7, Cultural Resources Program. Environment Consultants. Dallas, Texas.

Smith, M. D. 2006. Cumulative Impact Assessment Under the National Environmental Policy Act: An Analysis of Recent Case Law. Environmental Practice, Vol. 8, No. 4., pp. 228-240. December 2006.

(SPI) Schaumberg & Polk, Inc. 2003a. FM 2064 and FM 2750 Traffic Impact Study.

(SPI) Schaumberg & Polk, Inc. 2003b. Lake Eastex Utility Conflict Study, February 2003.

(SPI) Schaumberg & Polk, Inc., et al. 2006. 2006 Water Plan East Texas Region (Region I Plan), January 2006.

Stover, John D. 2007. Zeleskey Cornelius Hallmark Roper Hicks, PLLC. Memorandum to Kenneth Reneau, ANRA, re EPA Needs Analysis and Alternatives Evaluation Report. Lufkin, TX. July 9, 2007.

Stover, John D. 2009. Zeleskey Cornelius Hallmark Roper Hicks, PLLC. Letter to J. Machin, TRC, re value of recent mitigation land transactions. Lufkin, TX. February 20, 2009.

Stynes, Daniel J., Wen-Huei Chang, and Dennis B. Probst. 2006. National Economic Impacts of CE Recreation Visitor Spending: An Update for 1996. obtained from http://www.msu.edu/course/prr/840/econimpact/pdf/usce96.pdf. November 2006.

(TAC) Texas Association of Counties. 2006. http://www.txcip.org/tac/census/CountyProfiles.php. Accessed August 2006.

(TAMU IRNS) Texas A&M University, Institute of Renewable Natural Resources. 2003. Land Information Systems, Texas Land Trends, Land Value and Usage Characteristics. 2003. http://landinfo.tamu.edu/. Accessed 11/16/07.

(TCEQ) Texas Commission on Environmental Quality. 1999. Receiving Water Assessment Procedures Manual. TNRCC 61-253. June 1999.

(TCEQ) Texas Commission on Environmental Quality. 2004. Revisions to the State Implementation Plan (SIP) for the Control Of Ozone Air Pollution, Northeast Texas Area Early Action Compact, Ozone State Implementation Plan Revision. Rule Log Number 2004-077-SIP-NR. Adopted November 17, 2004.

(TCEQ) Texas Commission on Environmental Quality. 2005. 2004 Texas 303(d) List. May 13, 2005.

(TCEQ) Texas Commission on Environmental Quality. 2006. Regulatory and Compliance System, Wastewater Permit Detail Listing. Accessed September 2006.

(TCEQ) Texas Commission on Environmental Quality. 2007. http://www.tceq.state.tx.us/remediation/superfund/state/polycycl-tecula.html. Accessed July 2, 2007.

(TCEQ) Texas Commission on Environmental Quality. 2008. National Ambient Air Quality Standards. 40 CFR Part 50. http://www.tceq.state.tx.us/compliance/monitoring/air/monops/naaqs.html. Accessed, August 4, 2008.

(TCPA) Texas Comptroller of Public Accounts, Austin, TX. 2005 & 2006. State Comptroller’s Window on State Government. Accessed from http://www.window.state.tx.us/taxinfo/sales/index.html, November 2005 and August 2006.

(TCPA) Texas Comptroller of Public Accounts, Austin, TX. 2006a. Accessed from http://ecpa.cpa.state.tx.us/allocation/HistSales.jsp;jsessionid=0000-IOZzEtuJwCrL_vyU5ZVXy7:-1, August 2006.

(TCPA) Texas Comptroller of Public Accounts, Austin, TX. 2006b. Accessed from http://ecpa.cpa.state.tx.us/allocation/AllocHist.jsp;jsessionid=00000xXLX7kcMVPtg5QuS440Cl-:-, August 2006.

(TCPA) Texas Comptroller of Public Accounts. 2006c. Accessed from http://www.window.state.tx.us/ecodata/popdata/cpacopop1990_2030.xls, February 2006.

(TDWR) Texas Department of Water Resources. 1985. Intensive Survey of Angelina River Segment 0611, September 10-13, 1984.

(TEA) Texas Education Agency. 2006. Accessed from http://www.tea.state.tx.us/cgi/sas/broker, August 2006.

(TEDC) Tyler Economic Development Council. 2009. http://www.tedc.org/index.php. Personal communication between Tom Mullins, President and J. Machin, TRC. February 20, 2009.

(TFS) Texas Forest Service. 1980-2007. Harvest Trends. Texas A&M University. Annual publications.

(TFS) Texas Forest Service. 2004. Texas Forestry Best Management Practices. August 2004.

(TFS) Texas Forest Service. 2008. Voluntary Implementation of Forestry Best Management Practices in East Texas – Results from Round 7 of BMP Implementation Monitoring. Lufkin, Texas. December 2008.

(TFS) Texas Forest Service. 2009. Best Management Practices – FAQs, http://texasforestservice.tamu.edu/main/popup.aspx?id=75. Accessed January 8, 2009.

Texas Almanac: Sesquicentennial Edition 1857-2007. 2006. The Dallas Morning News, distributed by Texas A&M University Press.

(TNRCC) Texas Natural Resource Conservation Commission. 1996. Use Attainability Analysis for Ragsdale Creek, Keys Creek and Mud Creek, Cherokee County, Texas, Segment 0611 – Angelina River. Bayer, C.W.

(TNRCC) Texas Natural Resource Conservation Commission. 1999. Receiving Water Assessment Data for Mud and West Mud Creeks Collected 6-30-99. Provided by Art Crowe, Texas Commission on Environmental Quality, November 9, 2006.

(TNRCC) Texas Natural Resource Conservation Commission. 2000. 30 TAC Chapter 307: Texas Surface Water Quality Standards.

(TNRCC) Texas Natural Resource Conservation Commission. 2002. Hazard Ranking System Documentation Record for Poly-Cycle Industries, Inc. – Tecula. August 2002.

(TPWD) Texas Parks and Wildlife Department. 1998. Evaluation of Selected Natural Resources in Angelina, Nacogdoches, Rusk, and Smith Counties, Texas, Albert El-Hage and Daniel W. Moulton). November 1998.

(TPWD) Texas Parks and Wildlife Department. 2006. <http://www.tpwd.state.tx.us/ landwater/land/habitats/pineywood/regulatory/pop_trends/cherokee_pop_trends.phtml>. August 9, 2006.

(TPWD) Texas Parks and Wildlife Department. 2006c. Annotated County Lists of Rare Species, Cherokee County. http://gis2.tpwd.state.tx.us/ReportServer$gis_epasde_sql?%2fReport+Project2%2fReport5&rs:Command=Render&county=Cherokee. Accessed July 7, 2008.

(TPWD) Texas Parks and Wildlife Department. 2006d. Texas Lake Finder. http://www.tpwd.state.tx.us/fishboat/fish/recreational/lakes/. Accessed: July 21, 2006.

(TPWD) Texas Parks and Wildlife Department. 2008a. Annotated County Lists of Rare Species, Smith County. http://gis2.tpwd.state.tx.us/ReportServer$gis_epasde_sql?%2fReport+Project2%2fReport5&rs:Command=Render&county=Smith. Accessed: July 7, 2008.

(TPWD) Texas Parks and Wildlife Department. 2009a. Personal communication between Jim Wiersema, Horizon and Earl Chilton, TPWD. June 24, 2009.

(TPWD) Texas Parks and Wildlife Department. 2009b. Invasive, Prohibited, and Exotic Species. <http://www.tpwd.state.tx.us/huntwild/wild/species/exotic/>. Accessed June 24, 2009.

(TRA) Trinity River Authority of Texas. 2005. Water Use Planning for Reservoir Development in East Texas. Jim R. Sims letter to Robert J. Brandes, June 30, 2005.

TRC Brandes. 2007a. Hydrology Figures: Flow Duration Curves Below Lake Columbia Dam, Flow Duration Curves at Highway 110, and Mud Creek Cross-Section Channel Width and Depth at Various Stream Flows. James L. Machin, P.E., TRC Brandes, Austin, Texas. March 30, 2007.

TRC Brandes. 2007b. Personal communication from James L. Machin, P.E., TRC Brandes, Austin, Texas. January 25, 2007.

(TRWD) Tarrant Regional Water District. 2006. Letter from Alan Thomas, TRWD, to Kenneth Reneau, ANRA, July 25, 2006.

(TWC) Texas Water Commission. 1988. As cited in LAN, 1991b (Volume 2).

(TWC) Texas Water Commission. 1989. As cited in LAN, 1991b (Volume 2).

(TWC) Texas Workforce Commission, Labor Market Information Division. 2006. Obtained from http://www.tracer2.com/cgi/dataanalysis/?PAGEID=94&SUBID=12, February 2006.

(TWDB) Texas Water Development Board. 2002. Water for Texas – 2002. Document No. GP-7-1. Austin, Texas. January 2002.

(TWDB) Texas Water Development Board. 2004. Groundwater Availability Models for the Queen City and Sparta Aquifers, October 2004.

(TWDB) Texas Water Development Board. 2007a. Water for Texas – 2007. Document No. GP-8-1. Austin, Texas. January 2007.

(TWDB) Texas Water Development Board. 2007b. 2006 Regional Water Plan Population Projections for 2000 – 2060.

http://www.twdb.state.tx.us/data/popwaterdemand/2003Projections/Population%20Projections/STATE_REGION/region_Pop.htm. Accessed May 2, 2007.

(TWDB) Texas Water Development Board. 2009. http://www.twdb.state.tx.us/mapping/. Accessed February 26, 2009.

(TxDOT) Texas Department of Transportation. 2005. Letter from Mary Owen, P.E. to Judge Chris Davis, Cherokee County and associated Minute Orders. August 17, 2005.

(USFS and EPA) U.S. Forest Service and U.S. Environmental Protection Agency. 2004. EPA Funds Available for Forestry Projects – State Foresters, Landowners, and Private Organizations are Eligible. FS-765. Washington, D.C. July, 2004.

(USACE) U.S. Army Corps of Engineers, Fort Worth District. 2002. Draft Environmental Impact Statement, Three Oaks Mine, August 2002.

(USACE) U.S. Army Corps of Engineers, Fort Worth District. 2003a. Joint Public Notice, Angelina & Neches River Authority, Permit Application 198700524. September 5, 2003.

(USACE) U.S. Army Corps of Engineers. 2003b. Environmental Quality–Policy for Implementation and Integrated Application of the U.S. Army Corps of Engineers (USACE) Environmental Operating Principles (EOP) and Doctrine. ER 200-1-5. Washington, DC. October 2003.

(USACE) 2009. U. S. Army Corps of Engineers Representative. Lake Sam Rayburn Project Office.

(USBR) U.S. Bureau of Reclamation. 2006. http://www.usbr.gov/pmts/estimate/cct04-07.pdf and http://www.usbr.gov/pmts/estimate/cct88-91.pdf, accessed December 11, 2006.

(USCB) U.S. Census Bureau. 2006. Accessed from http://www.census.gov/popest/archives/2000s/vintage_2001/CO-EST2001-12/CO-EST2001-12-48.html. February 2006.

(USCB) US Census Bureau. 2007. http://quickfacts.census.gov/qfd/states/48000.html. Accessed November 2007.

(USCB) US Census Bureau. 2009. http://quickfacts.census.gov/qfd/states/48000.html and accompanying county links. Accessed October 2009.

(USDA) U.S. Department of Agriculture, Soil Conservation Service. 1979. Water Quality Effects of Impoundments. STSC Technical Note 802. December 31, 1979.

(USDA) U.S. Department of Agriculture, Soil Conservation Service. 1980. Final Environmental Impact Statement, Attoyac Bayou Watershed, Nacogdoches, Rusk, Shelby, and San Augustine Counties, Texas. Temple, Texas. October 1980.

(USDA) U.S. Department of Agriculture, Natural Resources Conservation Service. 1996. Final Supplemental Environmental Impact Statement, Attoyac Bayou Watershed, Nacogdoches, Rusk, Shelby, and San Augustine Counties, Texas. Temple, Texas. May 1996.

(US DOC) U.S. Dept. of Commerce. 2006. Bureau Of Economic Analysis, Regional Economic Information System. Accessed from http://www.bea.gov/bea/regional/reis/drill.cfm. February 2006.

(US DOL) U.S. Dept. of Labor 2006. Bureau of Labor Statistics, Consumer Price Indexes Series: CUUR0000SA0; U.S. city average, all items. Available http://www.bls.gov/cpi/home.htm. Accessed February 2006.

(USDA) U.S. Department of Agriculture, Soil Conservation Service. 1959. Soil Survey, Cherokee County, Texas. March 1959.

(USFWS) U.S. Fish & Wildlife Service. 1985. Department of the Interior Final Concept Plan; Texas Bottomland Hardwood Preservation Program, Albuquerque, NM, May 1985.

(USFWS) U.S. Fish and Wildlife Service. 1988. National List of Plant Species that Occur in Wetlands: 1988, Texas. National Wetlands Inventory. U.S. Fish and Wildlife Service. St. Petersburg, FL.

(USFWS) U.S. Fish and Wildlife Service. 2006. Red-Cockaded Woodpecker. http://www.fws.gov/rcwrecovery/rcw.htm. Accessed August 14, 2006.

(USFWS) U.S. Fish and Wildlife Service. 2008. Endangered Species List: List of Species by County for Texas, Smith and Cherokee Counties. http://www.fws.gov/southwest/es/EndangeredSpecies/lists/ListSpecies.cfm. Accessed July 2008.